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ARTICLE I
GENERAL CONDITIONS

Section 1. City of Nixa Extension Policies.

A. REQUEST FOR CITY UTILITIES INSIDE THE CITY OF NIXA PLANNING AREA.

1. All properties within the designated planning area must be annexed into the City Limits of Nixa to access any City utility.

2. All properties within the designated planning area will be considered for annexation upon request if state statute requirements are fulfilled.

3. All existing structures annexed into the city limits of Nixa will be required to pay the fees for wastewater as per voter approved guidelines.

4. It will be the responsibility of the annexation petitioner to determine zoning requirements and fee structures.

5. The petitioner must be the legal representative for the property owner and the petitioner may withdraw the annexation by a written and notarized request up to the time of the passage of the annexation ordinance.

6. All building and development plans under consideration at the time of annexation must be submitted for City staff review. Staff will review the request within a 30-day time frame.

7. Any building and development that is underway at the time of annexation shall conform to all current City Codes.

8. The City may reimburse the developer for ~~any~~ requested increase in lift station or line capacity that is over the size required by the State Department of Natural Resources. Lift station capacity and line sizing shall be approved by the City and its consulting engineer. Provided reimbursement is considered, the amount will be determined by computing the difference between the bids for the required versus requested improvements. The City reserves the right to reject any or all bids.

9. All street, stormwater, electric, water and wastewater extensions, whether internal or external to development shall be the sole expense of the party requesting the street and/or utility unless otherwise approved by the Board of Aldermen.

10. Off-street improvements may be required by the City. City staff will review traffic and road conditions, change in classification and potential traffic hazards. Off-street road improvements and upgrades will meet City Street Specifications and will be the responsibility of the developer. When necessary, City may require the developer to supply a professional traffic study to determine offsite needs.

11. The City encourages the formation of neighborhood improvement districts to pay for infrastructure improvements within the planning area.

B. REQUEST FOR CITY UTILITIES OUTSIDE THE CITY OF NIXA PLANNING AREA

1. All developments must be built to City of Nixa Development Standards.

2. All developments must contractually agree to pay the fees for wastewater capacity as per voter approved guidelines.

3. All developments must be approved by the Department of Natural Resources before construction begins.

4. Request for utilities from outside of the Nixa Planning Area will be considered for residential purposes only. Outside utilities will only be given in instances when annexation is not possible. Prior to connection, the applicant must sign a "Consent to Annex" form, to be executed when State Statute requirements can be met.

5. All street, stormwater, electric, water and wastewater extensions shall be the sole expense of the party requesting the street and/or utility unless otherwise approved by the Board of Aldermen.

6. Off-street improvements may be required by the City. City staff will review traffic and road conditions, change in classification and potential traffic hazards. Off-street road improvements and upgrades will meet City Street Specifications and will be the responsibility of the developer. When necessary, City may require the developer to supply a professional traffic study to determine offsite needs.

7. All developments must have approval from the Christian County Planning and Zoning Authority before construction begins.

8. All requests require thirty (30) day staff review before permits are granted or hearing scheduled.

Section 2. City of Nixa Construction Discussion Items.

This list is presented as a typical construction check list, but may not include specific items pertaining to a particular project.

If in doubt concerning any of the City requirements or Ordinances, contact the appropriate City Department. Failure to comply with any discussion item may be cause for a stop work order, exposure of completed work or lack of willingness of the City's part to accept part or all of the work.

A. GENERAL:

1. Prior to approval of the Preliminary Plat, it will be the individual developer's responsibility to acquire all required off-site water, sewer, drainage, street and electric easements required by the City to serve the proposed development.

2. The City of Nixa requires that prior to beginning construction; the Owner will be responsible for convening a pre-construction conference to be held at City Hall between the Consulting Engineer(s), the Owner, the Contractor, City of Nixa personnel and all private utility providers.

3. All construction and materials shall conform to the City of Nixa General Development Regulations and Technical Specifications as adopted and revised from time to time by the City of Nixa.

4. It shall be the sole responsibility of the contractor to contact the utility suppliers and arrange for any necessary modifications required to facilitate construction activities.

5. It shall be contractor's responsibility to keep rock, mud and other debris from adjacent streets by construction equipment throughout the day and at the end of each work day. Contractors shall provide a construction traffic plan for approval at the pre-construction conference and be responsible to notify all related contractor agencies.

6. All buried pipe shall comply to the City of Nixa's bedding requirements. (See Detail Drawing B-1 and B-4 in the attached Appendix)

7. No pipe shall be backfilled until it has been approved by the City's Superintendent or City Inspector. It shall be the responsibility of the contractor to contact City Public Works at (417) 727-2353 and arrange for this inspection.

8. All City inspections shall be made during regular City business hours unless prior arrangements for inspections have been made. All costs (including overtime) associated with inspections outside normal hours will be charged to the contractor.

9. Testing of water and wastewater lines shall meet the City of Nixa specifications. It shall be the Contractor or Developer's responsibility to notify both the **Engineer and the City of Nixa**, a minimum of 24 hours prior to the scheduled testing. It shall also be the Contractor's responsibility to have all necessary equipment needed to perform the testing on site and ready to proceed with testing at the scheduled time. Failure to make these arrangements may necessitate rescheduling the test.

10. All utility road crossings shall be properly bedded and the trench backfilled with ¾" base rock. Base Rock shall be installed in lifts no more than 6" thick and each lift shall be compacted individually to grade.

11. The City of Nixa will issue building permits only after all utilities, with the exception of street asphalting, are in place and all grading work has been completed.

12. Upon completion of the project, the Developer/Contractor will be responsible for furnishing a copy of redlined as-built drawings to the City. The as-built drawings shall indicate any deviations from the original City-approved drawings shall indicate dimensions from lot lines to sewer tees and shall locate water, sewer and buried electric by dimensions from the street right-of-way line. As-built drawings shall be submitted to the City prior to the issuance of building permits.

13. Prior to any changes to City approved specifications or approved construction plans, contractors shall be responsible for completing a Request for Plan Revision (Form found on Page 9 of this document.) all appropriate signatures will be required and copies distributed to all parties.

B. WATER:

1. Testing of waterlines shall meet the City of Nixa specifications. It shall be the

Contractor or Developer's responsibility to notify both the **Engineer** and **the City of Nixa** at least **24 hours** prior to the scheduled testing. It shall also be the Contractor's responsibility to have all necessary equipment to perform the testing on site and to be ready to proceed with testing at the scheduled time. A failure to do so could lead to rescheduling the testing.

2. All buried pipe shall comply to the City of Nixa bedding requirements. (See Detail Drawing B-1 and B-4 in the attached Appendix)

3. No cutting of concrete or asphalt surfaces shall be allowed unless prior City approval is obtained in writing. Crossing permits may be obtained from the Street Superintendent, 725-2353.

4. All utility road crossings shall be properly bedded and the trench backfilled with ¾" base rock. Base Rock shall be installed in lifts no more than 6" thick and each lift shall be compacted individually to grade.

5. Upon completion of waterline construction, no existing water valves shall be operated unless City Personnel are notified and are present. Contractor shall notify City personnel prior to making connection to the City's water distribution system.

6. A metal fence post shall be placed by all meter pits to prevent damage to the meter after installed;. (See Detail Drawing A-1 in the attached Appendix)

7. Water Meter Box Lids shall be equivalent to a Crouch 104 lid, which is a 2-piece lid.

8. Damage to all individual lot utilities shall be the responsibility of the person named on the building permit.

9. Subdivisions that opt to construct underground electric shall install the water line at 4-foot and the gas line at 7-foot behind the curb on the same side of the street, underground electric shall be installed at 4-foot and the sewer line at 7-foot distance behind the curb on the opposite side of the street. The water meters shall be on every other lot line and the electric meters are to be placed on alternate lots. (See Detail Drawing A-1 in the attached Appendix)

10. An insulated copper tracer wire shall be placed on top of all water mains and at all meter boxes and valves. Tracer wires within meter boxes and valves shall be extended to the top of the box plus 12-inches and back to the main in a continuous run. Any necessary stripping or splicing of the tracer wire shall

be repaired by placing electrical tape over the un-installed area. (See Detail Drawing B-3 in the attached Appendix)

11. All water mains shall be Class 200 SDR 21 pipe.

12. The water meter lids and valve boxes shall be set at final grade elevation by the contractor. Should final grade elevation change due to yard work, the builder responsible for the yard work shall reset meter lids and valve boxes to the revised grade. The cost incurred for raising meter setters shall be the responsibility of the builder.

13. These requirements are not intended to include all waterline construction information. The Developer/Contractor shall refer to the Water Specifications in the City of Nixa Technical Specifications Book for additional information.

14. All water main construction shall comply with Missouri Department of Natural Resources "Design Guide for Community Public Water Supplies", and the City of Nixa Technical Specifications.

15. The Developer shall be solely responsible for making connection to the City's existing water main and shall meet all construction specifications and guidelines set forth in this document.

16. Typical Water Service: (See Detail Drawing B-9 in the attached Appendix.)

C. WATER CROSSINGS:

All water services shall be Type K Copper tubing.

D. SEWER:

1. All new sewer construction shall be completed and accepted by the City before final tie in to the City system. This may be completed by keeping the two systems physically separated or by plugging the new system at the City connection point until approval has been completed.

2. All testing of sewer lines shall meet the City of Nixa specifications. It shall be the Contractor's/Developer's responsibility to notify both the Engineer and the City of Nixa, a minimum of 24 hours prior to the scheduled testing. It shall also be the Contractor's responsibility to have all necessary equipment needed to perform the testing on site and ready to proceed with testing at the

scheduled time. Failure to make these arrangements may necessitate rescheduling the test.

3. All buried pipe shall comply with the City of Nixa bedding requirements. (See Detail Drawing B-1 and B-4 in the attached Appendix)

4. No cutting of concrete or asphalt surfaces shall be allowed unless City approval is obtained in writing. Crossing or street cut permits may be obtained from the Street Superintendent, 725-2353.

5. All utility road crossings shall be properly bedded and the trench backfilled with ¾" base rock. Base Rock shall be installed in lifts no more than 6" thick and each lift shall be compacted individually to grade.

6. It shall be the responsibility of the Developer/Contractor to insure that all manholes on the street shoulders are at curb level at final grade.

7. All manholes placed within the street shall be flush with the final pavement and meet specification details in Drawing.

8. The City Inspector shall be contacted for inspection of any lateral crossings prior to backfilling.

9. Subdivisions that opt to construct underground electric shall install the water line at 4-foot and the gas line at 7- foot distance from the curb on the same side of street; underground electric shall be installed 4-foot and the sewer line at 7-foot behind the curb on the opposite side of the street. The water meters shall be on every other lot line and the electric meters are to be placed on alternate lots. (See Detail Drawing A-1 in the attached Appendix)

10. All sewer main lines shall be 8" or larger SCH 40 when the depth of sewer is less than 10 feet. Sewer mains greater than 10 feet in depth shall be SDR 21.

11. At the location of the sewer tees there shall be an "S" painted on the curb. A PVC pipe stake shall be set vertically to indicate the sewer tee location.

12. These requirements are not intended to include all sewer line construction

information. The Developer/Contractor shall refer to the Sewer Specification in the City of Nixa Technical Specifications Book for additional information.

E. STREETS:

1. All proposed street construction shall be placed on a suitable subgrade. Where over excavation is required, suitable, consistent material shall be placed to bring the excavation to subgrade elevations. (See Detail Drawing D-1 in the attached Appendix).

2. The City Inspector shall inspect the street sub-grade prior to base rock placement and after base rock placement. It shall be the responsibility of the Developer/Contractor to contact the City to arrange for these inspections.

3. At all locations where street construction terminates at a phase line, with construction to be continued in the future, a pavement construction joint shall be constructed by means of placing a 2"x4" board laterally across the roadway and paving flush with the board. The board shall remain in place.

4. Concrete lined ditches or suitable storm sewers shall be required at all locations where stormwater is conveyed from the streets or along back lot lines.

5. These requirements are not intended to include all street construction information. The Developer/Contractor shall refer to the Street Specifications in the City of Nixa Technical Specifications Book for additional information.

F. UNDERGROUND ELECTRIC AND STREET LIGHTS:

1. Street lights are to be placed every 200 feet on straight runs. At cul-de-sacs, lights shall be placed at the end of the cul-de-sac and spaced as indicated on straight runs.

2. Easements shall be provided for constructing buried and overhead electric lines to poles.

3. Subdivisions that opt to construct underground electric shall install the water line at 4-foot and the gas at 7-foot distance behind curb on the same side of street. Underground electric shall be installed 4-foot and the sewer line at 7-foot distance behind the curb on the opposite side. The water meters shall be on every other lot line and the electric meters are to be placed on alternate

lots. (See Detail Drawing A-1 in the attached Appendix)

4. The City does not stock maintenance or repair parts for street lighting other than standard lights included in this document. The developer shall contact the City Electric Superintendent to obtain pricing information for optional types of street lights if desired. Optional street lighting may require special agreement assuring future parts and materials necessary for maintenance as well as cost for same.

G. DRAINAGE/DETENTION:

1. All stormwater drainage shall be conveyed through concrete lined ditches or installed in pipe unless a grass lined ditch is allowed by the City of Nixa Development Department and a written approval is obtained.

2. The Contractor shall place sod on the entire floor of the ditch and shall be responsible for maintaining all sod through the first growing season after placement.

3. Contractor shall spray hydro mulch on interior and exterior sides and floors of all detention basins in areas where a 4 foot concrete trickle channel is constructed within the basin. Seeding and strawing shall be allowed within those basins where an 8 foot concrete low flow channel is constructed. (See Detail Drawing G-1 in the attached Appendix) The contractor/Developer shall be responsible for proper cover through the first full growing season.

4. Contractor shall provide erosion control by placing silt curtains at strategic locations within the project. Silt curtains shall consist of straw bales tied together and secured to any applicable drainage ways. (See Detail Drawing G-17 in the attached Appendix)

5. The Developer shall be responsible for maintenance of all required detention basins for a period of one year after City's acceptance of the work.

6. Building permits will normally be issued upon completion of all drainage and detention improvements. Permits may be issued on a case by case basis for those subdivisions with approved drainage plans and a letter of credit from the Developer's financial institution.

Section 3. Service Ownership/Responsibility.

Generally, after acceptance, all production, main distribution, service lines and other facilities such as transformers and meters are the responsibility of the City of Nixa. Customer's service lines include all piping and facilities from the outlet side of all meters is the responsibility of the customer. All customer lines shall be installed, maintained and repaired to meet currently adopted codes and ordinances of the City of Nixa. Transfer of commodity such as electricity and water also transfers ownership on the outlet side of the meter.

Customer's lines on the wastewater collection system include all building piping and yard piping from the structure to the City's main including the main tap or "Y" regardless of location. All customer lines shall be installed, maintained and repaired to meet currently adopted codes and ordinances of the City of Nixa.

Sections 4 thru 19 Reserved

ARTICLE II WATER AND SEWER SPECIFICATIONS

Section 20. Excavation and Trenching.

A. SCOPE: This section covers excavation and trenching work and shall include the necessary clearing, grubbing, and preparation of the site: removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

B. GENERAL REQUIREMENTS**:** Excavation work shall be performed in a safe and proper manner with appropriate precautions taken against all hazards. Excavations shall provide adequate work space and clearances for the work to be performed therein and for the installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Subgrade surfaces shall be clean and free of any loose material when concrete is placed thereon.

Excavations for manholes and similar structures constructed of masonry units shall have horizontal dimensions with at least a 6-inch clearance provided for outside plastering.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the City or City's 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.

C. BLASTING: The Contractor shall comply with all laws, ordinances, applicable safety codes, requirements, and regulations relative to the handling, storage, and use of explosives and the protection of life and property. The Contractor shall be responsible for all damage caused by any blasting operations. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.

The Contractor shall avoid excessive overbreak or damage to adjacent structures, equipment, utilities or buried pipeline. Blasting near utilities shall be subject to approval of the utility owner or City.

Before delivery of any explosives at the job site, the Contractor shall have blasting endorsement on his public liability and property damage insurance policy.

All rock which cannot be handled and compacted, as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed.

D. UNAUTHORIZED EXCAVATION**:** Except where otherwise authorized, shown, or specified, all material excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by and at the expense of the Contractor, with concrete placed at the same time and monolithic with the concrete above.

E. DEWATERING: 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 structure 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 concrete structures or trenches, which extend down to or below groundwater, shall be dewatered by lowering and keeping the ground water level beneath such excavations, 12 inches or more 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 is used for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

F. 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, for protection of workmen, work, 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.

Trench sheeting shall not be pulled before backfilling unless pipe strength is sufficient, in the opinion of the City or City's Engineer, to carry trench loads based on trench width to the back of sheeting; nor shall sheeting be pulled after backfilling.

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.

G. STABILIZATION: Subgrades for concrete structures 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.

Subgrades for concrete structures 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 rock or gravel. No more than 1/2 inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding materials are placed thereon. The finished elevation of stabilized subgrades for concrete structures shall not be above subgrade elevations shown on the drawings.

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

H. TRENCH EXCAVATION: The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (whichever is the shorter) shall be the maximum length of open trench on any line under construction.

Except where tunneling is shown on the drawings, is specified, or is permitted by the Engineer, all trench excavation shall be open cut from the surface.

1. Alignment, Grade, and Minimum Cover: The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of Section 25-21 Installation of Mains.

   Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of 42-inch backfill cover over the top of the pipe. Greater pipe cover depths may be necessary on vertical curves or to provide necessary clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation.

2. Limiting Trench Widths: Trenches shall be excavated to a width, which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. Unless otherwise shown on the drawings, the maximum trench widths, below an elevation of 6 inches above the top of the installed pipe, shall be no more than 24 inches greater than the outside diameter of the pipe. The minimum permissible clearances between the installed pipe and either trench wall shall be 6 inches.

   Stipulated minimum clearances are not minimum average clearances, but are minimum clear distances that will be required.

   Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes, not to extend lower than one foot above the top of the pipe.

3. Unauthorized Trench Widths: Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted, either pipe of adequate strength, 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.

4. Mechanical Excavation: The use of mechanical equipment will not be permitted in locations where its operation 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 sidewalks are obtained at least from an elevation one foot (1') 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 sidewalks of the trench. Undercutting the trench sidewalk to obtain clearance will not be permitted.

5. Cutting Concrete and Asphalt Surface Construction: No cutting of concrete/asphalt surfaces shall be allowed unless City approval is obtained in writing. Cuts in concrete or asphalt pavement and base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1 1/2 inch deep along each side of the trench and along the perimeter of cuts for structures.

   Concrete and asphalt pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than the top width; no undercutting will be permitted.

   Pavement cuts shall be made to and between straight or accurately marked curved lines, which unless required, shall be parallel to the centerline of the trench. Pavement removed for connection to existing lines or structures shall not be of greater extent than necessary for the installation as determined by the City or City's Engineer.

   Where the trench parallels the length of concrete walks and trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and replaced between existing joints or between saw cuts.

6. Excavation Below Pipe Subgrades: Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, to provide for the installation of either 3/4 inch crushed limestone embedment pipe foundation material or sand if in accordance with the material manufactures design specifications. (#1578 4/09)

7. Artificial Foundations in Trenches: Whenever so ordered by the City or City's

Engineer, the Contractor shall excavate to such depth below grade as directed and the trench bottom shall be brought to grade with such material as the City or City's Engineer may order installed.

8. Bell Holes: 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 embedment when the pipe is jointed.

Section 21. Installation of Mains.

A. STANDARDS: Specifications shall incorporate the provisions of the AWWA standards and/or manufacturer's recommendations and Missouri Department of Natural Resources "Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013.

B. BEDDING, EMBEDMENT AND BACKFILL: Bedding is the portion of the trench beneath the pipe and supporting the pipe to its spring line. Embedment is the material placed around the pipe to at least six inches above the top of the pipe. Backfill is the material placed into the trench above the embedment. Water main installation design shall meet the following requirements.

a. Trench construction, bedding, and embedment shall be appropriate for the type and size of the pipe installed.
b. Continuous, firm, stable, and uniform bedding shall be provided in the trench for all buried pipe. The bedding design shall insure that there is full support in the haunches of the pipe and be smooth and free of ridges, hollows, and lumps.
c. Bell holes should be excavated so that only the barrel of the pipe receives bearing from the trench bottom.
d. The weight of metallic fittings shall not be supported by the pipe. Metallic fittings shall be provided with proper support, such as crushed stone, concrete pads or a well compacted trench bottom.
e. Rocks and hard objects larger than one inch diameter found in the trench shall be removed at least four inches below and on each side of the pipe and the trench bottom should be filled with 4 to 6 inches of tamped bedding material.
f. When an unstable sub-grade condition which will provide inadequate pipe support is encountered, an alternative foundation shall be provided such as over digging and backfilling with tamped granular material.
g. The trench shall be kept free from water during pipe installation until the pipe has been installed, embedded and backfilled.
h. If the trench passes over another pipe or previous excavation, the trench bottom shall be filled with granular material and compacted.
i. Blocks shall not be used to change pipe grade or to intermittently support pipe across excavated sections.
j. All bedding and embedment material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones.

k. Embedment material should be tamped in layers around the pipe, and to a sufficient height above the pipe that the pipe is adequately supported, stabilized, and protected. Shaped beddings perform essentially as well as full-contact embedment with select granular soil and are considered equal to full contact bedding.
l. Bedding normally consists of free flowing material such as gravel, sand, silty sand, or clayey sand. If this material is not used, a chipper should be used on the trencher to prepare the soil removed from the trench as embedment and backfill.
m. Embedment material diameter for plastic pipe shall be no greater than ½ inch for 4-inch diameter pipe, ¾ inch for 6 and 8-inch diameter pipes, and 1-inch for pipe diameters from 10 inches and greater.
n. Sand or other non-acidic granular material shall be used for pipe bedding, embedment and backfill in high traffic areas and under paved roads.
o. Backfill may consist of the excavated material, provided it is free from unsuitable matter such as large lumps of clay, frozen soil, organic material, boulders, or stones larger than 8 inches, or construction debris.
p. Width of trenches shall be at least four inches larger than the pipe's diameter. The minimum clear width of a trench should be the pipe outside diameter plus twelve inches to be wide enough to accommodate the compaction equipment.

C. BEDDING: A continuous and uniform bedding shall be provided in the trench for all buried pipe; Backfill material shall be tamped in layers around the pipe, and to a sufficient height above the pipe that the pipe is adequately supported, stabilized and protected. Rocks and hard objects larger than one inch diameter found in the trench shall be removed for a depth of at least six inches below the bottom of the pipe.

D. MATERIAL: Material for bedding shall be 3/4 inch clean crushed limestone or sand in accordance with the material manufactures design specifications. (#1578 4/09)

E. TRENCH BACKFILL: All trench backfill above pipe bedding shall conform to the following requirements.

1. Compacted Crushed Stone Backfill: Compacted backfill above the bedding shall consist of 3/4 inches clean crushed limestone and will be required for the full depth in the following locations:

    a. Beneath pavements, surfacing, driveways, curbs, gutters, walks, or other surface construction or structures.

    b. In the street, road, or on highway shoulders or any paved roadways.

2. Other Backfill: A continuous and uniform material shall be provided in the trench for all buried pipe above the bedding and shall be free of brush, roots more than 2 inches in diameter, debris, and refuse, but may contain rubble and detritus from rock excavations and stones smaller than 2"; Compaction of trench backfill above pipe bedding in locations other than those specified will not be required except to the

extent necessary to prevent future settlement.

Uncompacted backfill material above bedding may be placed by any method, acceptable to the City or City's Engineer, which will not impose excessive concentrated or unbalanced loads, shock, or impact on, and which will not result in displacement of installed pipe.

F. LABORATORY TESTS: All laboratory tests to determine compliance of embedment and backfill materials with specified treatments and to determine compliance with specified compaction requirements will be paid for directly by the Contractor.

G. DRAINAGE MAINTENANCE**:** Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of 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 or water courses shall be restored. Surface drainage shall not be obstructed longer than necessary.

H. PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSE: Where trenches are constructed in ditches or other water courses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1 percent, ditch checks shall be installed. Unless otherwise shown on the drawings or directed by the Engineer, ditch checks shall be concrete. Ditch checks shall extend no 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 12 inches thick.

I. DISPOSAL OF EXCESS EXCAVATED MATERIALS: Except as otherwise permitted, all excess excavated materials shall be disposed of away from the site of the work.

Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be and actually installed in trench backfill, refuse, 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 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, grading, and surfacing shall be a subsidiary obligation of the Contractor.

J. SETTLEMENT: The Contractor shall be responsible for all settlement of backfill, fills, and embankments that may occur within one year after final completion of the contract under which the work was performed.

The Contractor shall make or cause to be made all repairs or replacements made necessary by settlement within 30 days after notice from the City or City's Engineer.

K. SEEDING AND SODDING: The work shall consist of furnishing all labor, equipment, and materials necessary for the preparation, fertilization, seeding, and mulching of the areas specified. All disturbed areas shall be seeded and mulched except for sodded areas, surfaced areas, and solid rock. Disturbed areas outside of authorized construction limits shall be seeded and mulched, or sodded at the contractor's expense.

1. Topsoil: Topsoil shall consist of a fertile, friable soil of loamy character, free of sub-soil, stumps, stones, refuse, and other foreign material. It shall contain a normal amount of natural humus and be reasonably free of roots, hard dirt, heavy or stiff clay, coarse sand, noxious weeds, noxious weed seeds, sticks, brush, and other litter. The topsoil shall be obtained from well-drained, arable land and be of even texture so that all the soil will pass a one-half (1/2) inch screen. The topsoil shall not be infested with nematodes or with any other noxious animal life or toxic substances. Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, will not be accepted.

2. Seed: Provide grass seed for established areas in a blend as specified below, unless directed otherwise by the landowner or City.

    a. 75% by weight of a three-way blend (equal parts) of turf fescues, consisting of any three of the following varieties: Olympic, Falcon, Bonanza, Rebel, Hound Dog, Astro 2000, Eldorado, Wrangle, FineLawn One, Anthem, or Apache.

    b. 15% by weight of Perennial Rye, consisting of one or more of the following varieties: Affinity, Derby, Regal, Manhattan, or Chateau.

    c. 10% by weight of Bluegrass, consisting of either Kentucky Bluegrass, Park Bluegrass, or both.

    d. Purity of seed shall be 98%.

    e. Germination shall be 85%.

3. Fertilizer: Provide a mixture containing 13 pounds each of soluble nitrogen, phosphate, and potash per 100 pounds.

4. Mulch for Hydraulically Seeded Areas: Provide a mixture of 50% recycled slick paper mulch and 50% ground corrugated paper mulch by weight. The recycled slick paper mulch shall be produced from printer's slick paper containing wood cellulose and kaolin clay. Newsprint is not allowed. The \slick paper mulch shall have a maximum moisture content of 8% by weight, and shall have a pH of 4.5 to 6.5. The corrugated paper mulch shall have a moisture capacity of 700 grams water per 100 grams dry mulch minimum, a dry moisture content of 12% maximum, and a pH of 5.0 to 8.0. All mulch materials must be free of any germination or growth-inhibiting substances, green in color, and have the property of being evenly dispersed and suspended when agitated in water.

Clean wheat straw shall be material applied over the hydraulic mulch.

5. Seed for Pasture and Cropland Areas: Match as nearly as possible the species in existence prior to disturbance. Alfalfa or other exotic grasses will not be replaced but will be compensated if the land is privately owned.

6. Replacement of Plants, Trees, Shrubs, Sod: Plants, trees, shrubs and sod shall be replaced with the same strain as removed and approximately the same size and dimensions as those removed including trees up to 4 inches in diameter.

7. Sod: Machine cut, strongly rooted, certified turf-grass sod, at least 2 years old, and be relatively free of weeds or other undesirable native grasses. Provide sod capable of vigorous growth and development when planted (viable, not dormant). Composed primarily of Kentucky bluegrass. Moisten sod to depth at which it is to be cut when stripped during dry periods. Provide sod in uniform thickness of 5/8-inch, plus or minus ¼-inch, measured at time of cutting and excluding top growth and thatch. Strips shall be of supplier's standard size of uniform length and width with maximum 5% allowable deviation in either length or width. Broken or torn pads, or pads with uneven ends are not acceptable. Sod pads shall be capable of supporting their own weight and retaining size and shape when pad is suspended vertically from a firm grasp on upper 10% of pad. Handle sod with care to prevent loss of native soil from roots.

8. Liming Material: Shall consist of agricultural liming materials conforming to the Missouri Agricultural Liming Materials Act of 1976.

L. STRUCTURE BACKFILL: Backfill around structures shall be compacted, to the extent necessary to prevent future settlement, by tamping or other means acceptable to the City or City's Engineer. Water settlement will be permitted only where no damage would be caused to the work.

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.

M. CLASSIFICATION OF EXCAVATED MATERIALS: No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.

Section 22. PVC Water Piping.

This section covers Polyvinyl Chloride Piping (PVC). PVC pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking encasement, and other necessary appurtenances. Waterline construction shall be in accordance with the "Missouri Department of Natural Resources Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013.

A. STANDARDS OF MATERIALS SELECTION: Unless otherwise required by the drawings or specified herein, all fittings shall be D.I.P. mechanical joint.

Pipes shall conform to the latest edition of the AWWA, ASTM, Plastic Pipe Institute (PPI), or UniBell Plastic Pipe Association standards or recommendations. Fittings, valves and fire hydrants shall conform to the latest standards issues by the AWWA and, where applicable, shall be certified by NSF or Underwriters Laboratories for use in drinking water. Special attention shall be given to selecting pipe materials that will protect against both internal and external pipe corrosion. PVC pipes must be at least Class 200 and conform to SDR-21. Pipes, fittings and appurtenances containing more than 0.25 percent lead calculated by weighted average shall not be used. Fittings shall have at least the same pressure rating as the pipe.

High Density Polyethylene (HDPE) Pipe

Anchored or end restrained pipe such as connections between HDPE pipe and other types of pipe will develop longitudinal stresses or thrust instead of undergoing a change in length. Restraining structures must be designed to resist these anticipated loads. The Plastic Pipe Institute technical guidelines for connecting HDPE pipe to other types of pipe shall be used. Heat fusion joining by butt fusion using certified methods is the preferred method of connecting lengths of HDPE pipe and of installing fittings in HDPE pipe. Any mechanical methods of joining HDPE pipe or of installing fittings shall be specifically designed for use with HDPE pipe. HDPE pipe with scrapes or gouges exceeding 10 percent of the wall thickness shall not be used. The damaged sections shall be removed and replaced. Kinked pipe shall not be installed and shall be removed and replaced. High density polyethylene plastic (HDPE) pipe shall meet the appropriate ANSI/AWWA standard and working pressure rating for the pipe size, PE code designation, and expected working pressures of the installation. All HDPE pipe shall be pressure tested in accordance with the recommended practice of the Plastic Pipe Institute for this pipe. Any leaks discovered shall be repaired.

B. PERMEATION OF PIPE WALLS: In areas that are contaminated with organic chemicals,

permeation of organic chemicals into the water system shall be prevented by using non-permeable materials for all portions of the water system including pipe, fittings, service connections and hydrant leads.

C. USED MATERIALS: Only water mains that have been used previously for conveying potable water may be reused, and must meet the above standards and have been practically restored to their original condition.

D. JOINTS: Packing and joining materials used in the joints of pipe shall conform to the latest edition of the AWWA standards. Pipe having mechanical joints or slip-on joints with nylon or synthetic rubber gaskets is preferred. Natural rubber shall not be used.

E. HANDLING: Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces.

F. CUTTING PIPE: Cutting shall be done in a neat manner, without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

G. CLEANING: The interior of all pipe and fittings shall be thoroughly cleaned for foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all joint contact surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

The end of the pipe must be protected from contamination when construction is terminated at the close of each day or for any extended period of discontinuation of construction activities. The pipe end must be sufficiently sealed with a cap or plug so is no foreign material may enter the line/pipe and maintained clean in accordance with all applicable specifications.

H. INSPECTION: Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

I. ALIGNMENT: Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not be permitted. Either shorter pipe sections or fittings shall be installed where the alignment or grade requires them.

J. LAYING PIPE: Pipe shall be protected from lateral displacement by placing the specified

pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions. Pipe shall be laid with the bell ends facing the direction of laying except when reverse laying is specifically authorized by the City or City's Engineer.

K. PUSH-ON JOINTS: All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

L. MECHANICAL JOINTS: Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Over tightening bolts to compensate for poor installation practice will not be permitted.

M. FLANGED JOINTS: Whenever screwed-on flanges are used, the pipe shall extend completely through the flange. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

When bolting flanged joints, care shall be taken to insure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell and spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.

N. WALL CASTINGS: Unless otherwise shown on the drawings, wall castings shall be provided where cast iron pipes pass through concrete or masonry walls.

O. CONNECTIONS WITH EXISTING PIPELINES: Where connections are made between new work and existing piping, such connections shall be made using suitable fittings for the conditions encountered. All live taps will be required. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the City or City's Engineer. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing pipe. No trench water, mud, or other contaminating substances shall be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, chlorine solution having chlorine content of 200 milligrams per liter.

P. REACTION ANCHORAGE AND BLOCKING: All unlugged bell and spigot or all-bell

tees, Y-branches, bends deflecting 11 degrees or more, and plugs which are installed in piping subjected to internal hydrostatic heads in excess of 30 feet shall be provided with suitable reaction blocking, anchors, joint harness or other acceptable means for preventing movements of the pipe caused by internal pressure.

1. Concrete Blocking: Concrete blocking shall extend from the fitting to solid undisturbed earth and shall be installed so that all joints are accessible for repair. The bearing area of concrete reaction blocking shall be as shown on the drawings or as determined by the Engineer. If adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.

2. For Other Locations: Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the drawings or as necessary to prevent movement.

3. Protection of Metal Surfaces: All steel clamps, rods, bolts, and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be protected from corrosion by two coats of coal tar paint applied to clean, dry metal surface. The first coat shall be dry and hard before the second coat is applied. Metal surface exposed above grade or within structures shall be painted with two coats (in addition to a prime coat) of paint acceptable to the City or City's Engineer.

   All joints shall be watertight and free from leaks. Each leak which is discovered within one year after final acceptance of the work by the City shall be repaired by and at the expense of the Contractor.

Q. TRACER WIRE: All PVC waterlines shall be buried with a 12 gauge (solid) coated copper wire for future location efforts. Wire is to lie on top of pipe and shall extend up into all meter boxes and valves. (See Detailed Drawing B-3 and the General Discussion Notes)

Section 23. Water Main Design.

A. PRESSURE: All water mains shall be sized in accordance with a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 35 psi at ground level at all points on the distribution system under all conditions of design flow not including fire flow, except that the department may approve a minimum design pressure of 20 psi in areas served by rural water districts that are isolated from the City's distribution system or on a case-by-case basis in accordance with the "Minimum Design Standards for Missouri Community Water Systems" effective December 10, 2013. The normal working pressure in the distribution system should be

approximately 60 psi.

B. DIAMETER**:**

1. The minimum size of a water main for providing fire protection and serving fire hydrants shall be six inches in diameter. Larger mains shall be required to allow withdrawal of the required fire flow while maintaining the minimum residual pressure of 20 psi throughout the distribution system.

2. For public water systems not providing fire protection, no water main shall be smaller than 2 inches in diameter. Water lines serving more than one service connection shall be considered a water main.

C. FIRE PROTECTION: Fire protection shall be provided for all waterline extensions. The system design should be such that fire flows and facilities meet the classification criteria of the state Insurance Service Offices (ISO). Systems that cannot provide a minimum fire flow of 250 gpm for a two hour duration are not designed to provide fire protection. All water mains shall be designed to carry fire flows and shall have fire hydrants connected to them.

D. FLUSHING:

1. Flushing devices and valving shall be provided to allow every main in the distribution system to be flushed. Flushing devices should be sized to provide flows that will give velocity of at least 2.5 feet per second on the water main being flushed.

2. In order to provide increased reliability of service and reduce head loss, dead ends shall be minimized by making appropriate tie-in wherever practical.

3. Where dead-end mains occur, they shall be provided with an approved flushing device.

4. No flushing device shall be directly connected to any sewer.

E. ISOLATION VALVES: Sufficient valves shall be provided on water mains so that inconvenience and sanitary hazards to customers will be minimized during repairs. Valves should be located at not more than 500 foot intervals in commercial districts and at not more than one block (or 800 foot) intervals in residential or other districts. Where systems serve widely scattered customers and where future development is not expected, the valve spacing should be at every water main branch on both the feeder main and the branch line.

Section 24. Fire Hydrants.

A. LOCATION AND SPACING: Fire Hydrants shall be provided at each street intersection and at intermediate points between intersections to meet the current

classification criteria of the Insurance Services Office (ISO). Generally, the fire hydrant spacing may range from 500 feet to 600 feet in residential areas or 300 feet to 350 feet in commercial areas. The number of hydrants required shall be based on use/occupancy type, required fire flow, along with distance and access considerations. The maximum distance from any structure's access point to a hydrant in a commercial area shall not exceed 200 feet, as measured along the required access. Final approval of fire hydrant spacing shall be by the Nixa Fire Protection District. (1701 9/2011)

B. VALVES AND NOZZLES: Fire hydrants should have a minimum bottom valve opening of at least 5 1/4 inches and one 4 ½ inch pumper nozzle and two 2 ½ inch nozzles.

C. HYDRANT LEADS**:** The hydrant lead shall be a minimum of six inches in diameter and contain a shutoff valve.

D. DRAINAGE: A gravel pocket or dry well shall be provided unless the natural soils will provide adequate drainage for the hydrant barrel. Hydrant drains shall not be connected to or located within ten feet of sanitary sewers or storm drains.

E. INSTALLATION: Installation of fire hydrants shall meet the following requirements.

a. The weight of the hydrant shall not be carried by the pipe. Hydrants, lead valves, fittings, and branch connections shall be provided with proper support, such as crushed stone, concrete pads or a well compacted trench bottom.
b. Drainage shall be provided for dry barrel hydrants. This is generally washed stone extending at least one foot on all sides of the hydrant.
c. Hydrants shall be plumb.
d. The center of a hose outlet shall be not less than 18 inches above final grade and so that the final hydrant installation is compatible with the final grade elevation.
e. As a rule, hydrants are either oriented with the pumper outlet perpendicular to the curb which faces the street, or with the pumper outlet set at a 45-degree angle to the street.
f. Hydrants shall be protected if subject to mechanical damage. The means of protection shall be arranged in a manner that will not interfere with the connection to, or operation of, hydrants.
g. A clearance space of at least three feet (3 ft.) surrounding the hydrant body should be provided around every hydrant.
h. Utility poles, vaults, walls, plants and other landscape materials should be kept outside the hydrant's clearance space.
i. In poor load-bearing soil, special construction such as support collars may be required.

Section 25. Air Relief Valves; Valve, Meter and Blow-off Chambers.

A. LOCATION: At high points in water mains where air can accumulate, provisions shall be made to remove air by means of manually operated hydrants or automatic air relief valves. Automatic air relief valves shall not be used in situations where flooding of the

manhole or chamber may occur.

B. PIPING: The open end of an air relief pipe from automatic valves shall be extended to at least one foot above grade and terminate in a downturned position with the opening covered with an 18-mesh, corrosion resistant screen. The pipe from a manually operated valve shall be capped with a threaded removable cap or plug and should be extended to the top of the pit. Vaults or wells housing automatic air relief valves shall be drained to daylight with drains sized to carry the maximum output of the air relief valve.

C. CHAMBER DRAINAGE: Chambers, pits or manholes containing valves, blow-offs, meters, or other such appurtenances to a distribution system shall not be connected directly to any storm drain or sanitary sewer, nor shall blow-offs or air relief valves be connected to any sanitary sewer. Such chambers or pits shall be drained to the surface of the ground or provided with a sump

D. INSTALLATON STANDARDS: Specifications shall incorporate the provisions of the AWWA C-605 standards and/or manufacturer's recommended installation procedures.

Section 26. Crossings:

A. GENERAL: The following factors shall be considered in providing adequate separation.

a. Materials and type of joints for water and sewer pipes.
b. Soil conditions.
c. Service and branch connections into the water main and sewer line.
d. Compensating variations in the horizontal and vertical separations.
e. Space for repair and alterations of water and sewer pipes.
f. Off-setting of water mains around manholes.

B. PARALLEL INSTALLATION: Water main shall be located at least ten feet horizontally from any existing or proposed line carrying non-potable fluids such as, but not limited to drains, storm sewers, sanitary sewers, combined sewers, sewer service connections, and process waste or product lines. The distance shall be measured edge to edge.

In cases where it is not practical to maintain a ten-foot separation, the City may allow deviation on a case by case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a non-potable fluid line, provided that the water main is laid in a separate trench located as far away from the non-potable line as feasible and meets other specific construction requirements. Locating a water main on an undisturbed earth shelf located on one side of the non-potable line as feasible and meets other specific construction requirements. Locating a water main on an undisturbed earth shelf located on one side of the non-potable line is not recommended and requires justification by the engineer and specific case-by-case approval of the department. In either case, an elevation shall be maintained such that the bottom of the water main is at least 18 inches above the top of the non-potable line while meeting minimum cover requirements.

In areas where the recommended separations cannot be obtained, either the waterline or the non-potable line shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing.l Casing pipe must be a material that is approved for use as water main. Conventional poured concrete is not an acceptable encasement.

C. LINE CROSSINGS: Water mains crossing sewers, or any other lines carrying non-potable fluids shall be laid to provide a minimum vertical clear distance of 18 inches between the outside of the water main and the outside of the non-potable pipeline. This shall be the case where the water main is either above or below the non-potable pipeline. An 18-inch separation is a structural protection measure to prevent the sewer or water main from settling and breaking the other pipe. At crossings, the full length of water pipe shall be located so both joints will be as far from the non-potable pipeline as possible but in no case less than ten feet or centered on a 20-foot pipe. In areas where the recommended separations cannot be obtained either the waterline or the non-potable pipeline shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing that extends no less than ten feet on both sides of the crossing. Special structural support for the water and sewer pipes may be required. Casing pipe must be a material that is approved for use as water main. Conventional poured concrete is not an acceptable encasement.

D. EXCEPTIONS: Any exceptions from the specified separation distances in paragraphs B and C must be submitted to the City for approval.

E. FORCE MAINS: There shall be at least a ten-foot horizontal separation between water mains and sanitary sewer force mains or other force mains carrying non-potable fluids and they shall be in separate trenches. In areas where the recommended separations cannot be obtained, either the waterline or the non-potable line shall be constructed of mechanical joint pipe or cased in a continuous casing, be constructed of mechanical joint pipe, or be jointless or fusion welded pipe. Where possible, the waterline shall also be at such an elevation that the bottom of the water main is at least 18 inches above the top of the non-potable line. Casing pipe must be a material that is approved for use as water main. Conventional poured concrete is not an acceptable encasement.

F. SEWER MANHOLES: No waterline shall be located closer than ten feet to any part of a sanitary or combined sewer manhole. Where the separation cannot be obtained, the waterline shall be constructed of mechanical or manufactured restrained joint pipe, fusion welded pipe, or cased in a continuous casing. Casing pipe must be a material that is approved for use as water main. The full length of water pipe shall be located so both joints will be as far from the manhole as possible, but I no case less than ten feet or centered on a 20-foot pipe. No water pipe shall pass through or come into contact with any part of a sanitary or combined sewer manhole.

G. DISPOSAL FACILITIES: No water main shall be located closer than 25 feet to any wastewater disposal facility, agricultural waste disposal facility, or landfill. Water mains shall be separated by a minimum of 25 feet from septic tanks and wastewater disposal

areas such as cesspools, subsurface disposal fields, pit privies, land application fields, and seepage beds.

H. ABOVE WATER CROSSINGS: The pipe shall be adequately supported and anchored, protected from damage and freezing and accessible for repair or replacement.

I. UNDERWATER CROSSINGS:

a. Flowing streams and water body crossings five hundred feet or less in length shall have a minimum cover of four feet over the pipe. When crossing water courses greater than 15 feet in width, the following shall be provided:
    i. The pipe shall be of special construction, having flexible watertight joints. Steel or ductile iron ball-joint river pipe shall be used for open cut crossings. Mechanical or restrained joint or fusion welded pipe may be used for open cut crossings, provided it is encased in a welded steel casing. Mechanical or restrained joint or fusion weld pipe shall be used for bored crossings.
    ii. Adequate support and anchorage shall be provided on both sides of the stream.
    iii. Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible and should not be subject to flooding.
    iv. The valve closest to the supply source shall be in an accessible location and installed in a vault, manhole, or meter pit sized to allow the installation of leak detection equipment.
    v. Permanent taps shall be provided on each side of the valve within the manhole, vault, or meter pit to allow insertion of a small meter to determine leakage and for sampling purposes.
    vi. Bank erosion is a major cause of stream crossing failures, and erosion protection measures such as rip rap have limited success. Stream movement and the history of bank erosion must be considered when choosing the length that the crossing pipe or casing shall extend beyond the upper edge of the stream channel. The stream crossing pipe or casing shall extend at least 15 feet beyond the upper edge of the stream channel on each side of the stream.
    vii. Large river crossings such as those crossing the Missouri or Mississippi River require specialized design and shall be considered on a case-by-case basis.
b. For lake, waterbody, and flood plain crossings greater than 500 feet in length, the design shall consider the ability to access and repair or replace the pipe in these crossings. Consideration shall also be given to the ability to continue service to areas served by the crossing in the event of a submerged leak or pipe break.
    i. Submerged portions of pipe crossing proposed lakes shall not be buried when the submerged pipe is greater than 500 feet in length except for the transition from water to land.

ii. Steel or ductile iron ball-joint river pipe or fusion welded pipe shall be used under water during normal flow conditions. Mechanical, restrained joint, or fusion welded pipe shall be used in flood plains.
iii. Underwater installations shall be tested for leaks prior to installation.
iv. Valves above the high water level shall be provided at both ends of water crossings so that the section can be isolated for testing or repair.
v. The valve closest to the supply source shall be in an accessible location and installed in a vault, manhole, or meter pit sized to allow the installation of leak detection equipment.
vi. Permanent taps shall be provided on each side of the valve within the manhole, vault, or meter pit to allow insertion of a small meter to determine leakage and for sampling purposes.

c. Intermittent flowing streams
i. Restrained joint or thermal welded pipe shall be used for all stream crossings.
ii. The pipe shall extend at least 15 feet beyond the upper edge of the stream channel on each side of the stream.
iii. Adequate support and anchorage shall be provided on both sides of the waterway.

J. STREET CROSSINGS: No cutting of concrete/asphalt surface shall be allowed unless prior City approval is obtained in writing. At all locations where water lines are placed within the street, water trench shall be backfilled with 3/4 inch clean crushed limestone to the subgrade of the proposed pavement.

K. WATER SERVICES: All water services shall be made with 200 psi High Density Polyethylene (HDPE) pipe equal to copper tubing size (CTS) SDR 9 potable water pipe. Service pipe shall meet the requirements of ASTM 2737, AWWA C901 and NSF Standards 14 and 61.

1. Typical Water Service: (See Detail Drawing B-9 in the City of Nixa's Technical Specifications Book)

a. Crossings Serving Single Lot: Water service crossing shall be made using 1 inch diameter High Density Polyethylene (HDPE) pipe.

Water services on same side as water main shall be High Density Polyethylene (HDPE) pipe.

b. Crossings serving Twin lots: Water service crossing shall be made using a single 2 inch diameter or 2 - 1" diameter High Density Polyethylene (HDPE) pipes. Dual Services on same side as water main shall be High Density Polyethylene (HDPE) pipe.

2. Typical Water Meter Box: (See Detail Drawing B-7 in the City of Nixa's Technical Specifications Book)

L. PROTECTION OF WATER METER BOXES: It shall be the responsibility of the contractor to place a metal fence post at each meter box to prevent damage to the meter after installation.

Section 27. Waterline Acceptance Testing.

A. GENERAL: This section covers simultaneous hydrostatic pressure testing and leakage testing of the waterline. The pipelines shall be tested as specified herein.

It shall be the responsibility of the contractor to notify the City of Nixa personnel at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the City of Nixa. (#1578 4/09)

Temporary discharge piping shall be provided for wasting test water at a suitable remote location where such water will drain away from the work.

B. PRESSURE/LEAKAGE TEST: The pipelines shall be subjected to a simultaneous hydrostatic pressure and leakage testing. The test shall be conducted prior to connection of the pipeline to the existing water lines. All shutoff valves shall be open during testing. Anchored or blocked test plugs shall be provided as necessary.

C. FILLING AND VENTING THE LINE: The pipelines shall be slowly filled with water and all air expelled from the pipe. Vents shall be provided where necessary. A suitable plug shall be provided for the tapped vents.

D. TESTING EQUIPMENT FACILITIES: The Contractor shall furnish the gauges and measuring device for the hydrostatic and leakage tests, pump, pipe, connections, and all other necessary apparatuses, unless otherwise specified, and shall furnish the necessary assistance to conduct the test.

E. TEST PRESSURE: During the test the pipeline shall be subjected to 150 percent of the working pressure at the point of the test, but not less than 125 percent of normal working pressure at the highest elevation in the pipeline. Working pressure is defined as the maximum anticipated sustained operating pressure.

F. TEST DURATION: The test pressure shall be maintained for at least 2 hours or for whatever longer period is necessary for the City Inspector to inspect the pipeline. (#1578 4/09)

G. LEAKAGE MEASUREMENT: Leakage shall be defined as the quantity of water that must be supplied into the pipe section being tested to maintain a pressure within 5 psi of the specified leakage-test pressure after the pipe has been filled with water and the air in the pipeline has been expelled.

H. ALLOWABLE LEAKAGE**:** No installation will be accepted if the leakage is greater than

that determined by the formula:

$$L = \frac{ND(P)^{1/2}}{7,400}$$

WHERE:

L = Allowable leakage (gal/hr)
N = Number of joints in the length of pipeline tested
D = Nominal diameter of pipe (inches)
P = Average test pressure during the leakage test (psi-gauge)

I. DEFECTS: It is the intent of these specifications and the contract based thereon that all joints in piping shall be watertight and free from visible leaks during the prescribed leakage test and each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the City shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

If the specified leakage test is made after the pipeline has been backfilled and the joints covered, and such test shows a leakage rate in excess of the permissible maximum, the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. Where evidence of leaking joints does not appear on the ground surface above or near the leaks, the Contractor shall prospect the line by sinking a hole, with an auger or otherwise, at the location of each joint and determine any undue saturation of the soil which would indicate a leak at such joint; such prospecting shall be done after pressure has been maintained in the line a sufficient time to provide adequate soil saturation for locating leaks by this method.

Leaks in mechanical joints shall be repaired by dismantling, cleaning, realigning gland and gasket, and rebolting. Under no circumstances shall gland bolts be tightened beyond the specified and allowable torque limits in an attempt to reduce or stop leakage from a defective joint or for any other purpose.

J. REPETITION: Materials shall be replaced as necessary and the pressure test shall then be repeated until the line and all parts thereof withstand the test in a satisfactory manner.

Section 28. Waterline Disinfection.

A. GENERAL: The waterline shall be disinfected with a strong chlorine solution. Disinfecting may be done concurrently with pressure and leakage testing or after pressure and leakage testing at the option of the Contractor. All necessary disinfection equipment and materials shall be provided by the Contractor. Disinfection work shall conform to the requirements of AWWA C651-99, "Standard for Disinfecting Water Mains" as modified or supplemented herein.

B. DISINFECTANTS: The forms of chlorine that may be used in the disinfection operations are liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets.

1. Liquid Chlorine: Liquid chlorine conforming to ANSI/AWWA B301 contains 100% available chlorine and is packaged in steel containers usually of 100-lb, 150-lb, or 1-ton net chlorine weight. Liquid chlorine shall be used only: (1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water to be chlorinated; (2) under the direct supervision of someone familiar with the physiological, chemical, and physical properties of liquid chlorine who is trained and equipped to handle any emergency that may arise; and (3) when appropriate safety practices are observed to protect working personnel and the public.

2. Sodium Hypochlorite: Sodium hypochlorite conforming to ANSI/AWWAB300 is available in liquid form in glass, rubber-lined, or plastic containers typically ranging in size from 1 qt. to 5 gal. Containers of 30 gal. or larger may be available in some areas. Sodium hypochlorite contains approximately 5% to 15% available chlorine, and the storage conditions and time must be controlled to minimize its deterioration.

3. Calcium Hypochlorite: Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form or in 5-g tablets, and must contain approximately 65% available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration. Minimum contact time to allow tablets to dissolve shall be 7 hours.

C. FEEDING: Pipelines shall be disinfected by the tablet method, the continuous feed method or the slug method in accordance with ANSI/AWWA C651-99.

1. Tablet Method: The tablet method consists of placing calcium hypochlorite granules or tablets in the water main as it is being installed and then filling the main with potable water when installation is completed. This method shall be used only if the pipes and appurtenances are kept clean and dry during construction.

2. Continuous Feed Method: The continuous feed method consists of placing calcium hypochlorite granules in the main during construction (optional), completely filling the main to remove all air pockets, flushing the completed main to remove particulates, and filling the main with potable water. The potable water shall be chlorinated so that after a 24 hour period in the main there will be a free chlorine residual of not less than 10 mg/l.

3. Slug Method: The slug method consists of placing calcium hypochlorite granules in the main during construction; completely filling the main to eliminate all air pockets; flushing the main to remove particulates; and slowly flowing through the main a slug of water dosed with chlorine to a concentration of 100 mg/l. The slow rate of flow ensures that all parts of the main and its appurtenances will be exposed to the highly

chlorinated water for a period of not less than 3 hours.

During disinfection all valves shall be operated to insure that all appurtenances are disinfected.

D. BACTERIOLOGICAL TESTS: After the chlorine solution is flushed out of the line and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the new main. At least one set of samples shall be collected from every 1,200 ft of the new water main, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater; and shall show the absence of coliform organisms; and, if required, the presence of a chlorine residual. Turbidity, pH, and a standard heterotrophic plate count or test may be required at the option of the purchaser, because new material does not typically contain coliform but does typically contain HPC bacteria.

Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by Standard Methods for the Examination of Water and Wastewater. No hose or fire hydrant shall be used in the collection of samples. The record of compliance shall be the bacteriological test results certifying that the water sampled from the new water main is free of coliform bacteria contamination and is equal to or better than the bacteriologic water quality in the distribution system.

E. REDISINFECTION: If initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained.

Section 29. Protection of Potable Water Supply.

The Contractor shall be solely responsible for assuring protection of the City's potable water supply by means of providing backflow prevention as indicated in these specifications.

A. PROTECTION OF POTABLE WATER OUTLETS: All potable water openings and outlets shall be protected against backflow, in accordance with one of the following.

1. Air Gap: Openings and outlets shall be protected by an air gap between the opening and the fixture flood level rim. Openings and outlets equipped for hose connection shall be protected by means other than an air gap.

2. Hose Connections: Sillcocks, hose bibs, wall hydrants and other openings with a hose connection shall be protected by an atmospheric-type or pressure type vacuum breaker or a permanently attached hose connection vacuum breaker.

3. Reduced Pressure Principle Backflow Preventer: Openings and outlets shall be protected by a reduced pressure principle backflow preventer.

B. CONNECTIONS:

1. Automatic Fire Sprinkler Systems and Standpipe Systems: The potable water supply to automatic fire sprinkler and standpipe systems shall be protected against backflow by a double check-valve assembly or a reduced pressure principle backflow preventer.

   The exception is where systems are installed as a portion of the water distribution system in accordance with the requirements of this code and are not provided with a fire department connection, isolation of the water system shall not be required

2. Additive or Non-potable Source: Where systems contain chemical additives or antifreeze, or where systems are connected to a non-potable secondary water supply, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer. Where chemical additive or antifreeze is added to only a portion of an automatic fire sprinkler or standpipe system, the reduced pressure principle backflow preventer shall be permitted to be located so as to isolate that portion of the system.

3. Subject to Back Pressure: Where a potable water connection is made to a non-potable line, fixture, tank, vat, pump or other equipment subject to backflow pressure, the potable water connection shall be protected by a reduced pressure principle backflow preventer.

4. Lawn Irrigation Systems**:** The potable water supply to lawn irrigation systems shall be protected against backflow by a double check valve back flow preventer or a reduced pressure principle backflow preventer. Where chemicals are introduced into the system, the potable water supply shall be protected against backflow by a reduced pressure principle backflow preventer.

Section 30. Sewer Pipe.

A. PVC SEWER PIPE:

1. Scope: This section covers Polyvinyl Chloride Piping (PVC). PVC pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances. All sewer line construction shall be in accordance with 10CSR 20-8.120, effective January 30, 2012.

2. Materials: In depth less than 10 feet SDR-35 gasket-bell type pipe shall be used. All sewer pipe with a depth of 10 feet or greater shall be SDR-21 gasket-bell type pipe. PVC pipe and fittings 4 inches through 15 inches shall meet or exceed the

requirements of the latest revision of ASTM D-3034 and shall be cell classification of 12454-B, 12454-C or 13364-B as defined in ASTM D-1784. Pipe and fittings 18 inches through 27 inches shall meet ASTM F-679 and shall be cell classification of 12364-C or 12454-C. (#1578 4/09)

Minimum pipe stiffness (F/Y) at 5ø deflection shall be 46 for all sizes when tested in accordance with ASTM D2412.

All joints of pipe and fittings shall have elastomeric gaskets and shall show no signs of leakage when tested in accordance with D 3212. Solvent weld joints will not be permitted below grade.

SIZES	O.D. DIMENSIONS	WALL THICKNESS
4"	4.215	.125 inches
6"	6.275	.180 niches
8"	8.400	.240 inches
10"	10.500	.300 inches
12"	12.500	.360 inches
15"	15.300	.414 inches
18" (T-1)	18.700	.536 inches
21" (T-1)	22.047	.632 inches
24" (T-1)	24.803	.711 inches

3. Location of Services: All SCH40 and SDR-21 PVC wyes or tee fittings will be located in the center of each lot for ease of location on future hookups.

4. Lateral Lines: All service lateral lines shall be schedule 40 meeting the requirements of ASTM D2665 or D2441.

5. Connection to existing: Any adaptation from SDR-35 to SDR-21 shall be completed with a solvent weld coupling.

6. Handling**:** Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces.

7. Cutting Pipe: Cutting shall be done in a neat manner, without damage to the pipe. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

8. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all contact surfaces shall be wire brushed, if necessary, wiped clean,

and kept clean until jointing is completed.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

9. Inspection: Pipe fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

10. Alignment: Sewers twenty-four inches (24") or less shall be laid with straight alignment between manholes. Straight alignment shall be checked by either using a laser beam or lamping.

    Curvilinear alignment of sewers larger than twenty-four inches (24") may be considered on a case-by-case basis provided compression joints are specified and ASTM or specified pipe manufacturers' maximum allowable pipe joint deflection limits are not exceeded. Curvilinear sewers shall be limited to simple curves which start and end at manholes. When curvilinear sewers are proposed, the recommended minimum slopes must be increased accordingly to provide a minimum velocity of two feet (2') per second when flowing full.

11. Laying Pipe: Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

    Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of four inches (4") below and on each side of all pipe(s).

12. Embedment Materials: Plastic Pipe – Embedment materials for bedding, haunching, and initial backfill, Classes I, II, or III, as described in ASTM D2321, shall be used and carefully compacted for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load based on the type of soil encountered and potential groundwater conditions.

    Composite pipe – Except as described in ASTM D2680, the bedding, haunching, and initial backfill requirements for composite pipe shall be the same as for plastic pipe.

    Final Backfill – Shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods, stones, organic matter, or other unstable materials shall not be used for final backfill within two (2') of the top of the pipe.

13. Steep Slope Protection: Sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

a. Not over thirty-six feet (36') center-to-center on grades twenty percent (20%) and up to thirty-five percent (35%);

b. Not over twenty-four feet (24') center-to-center on grades thirty-five percent (35%) and up to fifty percent (50%); and

c. Not over sixteen feet (16') center-to-center on grades fifty percent (50%) and over.

14. High Velocity Protection: Where velocities greater than fifteen feet (15') per second are attained, special provision shall be made to protect against displacement by erosion and impact.

15. Push-On-Joints: All instructions and recommendations of the pipe manufacturer relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

16. Cross Connections: There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

17. Service Connections: Service connections to the sewer main shall be watertight and not protrude into the sewer. If a saddle-type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.

18. Relation to Water Mains:

a. Horizontal Separation: Sewer mains shall be laid at least 10 feet (3.0 m) horizontally from any existing or proposed water main. The distances shall be measured from edge to edge. In cases where it is not practical to maintain a 10-foot separation, the City Superintendent may allow deviation on a case-by-case basis if supported by data from the design engineer. Such deviations may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches (46 cm) above the top of the sewer.

b. Crossings: Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches (46 cm) between the outside of

the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equal distance and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

c. Special Conditions**:** When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer must be constructed of slip-on or mechanical joint pipe or continuously encased and be pressure tested to one hundred fifty pounds per square inch (150 psi) to assure watertightness.

19. Street Crossing: No cutting of concrete/asphalt surfaces shall be allowed unless prior City approval is obtained in writing. At all locations where sewer lines are placed within the street, sewer trench shall be backfilled with 3/4 inch crushed limestone to the subgrade of the proposed pavement. Creek gravel or similar material will not be allowed.

20. Stream Crossing: Sewers entering or crossing streams shall be constructed of ductile iron pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

    Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods shall provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt laden water into the stream. Specifications shall require that clean-up, grading, seeding, planting, or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven (7) days.

21. Aerial Stream Crossing: Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning, and settlement. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize frost heaving.

    For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the fifty (50) year flood.

Aerial crossings shall be constructed of ductile-iron pipe with mechanical joints; otherwise, they shall be constructed so that they will remain watertight and free from changes in alignment or grade.

22. Marking: Each pipe and fitting shall have plainly and permanently marked thereon:

    a. Manufacturer's name or trademark.
    b. Nominal pipe size.
    c. ASTM Designation D3034 and Class Number
    d. SDR number.
    e. Material designation.

23. Acceptance Tests: Each reach of sewer shall meet the requirements of *SECTION 25-32. Sewerline Acceptance Testing*.

B. BUILDING SEWER:

1. General: It shall be the responsibility of the property owner to construct and maintain the sewer lines from the building to the sewer main. The property owner assumes all ownership of the line from the building to the main tap or "Y" on the City main.

2. Materials: All sewer service connection lines shall be a minimum of 4 inches diameter, Sch 40 PVC.

3. Laying of Pipe: All sewer lines shall have a minimum of 3 feet of cover over the top of the pipe with a fall of 1/4 inch per foot. At no time shall 90-degree turns be acceptable. It shall be acceptable to use 45-degree bends providing there is a minimum of 1 foot of pipe between each bend.

4. Service Hookup: The City shall be notified to provide assistance in locating building sewer extensions at the sewer main. No unauthorized connection to the sewer main at locations other than building sewer extensions shall be allowed. No split services will be allowed; all buildings will have a separate sewer service. Service connections to the sewer main shall be watertight and not protrude into the sewer. If a saddle-type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.

C. PVC FORCE MAIN:

1. Scope: This section covers bell and spigot rubber gasket PVC pressure pipe. Pipe shall be completely furnished with all fittings, jointing material, anchors, blocking, encasement, and other necessary appurtenances. All force main construction shall be in accordance with 10CSR 20-8.130, effective January 30, 2012.

2. Materials**:** All materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM D 1784, Type 1, Grade 1, Class 200. All pipe and fittings shall have integral bells and conform to the following:

Pipe Dimensions:	ASTM D2241, SDR 21
Fittings:	Rated to exceed pipe with MJ type fittings.
Rubber Joint Rings:	ASTM D1869

3. Handling**:** Pipe, fittings, and accessories shall be handled in a manner that will insure installation in sound, undamaged condition. Extra care shall be used in handling during cold weather.

   Pipe and fittings, which have been scratched during handling or installation, shall be replaced by and at the expense of the Contractor. Pipe repairs will not be permitted.

4. Storage: All pipe shall be stored on a flat surface so as to support the barrel evenly with the bell ends overhanging and not stacked in piles higher than 5 feet. Bells shall be inverted in alternate rows.

   Pipes stored for an extended period (several months) shall be covered with an opaque material to protect the pipe from the sun's rays.

   Rubber gaskets shall be stored away from grease, oil, ozone-producing electric motors, and excessive heat and in a cool dark place.

5. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed. All joint contact surfaces shall be kept clean until the jointing is completed.

   Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water, sand and earth from entering the pipe.

6. Cutting Pipe: Cutting shall be done with a fine-toothed saw and miter box or tubing cutter approved for PVC pipe. Remove all burrs from inside the cut end with a file or knife. The cut end shall be beveled with a milled curve-tooth flat file or beveling tool designed for PVC pipe.

7. Joints: All instructions and recommendations of the pipe manufacturer relative to gasket installation and other jointing operations shall be followed by the Contractor.

8. Alignment: Pipelines or runs intended to be straight shall be laid straight. Deflections

from a straight line or grade shall be as shown on the drawings.

Either shorter pipe or fittings shall be installed if the alignment or grade requires them. Pipe shall not be bent.

9. Laying Pipe: Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water and no pipe shall be laid under unsuitable weather or trench conditions.

   Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is authorized by the City or City's Engineer.

   A copper tracer wire (insulated #12 wire) shall be laid in the bedding within 1' above the top of the pipe. Tracer connections shall be placed in areas not to exceed 500'. Tracer connections shall be supplied at all air relief valves.

   Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of four inches (4") below and on each side of all pipe(s).

10. Embedment Materials: Plastic Pipe – Embedment materials for bedding, haunching, and initial backfill, Classes I, II, or III, as described in ASTM D2321, shall be used and carefully compacted for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load based on the type of soil encountered and potential groundwater conditions.

    Final Backfill – Shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods, stones, organic matter, or other unstable materials shall not be used for final backfill within two (2') of the top of the pipe.

11. Steep Slope Protection: Sewers on twenty percent (20%) slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

    a. Not over thirty-six feet (36') center-to-center on grades twenty percent (20%) and up to thirty-five percent (35%);

    b. Not over twenty-four feet (24') center-to-center on grades thirty-five percent (35%) and up to fifty percent (50%); and

    c. Not over sixteen feet (16') center-to-center on grades fifty percent (50%) and over.

12. Street Crossing: No cutting of concrete/asphalt surfaces shall be allowed unless prior City approval is obtained in writing. At all locations where sewer lines are placed within the street, sewer trench shall be backfilled with 3/4 inch crushed limestone to

the subgrade of the proposed pavement. Creek gravel or similar material will not be allowed.

Where pressure lines cross State maintained roadways, the PVC pipe shall conform to ASTM D-2241-76, or latest revision thereof, within the State right-of-way.

13. Stream Crossing: Sewers entering or crossing streams shall be constructed of ductile iron pipe with mechanical joints; otherwise, they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage pipe during placement, or corrode the pipe.

    Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods shall provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt laden water into the stream. Specifications shall require that clean-up, grading, seeding, planting, or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven (7) days.

14. Aerial Stream Crossing: Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning, and settlement. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers. Where buried sewers change to aerial sewers, special construction techniques shall be used to minimize frost heaving.

    For aerial stream crossings, the impact of flood waters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the fifty (50) year flood.

    Aerial crossings shall be constructed of ductile-iron pipe with mechanical joints; otherwise, they shall be constructed so that they will remain watertight and free from changes in alignment or grade.

15. Cross Connections: There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

16. Pressure Test: Pressure testing is required and is covered under *SECTION 25-32. Sewerline Acceptance Testing.*

17. Marking: Each pipe and fitting shall have plainly and permanently marked thereon:

    a. Manufacturer's name or trademark.
    b. Nominal pipe size.
    c. ASTM Designation D2241.
    d. SDR Number.

D. VITRIFIED CLAY SEWER PIPE:

Vitrified Clay Sewer Pipe is not allowed.

E. DUCTILE IRON PIPING:

1. Scope: This section covers ductile iron piping. Ductile iron pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances.

   Piping, furnished complete with all joint gaskets, bolts, and nuts, is required for installation.

2. Materials: Unless otherwise required by the drawings or specified herein, joints in ductile iron piping shall be mechanical or push-on type.

Ductile	ANSI A21.51; AWWA C151, ASMT A536, Grade 60-42-10; thickness Class 50.
Fittings	ANSI A21.10, AWWA C110, except shorter laying lengths will be acceptable.
12" and Under Over 12"	250 psi pressure rating. 150 psi pressure rating.
Mechanical Joints	ANSI A21.11, AWWA C111
Locked Joints	American "Loc-Fastite", U.S. Pipe "Lok-Tyton", or Clow "Super-Lock".
Push-On Joints	ANSI A21.11, except gaskets shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable.
Flexible Couplings	Elastomeric polyvinyl chloride or resin impregnated fabric provided with stainless steel tightening bands. Assemblies shall be capable of connecting pipe of different size and material with a flexible leak-proof joint.

Shop Coating and Lining

- Cement Lining — ANSI A21.4
- Bituminous Coating — Manufacturer's Standard.
- Field Coating — Heavy coal tar epoxy, MIL-C-18480; Koppers "50 Bitumastic", Tnemec "476 Super"

3. Handling: Pipe fittings and accessories shall be handled in a manner that will insure installation in sound, undamaged condition.

   Equipment, tools, and methods used in unloading, reloading, hauling and laying pipe and fittings shall be such that the pipe and fittings are not damaged. Hooks inserted in ends of pipes shall have broad, well-padded contact surfaces.

   Pipe fittings, in which the cement lining has been broken or loosened, shall be replaced by and at the expense of the Contractor.

4. Cutting Pipe: Cutting shall be done in a neat manner, without damage to the pipe or to the cement lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

   Ends of ductile iron pipe shall be cut with a saw, abrasive wheel, or oxyacetylene torch. Field cutting of holes for saddles shall be done by mechanical cutters; oxyacetylene cutting will not be permitted.

5. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Before jointing, all joint contact surfaces shall be wire brushed if necessary, wiped clean, and kept clean until jointing is completed.

   Every precaution shall be taken to prevent foreign matter from entering the pipe during installation. No debris, tools, clothing, or other materials shall be placed in the pipe.

   Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water from entering the pipe.

6. Inspection: Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective pipe and fittings shall be removed from the site of the work.

7. Laying Pipe: The pipe shall be protected from lateral displacement by placing the specified embedment material. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions.

Pipe shall be laid with the bell ends facing the direction of the laying except when reverse laying is specifically authorized by the City or City's Engineer.

8. Mechanical Joints: Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Over tightening of bolts to compensate for poor installation practice will not be permitted.

9. Push-on Joints: All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations shall be followed by the Contractor. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed.

   Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot shall be suitably beveled to facilitate assembly.

10. Couplings: Dresser couplings shall be carefully installed in accordance with the manufacturer's recommendations.

    Flexible couplings shall be installed at joints between ductile iron pipe and pipe of unlike material. Flexible couplings shall be concrete encased.

11. Shop Coating and Lining: The interior surfaces of all pipe for gravity sewers, drain lines and dewatering lines shall be provided with the standard cement lining. The exterior surfaces of all pipe and fittings shall be shop coated with a bituminous coating.

12. Concrete Encasement: Concrete encasement shall be installed where and as shown on the drawings. Concrete and reinforcing steel shall be in accordance with the cast-in-place concrete section. All pipe to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation.

13. Cross Connections: There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any wastewater or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

14. Leakage: All joints shall be watertight and free from leaks. Each leak, which is discovered within one year after final acceptance of work by the City, shall be repaired by and at the expense of the Contractor.

15. Marking: Each pipe or fitting shall be plainly and permanently marked thereon:
    a. Pipe Class.

b. Manufacturer's Name or Trademark.
c. Nominal Pipe Size.
d. Weight.
e. Date of Manufacture.
f. Sampling Period.

Section 31. Manholes.

A. GENERAL: This section covers standard, drop, and wet well manholes. Manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details shown on the drawings.

At the option of the Contractor, manholes shall be constructed of precast concrete sections or cast-in-place concrete.

1. Standard Manholes:

Manholes shall be installed at the end of each line, at changes in grade, size or alignment, at all sewer pipe intersections, at distances not greater than four hundred feet (400') for sewers fifteen inches (15") or less and at distances not greater than five hundred feet (500") for sewers sixteen inches to thirty inches (16"-30"). Greater distances may be permitted on larger sewers.

2. Drop Type Manholes:

A drop type manhole shall be provided for a sewer entering a manhole at an elevation of twenty-four inches (24") or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than twenty-four inches (24") the invert shall be filleted to prevent solids deposition.

Only manholes, which are required to have inside pipe and fittings for dropping sewage into the lower line, will be designated as drop manholes. All drop manholes shall have a minimum inside diameter of 5 feet to allow for securing the drop pipe to the interior wall of the manhole and providing adequate access for cleaning. When using precast manholes, drop connections shall not enter the manhole at a joint.

B. MATERIALS:

1. Portland Cement: ASTM C150, Type II.

2. Concrete: ASTM C94 with compressive strength of 3000 psi at 28 days. Curing and protection shall be in accordance with "Cast-In-Place Concrete ".

3. Brick: ASTM C32, Grade MS or ASTM C62, Grade SW.

4. Granular Backfill: See bedding requirements, *Section 25-20 Excavation and Trenching and Section 25-31 Manholes.*

5. Precast Sections:

a. Standard and Drop Manhole:	Circular precast concrete; ASTMC478 Manhole except as modified.
b. Wetwell Manhole:	Reinforced concrete pipe; ASTM C76, Class II, Wall B.
c. Minimum Thickness:	As indicated on drawings.
d. Openings:	Circular shaped boxout for each connecting pipewith A-Lock locking-type gaskets installed by manhole manufacturer.
e. Hydrated Lime:	ASTM C207, Type S.
f. Sand:	Concrete sand, fine aggregate, sieved through 8-mesh screen.
g. Shrinkage-Correcting:	Master Builders "Embeco" Sida"Kemox",or Sonneborn Aggregate “Ferrolith G-DS”.
h. Mortar:	One part Portland cement, 1/2 part hydrated lime, three parts sand.
i. Non-shrinking Mortar:	Premixed or job mixed; job mixed shall be one part shrinkage-correcting aggregate, one part Portland cement, and one part sand.

6. Gaskets:

a. Mastic:	Fed Spec SS-S-210; K.T. Snyder “Ram-Nek."
b. Rubber:	Neoprene or other synthetic, 40 plus or minus five hardness when measured by ASTM D2240, Type A durometer.
c. Rubber Joint Filler:	Natural or synthetic.
d. Hardness:	40 plus or minus five when measured by ASTM D2240, Type A durometer.
e. Tensile Strength:	1200 psi minimum.

7. Manhole Steps:

a. Cast Iron:	ASTM A48, with asphalt varnish coating applied at the foundry.
b. Composition:	Plastic ASTM 2146 Type II, Grade 16906. Steel reinforcing bar ASTM A615.
c. Manhole Frame:	ASTM A48, with coating applied at the foundry. Frame and cover shall be equal to a Neenah R-1642, Deeter 1247, or EJ 1045 Frame with 1040 AGS Cover imprinted with "City of Nixa Sanitary Sewer".

C. DELIVERY: Precast concrete sections shall not be delivered to the job until representative concrete control cylinders have attained strength of at least 80 percent of the specified minimum.

D. INSPECTION: Precast concrete sections and brick shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

E. CONSTRUCTION: All mortar shall be used within 40 minutes after mixing. Mortar, which has begun to take on initial set, shall be discarded and not mixed with additional cement or new mortar. In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with as large radius of curve as practicable. All inverts shall be troweled to a smooth clean surface.

Circular precast sections shall be provided with a rubber or mastic gasket to seal joints between sections. The space between connecting pipes and the wall of precast sections shall be equipped with A-Lock Locking-type gaskets or equal to be installed at the factory.

F. WATERPROOFING**:** Manholes shall be waterproofed by application of heavy-duty coal tar coating applied over entire exterior surface to attain a dry film thickness of not less than 15 mils. Surface to receive coating shall be thoroughly dry.

G. FRAMES AND COVERS: Frames shall be set so that the top of the cover is flush with finished pavement or 2 inches higher than finish grade in unpaved areas except where noted otherwise on the drawings. Watertight manhole covers shall be used wherever the manhole tops may be flooded by street runoff or high water. Bolt-down cover assemblies may be required on manholes subject to displacement by sewer surcharging. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

H. PIPE CONNECTIONS: Pipe connections shall be such that differential settlement between pipe and manholes is permitted and shall be made using water stops, A-Lok gaskets, standard O-ring gaskets, special manhole couplings, or other methods as approved.

I. STUBS: Future connections shall be provided in manholes at the locations shown on the drawings. Stubs shall be not less than 3 feet and shall terminate in a bell plug. Final length shall be determined by City for future anticipated connection.

J. HOLES: Core holes and handling holes shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to the Engineer.

K. PAINTING: If castings arrive on the job without a foundry coating, one coat of coal tar paint shall be applied. Before painting, all castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the paint is dry and hard.

L. BENCH: A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench should be sloped no less than one-half inch per foot (0.50 in/ft). No pipe shall discharge onto the surface of the bench.

M. CORROSION PROTECTION FOR MANHOLES: Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the interior of the manholes shall be provided.

N. STRUCTURES IN RELATION TO STREAMS: Manholes or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream.

O. MANHOLES IN RELATION TO WATER MAINS: Manholes shall be located at least ten feet (10') horizontally from any existing or proposed water main.

Section 32. Sewer Acceptance Testing.

A. SCOPE: This section covers the performance testing of the installed sewer, force main, and manholes.

B. GENERAL: The Contractor shall provide at his expense all necessary pumping equipment, testing water, means of conveying test water to the testing site to include piping connections between the piping and the nearest available source of test water, pressure gauges, and other equipment, materials and facilities necessary for the tests.

All pipe, fittings, valves, pipe joints and other materials that are found to be defective shall be removed immediately and replaced with new and acceptable material by and at the expense of the Contractor.

C. SEWER PERFORMANCE TESTING: Each reach of sewer shall be performance tested. It shall be the responsibility of the contractor to notify the City of Nixa personnel at least 24 hours in advance of the time and place at which testing work will be done. All defects shall be repaired to the satisfaction of the Engineer and the City of Nixa. (#1578 4/09)

1. Lamping: Each straight section of sewer between manholes shall be straight and uniformly graded. Each such section will be lamped by the Contractor in the presence of the City Inspector. (#1578 4/09)

2. Exfiltration: The Contractor shall conduct an exfiltration test on each reach of sewer between manholes. Exfiltration tests shall be conducted by blocking off all manhole openings except those connecting with the reach being tested, filling the line and measuring the water required to maintain a constant level in the manholes.

   Each manhole shall be subjected to at least one exfiltration test. During the exfiltration test, the water level shall be maintained at the top of the frame and cover on each manhole to locate all leaks. Testing shall conform to the test procedures in ASTM C969.

   The total exfiltration shall not exceed 100 gallons per inch of nominal diameter per mile of pipe per day for each reach tested. For purposes of determining maximum allowable leakage, manholes shall be considered sections of 48 inch pipe. The exfiltration tests shall be maintained on each reach for at least 2 hours and as much longer as necessary, in the opinion of the City Inspector, to locate all leaks. (#1578 4/09)

   The Contractor shall provide, at his own expense, all necessary piping between the reach to be tested and the source of water supply, together with equipment and materials required for the tests.

   If the leakage in any reach exceeds the allowable minimum, it shall be re-tested after the leaks are repaired.

   In lieu of water testing of manholes, vacuum testing will be allowed. A vacuum of 5 psi for a period of 5 minutes is required or as much longer as necessary, in the opinion of the City Inspector, to locate all leaks. (#1578 4/09)

   Air testing will be in accordance with ASTM F1417-92 "Installation Acceptance of Plastic Gravity Sewer Pipe Using Low Pressure Air." A minimum pressure of 4 psi for 4 minutes or longer, as necessary in the opinion of the City Inspector, shall be maintained through each reach of sewer. (#1578 4/09)

   3. Vacuum Test for Manhole: A vacuum test for manholes can be used in place of exfiltration. Ten inches of mercury is needed for 2 minutes if the manhole is less than 10 feet deep. Ten inches of mercury for 2.5 minutes is needed if the manhole depth is 10 to 15 feet deep. Ten inches of mercury for 3 minutes is needed if the manhole

depth is from 15 to 25 feet deep. A loss of 1 inch of mercury per test is all that is allowed. Testing shall conform to the test procedures in ASTM C1244 or the manufacturer's recommendations.

4. Infiltration**:** Infiltration shall also be tested by maintaining a minimum test pressure of 2 feet above the maximum groundwater elevation above the top of the pipe. If at any time prior to the expiration of the guarantee period infiltration exceeds 100 gallons per inch of nominal diameter per mile of sewer per day, the Contractor shall locate the leaks and make repairs as necessary to control in the infiltration.

5. Vertical Deflection: Initial installed vertical deflection for flexible pipe (PVC sewer pipe) shall not exceed 5 percent. The Contractor shall test the initial installed vertical deflection by pulling a mandrel or other device through all reaches of sewer to demonstrate that the 5 percent deflection limitation has not been exceeded. The deflection testing shall not be performed until a minimum of 30 days after backfilling of pipe. The method of test shall be acceptable to the Engineer and done in the presence of the City Inspector. The City Inspector shall submit all deflection test results to the Engineer. (#1578 4/09)

   The rigid ball or mandrel used for the deflection test shall have a diameter not less than ninety-five percent (95%) of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM specification, including the appendix, to which the pipe is manufactured. The test shall be performed without mechanical pulling devices. A mandrel must have nine (9) or more odd number of flutes or points.

D. FORCE MAIN PERFORMANCE TESTING: The force main shall be subjected to hydrostatic pressure testing and leakage testing as specified herein.

   All testing work shall be done in the presence of the City Inspector. The Contractor shall notify the City Inspector at least three days in advance of the times and places at which testing work is to be done. (#1578 4/09)

   1. Pressure Testing: The Contractor shall provide all necessary pumping equipment, piping connections, pressure gauges, anchored or blocked test plugs, and all other equipment, materials, and facilities necessary for the tests.

      The test pressure at any point in the pipeline shall be equal to 100 psi. The test pressure shall be maintained for at least 30 minutes and for whatever longer period is necessary for the City Inspector to inspect the pipeline. (#1578 4/09)

      All pipe, fittings, valves, pipe joints, and other materials that are found to be defective shall be removed immediately and replaced with new and acceptable material, by and at the expense of the Contractor. Following such replacement, the pressure test shall be repeated. Such replacement of defective materials and re-testing shall continue until the line and all parts thereof withstand the test pressure in a satisfactory manner.

2. Leakage Test: After the specified pressure test is completed and all pipeline repairs have been made and retested to the satisfaction of the Engineer, the line being tested shall be subjected to a leakage test. The hydrostatic pressure during leakage testing may be any predetermined pressure selected by the Contractor, provided that it does not exceed and is at least 75 percent of the pressure specified for pressure testing. The selected pressure shall be maintained constant (within a maximum variation of plus or minus 5 percent) during the entire time that line leakage measurements are being made.

   Leakage measurements shall not be started until a constant test pressure is established; compression of air trapped in unvented pipes or fittings will give false leakage readings under changing pressure conditions. After the selected test pressure is stabilized, the line leakage shall be measured by means of a suitable water meter installed in the pressure supply piping on the line side of the force pump. The water meter shall be furnished and installed by the Contractor.

   Line leakage shall be the total amount of water introduced into the line as measured by the meter during the leakage test.

   Each leakage test shall have a duration of 2 hours plus whatever additional period is necessary to accurately determine leakage in the opinion of the Engineer.

   The pipeline will not be accepted if the leakage indicated by the test is in excess of that determined by the following formula:

   where: $Q = 0.015\ DxLxN$

   Q = Allowable leakage in gallons per hour
   D = Nominal diameter of pipe in inches
   L = Length of section tested in thousand feet
   N = Square root of average test pressure in psi

3. Defects: It is the intent of these specifications that all joints in piping shall be watertight and free from visible leaks during the prescribed leakage test and each and every leak which may be discovered at any time prior to the expiration of one year from and after the date of final acceptance of the work by the City shall be located and repaired by and at the expense of the Contractor, regardless of any amount that the total line leakage rate during the specified leakage test may be below the specified maximum rate.

   The specified leakage test is to be made after the pipeline has been backfilled and the joints covered. If such test shows a leakage rate in excess of the permissible maximum, the Contractor shall make all necessary surveys in connection with the location and repair of leaking joints to the extent required to reduce the total leakage to an acceptable amount. Where evidence of leaking joints does not appear on the ground surface above or near the leaks, the Contractor shall prospect the line by sinking a hole, with an auger or otherwise, at the location of each joint and determine

any undue saturation of the soil which would indicate a leak at such joint; such prospecting shall be done after pressure has been maintained in the line for a sufficient time to provide adequate soil saturation for locating leaks by this method.

Sections 33 thru 39 Reserved

ARTICLE III
CONCRETE AND GROUTING

Section 40. Portland Cement Concrete.

A. DESCRIPTION: The concrete described herein shall consist of a mixture of Portland cement, fine aggregate, coarse aggregate, an air-entraining agent and water combined in the proportions specified for the various classes of concrete used in construction work and as set forth in these specifications.

B. MATERIALS: Cement shall be a standard brand Portland cement which shall form to ASTM Designation C-150. Type 1 cement shall be used unless otherwise provided in the special provisions.

Different brands or different types of cement from the same brand or type from different mills shall not be mixed or used alternately in the same item of construction unless authorized by the Engineer.

The Contractor shall not store cement at the site of the work without prior approval from the Engineer.

The right is reserved by the City to sample the cement either at the origin of the shipment or after delivery at the site of the work or the ready-mix concrete plant. Professional acceptance by the City prior to completion of tests shall in no way act as a waiver of the right to reject cement which has been shipped and not used if, on completion of the tests, it fails to meet the requirements of the specifications.

C. WATER: Water used with cement in concrete or mortar shall be clean, clear, free from sugar and shall be free from injurious quantities of oil, acid, alkali, salt, organic matter, vegetable matter or other deleterious substances.

D. FINE AGGREGATE: Fine aggregate shall consist of natural sand, manufactured sand, or a combination thereof. The gradation requirements of fine aggregate shall be as follows:

Passing 3/8 inch Sieve	100 percent
Passing No. 4 Sieve	95-100 percent
Passing No. 16 Sieve	40-80 percent
Passing No. 50 Sieve	5-30 percent
Passing No. 100 Sieve	0-10 percent

Fine aggregate shall conform to the requirements of ASTM Designation C-33 with

respect to deleterious substances, soundness and abrasion.

E. COURSE AGGREGATE: Coarse aggregates shall conform to the requirements of ASTM Designation C-33 with respect to deleterious substances, soundness and abrasion.

1. The coarse aggregate shall consist of a crushed stone or crushed gravel of uniform quality. The gradation requirements of the coarse aggregate for Class "A" concrete shall be as follows:

Passing 1 inch Sieve	100 percent
Passing No. 3/4 Sieve	90-100 percent
Passing No. 1/2 Sieve	40-60 percent
Passing No. 3/8 Sieve	10-30 percent
Passing No. 4 Sieve	0-5 percent

2. The gradation requirements of the Coarse aggregate for Class "X" concrete shall be as follows:

Passing 1 inch Sieve	100 percent
Passing No. 1/2 Sieve	25-60 percent
Passing No. 4 Sieve	0-10 percent
Passing No. 8 Sieve	0-5 percent

F. AIR-ENTRAINMENT: The air-entrainment shall be obtained by the use of an approved air-entrainment admixture conforming to ASTM Designation C260, which shall be added during the process of mixing the concrete. Air-entrainment Portland cement shall not be used. The admixture shall be dispensed by means of a mechanically activated dispenser approved by the Engineer, except that in the case of ready-mix concrete the flow may be started manually and the flow shall shut off automatically when the required amount is delivered. The air-entraining admixture shall be introduced into the stream of mixing water and the required amount shall be fully discharged before all the mixing water has entered the drum. The tank feeding the dispenser shall at all times contain an amount of air-entraining admixture sufficient for the next batch and shall be provided with a device approved by the Engineer for indicating visually when the supply runs low. The amount of admixture to be used shall be less than 3 percent nor more than 6 percent of the volume of the concrete.

G. FLY ASH: Fly Ash shall conform to ASTM Designation C-618.

H. PROPORTIONS OF MATERIALS: Class "A" concrete and Class "X" concrete shall contain not less than 470 pounds of cement per cubic yard.

I. WATER CONTENT: The mixing water, including free surface moisture on the aggregate, shall not exceed 6 gallons per sack of cement. The slump, when tested in accordance with ASTM Designation C-143 shall be from 1 inch to 3 inches.

J. AIR CONTENT: Portland cement concrete shall have air-testing of not less than 3 percent nor more than 6 percent of the volume of the concrete when tested in accordance with ASTM Designation C-173.

K. FLY ASH CONTENT: The Portland cement concrete shall contain not more than 100 pounds of fly ash per cubic yard.

L. MIX PROPORTIONS: In addition to the above requirements, the concrete materials shall be proportioned so as to provide a uniform workable mix. Prior to the beginning of construction, the Engineer may require the Contractor to furnish a written statement giving the properties of the materials and the proportions by weight (dry) of cement and of the fine and coarse aggregates that are proposed to be used in each class of concrete.

M. GENERAL REQUIREMENTS: Concrete pouring operations shall be discontinued when a descending ambient temperature away from artificial heat reaches 40 degrees Fahrenheit and not resumed until an ascending ambient temperature away from artificial heat reaches 35 degrees Fahrenheit. If it is necessary for the Contractor to take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates or applying heat directly to the contents of the mixer; aggregates shall not be heated higher than 150 degrees Fahrenheit, when cement is added. The temperature of the mixed concrete when heating is employed shall not be less than 30 degrees Fahrenheit and not more than 90 degrees Fahrenheit at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Concrete shall not be placed upon a frozen subgrade.

Ordinarily, the concrete shall be delivered to the job site in trucks so designed and operated that the concrete will be thoroughly mixed during the time it is in transit and shall be discharged at the site within a period of one and 1 1/2 hours after the introduction of the mixing water. When concrete is placed at the job site, it shall have the proper consistency and slump for satisfactory workability.

Testing shall be at the expense of the Contractor and shall consist of a slump test performed on each batch of concrete delivered. The slump test will be made after all on-site water has been added to the concrete prior to discharging. Three test cylinders will be collected each day on random deliveries as directed by the Engineer. Cylinders shall have a minimum 28-day compressive strength of 4,000 psi.

Section 41. Grouting.

A. SCOPE: This section covers grouting of pump, motor, and equipment baseplates or bedplates; other miscellaneous baseplates; and other uses of grout as shown on the drawings. All grouting shall be done with nonshrinking grout.

B. MATERIALS:

1. Nonshrinking: Grout Master Builders "Special LL-713 Grout", Sauereisen Cements "F-100 Level Fill Grout", or U.S. Grout "Five Star Grout".
2. Water: Clean and free from deleterious substances.

C. EXECUTION: Grout shall be furnished factory premixed so that only water is added at the job site. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.

1. Preparation: The concrete foundation to receive grout shall be saturated with water for 24 hours prior to grouting.

2. Placement Grout: Shall be placed in strict accordance with the directions of the manufacturer so that all space beneath baseplates and bedplates is completely filled without voids.

3. Edge Finishing: In all locations where the edge of the grout will be exposed to view, the grout after it has reached its initial set shall be finished smooth. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.

4. Curing: Grout shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 7 days.

Sections 42 thru 49 Reserved

ARTICLE IV
STREETS

Section 50. Portland Cement Concrete Curb and Gutter .

(Also see Detail Drawings D1-AC, D1-CC and D-5 in the attached Appendix.)

A. SCOPE OF WORK: The Contractor shall furnish all labor, materials, and equipment to perform all operations in connection with construction of concrete curb and gutter, in accordance with the City's concrete specifications and drawings, and subject to the terms and conditions of the contract.

B. MATERIALS: Class "A" Concrete shall be Portland Cement Concrete in accordance with the City's concrete specifications. Admixtures shall not be used unless specifically approved by the Engineer.

Expansion joints shall be made with performed expansion joint filler of a non-extruding type conforming to ASTM Designation D1751, configuration of the curb and gutter as indicated in the Appendix.

Joint sealing compound for contraction joints shall be CRS-2 Asphalt Emulsion meeting the requirements of ASTM Designation D3405. Curing compound shall be a white pigmented membrane-forming liquid conforming to the requirements of ASTM Designation C309, Type 2.

C. FORMS: Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge of the thickness of pavement slab. The minimum length of each section of form used shall be 10 feet. Each section or form shall be uniform and free from undesirable bends or warps.

The maximum deviation of the top surface of any section shall not exceed 1/8 inch, or the inside face not more than 1/4 inch from planned alignment. 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 impact and vibration of any equipment which they support, without springing or settlement.

Every 10 foot length of form shall have at least three form braces and pin sockets which shall be spaced at intervals of not more than 5 feet, having the end brace and socket not more than 6 inches from the end of the form. Approved flexible forms shall be used for construction where the radius is 150 feet or less.

The subgrade under the forms shall be compacted as specified herewith 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 prior to use.

The alignment and grade elevations of the forms shall be checked by the Contractor, and the necessary corrections made immediately before placing the concrete. When any form has been disturbed or any subgrade there under has become unstable, the forms shall be reset and rechecked.

D. PLACING CONCRETE: The subgrade shall be moist but not muddy at the time of placing concrete. If required by the Engineer, the prepared subgrade shall be saturated with water the previous night, or not less than 6 hours or more than 20 hours prior to placing the concrete. If the sub grade subsequently becomes too dry, it shall be sprinkled again ahead of placing concrete, in such a manner as not to form mud or puddles of water.

The Contractor shall give the Engineer at least 8 hours advance notice before placing concrete, and the subgrade shall be checked and approved by the Engineer before any concrete is placed.

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the curb and gutter in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. While being placed, the concrete shall be vibrated with suitable tools so that the formation of voids or honeycomb pockets is prevented.

The concrete shall be especially well-vibrated and tamped against the forms along all joints. Care shall be taken in the distribution of the concrete to deposit 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 adjusted to the required grade and alignment.

E. FINISHING: The curb shall be tooled to the required radii as soon as possible after the concrete takes its initial set. The gutter shall be shaped with a wood float at least 4 feet long. After the face forms and templates are removed, the joints shall be tooled and the surface shall be final finished with a hard bristle broom to remove all imperfections without additional mortar or dryer. In all cases, the resulting surface shall be smooth and of uniform color, free from sags, twists or warps and true to the specified lines and grades shown on the plans.

F. JOINTS: Expansion joints (formed with bituminous preformed expansion joints 3/4 inch thick or as specified on the plans and precut to exact cross section of curb) shall be placed at all driveway radii and intersection radii and at intervals of not more than 200 feet, and at the location shown on the plans or standard drawings, so that they are not moved by depositing and compacting the concrete at these joints. Preformed expansion joint filler shall be of non-extruding type and shall conform to ASTM Designation D1781.

Contraction Joints shall be sawed or formed with templates at intervals between not greater than 25 feet and at the location shown on the plans or standard drawings and shall be sawed to a depth of 1 1/2 inches. Asphalt material used in filling these joints shall be CRS-2 asphalt emulsion or as approved by the Engineer. Contraction joints in proposed medians shall match the location of joints in pavement. A template shall be 1/4 inch thick, cut to the configuration of the curb section shown on the plans. Templates shall be secured so that they are not moved by depositing and compacting the concrete.

Unless otherwise shown on the plans, and as soon as the concrete has hardened sufficiently, the templates shall be rounded with an edging tool of 1/8 inch radius.

G. CURING: Immediately after the finishing operation has been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be sealed by spraying with a uniform application of white pigmented membrane curing compound, at the rate of one gallon for each 150 square feet of surface. If rains fall on the newly coated surface before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the contractor will be required to apply additional curing material to the affected portions.

H. COLD WEATHER PROTECTION: Cold weather protection shall be as specified in Concrete General Requirements.

I. CURB AND GUTTER: Curb and gutter laid by slip-form or extruding equipment will be accepted providing it complies with all of the above requirements other than forms. The City retains the right to reject any slip-form equipment at its discretion.

J. BACKFILLING: After curing, the curb shall be immediately backfilled to within four (4) inches of the top curb to eliminate any possibility of washing beneath the curb. The remaining four (4) inches shall be topsoil.

K. DRIVEWAY ENTRANCES: At all entrances, the concrete curb shall be removed by saw cutting of either side of the entrance. After cutting, the exposed ends will be rounded off by applying grout to provide a pleasing appearance. Removal of curb by sledge hammer without first saw cutting shall not be allowed. All replacement curbing and gutter pan shall be installed to provide positive drainage

as originally designed.

Section 51. Portland Cement, Concrete Pavement, and Integral Concrete Curb.

A. SCOPE OF WORK: Shall consist of furnishing all labor, materials, and equipment necessary to perform all operations in connection with construction of Portland Cement Concrete Pavement, in accordance with the specifications and drawings, subject to the terms and conditions of the contract.

B. MATERIALS: Class "A" Concrete shall be Portland Cement Concrete in accordance with Section 3A of these specifications. Reinforcing steel, if specified by the plans, shall consist of deformed bars of grade 40 steel conforming to the requirements of ASTM Designation A615 or of wire fabric conforming to ASTM Designation A185.

Expansion joints shall be preformed expansion joint fillers of a non-extruding type conforming to ASTM Designation D1751.

Joint sealing compound for sawed contraction joints and construction joints shall be grade CRS-2 asphalt emulsion, or as approved by the Engineer.

Metal supports for tie bars or reinforcing bars shall be channel shaped pressed out of 12-gauge sheet steel or heavier or as shown on the plans.

Dowel bars, where specified, for transverse joints shall be smooth, round bars of the size specified. Burrs, mill scale and rust shall be removed. The free end shall be painted with a suitable paint followed by a thin uniform coating of graphite grease.

Expansion tubes or dowel caps shall be manufactured from 32 gauge sheet metal, shall be indented to provide a limiting stop for the dowel bar, and shall provide unobstructed expansion space of not less than one inch to permit movement of the dowel bar. They shall be of proper size to fit the specified bars tightly, and the closed end shall be watertight.

Curing compound shall be a white pigmented membrane-forming liquid, conforming to the requirements of ASTM Designation C309, Type 2. 4B-3

C. FORM: Forms shall be made of metal and shall have a depth equal to or greater than the prescribed edge thickness of the pavement slab. The minimum length of each section of form used shall be 10 feet. Each section of form shall be uniform and free from undesirable bends or warps.

The maximum deviation from planned grade of the top surface of any section shall not exceed 1/8 inch, or the inside face not more than 1/4 inch from planned

alignment. 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 planed, and the impact when planed, and the impact and vibration of any equipment which they support, without springing or settlement.

Each 10 foot length of form shall have at least three form braces and pin sockets which shall be spaced at intervals of not more than 5 feet, having the end brace and socket not more than 6 inches from the end of the form. Approved flexible forms shall be used for construction where radius is 150 feet or less.

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 prior to use.

The alignment and grade elevations of the forms shall be checked by the Contractor and the necessary corrections made 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.

D. PLACING CONCRETE: Specifications here shall be identical to similar section "Placing Concrete" above under section Portland Cement Concrete Curb and Gutter.

E. CONSOLIDATING AND FINISHING: The pavement shall be struck off and consolidated with a mechanical finishing machine or by hand-finishing methods. When a mechanical finishing machine is used, the concrete shall be struck off at such a height that after consolidated and finishing, it shall be at the elevations as shown on the plans. A depth of excess concrete shall be carried in front of the strike-off screed for the full width of the slab, whenever the screed is being used to strike off the pavement. The finishing machine shall be provided with a screed which will consolidate the concrete pressure. The concrete shall, through the use of this machine, be brought to a true and even surface, free from rock pockets, with the fewest possible number of passes of the machine. The edge of the screeds along the curb line may be notched out to allow for sufficient concrete to form the integral curb. Hand-finishing tools shall be kept available for use in case the finishing machine breaks down.

When hand-finishing is used, the pavement shall be struck off and consolidated by a vibrating screed or other approved equipment to the elevation shown on the plans. When the forward motion of the vibrating screed is stopped, the vibrator shall be shut off, and not be allowed to idle on the concrete. Internal mechanical vibration shall be used along side all formed surfaces.

F. FLOATING, STRAIGHTENING AND EDGING: After the concrete has been struck off and consolidated, it shall be further smoothed by means of a wood or aluminum float at least 5 feet wide with a handle long enough to reach the entire width of the slab being placed. The float shall be operated so as to remove any excess water and laitance as well as surface irregularities. After the floating operation, the pavement surface should be within the specified tolerances.

While the concrete is still plastic, the slab surface shall be tested for smoothness with a 10 foot straightedge swung from handles 3 feet longer than one-half the width of the slab. The straightedge shall be placed on the surface parallel to the center line of the pavement and at not more than 5 foot intervals transversely. After each test the straightedge shall be moved forward one-half of its length and the operation repeated.

When irregularities are discovered, they shall be corrected by adding or removing concrete. All disturbed places shall again be floated with the wooded float and again straightedged. The pavement surface shall have no depression in which water will stand.

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

G. FINAL SURFACE FINISH: A broom finish shall be used as the final finishing method. A hard bristle broom shall be used which shall be kept clean and used in such a manner as to provide a uniform textured surface. The curb shall have the same final touch as the pavement.

The final surface of the concrete pavement and curb shall have a uniform gritty texture that is free from excessive roughness and true to the grades and cross section shown on the plans. The Engineer may require changes in the final finishing procedure as required to produce the desired final surface texture.

H. JOINTS: Longitudinal and transverse joints shall be constructed as shown on the plans or standard drawings.

Longitudinal joints are those joints parallel to the lane of construction. They may be either center joints or the construction joints between construction lanes.

Traverse joints shall be contraction joints or contraction joints or construction joints. Construction joints are put in transversely whenever construction operations require them.

Expansion joints may be either longitudinal or transverse. They are used only where specifically shown on the plans or standard drawings.

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 1/8 inch. Transverse joints, except keyed and tied construction joints, shall be continuous across the entire paved area including the curb.

I. 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 center line of the pavement and with the surface of the subgrade.

Expansion joints shall be installed in accordance with the size and locations shown on the plans, and shall conform to the "Materials" requirements of these specifications. They shall conform to the exact configuration of the curb section. The filler shall be held accurately in place during the placing and finishing of the concrete by means of a bulkhead, a metal channel cap or other approved methods.

Under no circumstances shall any concrete be left above or below 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.

Transverse contraction joints shall be of the sawed type, unless otherwise shown on the plans. Care must be taken to saw the joints soon after concrete placement to prevent contraction cracks. 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 joint.

Transverse construction joints of the type shown on the plans or standard drawings 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 tie bars are used if the joint occurs at any other location.

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, and accurately aligned parallel to the pavement grade and the center line of the pavement by means of a dowel support which will remain in the pavement and will insure that the dowels are not displaced during construction. One-half of each dowel shall be painted and greased and in an expansion joint, one end shall be equipped with a tight fitting expansion tube of the dimensions shown on the plans and conforming to the "Materials" requirements of these Specifications.

J. LONGITUDINAL JOINTS: Longitudinal joints shall be placed as shown on the plans or standard drawings. They shall be of the sawed or the keyed construction type, unless otherwise shown on the plans.

Sawed longitudinal center joints shall be sawed grooves made with a concrete saw after the concrete hardened. The saw cut shall be at least 1/4 of the slab depth. These joints are otherwise formed in the same manner as the transverse sawed joints entitled "Transverse Contraction Joints."

Longitudinal keyed construction joints (i.e. joints between construction lanes) shall be of the dimensions shown on the plans or standard drawings.

K. TIEBARS: Tiebars or tiebolts when shown on the plans or standard drawings shall be of deformed steel and of the dimensions and at the spacing specified. Tiebars shall be firmly supported by subgrade chairs or so installed as not to be displaced during construction operation.

L. 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 under "Materials" in this Specification. All foreign materials, joint sawing residue, dirt and curing membrane shall be removed. Joints shall be lightly underfilled (about 1/2 inch) to prevent extrusion of sealer. Any excess material should be removed from the pavement surface as soon after sealing as possible.

M. STRUCTURES: All manholes, catch basins, or structures of a permanent nature encountered in the area to be paved shall be raised or lowered as the case may be, to the surface of the new pavement, and the necessary expansion joint material placed around each structure for the full depth of the slab and of the thickness shown on the plans or standard drawings.

N. CURING: Immediately after the finishing operation has been completed and as soon as marring of the concrete would not occur, then entire surface of the newly placed concrete shall be sealed by spraying it with a uniform application of white pigmented membrane curing compound, at the rate of one gallon for each 150 square feet of surface. If rain falls on the newly coated surface before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply additional curing material to the affected portions.

O. COLD WEATHER PROTECTION: Cold weather protection shall be provided as necessary.

P. TOLERANCE IN PAVEMENT THICKNESS: It is the intent of these specifications that pavement shall be constructed strictly in accordance with the thickness shown on the plans. The thickness of the pavement will be measured, and where any pavement is found deficient in thickness, in excess of one inch, it shall be

removed and replaced.

The thickness of the pavement will be determined by average caliper measurement of cores. For the purpose of determining the construction thickness of the pavement, 10 cores per mile will be taken at random intervals in each traffic lane. In addition, cores may be taken at other locations as may be determined by the Engineer. If the measurement of any core is deficient in excess of 1 inch from the plan thickness, additional cores will be taken at 25-foot intervals parallel to center line ahead and back of the affected location until the extent of the deficiency has been determined

It will be assumed that each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along center line, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section.

The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of concrete pavement, may be waived by the Engineer. In this case the designed thickness will be considered as the measured thickness.

Q. PROTECTION AND OPENING TO TRAFFIC: The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the Engineer. Traffic shall be excluded from the pavement by erecting and maintaining barricades and signs for at least seven days.

R. PAVING BY SLIP FORM: Slip-forming equipment will be accepted providing it produces a paving operation in compliance with all the foregoing requirements other than forms.

S. INTEGRAL CURB: The work shall consist of furnishing all labor, materials, and equipment necessary to construct integral curbs in accordance with the plans and specifications. 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 curbs shall be provided at all driveway entrances and sidewalks shown on the plans.

T. MATERIALS: Class "A" concrete shall be Portland Cement Concrete in accordance with these Specifications.

Expansion joints shall be preformed expansion joint fillers of a non-extruding type conforming to ASTM Designation D1751.

Joint sealing compound for sawed contraction joints and construction joints shall be grade CRS-2 emulsified asphalt, or as approved by the Engineer.

Liquid curing compound shall be a white pigmented membrane-forming liquid conforming to the requirements of the ASTM Designation C309, Type 2.

U. CONSTRUCTION METHODS: The integral curb shall be constructed immediately following the finishing operation unless otherwise shown on the plans. Special care shall be taken so that the curb construction does not lag the pavement construction and form a "Cold Joint".

Metal 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 forms impractical.

The drilling of cores in irregular areas, or on projects involving less than 2500 square yards of concrete pavement, may be waived by the Engineer. In this case, the designed thickness will be considered as the measured thickness.

V. PAVING BY SLIP FORM: Slip-forming equipment will be accepted, providing it produces a paving operation in compliance with all the foregoing requirements other than forms. In placing curb concrete, sufficient vibrating shall be done to secure adequate bond with the paving slab and eliminate all voids in the curb.

Curbs shall be formed to the cross section as shown on the drawings with a mule or templates supported on the side forms and with a wood float not less than four feet in length.

The finished surface of the curb and gutter shall be checked by the use of the 10 foot straightedge and corrected if necessary. Where grades are flat and while concrete is still plastic, the Engineer may require the Contractor to check the drainage at the gutter by pouring water at the gutter summit and observing its flow to the inlet. In order to prevent damage to the concrete surface, water should be poured onto a piece of impervious paper or plastic.

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.

Section 52. Plant Mix Bituminous Surface Course.

A. SCOPE OF WORK: The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling, placing and consolidation of plant mix bituminous surface course in accordance with the drawings and contract documents.

B. MATERIALS: Asphalt cement for Surface Course shall meet, at minimum, PG grade 64-22, homogeneous and free from water, and shall not, on heating, foam below

the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements for the specified grade.

NOTE: The spot test shall be conducted in accordance with AASHTO T102, with the following modifications: Add to Section 5.2.1, "If, however, the drop forms a uniformly brown circular stain, the test shall be reported as negative. In case of dispute, the entire test shall be repeated. "Delete Section 5.3 through 7.3, inclusive."

C. COURSE OF AGGREGATE: All course aggregate shall consist of sound, durable rock, free from cemented lumps or objectionable coatings. When tested in accordance with AASHTO T96, the percentage of wear shall not exceed 50. The percentage of delirious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 8 percent.

Rock Type	Percent by Weight
Deleterious Rock	8.0
Shale	1.0
Other foreign material	0.5

The requirements of this section apply to each size or fraction of aggregate produced.

If a density requirement is specified for plant mix bituminous surface course the total quantity of chert in each size or fraction of produced crushed stone aggregate, including that permitted as deleterious, shall not vary more than 10 percentage points from the quantity present in the aggregates used in the approved laboratory job mixtures.

D. FINE AGGREGATE: Fine aggregate for plant mix bituminous surface course shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature. With written approval of the Engineer, chat sand produced from flint chat in the Joplin area, or fines manufactured from crushed limestone, igneous rock and chert gravel, or wet bottom boiler slag may be used as fine aggregate for plant mix bituminous surface course. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coatings or injurious material. The percentage of deleterious substances shall not exceed the following values:

Item	Percent by Weight
Clay lumps and shale	1.0
Total lightweight particles, including coal and lignite	0.5
Other deleterious substances	0.1

Lightweight sand particles are not considered deleterious lightweight particles. The total lightweight particles requirement shall not apply to wet bottom boiler slag, angular chert sand, or manufactured sand.

E. MINERAL FILLER: Mineral filler shall consist of limestone dust, Portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps of aggregations or fine particles. When tested in accordance with AASHTO T37 the mineral filler shall conform to the following gradation requirements:

Sieve Size Passing	Percent
Passing No. 30 sieve	100
Passing No. 50 sieve	95-100
Passing No. 100 sieve	90-100
Passing No. 200 sieve	70-100

The gradation of coarse aggregate shall be such that the total aggregate meets the gradation requirements specified hereafter in Composition of Mixtures.".

F. COMPOSITION OF MIXTURES: The total aggregate prior to mixing with asphalt cement, shall meet the following requirements for Grade D mixture:

Grade D Gradation	Percent by Weight
Passing 3/4 inch sieve	100
Passing 1/2 inch sieve	95-100
Passing No. 4 sieve	60-90
Passing No. 10 sieve	35-65
Passing No. 40 sieve	10-30
Passing No. 200 sieve	4-12

The combinations of materials as required in this section shall meet the gradation requirements specified for the work.

Not less than 15 percent nor more than 30 percent natural siliceous sand, porphyry sand, manufactured sand or flint sand of approved quality shall be added as a separate ingredient. Sand shall have 100 percent passing the 3/8-inch sieve and not more than 6 percent passing the No. 200 sieve.

The composition of the mixture shall conform to the following limits by weight:

Item	Percent
Total Mineral Aggregate	92.0 - 96.5
Asphalt Cement	3.5 - 8.0

G. JOB-MIX FORMULA: Prior to preparing any mixture on the project, the Contractor shall submit for the Engineer's approval, a job-mix formula for the mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the Engineer. The job-mix formula shall be within the gradation range specified and shall include the type and sources of all materials, the gradation of the aggregates, and the relative quantity of each ingredient and shall state a definite percentage for each fraction of aggregate. No job-mix formula will be approved which does not permit within the limits specified in "Composition of Mixture", the full tolerances specified in "Changes in Proportion" for asphalt cement and not less than 1/2 the tolerances designated for material passing the No. 10 sieve and the material passing the No. 200 sieve. The job-mix formula approved for the mixture shall be in effect until modified in writing by the Engineer. When unsatisfactory results or other conditions make it necessary or should a source of material be changed, a new job-mix formula may be required.

H. CHANGES IN PROPORTIONS: The Engineer will make such changes in the proportions of asphalt cement and aggregates as he considers necessary within the limits of the specifications. The proposed mixture will be compacted and tested in a laboratory in accordance with AASHTO T167 and the bulk specific gravity will be determined in accordance with the procedures described in AASHTO T165.

The mixture of mineral aggregate and asphalt cement shall result in a bituminous mixture which will be durable and retain satisfactory cohesion in the presence of moisture. Chemical additions approved by the Engineer may be made to the asphalt cement or to the mixture.

I. GRADATION CONTROL: In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls.

Total aggregated gradation shall be within the master range specified in "Composition of Mixtures" for Grade D mixture.

Maximum variation from the approved job-mix formula shall be within the following tolerances:

Passing No. 10 sieve	+ 5.0 percentage points
Passing No. 200 sieve	+ 2.0 percentage points

Quality of Asphalt Cement introduced into the mixture shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the Engineer. The quantity of asphalt cement determined by calculation or tests on the final mixture shall not vary more than + 0.5 percentage points from the job-mix

formula.

J. COMMERCIAL MIXTURE: The Contractor may, at his option, use an approved commercial mixture. The Contractor shall, at least 7 days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture he proposes to furnish. The statement shall include: (1) the types and sources of aggregates, percentage range of each, and range of combined gradation; (2) the percent and grade of asphalt; and (3) the mixing time and range of mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. If the proposed mixture and plant are approved by the Engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with each truck load, a certification in triplicate that the materials and mixture delivered are in conformance with his approved proposal. The mixture shall be transported, placed and compacted as specified hereinafter.

K. WEATHER LIMITATIONS: Bituminous mixtures shall not be placed: (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 40 degrees Fahrenheit, (2) on any wet or frozen surface, or (3) when weather conditions prevent the proper handling or finishing of the mixture.

L. SUBGRADE PREPARATION: The subgrade upon which bituminous surface course is to be placed shall be prepared in accordance with the requirements as shown on the plans. If the bituminous surface course is to be placed upon the top of a complete base course or existing hard surfaced pavement, then the base course or existing pavement will be considered the subgrade for the next operation.

M. TACK COAT: The asphalt cement material used for tack coat shall be emulsified asphalt meeting the requirements of AASHTO M140 or M208, and shall be Grade SS-1 or SS-1H as designated by the Engineer.

N. PREPARATION OF SURFACE: The existing surface shall be free of all dust, loose material, grease, or other foreign material at the time the tack is applied. Any fat bituminous surface mixture or bituminous joint material will be removed by others without cost to the Contractor before the tack is applied. The surface shall be dry when the tack is applied, except in the case of emulsified asphalt.

O. APPLICATIONS: Bituminous material shall be applied uniformly with a pressure distributor at the rate specified in the contract, or as revised by the Engineer to be within a minimum of 0.02 and a maximum of 0.10 gallon per square yard. In using emulsified asphalt water may be added to the material and mixed therewith in such proportion that the resulting mixture will contain not more than 50 percent of added water, the exact quantity of added water to be specified by the Engineer. The application of the resulting mixture shall be such that the original emulsion will be spread at the specified rate. The tack material shall be heated at the time of application to the temperature specified in the table below. The tack material shall

be properly cured and the tacked surface shall be cleaned of all dirt and surplus sand before the next course is placed.

APPLICATION TEMPERATURES FOR BITUMINOUS MATERIALS
Temperature in Degrees Fahrenheit

	Spraying		Mixing Asphalt Emulsions	
Bituminous Material	Min.	Max.	Min.	Max.
SS-1	75	130	75	130
SS-1H	75	130	75	130

The tack coat shall be applied in such manner as to cause the least inconvenience to traffic. The tack may be applied full width, provided the tacked surface is blotted with sand in such quantity as specified by the Engineer before it is opened to traffic.

P. HAULING EQUIPMENT: Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum quantity of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the bed. Each load shall be covered with canvas or other suitable material of sufficient size to protect the mixture from the weather. When necessary, truck beds shall be insulated so that the mixture will be delivered on the road to meet the requirements. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight.

Q. SPREADING: The base course, primed surface, or preceding course or layer shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading the bituminous mixture. When delivered to the roadbed, the mixture shall be at a temperature which will permit proper placement and compaction. It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The paver shall be operated at a speed that will give the best results.

R. SURFACE CONDITION: The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with suitable mixture. The outside edges of the pavement shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

S. SPOT WEDGING AND LEVELING COURSE: Leveling course, consisting of a layer of variable thickness used to eliminate irregularities in the existing surface,

shall be spread to the desired grade and cross section. Rigid control of the placement thickness of the leveling course will be required. Spot wedging operations over small areas, with featheredging at high points and ends of spot areas, may be required prior to placing the leveling course. The use of an approved finishing machine will be required on the spot wedging and leveling course, except that the spreading of the spot wedging with a blade grader will be permitted if results indicate the mixture is practically free from segregation.

T. JOINTS: Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. A single lane of any layer shall not be constructed to a length for which the adjacent lane cannot be completed in succeeding operating day. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches; however, the joints in the final layer shall be at the lane lines of the travel way.

At locations designated in the contract or as specified by the Engineer, approaches shall be tacked in accordance with "Tack Coat" and surfaced with a plant bituminous mixture. The bituminous surface shall be placed in accordance with the details shown on the typical section or as specified by the Engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

The mixture shall be thoroughly compacted by at least three complete coverages over the entire area with either a pneumatic tire roller weighing not less than 10 tons, or a tandem-type steel wheel weighing not less than 10 tons. All rollers used shall be in satisfactory condition, capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roll or wheel. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. Final rolling shall be done by the steel wheel roller. Rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation and until all roller marks are eliminated.

The finished course shall have the nominal thickness shown on the plans and shall be substantially free from waves or irregularities. The final riding surface, except on medians and similar areas, shoulders, and temporary bypasses shall not vary from a 10-foot straightedge, applied parallel to the center line, by more than 1/8 inch. At transverse construction joints, the surface of all other layers shall not vary from the 10-foot straightedge by more than 1/4 inch. Surfaces exceeding these tolerances shall be re-rolled, replaced, or otherwise corrected in a manner satisfactory to the Engineer.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture showing an excess of asphalt cement

or that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with satisfactory mixture, which shall be immediately compacted to conform with the surrounding area.

It is the intent of these specifications that the plant mix bituminous surface course shall be constructed strictly in accordance with the plant mix bituminous surface course and the plant mix bituminous base course will be measured, and where the total thickness is found to be deficient, corrective actions will be taken as indicated hereinafter.

The total combined thickness of the bituminous surface course and the bituminous base course will be measured and determined by average caliper measurement of cores. For the purpose of determining the constructed thickness, 10 cores per mile will be taken at random integrals in each traffic lane. In addition, cores may be taken at other locations as may be determined by the Engineer. If the measurements of any core is deficient in excess of 1/4 inch from the plan thickness, additional cores will be taken at 25-foot intervals parallel to center line ahead and back of the affected location until the extent of the deficiency has been determined.

It will be assumed that each core is representative of the total combined thickness for a distance extending one-half the distance to the next core, measured along center line, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section.

The areas of deficiency shall be corrected by the addition of plant mix bituminous surface course material and the areas shall be recompacted in accordance with these specifications. The limits of the area of deficiency shall be defined as the transverse distance from the outside edge of the pavement to the center line of the street and a minimum longitudinal distance of 15 feet in both directions from the deficient core. If the number of deficient pavement locations exceeds four per 1/4 mile or if the total area of deficient pavement sections exceed 5 percent of the total pavement area in 1/4 mile, the Contractor shall be required to resurface the entire 1/4 mile street surface area with a minimum thickness of 1/2 inch of plant mix bituminous surface course. Additional test cores will be taken in order to determine if the deficiencies have been corrected. The costs of all such additional check cores will be at the Contractor's expense. The surface form which the cores have been taken shall be restored by the Contractor within 48 hours using a mixture acceptable to the Engineer.

Section 53. Plant Mix Bituminous Base Course.

A. SCOPE OF WORK: The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling, placing and consolidation of plant mix bituminous base course in accordance with the plans and contract documents.

B. MATERIALS: Asphalt cement for Base Course shall meet, at minimum, PG grade 64-22, homogeneous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements.

C. FINE AGGREGATE: Fine aggregate for bituminous surface course shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature. With written approval of the Engineer, chat sand produced from flint chat in the Joplin area, or fines manufactured from crushed limestone, igneous rock and chert gravel, or wet bottom boiler slag may be used as fine aggregate for plant mix bituminous surface course. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coatings or injurious material. The percentage of deleterious substances shall not exceed the following values:

Item	Percent by Weight
Clay lumps and shale	1.0
Total lightweight particles, including coal and lignite	0.5
Other deleterious substances	0.1

Lightweight sand particles are not considered deleterious lightweight particles. The total lightweight particles requirement shall not apply to wet bottom boiler slag, angular chert sand, or manufactured sand.

D. MINERAL FILLER: Mineral filler shall consist of limestone dust, Portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps of aggregations of fine particles. When tested in accordance with AASHTO T37 the mineral filler shall conform to the following gradation requirements:

Sieve Size Passing	Percent
Passing No. 30 sieve	100
Passing No. 50 sieve	95-100
Passing No. 100 sieve	90-100
Passing No. 200 sieve	70-100

E. GRADED AGGREGATE: Graded aggregate for bituminous base shall consist of sound, durable rock particles, free from objectionable coatings. When tested in accordance with AASHTO T96, the percentage of wear shall not exceed 55. The percentage of deleterious substances shall not exceed the following values and the sum or percentages of all deleterious substances shall not exceed 8 percent.

Aggregate Type	Percent Passing By Weight
Deleterious Rock	8.0
Mud Balls and Shale combined	2.0
Clay, uniformly dispersed	3.0
Other foreign material	0.5

The gradation of the course aggregate shall be such that the total aggregate meets the gradation requirements specified hereafter under "Job Mix Formula, page 71, prior to being fed into the cold aggregate feeders.

F. COMPOSITIONS OF MIXTURES: The bituminous base shall be composed of a mixture of crushed limestone or dolomite, except as hereinafter permitted, filler if needed, and asphalt cement. The aggregate prior to mixing with asphalt cement shall meet the following gradation requirements:

Sieve Size Passing	Percent by Weight
Passing 1 inch sieve	100
Passing 1/2 inch sieve	60-90
Passing No. 4 sieve	35-65
Passing No. 10 sieve	25-45
Passing No. 40 sieve	10-30
Passing No. 200 sieve	5-12

At the option of the Contractor, fine aggregate having 100 percent passing the 3/8-inch sieve and not more than 6 percent passing the No. 200 sieve may be incorporated into the mixture. The total quantity of such fine aggregate shall not exceed 30 percent by weight of the combined aggregate.

The composition of the mixture shall be as directed by the Engineer and shall conform to the following limits by weight:

Item	Percent
Total Mineral Aggregate	94-97
Asphalt Cement	3-6

G. JOB-MIX FORMULA: Prior to preparing any of the mixture on the project, the contractor shall submit for the Engineer's approval, a job-mix formula for the mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the Engineer. The job-mix formula shall be within the gradation range specified for bituminous base and shall include the type and sources of all materials, the gradations of the aggregates and the relative quantity of each ingredient, if more than one, and shall state a definite percentage for each fraction of aggregate. No job-mix formula will be

approved, which does not permit within the limits specified in "Compositions of Nature," in the full tolerances specified in "Changes in Proportions," and in the full tolerances specified in "Gradation Control," for material passing the No. 10 sieve and the material passing the No. 200 sieve. The job-mix formula approved for the mixture shall be in effect until modified in writing by the Engineer. When unsatisfactory results or other conditions make it necessary, or should a source of material be changed, a new job-mix formula may be required.

H. CHANGES IN PROPORTIONS: The Engineer will make such changes in the proportions of asphalt cement and aggregates as he considers necessary within the limits of the specifications. The proposed mixture will be compacted and tested in the laboratory in accordance with AASHTO T167 and the bulk specific gravity will be determined in accordance with the procedures described in AASHTO T165. The mixture of mineral aggregate and asphalt cement shall result in a bituminous mixture which will be durable and retain satisfactory cohesion and stability in the presence of moisture. Chemical additions approved in writing by the Engineer may be made to the asphalt, cement, or to the mixture.

I. GRADATION CONTROL: In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls.

Total aggregated gradation shall be within the master range specified in "Composition of Natures" herein.

Maximum variation from the approved job-mix formula shall be within the following tolerances:

Passing No. 10 sieve	+/-5.0 percentage points
Passing No. 200 sieve	+/-2.0 percentage points

J. QUALITY OF ASPHALT: Cement introduced into the mixture shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the Engineer. The quantity of asphalt cement determined by calculation or tests on the final mixture shall not vary more than +/-0.5 percentage points from the job-mix formula.

K. COMMERCIAL MIXTURE: The Contractor may, at his option, use an approved commercial mixture. The Contractor shall, at least 7 days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture he proposes to furnish. The statement shall include: (1) the types and sources of aggregates, percentage range of each, and range of combined gradation; (2) the percent and grade of asphalt; and (3) the mixing time and range of mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. If the proposed mixture and

plant are approved by the Engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with each truck load, a certification in triplicate that the materials and mixture delivered are in conformance with his approved proposal. The mixture shall be transported, placed and compacted as specified hereinafter.

L. WEATHER LIMITATIONS: Bituminous mixtures shall not be placed: (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 35 degrees F and, (2) on any wet or frozen surface, or (3) when weather conditions prevent the proper handling or finishing of the mixture.

M. SUBGRADE PREPARATION: The subgrade shall be prepared in accordance with the requirements "Subgrade Preparation" of these specifications.

N. PRIME COAT: The asphalt cement material used for prime coat on base rock shall be Type MC, grade MC-30 and not be homogenous and be free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements.

O. APPLICATION: Bituminous material shall be applied to the width of the section to be primed by means of pressure distributor in a uniform, continuous spread. The application rate shall be as specified in the contract or as revised by the Engineer between 0.2 and 0.5 gallon per square yard. The primer shall be heated at the time of application to a temperature specified in the following table.

P. PRIME COAT: The asphalt cement material used for prime coat on asphalt base shall be Type SS-1, and not be homogenous and be free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to all standard industry requirements.

Q. APPLICATION: Bituminous material shall be applied to the width of the section to be primed by means of pressure distributor in a uniform, continuous spread. The application rate shall be as specified in the contract or as revised by the Engineer between 0.2 and 0.5 gallon per square yard. The primer shall be heated at the time of application to a temperature specified in the following table.

APPLICATION TEMPERATURES FOR BITUMINOUS MATERIALS
Temperature, Degrees Fahrenheit

Bituminous Material	Spraying		Mixing	
	Min.	Max.	Min.	Max.
Liquid Asphalt SS1 and MC Grade	150		50	110

Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified quantity. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed. Pools of primer material remaining on the surface after the application shall be removed.

When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will 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 routed to the treated portion and the remaining width of the section shall be primed.

If, after the application of the prime coat, the bituminous material fails to penetrate, and the roadbed must be used by traffic, sand blotter material shall be spread in the quantity required to absorb any excess bituminous material. The primer shall be properly cured, and the primed surface shall be cleaned of all dirt and surplus sand before the next course is placed.

R. TRANSPORTATION: The prepared base course mixture shall be transported from the paving plant to the work in tight vehicles previously cleaned of all foreign materials. The inside of truck beds shall be lubricated with a thin oil to prevent the mixture from adhering to the bed but an excess of lubricant will not be permitted. Each load shall be covered with canvas or other suitable material of sufficient size to protect it from the weather. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be done during daylight.

S. SPREADING: The base course, primed surface, or preceding course or layer shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading the bituminous mixture. When delivered to the roadbed, the mixture shall be at a temperature which will permit proper placement and compaction. It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The compacted thickness of a single layer shall not exceed 4 inches except the uppermost layer directly under the surface course for travel ways and auxiliary lanes shall be placed in a single layer not to exceed the width and thickness shown on the plans. In widening construction, the material may be placed in two layers, provided the thickest layer is placed first and no individual layer has a compacted thickness greater than 7 inches. On base widening work, a succeeding layer of bituminous mixture may be placed the same day as the previous layer, if it can be shown that the desired results are being obtained. On small areas, and on areas which are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the Engineer.

The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. The outside edges of the base shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

If required by the contract, a leveling course consisting of a layer of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface. Spot-leveling operations over small areas, with featheredging at high points and ends of spot areas, may be required prior to placing the leveling course. Rigid control of the placement thickness of the leveling course will be required. The use of an approved finishing machine will be required on the spot-leveling and the leveling course, except that the spreading of the spot-leveling with a blade grader will be permitted if results indicate the mixture is practically free from segregation.

T. JOINTS: Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. The longitudinal joints in one layer shall offset those in layers immediately below by approximately 6 inches.

U. COMPACTION: Rolling shall include the use of both a pneumatic tire roller and a steel wheel roller. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. All rollers shall be in satisfactory condition capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roller wheel. A trench roller shall be used on depressed areas inaccessible to regular width equipment. The compacted mixture shall have a density of not less than 95 percent of that obtained by the laboratory compaction of a specimen made in the proportions of the approved mixture. Density will be determined by the direct transmission nuclear method or by a specific gravity method.

In lieu of roller and density requirements, mixtures used for shoulders adjacent to rigid pavement, shoulders adjacent to resurfaced rigid pavement, temporary bypasses to be maintained at the expense of the Contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverage over the entire area with either a pneumatic tire roller weighing not less than 10 tons, a tandem-type steel wheel roller weighing not less than 10 tons, or an approved vibratory roller. Final rolling shall be done with the tandem-type steel wheel roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation.

V. SURFACE TOLERANCES: The finished layers shall be substantially free from

waves or irregularities and shall be true to the established crown and grade. At transverse construction joints the surface of all layers shall not vary from a 10-foot straight-edge, applied parallel to the centerline, by more than 1/4 inch, except that the entire surface of the final layer of plant mix bituminous base mixture shall not vary from the 10-foot straightedge by more than 1/8 inch if this layer is used as the final riding surface course. Areas exceeding this tolerance shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the Engineer.

W. TOLERANCE IN PAVEMENT THICKNESS: It is the intent of these specifications that the plant mix bituminous base course shall be constructed strictly in accordance with the thickness shown on the plans. The total thickness of the pavement will be measured by coring as indicated under "Plant Mix Bituminous Base Course", Section 25-52. Where any pavement is found deficient in thickness, corrective actions shall be taken as indicated under "Plant Mix Bituminous Base Course", Section 25-52.

No additional compensation will be allowed the Contractor for any plant mix bituminous base course constructed in excess of the thickness requirements of the plans and specifications. The surface from which the cores have been taken shall be restored by the Contractor within 48 hours using a mixture acceptable to the Engineer.

X. METHOD OF MEASUREMENT: Full depth pavement areas of plant mix bituminous base course will be measured to the nearest 1/10 square yard. Areas requiring a variable thickness bituminous base course will be measured on a per ton basis. The weight of the bituminous base course for the areas requiring a variable thickness will be determined from weight tickets for each truck delivering base course to the job site. Final measurement for variable thickness base course will be to the nearest 1/10 ton of acceptable base course.

Y. BASIS OF PAYMENT: Payment for all plant mix bituminous base course shall include all labor, materials and equipment necessary for the construction of the bituminous base course, in place. Prime coat will be considered incidental to said construction unless specified separately in the specifications.

Payment for full depth pavement areas of plant mix bituminous base course will be on a square yard basis. Payment for variable thickness bituminous base course will be on a per ton basis. In case a truck load of bituminous base course is to be spread in both areas of full depth pavement and variable depth pavement, the Contractor and Engineer shall agree on the tonnage of that portion of the load used in the variable depth area, prior to its placement. The conversion from tons to square yards is based on 110 lb./sq. yd/inch.

Section 54. Aggregate for Base (Rock Base Course).

A. SCOPE OF WORK: The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling and placing aggregate base course (rock base) in accordance with the plans and contract documents.

B. TYPE 1 AGGREGATE: Type 1 aggregate for base shall be essentially limestone or dolomite. It shall not contain more than 15 percent deleterious rock and shale. Sand may be added only for the purpose of reducing the plasticity index of the fraction passing the No. 40 sieve in the finished product. Any sand, silt and clay, and any deleterious rock and shale shall be uniformly distributed throughout the mass. The aggregates shall conform to the following gradation requirements:

SIEVE SIZE	PERCENT
Passing 1-inch sieve	100
Passing 1/2-inch sieve	60-90
Passing No. 4 sieve	40-60
Passing No. 40 sieve	15-35

The fraction passing the No. 40 sieve shall have a plasticity index not to exceed six.

C. PLACEMENT AND COMPACTION: Shall be well drained and compaction of earthwork below street, sidewalk and driveway approaches by rolling, tamping or any combination of these methods to meet minimum 95% compaction. (reference MoDOT standards and specifications section 209).

D. SURFACE TOLERANCES: The finished layers shall be substantially free from waves or irregularities and shall be true to the established crown and grade. At transverse construction joints the surface of all layers shall not vary from a 10-foot straight-edge, applied parallel to the centerline, by more than 1/4 inch. Areas exceeding this tolerance shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the City or Engineer.

E. TESTING SAMPLES: All samples collected for testing purposes shall be obtained in the presence of an authorized City of Nixa employee. Any samples tested that have not been obtained in the presence of an appointed City of Nixa employee shall be considered invalid. All costs associated with testing shall be borne by the contractor. The City of Nixa reserves the right to request testing at its discretion (3/9/98).

Section 55. Sub Grade Preparations.

A. SCOPE OF WORK: The work shall include all labor, equipment, and materials necessary for the furnishing, mixing, hauling and placing sub grade in accordance with the plans and contract documents.

B. PLACEMENT AND COMPACTION: Sub grade shall consist of the compaction of earth below the rock base for street, sidewalk and driveway approaches by rolling, tamping or any combination of these methods to meet minimum 98% compaction. (reference MoDOT standards and specifications).

C. SURFACE TOLERANCES: The finished layers shall be substantially free from waves or irregularities and shall be true to the established crown and grade. Areas exceeding this shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the City or Engineer.

D. TESTING SAMPLES: All samples collected for testing purposes shall be obtained in the presence of an authorized City of Nixa employee. Any samples tested that have not been obtained in the presence of an appointed City of Nixa employee shall be considered invalid. All costs associated with testing shall be borne by the contractor. The City of Nixa reserves the right to request testing at its discretion as specified above.

Section 56. General Notes.

A. Expansion joints shall be placed on concrete curb & gutter at all driveway radii and intersection radii and at intervals of not more than two hundred (200) feet. Preformed expansion joint filler shall be of non-extruding type and shall conform to ASTM Designation D1751. (See Detailed Drawing D-9 in the City of Nixa Technical Specifications Book)

B. Contraction joints shall be placed on concrete curb and gutter at intervals not greater than twenty-five feet. Joints shall be filled with asphalt material. (See Detailed Drawing D-9 in the City of Nixa Technical Specifications Book)

C. Where concrete curbs must be removed to facilitate drive entrances, curbs must be cut out prior to removal and the cut ends grouted to provide a pleasing appearance.

Expansion joints shall be placed on concrete pavements as shown on the City of Nixa standard joint location plan sheet for concrete pavements and concrete pavement with integral curb. Expansion joints shall be located on straight runs at intervals not exceeding 50 feet. Preformed expansion joint filler shall be of non-extruding type and shall conform to ASTM Designation D1751.

D. Contraction joints shall be placed on concrete pavement as shown on the City of Nixa standard joint location plan sheet for concrete pavements and concrete pavement with integral curb.

Section 57. Design Standards for Streets and Roadways.

A. GRADES:

All street grades shall comply with the following minimum and maximum.

CLASSIFICATION	MINIMUM	MAXIMUM*
Alleys	0.5%	12%*
Local	0.5%	12%*
Collector	0.5%	10%*
Arterials	0.5%	8%
Parkways	0.5%	8%

* These are maximum allowable under any circumstance. The City reserves the right to modify standards for all grades over 8%. All grades grater than 8% are subject to review by the City and the Engineer and may require special construction standards including additional subgrade, base and pavement thickness and specifications. Additional requirements to meet this section will be the responsibility of the developer/owner.

B. VERTICAL CURVES:

The length of vertical curves shall be no less than that determined by the formula:

L = KA, where
L = Length of vertical curve, feet,
A = Algebraic difference in grades
K = Constant defined in the following table.

K VALUES

CLASSIFICATION	CREST	SAG
Alleys	10	20
Local	20	30
Collector	40	50
Arterials	80	70
Parkways	80	70

C. HORIZONTAL CURVES AND SUPER ELEVATION:

The minimum centerline radii (R), maximum super elevation (E) and super elevation runout length (L) shall be in accordance with the following table.

K VALUES

CLASSIFICATION	R	E	L
Alleys	150	N/A	N/A
Local	150	.02	80
Collector	250	.04	100
Arterials	500	.04	115
Parkways	500	.04	115

D. MINIMUM CURB RADII AT INTERSECTIONS:

CLASSIFICATION	INTERSECTING LOCAL & COLLECTOR
Alleys	15'
Local	15'
Collector	20’
Arterials	30'
Parkways	30'

E. INTERSECTIONS:

All curb returns shall be designed with a wheel chair ramp meeting the requirements of Drawing D-10. No structures will be permitted in the ramp area.

Where the approach grade of either or both streets exceed four percent, a leveling area shall be provided. The leveling area shall have a minimum length of 75 feet measured from the intersection of the edge of gutter flag or edge of road within which no grade shall exceed a maximum of three percent.

Right angle intersections shall be used whenever practical. The angle of intersection shall not be less than 75 degrees.

F. PAVEMENT DESIGN:

Pavement sections shall be in accordance with the Drawing D-1. Soils information and design calculations shall be submitted when deviating from the standards shown on Drawing D-1.

Section 58. Street Permit and Inspections Required for all Street Cuts, Bores, and Curb Cuts.

Street Permit shall be submitted and approved by the City before any street cut, bore or curb cut begins. Street cuts within 4' of final grade must be backfilled with Base Rock, installed in 6" compacted lifts to within 8" of final grade. The final 8" shall be filled with concrete. A City inspection of the rock fill is required before concrete is placed. Street Cuts greater than 4' shall be filled to within 4' of final grade with ¾" clean rock.

Sections 59 Reserved

ARTICLE V
EQUIPMENT

Section 60. Submersible Pump Station.

A. SCOPE: The pump station shall be furnished and installed complete as shown, including wet well, wet well cover, pumps, controls, valves, valve box, slide rails, supervisory system, high level alarms with lights and horn, security fencing, and all equipment and appurtenances required to provide a complete and satisfactory pumping installation. Potable water shall be extended to pump station location.

B. GENERAL: The complete pump station assembly including all equipment and appurtenances shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the sewage pumping station manufacturer unless exceptions are noted by the Engineer.

The station shall be designated to withstand soil pressure based on a soil weight of at least 120 pounds per cubic feet. All sizes, thickness, and deflection of the component parts shall be acceptable to the Engineer.

C. WET WELL/VALVE BOX ACCESS: A wet well cover and valve box cover shall be constructed of 1/4 " steel plate as shown. The wet well cover shall consist of a double door access opening provided in the top to allow removal of either the pump from the wet well or access to the float switch assembly. Each cover shall be provided with a continuous hinge welded to a support frame. Each cover at the wet well shall be reinforced to allow the total weight of a pump to be rested on it during removal. Each cover at the wet well shall be reinforced with an angle anchored to the circular wall to provide sufficient support if deemed necessary by the Engineer.

D. SEWAGE PUMPING EQUIPMENT: The sewage pumping equipment to be furnished and installed in the pumping station shall consist of motor driven, nonclog sewage pumps, each complete with all specified accessories and appurtenances.

Pumps shall be non-clog submersible pumps. All pumps in a station shall be the same type. Each pumping unit shall conform to the following requirements:

1. Performance and Design Requirements:

Number of pumps and motors	2
Rated total head, feet	As Required
Capacity at rated head, gpm	As Required
Min. shutoff head, feet	As Required
Min. total head for continuous operation, feet	As Required
Max. bhp requirement of pump at any total head in excess of min. head for continuous operation	As Required
Operation speed, rpm	As Required
Min. diameter of test sphere, inches.	As Required
Min. suction inlet diameter, inches	As Required
Min. discharge outlet diameter, inches	As Required

Head losses through the pump, including pump suction elbow losses, are not included in the total pumping heads stipulated in the foregoing design data tabulation.

2. Pump Materials:

Item	Material
Case	Cast iron, ASTM A48
Impeller	Cast iron, ASTM A48
Shaft	Stainless steel or carbon steel w/ stainless steel sleeve
Mechanical Seal	Dura metallic "Dura Seal", double seal, carbon and ceramic with No. 9 or better carbon rings.

3. Non-Clog Submersible Pump Construction:

a. Motor - Pump motor shall be of the sealed submersible type rated as necessary to meet the specified performance and design requirements. Motors shall be for 240/480 volt, 60 Hz, 3 phase power supply. Stator winding to be of the open type with insulation good for 80 degrees C. Winding housing to be filled with a clean high dielectric oil that lubricates bearings and seals and transfers heat from winding and rotor to outer shell.

Motor shall have two heavy duty ball bearings to support pump shaft and take radial and thrust loads and a sleeve guide bushing directly above the lower seal to take radial load and act as flame path for seal chamber. Ball bearings shall be designed for 30,000 hours B-10 life. Stator shall be heat shrunk into motor housing.

A heat sensor thermostat shall be attached to and imbedded in the winding and be connected in series with the motor starter contactor coil to stop motor if temperature of winding is more than 220 degrees F. Thermostat to reset automatically when motor cools to safe operating temperature. Two heat sensors to be used on 3 phase motors. The common pump motor shaft shall be of 416 stainless steel.

b. Seals - Motor shall be protected by two mechanical seals mounted in tandem with a seal chamber between the seals. Seal chamber shall be oil filled to lubricate seal face and to transmit heat from shaft to outer shell. Seal face shall be carbon and ceramic and lapped to a flatness of one light band.

   A double electrode shall be mounted in the seal chamber to detect any water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control panel. This signal shall not stop the motor but shall act as a warning only, indicating service is required.

c. Impeller - Shall be cast iron and of the 2 vane non-clog enclosed type. Vane inlet tips shall be carefully rounded to prevent stringy material from catching in vanes. Pump-out vane shall be used in front and back chamber and impeller shall be dynamically balanced by grinding on shroud faces. No holes are to be drilled for balancing.

   Impeller to be driven by stainless steel shaft key and impeller held in place with lock screw and washer.

   Impeller and motor shall lift off case as a unit without disturbing discharge piping.

   Impeller neck shall run in bronze wear ring that is pressed into volute case.

d. Pump Case - The volute case shall be cast iron and have aflanged center line discharge. Discharge flange shall be 4 inch standard with bold holes straddling center line. Bronze wear ring to be pressed into case for guiding impeller neck and to prevent corrosion freeze up.

   Wear ring to be held from rotating by locking with stainless steel set screw in end of ring.

e. Pump and Motor Casting - All castings shall be of high tensile cast iron and shall be treated with phosphate and chromate rinse.

f. Bearing End Cap - Upper motor bearing cap shall be a separate casting for easy mounting and replacement.

g. Power Cables - Power cord and control cord shall be double sealed. The power and control conductor shall be single strand sealed with epoxy potting compound and then clamped in place with rubber seal bushing to seal outer jacket against leakage and to provide for strain pull. Cords shall withstand a pull of 300 pounds to meet U.L. requirements.

   Insulation of power control cords shall be type SO or STOW. Both control and power cords shall have a green carrier ground conductor that attaches to motor frame.

E. DATA TO BE SUBMITTED: Each request from the Contractor for review of equipment shall be accompanied by complete descriptive, performance and engineering data covering equipment offered. Two copies of the following items are required information.

Pump Data:

Name of Manufacturer,
Type and Model,
Design rotative speed,
Size of pump section inlet,
Size of suction elbow outlet,
Type and number of bearings,
Maximum bhp requirement of pump at any total head
specified minimum for continuous operation,
Maximum diameter of test sphere,
Complete performance curves showing capacity, head, &
NSPE requirements, efficiency and bhp requirements,
Shaft diameter,
Type of pump seal.

Motor Data:

Name of manufacturer
Type designation
Rated size of motor (hp), service factor, and temperature rating
Full load rotative speed
Weight
Input-Output efficiency at:
(a) Full Load
(b) Rated pump condition

Full Load current
Locked rotor current
Shaft diameter
Type of lubricant
Description of special moisture resistant treatment of motor air gap surfaces

F. SHOP TESTS: Each pump shall be shop tested for capacity, power requirement, and efficiency at specified minimum head for continuous operation, rated head, shutoff head, and at as many other points as necessary for accurate performance curve plotting in each case. All tests shall be made in conformity with the requirements and recommendations of the Hydraulic Institute. Shop tests shall be conducted by the pump manufacturer or by the pumping station manufacturer after installation in the pumping station.

Not less than two certified copies of a report covering each test, and capacity, power, and efficiency curves based on shop test results shall be prepared and delivered to the Engineer not less than 10 days prior to shipment of the equipment from the factory.

G. RESPONSIBILITY: The manufacturer of the pumping station assembly shall be responsible for proper installation, alignment, and operating conditions of the pumping equipment when placed in service.

H. PUMPING STATION ELECTRICAL SYSTEM: The pumping station shall be designed for 3 phase, 3 wire, 240 volt power service. Single phase, 120 volt auxiliary power requirements and 24 volt control power requirements shall be provided for by furnishing suitably sized dry type transformers within the station. All wiring shall conform to the National Electrical Code and shall comply with local regulations and ordinances of the community for which the station is constructed.

1. Conduit: Except for plug-in cords and in control enclosures, all wiring shall be in rigid galvanized steel or aluminum conduit or enclosed galvanized steel or aluminum rectangular raceways. Conduit entering the wet well and control panel shall be caulked to prevent the movement of gases from the wet well into the control panel.

2. Cable: Except for continuation of exterior cables, cable and wiring shall be factory installed. On stations where the disconnect shall employ more than one breaker, breaker cable lugs shall be sized to fully accommodate both service entrance conductors and branch service conductors. Removal of outer strands of conductors to make up branch connections will not be permitted. Where breaker lugs will not accommodate service, and branch conductors, T type connectors or double lugs shall be provided. Thermoplastic insulated neoprene covered service entrance conductors of the size required shall be provided.

All power and control cable installed in the station shall be copper, insulated for 600 volts, 75C, wet and dry locations, Underwriters Laboratories Type RHH for power cable and Type RHH or THW for control cable. Bare copper conductors shall be installed in all but lighting conduits for grounding connections.

3. Equipment: All equipment and devices expressly intended as a means of switching, adjusting, or actuating shall be mounted within convenient reach of an attendant.

   Externally operable circuit breaker type disconnect means shall permit disconnecting all phase conductors in the station from service entrance conductors.

   Control and switching equipment enclosures shall be NEMA Type 3 finished steel or rigid heavy-duty construction. Enclosures housing an assembly of switches, contactors, relays, starters, etc., shall have hinged doors with latches.

   Each pump motor and auxiliary circuit shall be provided with thermal-magnetic circuit breakers. Breakers for 3 phase loads shall be 3 pole. All breakers shall be operable from outside the control panel. A three position selector switch with HAND-OFF-AUTO position shall be flush mounted on the panel door for operation of each pump motor. Auxiliary and control power may be supplied through a circuit breaker load center.

   All equipment shall be identified by nameplates and device identifications in agreement

4. Panel Wiring: All control wiring in switching and control assemblies shall be color coded or numbered. Color coding shall be such that electrically common interconnections of devices are the same color. The colors may be used more than once but not in the same circuit or cable grouping. Color of plug-in cord conductors does not need to comply with the color code. The power and control enclosure shall contain ground lugs or an AWG ground in the service entrance circuit and each ground cable to devices in the station. The enclosure shall be well grounded to the station shell by mounting or by an AWG band jumper.

5. Controls: Wet well level and alarm controls shall be 120 volt and shall be provided by sealed float type mercury switches. The mercury tube switches shall be sealed in a solid polyurethane float for corrosion and shock resistance. The support wire for each float switch shall have a heavy neoprene jacket. A weight shall be attached to each support cord above the float to hold the switch in place in the wet well. Weight shall be above the float to effectively prevent sharp bends in the cord when the float operates. Each float switch

shall hang in the wet well supported only by the individual cord connected thereto.

Three level sensors (normally open) and an electric alternator shall provide automatic operation. The lower control shall be at the turn-off (STOP) level, the upper control is to be set at the turn-on (START #1) level required and the override control (START #2) is to be set above the upper control so both pumps will come on if the level rises above the upper control. If one pump fails for any reason, the other pump shall automatically operate on the override control until cause of failure is corrected. A fourth level sensor (normally open) shall operate a high level alarm and the supervisory system.

An automatic alternator with manual switch shall be provided to change the sequence of operation at the end of each pumping cycle. The manual switch shall allow for either pump to be selected as lead pump or for automatic alteration.

An explosion proof junction box, suitable for a corrosive environment and mounting outside the wet well, shall be furnished to connect the four control cords to cables connecting the wet well controls to the pump station. This box shall be constructed so incoming control wires are individually sealed with mechanical rubber seal and so no sealing compounds are required to make explosion-proof joints. Box shall be provided with terminal strip to connect incoming wires with control cords. Control cords shall be sealed in box with mechanical held rubber seal. Box cover shall be bolted on and sealed with rubber "O" ring. Box and all connections shall be completely explosion-proof and waterproof and shall not leak under an outside pressure of 10 psi. A galvanized steel control cord support bracket shall be attached to the junction box and the outside of the wet well top slab. Cord snubbers shall be furnished to hold control cords at any set height.

6. Convenience Outlets: Convenience outlets for auxiliaries shall be 3 wire, polarized grounded type, 15 amp, 125 volt. At least one similar duplex convenience outlet shall be provided on a separate circuit for maintenance tools.

7. Wiring Diagrams: The manufacturer shall provide both connection diagrams and schematics, identifying all items in wiring connections in accordance with terminal identification of equipment.

8. Supervisory: An audio/visual supervisory system shall be located at the pump station to monitor the occurrence of a high wet well level situation. The supervisory information shall be provided by normally open switches which are wired into the control panel.

9. Elapsed Time Meters: An elapsed time meter capable of recording actual

running time shall be provided for each motor. Elapsed time meters shall be mounted in the control panel of the pump station.

I. PIPING: Except where otherwise shown, all sewage piping shall be cast iron. Cast iron pipe shall be ANSI Class 22 conforming to ANSI A21.6 or A21.8. Fittings shall conform to ANSI A21.10. Mechanical joints shall conform to ANSI A21.11 and flanges shall be ANSI 125 lb. All pipe and fittings shall be coated inside and out with the manufacturer's standard bituminous coating. Flange bolts and nuts shall be ASTM A307, Grade B, of such length that, after installation, bolts will project 1/8 to 3/8 inch beyond the outer face of the nut. Flange gaskets shall be of ring type made from 1/11 inch thick red rubber or other approved material. Flanged or mechanical joint pipe and fittings shall be used inside the pumping station, and mechanical joint type bells shall be provided outside the station walls.

J. VALVES: Each pump discharge shall be provided with a check valve and an eccentric plug valve. The check valves shall be located between the pumps and the plug valve. In addition, the manufacturer shall provide auxiliary valve and piping as shown on plans to a portable gasoline powered sewage pump.

1. Gate Valves: All 4 inch and larger gate valves shall conform to AWWA C500 as modified herein. Gate valves shall be double disc. AWWA gate valves shall have O-ring stem seals.

2. Eccentric Plug Valves: Eccentric plug valves shall have a port area of at least 80 percent of the cross-section of the connecting piping and shall be equivalent to DeZurik "Eccentric Valves". Eccentric plug valves shall be installed with the shaft horizontal and the plug in the upper half of the body.

3. Check Valves: All check valves shall be flanged, iron body, horizontal swing type with all seats, seat rings, pins, bushings and other parts subject to wear constructed of bronze. Vertical check valves and straight globe check valves will not be acceptable.

K. PAINTING AND CORROSION PROTECTION: Preparation of surfaces to be painted and all painting shall be done in the shop before shipment of the station assembly so that field painting will be limited to coating joints or areas not previously painted, or damaged or abraded areas.

All pumps, motors, the control cabinet, explosion-proof junction box and controls and other machines or equipment shall be painted in the shop using epoxy coating or machinery enamel.

Exposed surfaces of copper tubing, including fittings, and valves, inside the station shall have a natural finish obtained by cleaning and burnishing with "00" steel wool and applying a coat of clear lacquer or shall be painted with epoxy.

All joints in wrought metal piping, including exposed threads, to be buried underground, shall be painted with one heavy coat of Tnemec "Tnemecol 456", Koppers "Bitumastic 50" or equal.

All painted surfaces damaged during shipment or installation shall be repainted using the same or equivalent materials as used in the original application.

L. FACTORY TESTS: Before shipment from the factory, the pumping station shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or welds; and proper operation of the automatic control system and auxiliary equipment.

Pump suction and discharge lines shall be connected to a water tank and the sewage pumps operated at least one hour to simulate the field service conditions. The automatic control shall be adjusted to the specified levels. Defective equipment and materials disclosed by such tests shall be replaced and the station placed in satisfactory operating condition before shipment.

M. INSTALLATION OF PUMPING STATION: Backfill around structures shall be placed as soon as the station installation is completed to the Engineer's satisfaction. Backfilling shall be performed in accordance with the requirements of “Structural Backfill” under “Excavation and Trenching.”

N. ACCESS ROAD: An access road shall be constructed from the nearest City street to the lift station to provide access. Road shall be a minimum of fifteen feet wide and shall meet all requirements for base rock, bituminous base and asphalt as contained in these specifications. (See Detail Drawing D-1 in the City of Nixa Technical Specifications Book)

O. SECURITY FENCING: Fencing shall be installed along the entire property line and shall be constructed as approved on the design plans. Chain link or wood privacy are most common and shall be 8’ in height. Gates shall be provided for access by necessary equipment for future maintenance of the facility.

P. POTABLE WATER: A 1-inch PVC waterline shall be extended from the nearest City water main to the pump station. A frost proof hydrant shall be installed at the pump station for cleanup.

Q. GRADING: Maximum grading at the pump station shall be 3:1 for maintenance purposes. Any grades exceeding 3:1 shall be poured concrete 4-inches in thickness to a point where 3:1 slope can be achieved.

R. DRAWINGS AND DESCRIPTIVE DATA: Shop drawings shall be submitted showing materials and assembly of all elements of the pump station. In addition to pump and motor data to be submitted in paragraph "Data to be Submitted" descriptive literature shall clearly indicate all information necessary to evaluate conformance with specification requirements for all features of the pump station including valves. Complete data for all electrical items, switches, enclosures, relays, motor starters and controls, and a drawing of the control panel layout and a schematic diagram of the control panel circuitry shall be included.

Section 61. Wet Well Mounted Pump Station.

Though some older Wet Well Mounted systems still exist on the system, no new systems of this type shall be allowed.

Section 62. Standby Generator.

A. SCOPE: This section covers the furnishing and installation of a standby generator system, complete including all material and control wiring, etc., required for a complete installation.

B. GENERAL: The generator set shall be as specified herein; with dry-type transformer and all accessories and transfer switches as required and shall be supplied by an authorized distributor of the engine generator set manufacturer who warrants and services the entire package, and having a service and parts organization within a reasonable distance of this project, backed up by a national sales and service organization.

The generator set shall be rated for continuous service at the required loading 80% power factor, 240/480 Volts AC, 3 Phase, at 60 Hertz, for operation at 38 degrees C ambient temperature, and 1500 meters altitude. Approved manufacturers are Onan, Cummings and Caterpillar. Dry-type transformer and all appurtenances shall be installed to carry required 120v systems installed with the project during generator operations.

C. ENGINE: The engine shall be L.P. fueled, liquid-cooled and capable of satisfactory performance operating on L.P. fuel. Engine speed shall be governed within 5 percent from no load to full rated output.

Engine shall be equipped with 12 Volt starting motor, battery charging alternator with automatic regulator, 50 degree C (122 degree F) ambient radiator with fan guards, engine coolant heater, 1500 watts minimum, thermostatically controlled to maintain engine block coolant temperature between 120 and 140 degrees F.

D. ALTERNATOR: The alternator, having a single, maintenance free bearing, shall be

direct connected to the engine and shall be a broad range, 12 lead reconnectable, four pole rotating field unit with rotating brushless exciter. It shall be self-ventilated, with skewed stator and full amourtissuer windings with, 2/3 pitch for smooth voltage wave form. Temperature rise shall be within NEMA MG1-22.40, IEEE, and ANSI standards for standby duty at rated output. The balanced telephone influence factor (TIF) shall not exceed 50. Insulation shall be within class F with vacuum pressure impregnated epoxy on both rotor and stator.

The voltage regulator shall be of the static type and regulation shall be within plus or minus two percent of rated voltage from no load to full load. The voltage regulator shall include under frequency protection and moisture resistance protection. On application of rated load at rated Power Factor, instantaneous voltage dip shall not exceed 20% with recovery within one second.

E. FUEL TANK: The generator shall be equipped with a 250 gallon L.P. fuel tank. The tank shall be equipped with level gauge. The tank shall be filled with L.P. as recommended by the manufacturer.

F. CONTROLS: Set mounted controls shall include automatic start/stop control operable by a remote contact with a switch to select off, automatic or test (allowing set operation without interrupting the normal power supply) modes, a voltage adjustment rheostat, automatic shutdown protection against high engine coolant temperature, low engine oil pressure, engine cranking over 30-45 seconds, and overspeed by directly cutting off the fuel supply, and a lamp to indicate an engine failure has occurred.

G. INSTRUMENTS: The following engine and generator instruments will be set mounted through vibration isolators in a NEMA 1 enclosure and fully wired with appropriate reading lights: ENGINE: battery voltmeter, engine oil pressure and coolant temperature gauges and running time hour-meter. GENERATOR: A.C. voltmeter, A.C. ammeter, phase selector switch, and frequency meter.

H. MOUNTING: The electric plant shall be equipped with vibration isolators mounted between the engine-generator and steel skid base.

I. ACCESSORIES: All accessories required for a complete operating system shall be furnished. These shall include: one 12 volt lead acid battery sized per engine manufacturers requirements, battery cables and rack, automatic float charger (5 amp minimum), residential muffler, stainless steel flexible exhaust connector, fuel lines, 60 amp main line thermal magnetic circuit breaker, oil pan heater, and a weather protective housing with removable side panels.

J. TRANSFER SWITCH: A manually operated transfer switch shall be provided by the generator set manufacturer, rated at 400 amperes, 480 volts and 60 hz. The switch shall have closing, withstanding and interrupting ratings equal to the available short circuit current on the normal supply and shall be rated for continuous duty.

It shall be housed in a NEMA-1 enclosure suitable for wall mounting, shall conform with Underwriters Laboratories 1008 Standards and all classes of load, and meet the National Electric Code (NEC) requirements for critical applications. The transfer mechanism shall be a circuit breaker type. Control circuitry shall be solid state.

The transfer switch shall be equipped with; normal push buttons, transfer push buttons, fixed 5 minute time delay for engine cool down, a test switch to simulate a normal power source failure, pilot lights to visually indicate the transfer switch position, and one set of normally open and normally closed contacts that indicate switch position. The switch shall also be equipped with the following; volt, amp, and frequency meters, 7-day exerciser clock for exercising with or without load.

K. TEST: Certified final factory test report shall be provided to the Engineer certifying the units full power rating, voltage stability, and frequency regulation.

L. START-UP INSTRUCTIONS: A factory trained representative shall consult with the contractor during installation and start-up. The representative shall fully instruct the owners personnel as to correct operating and testing procedures and supply a parts book and a complete operators manual for installation, operation and maintenance.

M. WARRANTY: The generator set, transfer switch and accessories as furnished will carry a one-year guarantee (two years if installed in the U.S. or Canada) against defective parts and workmanship from the date of field testing and acceptance by the first owner and shall include 100 percent parts and labor coverage.

Section 63. Lift Cranes.

A. PORTABLE CRANES:

1. General: Work under this section consists of furnishing and installing portable hand winch operated crane and base for removal of the submersible pumps at the pump station site.

2. Portable Crane: Portable cranes shall be geared hand winch operated, adjustable boom type having a minimum lift capacity of 1,000 pounds. Boom shall be easily detachable for moving. Mast height shall be a minimum of 61 inches above base and boom shall be adjustable with a range of 41 to 65 inches of reach and shall rotate a minimum of 240 degree. Winch shall be double geared with automatic safety brake handle for safe positive to lower load. Portable crane shall be Therm-o-matic Portacrane Model 533, Gilco Type Jt10 or equal. Winch shall have a minimum of 30 feet of 1/2 inch lift cable.

Section 64. Mechanical and Plumbing.

A. VALVES

1. General: All valves shall comply with the following:

a. Ends**:** All buried valves shall have push-on or mechanical joint ends and conform to ANSI A21.11.

b. Rotation: The direction of rotation of the wrench nut to open shall be to the left (counterclockwise). Each valve body or operator shall have cast thereon the word OPEN and an arrow indicating the direction to open.

c. Shop Painting: The interior and exterior of all valves shall be shop painted for corrosion protection. The valve manufacturer's standard paint will be acceptable.

B. GATE VALVES**:** Distribution valves in sizes through 12 inches shall be of the iron body, non-rising bronze stem, resilient seated wedge type manufactured to equal or exceed all applicable provisions of AWWA Standard C509. Gate valves shall be wedge type epoxy coated 200 psi or approved equal to Mueller Series A-2360.

C. FIRE HYDRANTS: Fire hydrants shall be 3-way, 6" mj shoe, 3'6" bury traffic model with non-freezing, cast iron bodies, full bronze mounted, suitable for a working pressure of 200 psi. Hydrants will be Mueller A-423, or approved equal.

All hydrants will be installed with a mechanical joint hydrant swivel tee and a 6"x13" swivel coupling for a complete restrained assembly from tee to hydrant. No star bolts, dvc lugs, all thread rod, mega-lug or retainer glands will be accepted.

D. VALVE BOXES: All gate valves in water lines shall be provided with valve boxes. Valve boxes shall be a cast iron, extension sleeve type or Sch 40 PVC, suitable for the depth of cover required by the drawings. Valve boxes shall not be less than 5 inches in diameter, shall have a minimum thickness at any point of 3/16 inch, and shall be provided with suitable cast iron bases and covers.

E. FLANGED JOINTS: Whenever screwed-on flanges are used, the pipe shall extend completely through the flange. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

When bolting flange joints, care shall be taken to insure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket

compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell and spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate, so that gasket compression is uniform.

Special care shall be taken when connecting to pumping equipment to insure that no stresses are transmitted to the pumping equipment to insure that no stresses are transmitted to the pump flanges by the connected piping. All such piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of abutting pump and piping flanges are obtained before installation of any bolts in those flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are tightened.

F. CONNECTIONS WITH EXISTING PIPELINES: Where connections are made between new work and existing piping, such connections shall be made using suitable fittings for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the Owner. Live tapping will be required. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines without damage to adjacent property.

G. REACTION TO ANCHORAGE AND BLOCKING: All piping exposed in interior locations and subject to internal pressure in which mechanical or similar type joints are installed shall be blocked, anchored, or harnessed to preclude separation of joints. All steel clamps, rods, bolts, and other metal accessories used in reaction anchorages or joint harnesses shall be painted with two coats (in addition to a prime coat) of a paint acceptable to the Engineer.

H. LEAKAGE: All joints shall be watertight and free from leaks. Each leak which is discovered within one year after final acceptance of the work by the Owner shall be repaired by and at the expense of the Contractor.

Section 65. Meter Services.

A. METER PITS AND COVERS: All 5/8 x 3/4 meters shall be housed in an 18" diameter by 30" deep "White" PVC meter pit with a notched bottom for tube entry into the pit.

Lids for meter pits shall be a cast iron, two piece raised similar to Crouch Foundry Model C-104 or approved equal.

B. METER BRASS: All 5/8 x 3/4 meters shall be supplied with a brass service saddle similar to a Ford S70 series or equal.

Service corporation stops shall be similar to Mueller H-15000 series or approved equal.

Meter setters shall be a 5/8 x 3/4 x 7 setter similar to Mueller H-1404 and will have a ball valve with lockwing. Yoke connectors will be Mueller 3/4 H-14227 or similar.

Where meter services are split, all services shall be 1" from the service corporation stop to a service wye similar to Ford Y44-243 or approved equal.

C. SERVICE TUBE: All service tubing shall be as follows:

All services shall be Type K copper tubing.

D. METERS: All meters when not supplied by the city shall be a 5/8 x 3/4 bronze disc meter with cast iron freeze plate. Meters shall be equal to Badger M-25 and shall meet the AWWA C-700 standard. All registers shall read in U.S. gallons.

Sections 66 thru 69 Reserved.

ARTICLE VI
ELECTRICAL

Section 70. Electrical General Requirements.

A. SCOPE: This section addresses specifications and requirements for numerous Electrical Systems including City owned infrastructure projects and facilities as well as requirements for subdivision development. Electrical work includes complete Electrical Systems as indicated in the Contract Documents and shown on the Contract Drawings.

This Section generally describes these systems, but the scope of electrical work includes all electrical infrastructure work indicated in all Contract Documents: Instructions to Bidders; Bid Form; General Conditions; Supplementary Conditions; Drawings and Specifications; and Addenda.

This Section requires the furnishing and installation of a complete functioning system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred; including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's operation, as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. COORDINATION: The Contractor shall visit the site before submitting a bid and shall verify all dimensions and locations before purchasing equipment not supplied by Nixa Municipal Electric System (hereinafter Nixa Electric) or commencing work.

The contractor shall maintain a Supervisor on the job, whenever necessary, to coordinate with Nixa Electric and other Contractors and Subcontractors to avoid interference or delay.

The Contractor shall refer to the plans and ~~to~~ relevant equipment drawings and design drawings to determine the extent of clear spaces. The Contractor shall make all offsets required to clear equipment, beams, and other structural members; and to facilitate concealing conduit in the manner anticipated in the design.

C. MEASUREMENTS AND LAYOUTS: The Drawings are intended to cover the layout and design of the work and are not to be scaled for exact measurements. Where specific detail and dimension for electrical work are not shown on the Drawings, the Contractor shall take measurements and make layouts as required for the proper installation of the electrical work in coordination with all other work on the project.

D. PERMITS AND LICENSES: All permits and licenses that are required by governing authorities for the performance of electrical work shall be procured and paid for by the Contractor.

E. SHOP DRAWINGS AND MATERIAL LISTS: The Contractor shall submit two copies, or a digital copy of the material lists and of each design drawing within thirty days after award of the contract. If any shop drawing cannot be obtained within thirty days, Nixa Electric shall be notified immediately.

All material and equipment supplied by the Contractor must be approved by Nixa Electric. The Contractor shall verify that all equipment submitted is mutually compatible and suitable for the intended use. All material and equipment must fit the available space and allow ample room for maintenance. If the size of the material and/or equipment furnished makes necessary any change in location, or configuration, the Contractor shall submit a revised design drawing showing the proposed layout.

All design drawings prepared by manufacturers must be pre-checked by Contractor; must bear Contractor's stamp of approval and date; and must indicate a specification paragraph under which submitted and the project's name. Any submittals not so identified will be returned to the Contractor without action.

Nixa Electric's review and subsequent approval of such drawings, schedules, literature, and/or illustrations shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless it has, in writing, been called to Nixa Electric's attention to such deviation at the time of submission, and secured Nixa Electric's written approval. Nor shall it relieve the Contractor from responsibility for errors in dimensions, details, size of members, quantities, or omissions of components or fittings; or for coordinating items with actual building conditions and adjacent work.

Any corrections or modifications made by ~~the~~ Nixa Electric shall be deemed acceptable to the Contractor at no change in price, unless written notice is received

and approved by Nixa Electric prior to the performance of any work incorporating such corrections or modifications.

Design drawings shall be submitted for all major items of equipment and all articles requiring coordination between Contractors. This shall include light fixtures, panelboards, wiring devices, transformers, and special systems. Any shop drawings being submitted shall be flagged and clouded where changed.

F. CODES, LAWS AND STANDARDS: The Contractor's performance, workmanship, and material shall comply with all governing codes, state statutes, city ordinances, and regulations of regulatory bodies having jurisdiction.

Without limiting the generality of the foregoing paragraphs, the provisions of the following National Fire Code shall be deemed applicable as Contractual provisions: NFPA-70-National Electrical Code (current version adopted by City of Nixa) is incorporated herein by references.

A reference to a NESC, NECA, NEMA, IEEE, ANSI, OR U.L. standard shall indicate that the article shall be the most currently adopted version of the article and conform to that standard in all respects (including material, manufacturer, handling, dimensions, and test procedure).

The Contractor shall comply with rules and regulations of any public utilities and/or municipal departments affected by connections of service.

Laws, codes, ordinances and regulations shall take precedence excepting only where work called for by the Drawings and Specifications exceeds code requirements in quality and/or quantity.

All articles shall be listed or certified by a nationally recognized testing authority (such as, but not limited to: Underwriters Laboratories or Factory Mutual Engineering Corporation).

G. CLEANING: Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Contractor shall cooperate in maintaining reasonably clean premises at all times. Immediately prior to the final inspection, the Contractor shall clean all material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from all surfaces. Damaged finishes shall be touched up and restored to their original condition.

H. MATERIAL AND MANUFACTURER: All material and equipment shall be new, of the best quality and design, free from defects and imperfections, and have markings or nameplate identifying the manufacturer and provide sufficient reference to establish quality, size, and capacity. All material and equipment of the same type shall be made by the same manufacturer whenever that is practicable.

I. LABOR AND WORKMANSHIP: All labor for the installation of material and equipment furnished under the General Contract shall be done by experienced professionals of the proper trade. All workmanship shall be of the highest quality and in compliance with the specific requirements of Drawings and Specifications.

J. CONTRACTOR'S EQUIPMENT: All hoists, scaffolds, staging, runways, tools, machinery, or other equipment required for the performance of the electrical work shall be furnished by the Contractor.

K. SAFETY REGULATIONS: All electrical work shall be performed in compliance with all applicable and governing safety regulations, including the National Electric Safety Code (current addition) and OSHA regulations. All safety lights, guards, and signs required for the performance of the electrical work shall be provided and operated by the Contractor.

L. STORAGE AND PROTECTION: Material and equipment shall be stored as directed by the manufacturer or by Nixa Electric, maintained in a clean condition, and protected from weather, moisture, and physical damage. Material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to Nixa Electric at the Contractor's expense.

M. ADJUSTING, ALIGNING, TESTING: All electrical equipment on a project furnished under this Division and all electrical equipment furnished by others shall be adjusted, aligned, and tested by the Contractor.

Mechanisms of all electrical equipment shall be checked, adjusted and tested for proper operation. Motors shall be checked for alignment with drive and adjusted as required. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required. Adjustable parts of all lighting fixtures and electrical equipment shall be checked, tested, and adjusted as required to produce the intended performance.

Completed wiring systems shall be free from short circuits. After completion, the Contractor shall perform tests for insulation resistance in accordance with the requirements of the National Electrical Code.

The Contractor shall be held responsible for the operation, service, and maintenance of all new electrical equipment during construction and prior to acceptance by Nixa Electric of the completed project under this contract. All electrical equipment shall be maintained in the best operating condition, including proper lubrication. Operational failure caused by defective material and/or labor shall be immediately corrected and Nixa Electric shall be immediately notified of any operation failure caused by defective material and/or labor provided by others.

The Contractor shall maintain service and equipment for the testing of electrical equipment and apparatus until all work is approved and accepted by Nixa Electric. A voltmeter and ammeter, approved by Nixa Electric, shall be kept available at all times and the Contractor shall provide service for test readings when, and as required.

N. EXCAVATION AND BACKFILLING: Each Contractor shall perform all excavation necessary for installation of work included in this section of the specifications, regardless of character of material encountered. The contract price will not be increased because of rock excavation; no matter what procedure is utilized.

Each trench shall be uniformly graded and the bottom shall be free of soft spots and stone. All water encountered in trenches must be drained away, bailed or pumped out, and the trench kept dry for the conduit installation. In no case shall sewers be used as drains for such water. Trenches, close to walks or columns, shall not be excavated without prior consultation with Nixa Electric.

For safety, the Contractor shall erect barricades around excavations; and shall place an adequate number of amber lights on or near the work and shall keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

Each system shall be tested and accepted before backfilling. Backfill shall be in layers not exceeding 12 inches. Fill shall be well tamped before additional backfill material is placed. Backfill shall consist of earth or sand free of stone, bricks, or foreign matter.

O. RECORD DRAWINGS: The Contractor shall show, on blue-line prints furnished for that purpose, all changes from the original drawings made during the installation of work, and shall file them with Nixa Electric when the work is completed.

P. NECA STANDARDS: The current NECA Standard of Installation, published by the National Electrical Contractors Association, incorporated herein by reference shall be the minimum standard of performance on any matter not consistent with express specifications.

Q. START UP OF SYSTEMS: Prior to start-up of electrical systems, the Contractor shall check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers specifications.

The Contractor shall review manufacturer's instructions on the proper procedure for checking out each device and system, and shall follow those instructions. After all systems have been inspected and adjusted, confirm all operating features required by the specifications. Record and report malfunctions and then make final adjustments. Operate all systems under full load.

R. OPERATING AND SERVICE MANUALS: At the completion of the project and at least 14 days in advance of the request for final inspection, the Contractor shall provide two volumes of manuals containing the following:

1. "Operating Instructions" for all major items of equipment, including start-up and shut-down procedures.
2. "Service and Lubrication Instructions" for each unit of equipment, including spare parts list indicating local source of supply.

Each complete set of manuals shall be bound in a three-ring, loose leaf, hard-back binder or in common digital form.

S. TEMPORARY WIRING: The Contractor shall furnish and install 120/240 volt, three-phase, four-wire, temporary power service and temporary lighting system to facilitate construction.

The Contractor shall pay all charges made by the Electric utility, in respect to energy charges.

The work by the Contractor shall consist of all labor and materials required to complete the power system.

All temporary wiring shall be installed in accordance with applicable codes, and shall be maintained in a safe manner.

When permanent wiring for lighting and power is installed, the Contractor may use the permanent system, provided he assumes full responsibility for all electrical material, equipment, and devices contained in the system.

When directed by Nixa Electric, all temporary service, wiring, and devices shall be removed from the property by the Contractor.

Section 71. Underground Electric Service.

A. APPLICATION FOR SERVICE: Any person who desires to purchase electrical energy from Nixa Electric shall make written application, signed by the customer. All such applications shall contain a printed agreement stating that the applicant will conform to and abide by all the rules, regulations and provisions of the ordinances of the City pertaining to the regulation of electrical energy customers. If required, easements shall be provided for constructing buried and overhead electric lines to poles.

B. INSPECTION: The application for a new service shall contain a description of the premises to be served

Nixa Electric shall also have the right to inspect the installation by the customer before electric service is provided.

C. CONSTRUCTION REQUIREMENTS: Construction of underground distribution facilities must meet the requirements of the National Electrical Safety Code (NESC) and the National Electric Code (NEC). The latest edition of all codes shall apply.

Nixa Electric shall approve proposed contractors who will provide the installation, together with evidence of insurance and financial capability of the contractor. No work is to be performed by a contractor, if not so approved by the Nixa Electric.

D. SUBDIVISIONS: The contractor/developer is required to install all conduits, caution tape, bedding/base rock, cement vaults, secondary enclosures, street light bases and other materials as indicated on the approved plans. All conduits, caution tape, and required bedding/base rock are to be purchased independently and must meet Nixa Electric standards. All other materials and equipment except transformers shall be purchased through Nixa Electric and paid for prior to the time of each subdivisions pre-construction meeting.

At least 60 days prior to the time that the Contractor/Developer desires approval, the Contractor/Developer shall file a complete set of plans, including a complete outline of the equipment and material to be included, with the City of Nixa Development Department. Nixa Electric will then design electrical plans, at the Contractor/Developer's expense, based upon subdivision and system needs and provide them to the Contractor/Developer.

Construction shall not commence without City of Nixa authorization.

Nixa Electric will bill the Owner/Developer $3.00 per lineal foot of conductor, served by the newly installed electric system. Billing for these services will be due and payable prior to the pre-construction meeting. Only after installation, inspection and final acceptance by Nixa Electric shall power be supplied and ownership transferred.

E. PROCEDURE: Upon completion of the design plans, Nixa Electric will order the appropriate supplies, materials, and equipment as indicated in "D" above. The developer's contractor may begin installation of conduits and systems based on the plans and Technical Specifications Diagrams of Nixa Electric. The Contractor/Developer is responsible for notifying Nixa Electric prior to beginning work on the electrical system and for each inspection throughout the development as determined by the inspector.

Once the installation of all conduits, caution tape, bedding/base rock, and street light bases is complete, Nixa Electric will pull wire, install transformers and junction cabinets, set street lights, and make terminations as needed without expense to the contractor/developer.

F. UNDERGROUND PRIMARY SYSTEMS SPECIFICATIONS**:** The basic underground distribution system within subdivision confines includes single phase, 7200 volts; jacketed concentric neutral 15 KV ethylene-propylene rubber insulated,

direct buried cable, installed in conduit with a normal minimal depth of thirty- six inches below the final established grade line. Some three-phase primary may be required for looping, load distribution and overall reliability of the electric system. In some cases, certain switching capabilities may also be required. Necessary three-phase and switching requirements may also be part of the Owner/Developer's financial responsibility and will be determined by Nixa Electric on a case by case basis.

Primary Distribution cables shall be terminated in primary fused/switching pad mounted enclosures, junction boxes or in pad mounted transformers. The single phase, 7200/120-240-volt transformer shall be the standard unit for residential subdivision usage. Nixa Electric will determine appropriate sizing.

Cement vaults required for electrical equipment shall be bedded in 6" of 3/4" clean rock, and installed per the corresponding Technical Specification Diagram. Cement pads shall be installed, or staged next to its corresponding vault when construction is complete.

Conduits for primary cables are to be 3" diameter sch40 PVC electric conduit. All sweeps are to be of same type and size and have a minimum radius of 36" unless otherwise allowed or instructed by Nixa Electric.

The distribution cable conduits shall be installed at the front lot lines, wherever practical; the side lot lines when crossing from one block or area to another; or the curb edge of the street for main line distribution runs to enter or leave an area. The underground primary distribution system shall be of the loop-fed type, capable of being separated at each transformer location by means of load break cable terminators.

Caution tape shall be installed 12" below finish grade directly above all electrical conduits.

G. UNDERGROUND SECONDARY SYSTEMS SPECIFICATIONS: The basic underground secondary distribution system shall be of the 120-240 volt; single phase; triplex; cross-linked polyethylene, 600-volt type insulation; direct burial cable. The secondary distribution triplex conductor shall terminate in a connection box (pedestal).

All conduits for secondary cables are to be 3” diameter sch40 PVC electric conduit installed at a minimum depth of thirty (30) inches below the final established grade line.

Secondary vaults/pedestals shall be bedded in 6” of 3/4” clean rock, and installed per the corresponding Technical Specification Diagram.

H. EASEMENTS: For locations being served by the underground electrical distribution system, the owner or developer shall provide utility easements, at no cost for electrical facilities to Nixa Electric. Easements for subdivisions shall be shown and recorded on the subdivision plat map.

I. DEVELOPER OR BUILDER’S RESPONSIBILITY: The electric system shall be designed by Nixa Electric as an underground distribution system, and the Sub-divider, Builder, or Developer must present a construction schedule for the area so that the underground electrical system can be installed in an orderly, logical method. All sewer and water main installations and any other underground systems located deeper than the electrical system shall be installed prior to installation of the underground electrical system. The lots or easements for underground electrical systems shall be graded to within 6 inches of final grade; all lots and easements shall be staked with all stakes to be marked to show lot numbers and final grades; and all obstructions including vegetation and dirt piles shall be removed from the easements and R-O-W by the Developer prior to the installation of the electric system. The Developer shall coordinate the installation of the streets to properly install the underground electrical system or install conduit across the roads and streets after the street has been brought to sub-grade elevation and prior to any further street construction in the area of the crossing. If the installation of streets is not coordinated and the Developer incurs extra expense in installing crossings due to requirements for boring, tunneling, street repair, etc., such extra expenses shall be paid by the Developer.

J. GRADES AND STAKING: It shall be the Developer's responsibility to provide the final grades; all staking for easements, road crossings and lots; and to coordinate the installation of the underground facilities. If the grades, easement stakes, or street crossings are wrong or are changed after the installation of the street crossings or the underground electrical system, the cost of moving or rebuilding the underground electrical system as a result of the error or change shall be paid for by the Developer.

K. DAMAGE TO UNDERGROUND SYSTEMS AFTER INSTALLATION: It shall be the responsibility of any Contractors, Excavators, Developers, Builders or any person working in an area with underground electrical cables to determine the location of same and take whatever precautions necessary to avoid damage to same. Any damage to the system repaired by ~~the~~ Nixa Electric shall be billed at full cost, including any administrative cost necessary to accommodate the repair to the persons causing the damage.

L. DRAWINGS AND DESIGNS: It shall be the Developer or Customer's responsibility to provide the City of Nixa and Nixa Electric with complete and accurate drawings and layouts for new subdivisions, planned unit developments or any other project requiring the installation of new electrical facilities. The drawings must be furnished far enough in advance of construction to allow sufficient time for the review of the facilities and the layout of easements. If the Developer or Customer should change the plans or change the project at any time after the design has begun, the developer shall pay the full expense incurred by the changes.

Section 72. Overhead Electric.

Nixa Utilities encourages underground electric systems and therefore any proposed overhead electric system shall be approved by Nixa Utilities. The complete overhead electric system, including all materials plus 5% for a completed system shall be furnished and installed by Nixa Electric. The City of Nixa will bill the Owner/Developer for all materials required to build the newly installed electric system. Billing for these services will be due and payable prior to the pre-construction meeting; Nixa Electric shall thereafter operate and maintain the electric system. All new overhead electric will be required to be along roads and streets as backlot construction will not be allowed unless overhead lines are currently installed prior to the subdivision.

Section 73. Metering.

A. GENERAL: The Owner/Developer shall be responsible for the furnishing and installation of the metering service, including the required wire, conduit and meter base(s). Any metered service that requires current transformers must use meter bases purchased through Nixa Electric. The equipment Nixa Electric uses for a

specific installation will be dependent upon industry standards and current/future practices.

B. SELF-CONTAINED INSTALLATION: If the voltage of the electricity to be metered is 480 volts or less and the customer's disconnecting means has a rating of 400 amperes or less, self-contained metering equipment shall be installed for all new and revised installations.

The meter-switch-fuse sequence shall be followed where practical for all installations where single phase or three-phase, self-contained meters are used. New or revised single phase or three phase installations shall be installed outside of the building. However, if a large number of self-contained meters are involved, or if for any other reason ~~the~~ Nixa Electric determines that outdoor metering is impractical or inadvisable, the metering equipment shall be installed indoors.

Where two or more meters are installed within a building, the meter sockets shall be banked on a panel in a location that will be accessible for meter reading, meter testing or other maintenance and labeled, tagged or stenciled showing the complete address and location of the area served such as apartment, office, suite or store in the building for which the metering equipment is being installed.

Multiple meter type services shall be reviewed with and approved by Nixa Electric prior to ordering or installing equipment.

C. INSTRUMENTAL TRANSFORMER TYPE INSTALLATIONS: If the voltage of the electricity to be metered is 480 volts or less and the customer's disconnecting means has a rating in excess of 400 amperes, a current transformer metering installation shall be installed for all new or revised installations.

The meter-switch-fuse sequence shall be followed where practical for all installations where single-phase or three-phase, instrument transformer type meters are used.

For single-phase and three-phase services requiring multiple metering, the details of the service entrance and equipment must be reviewed and approved by the City of Nixa prior to ordering or installing equipment.

In all cases where current transformers (C.T.) are required, they shall be provided and installed by Nixa Electric. Some installations will require a C.T. cabinet that

will be purchased and installed independently by the Owner/Contractor. All C.T. cabinets must meet Nixa Electric and industry standards.

The meter bases for C.T. applications must be purchased through Nixa Electric and may be mounted by the Owner/Contractor on the switchgear, provided, the meters are located 5 feet above the floor and that the meters will be completely accessible at all times for meter reading, meter testing and other maintenance.

The Owner or Customer shall also provide and install a 1-inch conduit from each meter socket to its respective current transformers. Nixa Electric will provide and install the metering.

Services and metering installations for primary metering will be handled on an individual basis. All service installations must be reviewed and approved by Nixa Electric prior to ordering or installing equipment.

D. RESIDENTIAL SERVICES: The standard electric service to residential customers is 120/240 single phase 200 ampere service. When underground service is fed from a pole, the necessary amount of wire shall be coiled up at the bottom of the pole. When underground service is fed from secondary vault/pedestal, 2-feet of wire should be extended into the secondary vault/pedestal. For either configuration, wire should be landed in the meter base by a qualified person.

All standard electric services to residential customers will be provided by the Owner/Developer at no cost to Nixa Electric. One electric service will be provided to each residential premise, and not more than one. All services other than 200-amp 120-240-volt services shall be considered non-standard and will be installed only with special permission from the City of Nixa/Nixa Electric after reviewing all circumstances. The excess cost will be paid by the customer (Owner/Developer), prior to installation of the facilities.

E. UNDERGROUND SERVICES: Underground services shall be installed to residences by a qualified person. The installation of the cable and replacement cost of this cable is the responsibility of the customer.

Section 75. Street Lighting.

A. GENERAL: Street lighting for new developments shall be paid for by the Owner/Developer. Street light bases, poles, arms and lamps shall be purchased through Nixa Electric and paid for prior to each subdivisions pre-construction meeting.

Upon completion of the pre-construction meeting, Nixa Electric will order street light bases, poles arms and lamps. Street light bases will be delivered on site by Nixa Electric and shall be installed by Contractor/Developer per the corresponding Technical Specification diagram.

If conflicts exist with other utilities for installation of the light bases, the light base shall be moved to a location that is approved by Nixa Electric. Thus, conduits for street lights should be installed after the final location of the light base is determined. The Developer or Contractor is responsible to notify Nixa Electric for inspection prior to burying any conduit. Once the installation of conduit and bases is complete, Nixa Electric will pull wire and install the light pole, arm and lamp.

All conduits and fittings for street lighting are to be 2" diameter sch40 PVC electric conduit. 2" conduit must be installed into the street light bases per the corresponding Technical Specification diagram.

Street lights are to be placed at intersections and thereafter every 200 feet minimum on straight runs. At cul-de-sacs, lights shall be placed at the end of the cul-de-sac and spaced as indicated on straight runs. Additional lighting may be required by Nixa Electric upon plan review to assure proper lighting of certain areas such as intersections or special locations.

B. STANDARDS FOR DECORARTIVE LIGHTING SYSTEMS: Decorative lighting systems, if desired, must meet City of Nixa/Nixa Electric standards and shall be purchased, installed, owned and maintained by the Owner/Developer, with no cost or labor provided by Nixa Electric. These systems must meet minimum lighting requirements as those for Nixa Electric owned systems.

Nixa Electric does not stock maintenance or repair parts for street lighting other than standard street lights currently being used.

At the completion of construction, all decorative lighting systems shall be owned by the respective HOA or Owner/Developer and maintained in a fully functional

condition. If for any reason Nixa Electric takes ownership of said decorative lighting system in the future, Nixa Electric may utilize sole discretion to keep the system or transition to a standard street lighting system. Maintenance of HOA/Developer owned systems may be completed by Nixa Electric only upon the execution of a written agreement recommended by Nixa Electric and approved by the City Attorney and the Nixa City Council.

All fixtures must be equipped with individual photo-electric controls. The street lights will be served underground and the circuits shall be of the 120/240-volt single phase; 10-2 Romex specifically designed for underground and shall follow established side lot lines or the curb edge of the street, whichever is approved by Nixa Electric.

C. DESIGN REVIEW: The design and materials for decorative street lighting systems shall be reviewed and approved by the City of Nixa prior to construction. (The design review will be accelerated if calculations and photometric curves are also submitted). Where electrical connections are required, the Sub-divider will be furnished with drawings showing Nixa Electric's distribution system.

D. LIGHTING FOR AREAS OTHER THAN STREETS: Lighting for all areas other than streets will be provided by either the Developer or Owner. Such area lighting shall be installed, owned and maintained by the Developer or Owner.

ARTICLE VII
STORM WATER MANAGEMENT PLAN

PART I. GUIDELINES AND DESIGN

Section 80. General Provisions.

A. SCOPE: The design criteria sets forth the minimum standards for design of storm drainage facilities on public right-of-way and private property in the City of Nixa.

B. AUTHORITY: The design criteria and standards set forth herein have been adopted by the Nixa Planning and Zoning Commission, and the Nixa Board of Alderman in accordance with the procedures and authority set forth in the City of Nixa Land Development Ordinance.

Any development or grading started after the date of the passage of these criteria and standards that does not comply with the requirements set forth herein, shall be deemed to be in violation of the Land Development Ordinance and shall be subject to enforcement measures and penalties set forth in Article VII of this Ordinance.

C. INTERPRETATIONS: Where any of the provisions contained herein may be unclear or ambiguous as they pertain to a particular site or situation; interpretations of the policies, criteria, and standards set forth herein shall be made in writing by the City Planner.

Such written interpretations shall be kept on file for future reference for use in similar situations, and shall be incorporated in subsequent revisions for the standards, if deemed necessary for general reference.

D. APPEALS: Where disagreements may arise over the interpretations of the requirements set forth herein by the City Planner, appeals may be made to the City Administrator upon written request.

Requests for appeals in subdivisions shall be addressed to the City Planner.

Information and supporting documentation for the appeal shall be submitted with the request. The City Planner shall forward the information to the City Administrator within 3 calendar days following receipt of the information.

E. VARIANCES: In the event that compliance with the standards and criteria set forth herein is not practical or feasible, and that reasonable alternative measures can be proposed, an application for a variance can be made.

Requests for variances shall be made in writing to the City Planner and shall be considered in accordance with the procedures set forth in the Article V & VI of the Land Development Code.

F. AMENDMENTS AND REVISIONS: By the first day of February of each year the City shall issue any updates or revisions which have been made during the previous calendar year.

Revisions or interpretations made by the City Planner during the calendar year shall be mailed to interested parties who have requested such notification at the Planning Department.

Notices: Persons, firms or agencies wishing to be notified of the revisions or updates in these criteria shall notify the Planning and Zoning Department in order to be placed on the mailing list.

G. APPROVALS AND PERMITS REQUIRED:

1. Grading Permits: Storm drainage facilities may not be constructed or altered without review and approval of the plans by the City Planner and issuance of a Grading Permit by the Planning Department for subdivisions or for commercial or other sites.

2. National Pollutant Discharge Elimination System (NPDES) Stormwater Permit: Provisions of the 1987 Clean Water Act require that certain stormwater discharges obtain an NPDES stormwater permit. In Missouri, these permits are administered by the Missouri Department of Natural Resources.

   Federal rules for NPDES stormwater discharges are contained in 40 CFR Parts 122, 123 and 124 of the Code of Federal Regulations.

   State NPDES stormwater regulations are contained in 10 CSR 20- 6.200 of the Code of State Regulations.

   Copies of these regulations are available at the Planning Department.

   Additional provisions for NPDES stormwater permits for land disturbance activities and information regarding the City of Nixa General Permit for land disturbance activities are contained in "Sinkholes and Karst Features," page 131 of these Criteria.

3. "404" Permits: For certain activities which involve the discharge of dredged or fill materials into the waters of the United States, a Department of the Army permit may be required as set forth in Section 4040 of the Clean Water

Act. Rules for 404 permits are contained in 33 CRF Parts 320 through 330 of the Code of Federal Regulations.

Determination of applicability for Section 404 requirements are generally made by the Little Rock District office of the Corps of Engineers for the James River and its tributaries which are located within the White River drainage basin. Questions regarding the Department of the Army Permits may be directed to:

Chief, Permits Branch
Little Rock District
U.S. Army Corps of Engineers
P.O. Box 867
Little Rock, AR 72203-0867
Phone: 501-378-5296

A brochure regarding the Corps of Engineers regulatory program may be obtained from the Corps offices.

H. COORDINATION WITH OTHER JURISDICTIONS: Where proposed storm drainage facilities are located on property adjoining to other local government jurisdictions, design of storm drainage facilities shall include provisions to receive or discharge storm water in accordance with the requirements of the adjoining jurisdiction, in addition to meeting City requirements.

In these cases two additional sets of plans shall be submitted and will be forwarded to the adjoining jurisdiction for review and comment.

No grading or construction of storm drainage facilities may commence without prior notification of the Missouri One-Call utility warning system at 1-800-DIG-RITE, as required by law.

I. COMMUNICATIONS AND CORRESPONDENCE: Communications and correspondence regarding storm water plan review, policies, design standards, criteria, or drainage complaints shall be directed to the City Planner at the City of Nixa Planning Department, P. O. Box 395, 715 W. Mt. Vernon, Nixa, Missouri 65714, Phone 417-725-5850.

J. STORMWATER PLAN REVIEW:

1. Subdivision

a. Sketch Plat: Storm drainage planning requirements for sketch plats are set forth in The Stormwater Management Plan, Article IV of the Land Development Code.

b. Preliminary Plat & Engineering Report: Storm drainage Requirements for the preliminary plat and engineer's report are set forth in The Stormwater Management Plan, Article IV of the Land Development Code.

The City Planner will review the plat and report and will forward written comments to the Planning Commission with copies to the engineer within three working days.

c. Construction Plans: General Requirements for submittal of construction plans are set forth in The Stormwater Management Plan, Article IV of the Land Development Code.

d. Final Plat: The City Planner shall review the final plat for conformity with storm drainage requirements and return written comments to the engineer within fourteen calendar days following receipt.

2. Grading and Building Permits:

a. Pre-Construction Conference: A pre-construction conference shall be held prior to beginning any construction.

The developer or his representative shall schedule the pre-construction conference by contacting the City Planner at 725-5850. The developer, engineer, and contractor, or their authorized representative shall attend the conference.

b. Inspections: Periodic inspection will be made of the construction of stormwater improvements, and facilities for sediment and erosion control throughout the construction period.

Routine inspections of sediment and erosion control measures, and storm drainage facilities located on private property will be made by the City Planning Department on approximately a weekly basis.

Special inspections shall be made at the following times: Prior to backfilling storm sewers and after placement of reinforcing steel and prior to placement of concrete for any reinforced concrete structure.

c. Final Inspection and Acceptance of Improvement: After all storm drainage improvements are constructed, the consultant shall perform construction record surveys and prepare construction record drawings in accordance with the requirements of Stormwater Planning and Design.

As-Built drawings shall be submitted to the City Planner.

The developer will be notified in writing of any deficiencies discovered during review of the construction record drawings or field inspections.

Upon correction of the noted deficiencies, the developer shall notify the City Planner and schedule a field inspection. When all deficiencies have been corrected, the consultant shall submit one set of reproducible as-built drawings.

d. Release of Security: Escrow or other required security may be released by the City Administrator after acceptance of the constructed improvements.

K. OWNERSHIP AND MAINTENANCE:

1. Improvements on public road right-of-way: Storm drainage improvements on public right-of-way shall, upon acceptance of the constructed improvements, become the property of and shall be maintained by the City of Nixa.

2. Improvements on private property: Storm drainage improvements on private property shall be maintained by the owner of the lot upon which the improvements are located, or by the Homeowners' Association for improvements located in common areas.

All such improvements, which serve a drainage area of 5 acres or more, shall be located in a drainage easement as defined in the Land Development Code; and the public shall have such rights of access to repair or maintain such facilities as set forth in the Land Development Ordinance.

Section 81. Stormwater Planning and Design:

A. STORMWATER MANAGEMENT GOALS: In order to ensure protection of the general health and welfare of the citizens of the City of Nixa, planning and design of stormwater management measures shall meet the following:

1. Prevent damage to residential dwellings and other building structures from flood waters.

2. Maintain emergency vehicle access to all areas during periods of high water.

3. Prevent damage to roads, bridges, utilities, and other valuable components of the community's infrastructure from damage due to flood waters and erosion.

4. Prevent degradation of surface and ground water quality from stormwater

runoff; preserve and protect quality of the environment; and promote conservation of the City's natural resources.

5. Minimize flood water and erosion damage to lawns, recreational facilities, and other outdoor improvements.

6. Minimize traffic hazards from runoff carried in streets and roads.

7. Comply with applicable State and Federal laws and regulations.

8. Meet the foregoing goals in a manner which is cost effective and which minimizes the cost of housing and development while encouraging sound development.

9. Encourage innovative and cost effective planning and design of stormwater management facilities.

10. Encourage multiple purpose design of stormwater management facilities, to provide opportunities for recreational use, and other benefits to the community wherever possible.

The standards and criteria set forth herein provide the minimum standards for planning and design of stormwater facilities. Where a particular plan or design may be found to be in conflict with a specific standard, achievement of the goals set forth above will have precedence.

B. GENERAL PLANNING AND DESIGN PRINCIPLES: The City of Nixa recognizes that stormwater management is an important component of overall land use planning.
The City of Nixa further recognizes that proper stormwater planning significantly reduces the long term costs to the community both in terms of infrastructure cost and property losses due to flood damage.

It is much more cost effective to prevent flood damage by proper design and construction, than to repair and remediate problems which have occurred through poor planning and design.

The following general principles must be followed in preparing the grading and storm drainage plans for all development sites.

1. Recognize the existing drainage systems. The storm drainage system differs from other utility systems in very important ways:

    a. There is an existing natural drainage system.

b. It is only needed when runoff occurs.

c. The capacity of the system varies greatly depending on the amount of rains.

d. The system does not have to be constructed of man-made components in order to function.

Because of these characteristics, there has been a historic inclination for fragmented planning and design of storm drainage facilities.

Proper planning of storm drainage facilities must begin with the recognition of the existing system, and include necessary provisions for preserving or altering the existing system to meet the needs of proposed development or construction.

Methods of delineating existing watercourses are outlined under Stormwater Runoff Calculations.

2. Allow for increase in runoff rates due to future urbanization: As areas urbanize, peak rates of runoff increase significantly. The City of Nixa may require temporary detention and storage of increased volumes of urban runoff in order to minimize increases in flow rates as urbanization occurs. However, the cumulative effects of on-site detention are difficult to predict and control, and development of comprehensive basin-wide runoff models to determine these effects does not appear likely in the foreseeable future.

   For this reason, design of storm drainage improvements must be based upon the assumption of fully urbanized conditions in the area under consideration. No reduction allowed in peak flow rates due to detention, unless an approved runoff model has been developed for the drainage basin under consideration. Any detention storage facilities, whose effects are considered, must be located within approved drainage easements.

3. Provide for acceptance of runoff from upstream drainage areas: It is critical that provisions must be made to receive runoff from upstream drainage areas. Drainage easements or public right-of- way must extend to a point where the upstream drainage areas is no greater than 5 acres. Drainage easements or public right-of-way must extend to the point where existing watercourses enter the site. Where the upstream drainage area is 5 acres or greater, but does not discharge onto the site through a defined watercourse, the drainage easement shall extend to the point of lowest elevation.

4. Provide a means to convey runoff across the site: Stormwater shall be conveyed across the site in a system of overland drainageways and storm sewers. Overland drainageways consists of streets, open channels, swales, and

overland flow within drainage easements.

5. Discharge of runoff to downstream properties: Concentrated runoff shall be discharged only into existing watercourses, drainage easements, or public road rights-of-way. Where none of these exist, a drainage easement which extends to the nearest watercourse, drainage easement or public road right-of-way must be obtained from the downstream property owner, and proper provisions made for conveyance of the peak flow from the 4 percent Annual Probability storm within the drainage easement.

   One of the typical results of urbanization is that diffuse surface flow or "sheet flow" is replaced with concentrated points of discharge. Where concentrated flows are discharged to downstream properties proper provisions must be made to:

   a. Allow the flow to spread over the same area as would have occurred for the same rate of flow prior to the development, and

   b. Reduce the rate of velocity to rates at least equal to the predevelopment values at the same rate of flow.

6. Assess potential downstream flooding problems: It is important that a determination be made of conditions in the watershed downstream of each development site to determine whether there are existing structures which are subject to an unacceptable flooding hazard (10 percent annual probability or greater).

   If areas having an unacceptable flooding hazard occur downstream of a development site, either on-site detention for peak flow control, or mutually agreed off-site improvements will be required, as set forth in Part V Detention.

7. Assess potential water quality impacts on receiving water: Sediment, erosion and other water quality controls are required as set forth in the Detention Section.

8. Provide for operation and maintenance of drainage facilities.

C. THE MAJOR-MINOR STORM APPROACH: The amount of water that the storm drainage system must carry varies greatly depending upon the amount of precipitation which may occur.

   The degree of flooding protection desired and the cost of providing that level of protection must be balanced against the risk and potential costs to life and property.

The City of Nixa recognizes that it is neither cost effective nor necessary to require construction of a conveyance system for large infrequent floods in all cases.

Design of storm drainage systems can be made much more cost effective while providing desired levels of property protection by taking a major-minor storm approach to design of drainage facilities.

1. Major storm: The major storm is defined as a storm with an annual probability of 4 percent (a "25-year storm").

   The combination of all overland and underground conveyance systems shall have sufficient capacity to convey the peak flow from the major storm without resulting in flooding of any new building structures, and without exceeding maximum flooding depths in streets necessary to allow passage of emergency vehicles.

   It is recommended that the floor elevations of all new structures be located at least 1 foot above the estimated high water elevation resulting from the peak flow from the 4 percent annual probability storm.

2. Minor storm: The minor storm is defined as a storm with an annual probability of 20 percent (a"5-year storm"). Inlets and storm sewers must have sufficient capacity to maintain acceptable flooding depths in street and road rights-of-way during the minor storm as required in “Drainage of Streets & Roadway“ Section.

D. DRAINAGE EASEMENTS: All areas subject to inundation during the major storm must be included in drainage easements, Specific standards for drainage easements to be provided for storm sewers, open channels, and detention facilities are set forth under Storm Sewers; Open Channels; and Detention Facilities respectively.

Section 82. Storm Water Runoff Calculations.

This section outlines acceptable methods of determining storm water runoff.

A. GENERAL GUIDELINES: For watersheds with a total tributary area less than 200 acres and a one percent annual probability fully developed discharge less than 300 cfs, the design storm runoff may be analyzed using the rational formula.

For watersheds with a total tributary area greater than 200 acres or with a one percent annual probability fully developed discharge greater than 300 cfs, the design storm runoff shall be analyzed using an approved hydrographic method.

B. RATIONAL FORMULA: The rational formula, when properly understood and applied, can produce satisfactory results for urban storm sewer design. The rational formula is as follows:

$$Q = CIA$$

Where: Q = Peak discharge in cubic feet per second
C = Runoff coefficient which is the ratio of the maximum rate of runoff from the area to the average rate of rainfall intensity for the time of concentration.
I = Average rainfall intensity in inches per hour for a duration equal to the time of concentration.
A = Contributing watershed area in acres.

The basic assumptions made when applying the rational formula are:

1. The rainfall intensity is uniform over the basin during the entire storm duration
2. The maximum runoff rate occurs when the rainfall lasts as long or longer than the basin time of concentration.
3. Runoff response characteristics are relatively uniform over the entire basin.
4. The time of concentration is the time required for the runoff from the most hydraulically remote part of the basin to reach the point of interest.

The drainage basin should be divided into sub-basins of a size where all of the basic assumptions apply.

C. TIME OF CONCENTRATION:

Time of concentration, tc, is calculated by:

tc = ti where
ti = initial, inlet or overland flow time in minutes,
tt = shallow channel and open channel flow time in minutes

Overland flow (sheet flow) time shall be calculated as:

$$ti = \frac{(n \times l)^{0.8}}{4.64 \times s^{0.4}}$$ where

ti = initial, inlet or overland flow time in minutes
n = Manning's n for sheet flow (from the following table),
L = Overland flow length in feet, (maximum of 300 feet),
S = Slope in feet per foot.

Roughness coefficients (Manning's n) for sheet flow

D. SURFACE DESCRIPTION:

Smooth surfaces (concrete, asphalt, gravel or bare soil) 0.011

Fallow (no residue) 0.05

Cultivated soils:
- Residue cover less than or equal to 20 percent 0.06
- Residue cover greater than or equal to 20 percent 0.10

Grass:
- Short grass prairie 0.15
- Dense Grasses* 0.24
- Bermuda Grass 0.41

Range (natural) 0.13

Woods: **
- Light underbrush 0.40
- Dense underbrush 0.80

* Includes species such as weeping lovegrass, blue grass, buffalo grass, glue grama grass and native grass mixtures.

** When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

Shallow channel velocities may be estimated from Figure 3-1 in Reference 11.

Open channel flow velocities may be estimated from Manning's equation. Open channel velocities are generally estimated under bank full conditions.

The basin time of concentration calculation techniques are described in detain in TR-55, Chapter 3 (Reference 11).

E. HYDROGRAPHIC METHODS:

Methodologies. The most common hydrographic techniques are those developed by Corps of Engineers and the Soil Conservation Service. These methods are preferred, however other proven techniques will be accepted.

The Corps of Engineers HEC-1 Flood Hydrographic Package (Reference 18) and Soil Conservation Service TR-55 computer models (Reference 11) are the preferred runoff models. Other models may be used with approval from the City Planner.

The runoff model must include the entire drainage basin upstream of the proposed development. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

The runoff model shall be developed for the following cases:

Case 1: Existing conditions in the drainage basin prior to development of the applicant's property.

Case 2: Existing conditions in the drainage basin with developed conditions on the applicant's property.

Case 3: Fully developed conditions in the entire drainage basin.

F. RAINFALL: Rainfall depth-duration-frequency and intensity-duration-frequency curves for the Nixa area are included in the Standard Drawing Section of this document. The design rainfall intensities were developed from the U.S. Department of Commerce, National Weather Service, Technical Paper 40 (Reference 19) and the National Oceanic and Atmospheric Administration Publication "HYDRO-35" (Reference 9).

Rainfall shall be distributed in time using the SCS Type II distribution (Reference 11) or the Pilgrim-Cordery Distribution adapted to local rainfall data (References 20 and 21) as shown in the following table. Other distributions may be used upon approval from the City Planner.

PILGRIM-CORDERY METHOD
SYNTHETIC RAINFALL MASS CURVES

Cumulative Fraction of Storm Duration	Cumulative Fraction of Storm Duration				
	1-Hour	2-Hour	3-Hour	4-Hour	6-Hour
.00	.00	.00	.00	.00	.00
.05	.03	.03	.03	.02	.05
.10	.07	.05	.05	.03	.09
.15	.11	.10	.06	.05	.14
.20	.14	.17	.09	.06	.20
.25	.17	.22	.11	.08	.28
.30	.23	.25	.13	.14	.35
.35	.29	.27	.19	.20	.41
.40	.35	.29	.31	.27	.43
.45	.41	.30	.39	.33	.46
.50	.47	.31	.44	.38	.49

Sections 83-89 Reserved

PART II - EFFECTS OF DRAINAGE ON NATURAL FEATURES

Section 90. Sinkholes and Karst Features

A. GENERAL: The City of Nixa is located on the Springfield Plateau of the Ozarks physiographic region. This area is underlain by Mississippian Age limestone which is highly susceptible to solution weathering. As a result, sinkholes, springs and caves are common.

Nixa sets on a broad upland area that serves as the drainage divide between the James and Finely Rivers. A karst plain has developed on the relatively flat surface of the upland area within which surface runoff is drained internally to sinkholes; swallow holes, and losing streams. The sinkholes swallow holes, and losing streams feed a shallow subsurface drainage system which discharges at springs along the James and Finley Rivers.

In many areas of the City special consideration must be given to flood hazards and potential for ground water contamination due to the presence of sinkholes, caves, losing streams, springs, and other features associated with karst geology.
The requirements set forth herein are intended to provide specific criteria for design and construction for any site upon which sinkholes or other karst features are located.

Interpretations of these requirements shall be made and appeals may be made according to the procedures set forth in Article VI of the Land Development Code.

B. DEFINITIONS: The following are terms used to interpret this portion of the Technical Specifications. The following definitions are related specifically to sink holes and sinkhole development.

Altered Sinkhole: A sinkhole which has been filled, excavated or otherwise disturbed.

Collapse Sinkhole: A collapse sinkhole is a sinkhole that forms suddenly when surface soil collapses into a subsurface cavity. Collapse sinkholes typically originate at the bedrock surface and propagate upward to the ground surface.

Heavy Equipment: Motorized equipment having a gross weight of more than 6 tons.

Light Equipment: Motorized equipment weighing 6 tons or less.

Losing Stream: A losing stream is a surface stream which loses 30 percent or more of its flow through natural processes such as permeable geologic materials into an aquifer.

Piracy Sinkhole: a piracy sinkhole is a sinkhole that has captured the normal flow of a surface stream and diverted it to an underground drainage system.

Qualified Geologist: A person who is licensed to practice geology in the State of Missouri; who has met or exceeded the minimum geological education requirements and

who can interpret and apply geologic principles; and who by reason of experience and education has an understanding of local karst geology.

Qualified Professional Engineer: A person who is licensed to practice engineering in the State of Missouri; who has met or exceeded the minimum engineering education requirements and can interpret and apply the fundamentals of storm drainage, soils engineering, and karst geology; and who by reason of experience and education has an understanding of local karst geology.

Side Slope Sinkhole: A side slope sinkhole is a type of solution sinkhole which has formed on a sloped surface, but which has not subsided to the degree that a closed depression is formed. Side slope sinkholes are characterized by a localized flattening of the topography. Storm water drains naturally thru the open (downslope) side of the sinkhole.

Sinkhole: A sinkhole, also known as a sink or doline, is a natural depression or hole in the surface topography caused by the removal of soil or bedrock by water. Sinkholes may vary in size from a few feet to several hundred feet both in diameter and depth, and vary in form from shallow bowl-shaped depressions to deep chasms. They may be formed gradually or suddenly, and are found around the world.

Sinkhole Cluster Area: An area containing 2 or more sinkholes located in close proximity, generally interconnected by ground water conduits. 125

Sinkhole Eye: A sinkhole eye consists of a discrete hole, or shaft, within the floor or slope of a solution sinkhole that provides a conduit for drainage of storm water to the subsurface drainage system.

Sinkhole Flooding Area: The area inundated by runoff from a storm with an annual exceedance probability of 1% and duration of 6 hours.

Sinkhole Floor: The sinkhole floor consists of the flat or slightly convex surface at the bottom of a solution sinkhole. Sinkhole floors are typically covered with an accumulation of sediment or organic material. The edge, or limit, of the sinkhole floor is defined by the topographic break between the relatively flat floor and the sloped side wall of the sinkhole.

Sinkhole Rim: The sinkhole rim constitutes the lateral limit of a sinkhole and is defined by the topographic break, or transition, between the natural ground surface and the sloped sinkhole wall.

Sinkhole Slope: The sinkhole slope, or wall, consists of the inclined surface between the sinkhole rim and the sinkhole floor. The sinkhole slope may be convex in its upper reaches and concave in its lower reaches.

Sinkhole Watershed: The ground surface area that provides drainage to the sinkhole. This area extends beyond the sinkhole depression, and generally crosses property boundaries.

Solution Sinkholes: A solution sinkhole is a sinkhole that forms by dissolution of soluble bedrock, such as limestone, dolomite, or gypsum Solution sinkholes typically occur as bowl-shaped depressions.

Subsidence Sinkhole: A subsidence sinkhole is a sinkhole that occurs in areas of sandy, non-cohesive soils, and forms when surface soils migrate into subsurface cavities within the bedrock. Subsidence sinkholes are common in other parts of the nation, such as Florida.

Swallow Hole: A swallow hole is a discrete sinkhole that forms in the floor of a stream channel and which captures a portion, or all, of the stream flow. Swallow holes are related to losing streams, but losing streams lack an identifiable point of water loss.

Terminal Sinkhole: The lowest sinkholes in a sinkhole cluster to which any surface water overflowing from other sinkholes in the cluster will flow.

Unaltered Sinkhole: A sinkhole which has never been altered or disturbed.

C. POLICY: In keeping with the intent of the Land Development Code the following policy is set forth for development in areas containing sinkholes:

Development in sinkhole areas will be based upon the following axioms:

1. Avoidance
2. Minimization
3. Mitigation

Construction in sinkholes should be avoided. Exceptions will be made only in situations where it can be conclusively demonstrated that there are no practical alternative to such construction.

These situations are most likely to arise where:

1. An underground cavity has caused a collapsed sinkhole to form, after subdivision approval or building construction.
2. A sinkhole has been altered or filled either unknowingly or prior to passage of these regulations.
3. Maintenance and operation is required for existing roads and utilities.
4. Location of existing streets or utilities would render access or utility service to property impractical or cost prohibitive.
5. It is demonstrated, subject to city approval, that sinkhole location renders the site undevelopable and economically unaffordable.
6. For road construction when it is demonstrated to the City's satisfaction that movement of the roadway to avoid a sinkhole would conflict with the City's traffic circulation plan and conflict with city adopted street standards.

In these types of cases, measures which will have minimal impact on the sinkhole or receiving water may be proposed.

In circumstances where sinkhole closure is deemed necessary and appropriate to the site development plan sinkhole closure (filling) will be allowed with proper site investigation and design. Clean, engineered soil fill can satisfy the goals of development in sinkhole areas, in that it can actually improve the structural integrity of the site, simplify storm water management, and enhance groundwater quality protection, while opening up additional areas for development. Proposals for sinkhole closure shall be reviewed on case-by-case basis, with the burden of proof on the applicant.

D. GOALS FOR DEVELOPMENT IN SINKHOLE AREAS: There are four basic goals for development in sinkhole areas; assurance of structural integrity, maintenance of the storm water drainage system, protection of groundwater quality, and sustainability. Each of these goals is discussed in the following:

1. Structural Integrity: Structures that are constructed in proximity to sinkholes should be required to have properly designed foundations. Lightly Loaded (residential) structures must maintain a 10' setback from the sinkhole rim as determined by a qualified geologist. Heavier structures (commercial or industrial) may encroach into the sinkhole provided it has been filled in accordance with the regulations. In these circumstances construction of the building may require piers to bedrock. Foundation shall be designed by qualified professional engineer and the design documented to the City's satisfaction.

2. Storm Water Management: There are two primary storm water concerns with respect to development in karst areas. The first concern is that the development does not cause a concentration of storm water in sinkholes (depth or duration of storage) beyond what would be expected in the pre-development condition, because increased saturation of soils can induce sinkhole collapses. This can be accomplished by diverting storm water inflow away from the sinkhole or draining storm water from the sinkhole more quickly, and ensuring that the natural permeability of the sinkhole floor is not compromised by construction equipment traffic. Diversion of storm water away from individual sinkholes does not have a significant impact on groundwater recharge since the diverted water typically flows to a losing stream or to another sinkhole. The second concern is that the development does not cause an increase in flood elevations in post-development condition. This can be accomplished by excavation of additional storm water storage capacity within the sinkhole bowl or construction of external storm water detention basins.

3. Groundwater Protection: Much of the potential impact on groundwater quality occurs during construction. Best management practices (BMPs) must be instituted and maintained to prevent sediment or other deleterious materials

from entering the sinkhole during the construction phase. Construction equipment should not be allowed within the sinkhole floor, since the inadvertent soil compaction caused by this equipment can reduce the natural permeability of the soil and reduce the ability of the sinkhole to drain. Developments should be designed to route urban runoff around or away from, sinkholes to the degree possible. This can be accomplished by construction of surface drainage swales or hard-piped storm water conveyance systems. Where storm water drainage to sinkholes concentrated biofiltrations swales and biofiltration strips may be bused to protect groundwater quality. Institutional controls (subdivision covenants, city ordinances) may also be required to preclude the introduction of pesticides, fertilizers, and other deleterious chemicals into sinkholes. Sinkhole eyes are very critical features for groundwater protection, since the sinkholes collect the storm water that falls within their drainage areas and the eyes allow unrestricted transfer of storm water to the karst drainage system. Sinkhole eyes can be modified to provide a measure of treatment by incorporating layer of sand (for filtrations) and peat moss (for absorption) into the design of a graded filter.

4. Sustainability: Development in sinkhole areas must provide permanent solutions to the issues of structural integrity, storm water management, and groundwater protection, and cannot create an ongoing maintenance issue or a source of liability for the developer, the homeowners association, or the City.

E. PERMITS REQUIRED:

1. Grading Permit: A grading permit must be obtained prior to any alteration of sinkholes associated with new subdivision construction in accordance with the Land Development Code. Procedures and requirements for grading permits are set forth in the "Design Standards and Criteria" Section (page 166).

F. GENERAL PLAN REQUIREMENTS: General requirements for grading and drainage plans are set forth in the "Guidelines and Design" Section.

G. IDENTIFICATIONS AND INVESTIGATION OF SINKHOLES: Sinkholes can typically be identified on the basis of visual observation by qualified geologist. More detailed information on sinkhole structure can be obtained by soil borings, seismic surveys, and resistivity surveys. Ground penetrating radar (GPR) surveys are also useful but are somewhat limited by the clay soils in the area. Borehole data is also useful in determining depth to bedrock, but can be misleading due to the highly variable nature of the bedrock surface. Light truck-and trailer-mounted drilling rigs can provide misleading data on depth to bedrock due to the presence of chert boulders in the soil column. In all cases, site investigation data should be evaluated and interpreted by a geologist registered in the State of Missouri.

Excavated farm ponds can often be mistaken for sinkholes, but can usually be differentiated from sinkholes on the basis of soil borings. Soil cross sections through

sinkholes will typically exhibit a sag in the soil profile resulting from subsidence, while soil cross sections through excavated farm ponds will not. Other conditions which can potentially form surface depressions that may be mistaken for sinkholes include:

1. Improper compactions of backfill
2. Buried compressible material
3. Decomposing organic material (such as a tree stump)
4. A failed septic tank, lateral field, or utility trench

H. SINKHOLE EVALUATION: An evaluation including the following information shall be made for all sites upon which sinkholes are fully or partially located.

The site plan for the proposed development must show the following items with respect to location of proposed construction, proposed or existing property lines; and existing structures

1. Sinkholes

   a. Location and limits of the area of the sinkhole depression as determined by field surveys or other reliable sources as may be approved. Location of sinkholes based solely upon USGS 7-1/2 Minute Series Quadrangle Maps will not be considered sufficient unless field verified.

   b. Location and elevation of the sinkhole eye where visible or known.

   c. Topographic contours at maximum intervals of one foot, and spot elevations sufficient to determine the low point on the sinkhole rim and the profile of the potential overflow area.

   d. Minimum entry elevations of any existing structures located within the sinkhole rim.

   e. Elevation of any roadway located within or adjacent to the sinkhole.

2. Water Supply Sources

   a. The approximate location of public or private water supply sources such as springs or wells, as determined from information available from the City Planner and Missouri Department of Natural Resources.

   b. Boundaries of any known recharge areas to wells or springs as determined from information available from the City Planner and Missouri Department of Natural Resources.

3. Other Geologic Features

Locations of caves, springs, faults and fracture trends, geologic mapping units based upon information from the City Planning Department or other reliable sources.

4. Flooding Limits for the sinkholes determined as set forth in this section.

   a. A drainage area map showing the sinkhole watershed area.

   b. Where the site is located in a sinkhole cluster area, this map shall be extended to include the watershed area and any sinkholes located downstream of the site which may receive overflow drainage from the site.

   c. Assessment of potential impacts on ground water quality and proposed water quality management measures as provided in this section.

I. FLOODING CONSIDERATIONS:

1. Minimum Flooding Analysis: Maximum estimated flooding elevations shall be determined for each sinkhole for both pre-development and post development conditions, assuming no subsurface outflow from the sinkhole.

   Where the estimated volume of runoff exceeds the volume of the sinkhole depression, the depth, spread, and path of overflow shall be estimated using methods set forth in "Stormwater Runoff Calculations" (page 127) and shown on the map.

   The overflow volume shall be included, determining the maximum estimated flooding elevations in the next downstream sinkhole. This analysis shall continue downstream until the lowest sinkhole of the sinkhole cluster is reached or overflow reaches a surface watercourse.

   The volume of runoff considered shall be that which results from a rainstorm with an annual probability of 1 percent (100-year storm) and a duration of 6 hours (5.8 inches for Nixa).

   The runoff volume shall be determined by the method set forth in Chapter 2 of the SCS TR-55 Manual (Reference 11).

   No further flooding analysis will be required, provided that:

   a. The post-development flooding area of any sinkhole which receives drainage from the site is located entirely on the site.

   b. A drainage easement covering the post-development flooding area is provided for any off-site sinkhole or portion of a sinkhole which receives increased peak rates of runoff from the site. If the sinkhole is not contiguous to the site, an easement must also be provided for the waterway which connects the site to the sinkhole.

c. The minimum entry elevation of any existing structure is at least 1 foot higher than the estimated flooding elevation from the 1 percent annual probability 6-hour storm.

d. The flooding depth on any existing public road does not exceed the maximum depths set forth in Drainage of Street and Roadways.

2. Detailed Flooding Analysis. In cases where the conditions set forth in "Minimum Flooding Analysis" (above) cannot be met, a detailed flooding analysis will be required if any increase in runoff volume is proposed. For detailed flooding analysis a runoff model must be made for the sinkhole watershed and reservoir routing analysis performed using hydrographic techniques as set froth in Stormwater Runoff Calculations.

The following alternative methods may be used singularly or in combination to keep flooding levels at pre-development levels:

a. Diversion of Excess Runoff to Surface Watercourses

Where feasible, increased post-development runoff may be diverted to a surface watercourse, provided that:

1). Any increase in peak runoff rate in the receiving watercourse does not crater or worsen existing flooding problems downstream, and

2). The diverted storm water remains in the same surface watershed.

Storm sewers, open channels and other appurtenances provided for diversions shall be designed in accordance with the applicable sections of these Design Criteria.

The effect of diverted water on downstream watercourses and developments, and requirements for additional detention facilities prior to release of runoff to the surface watercourse shall be determined as set forth in "Detention Facilities" (page 173).

Effects of the diversion shall be shown by reservoir routing analysis. Routing of excess runoff shall be considered satisfactory when it can be demonstrated that the post-development flooding elevation in the sinkhole does not exceed the pre-development flooding elevation within reasonable tolerance (generally 0.1 ft.).

b. Determination of Outflow Capacity of Sinkhole

The stage-discharge characteristics of the sinkhole shall be estimated by

monitoring the sinkhole during at least two storm events exceeding 1 inch of runoff in a 6 hour period.

In sinkhole complexes, receiving or terminal sinkholes must also be analyzed if they receive overflow from upstream sinkholes.

Input rainfall hydrographic shall be determined either by a recording rain gage or readings from an approved rain gage at 15 minute intervals.

The outflow rate shall be estimated by adjusting the stage-discharge relationship of the reservoir routing model until the maximum reservoir stage in the model correlates with the maximum observed stage in the sinkhole. The maximum stage shall be determined to the nearest 0.1 foot by field survey.

Stages may be determined by field instrumentation at the consultant's option. Information regarding the instrument used shall be submitted with the report.

Where debris lines are used as evidence of maximum stage, photographs shall be provided.

If by accounting for the outflow from the sinkhole, the conditions set forth in this section can be met, no further flooding analysis is necessary.

The volume of runoff storage in the sinkhole(s) can be counted toward storm water detention requirements, provided that proper sediment and erosion control measures are provided as set forth in "Sediment and Erosion Control" and water quality considerations as set forth in this section can be met.

If in the opinion of the City Planner, the outflow capacity of the sinkhole may be adversely affected by ground water conditions, the effects of which may not be adequately determined by observing surface water stages, the City Planner may require installation of a monitoring well in each sinkhole, for the purpose of monitoring ground water levels in comparison with surface water levels.

c. Storage of Excess Runoff within the Sinkhole Watershed

Where feasible, detention facilities may be constructed within the sinkhole watershed or in perimeter areas of the sinkhole. These detention facilities must be located outside the sinkhole flooding area determined for post-development conditions.

The flooding considerations set forth in this Section will be met if it can be demonstrated that:

1). Inflow rates to the sinkhole can be reduced to a degree that, in conjunction with the observed outflow rate, the post-

development flooding elevation in the sinkhole does not exceed the pre-development flooding elevation within reasonable tolerance (generally 0.1ft).

2). Sediment & erosion control and water quality considerations as set forth elsewhere in this section can be satisfied.

J. WATER QUALITY CONSIDERATION: Sinkholes provide direct recharge routes to ground water. As a result water quality in wells, caves and springs may be affected by discharge of runoff from developed areas.

The Sinkhole Evaluation must consider potential impacts of the proposed construction of receiving ground waters and propose measures to mitigate such impacts.

Four primary factors must be considered: (1) Receiving Ground water Use; (2) Relative ground water contamination hazard associated with the proposed development; (3) Ability to capture pollutants; (4) Management measures to be provided to reduce pollutant levels.

1. Receiving Ground Water Use: The Sinkhole Evaluation Report shall identify whether the site lies within a critical area based upon information available from the City Planning Department.

   Where disagreements may arise over whether a site is located within a particular recharge area, dye tracing may be required for confirmation of the destination of water discharges through a sinkhole.

   a. Critical Areas: The following areas are classified as critically sensitive to contamination from urban runoff:

      - Recharge areas of domestic water supply wells
      - Recharge areas of springs used for public or private water supply
      - Recharge areas of caves provide habitat to endangered species such as the Ozark cave fish

   b. Sensitive Areas: All other sinkhole areas will be classified as sensitive to contamination from urban runoff.

2. Ground Water Contamination Hazard: The relative potential for ground water contamination will be classified as low, moderate, or high depending upon the type of land use, development density and amount of directly connected impervious area. The Sinkhole Evaluation shall identify whether the proposed development poses a low, moderate, or high hazard to ground water uses, as defined below.

   a. Low Hazard: The following land uses are classified as posing a relatively low hazard to ground water contamination:

1). Wooded areas and lawns.

2). Parks and recreation areas.

3). Residential developments on sewer, provided directly connected impervious areas discharging to the sinkhole are less than 1 acre.

4). Low density commercial and office developments provided directly connected impervious areas discharging to the sinkhole and less than 1 acre.

5). Discharge from graded areas less than 1 acre having required sediment controls per "Sediment and Erosion Control" Section.

b. Moderate Hazard:

1). Concentrated discharge from streets and parking lots and roofs and other directly connected impervious areas having an area greater than 1 acre and less than 5 acres.

2). Multifamily residential developments and higher intensity office developments provided the directly connected impervious areas discharging to the sinkhole are less than 5 acres.

3). Discharge from graded areas greater than 1 acre and less than 5 acres having required sediment controls per "Sediment and Erosion Control" Section.

c. High Hazard:

1). Collector and arterial streets and highways used for commercial transport of toxic materials.

2). Railroads

3). Concentrated discharge from streets and parking lots and roofs and other directly connected impervious areas having an area greater than 5 acres.

4). Commercial, industrial and manufacturing areas.

5). Individual waste water treatment systems.

6). Commercial feedlots or poultry operations.

7). Discharge from graded areas greater than 5 acres having required sediment controls per "Sediment and Erosion Control" Section.

3. Capturing and Filtering Pollutants: The majority of sinkholes drain a limited watershed area. For sinkholes where the surrounding drainage area is small enough

that the area draining to the sinkhole flows predominantly as "sheet flow", potential impacts on water quality can be addressed by erecting silt control barriers around the sinkhole during construction and providing a vegetative buffer area around the sinkhole to filter out potential contaminants.

When the volume of runoff into the sinkhole increases to the point where flow becomes concentrated, the degree of effort required capturing and filtering out contaminants increases significantly.

Concentration inflow occurs naturally when the sinkhole watershed area reaches a sufficient size for watercourses leading into the sinkhole to form. Concentrated surface flows result as urbanization occurs due to construction of roads, storm sewers, and drainage channels. Subsurface flows can become concentrated through utility trenches.

The Sinkhole Evaluation shall include maps showing any existing watercourse which flows into the sinkhole and location of any proposed concentrated storm water discharges into the sinkhole.

4. Water Quality Management Measures:

   a. Sediment and Erosion Control:

      1). Non-Concentrated Flow (sheet flow)

      In critical areas, existing ground cover shall not be removed within 25 feet of the sinkhole rim and a silt barrier shall be provided around the outer perimeter of the buffer area.

      2). Concentrated Flow

      A sediment basin will be required at each point where concentration flows are discharged into the sinkhole.

      Sediment basins shall be designed according to the procedures per “Sediments and Erosion Control” Section.

   b. Minimizing Directly Connected Impervious Area:

      The ground water contamination hazard category for impervious areas may be reduced by reducing the amount of Directly Connected Impervious Area. This is the area of roofs, drives, streets, parking lots, etc. which are connected via paved gutters, channels, or storm sewers.

Directly Connected Impervious Areas can be reduced by providing properly sized grass swales, vegetative filter strips or other Best Management Practices to separate paved areas.

c. Diversion of Runoff:

Concentrated discharges to sinkholes can be reduced to manageable levels or avoided by diverting runoff from impervious areas away from sinkholes where possible.

Diversions shall be done in a manner that does not increase flooding hazards on downstream properties and, generally, shall not be directed out of the surface watershed in which the sinkhole is located.

d. Filtration Areas:

For areas having a low or moderate ground water contamination hazard and where flow into the sinkhole occurs as sheet flow, water quality requirements can be satisfied by maintaining a permanent vegetative buffer area with a minimum width of 30 feet around the sinkhole.

Use of pesticides and fertilizers will not be permitted within the buffer area. Animal wastes will not be permitted to accumulate in the buffer area.

e. Grassed Swales and Channels:

For areas having a low ground water contamination hazard concentrated flows from directly connected impervious areas of less than one acre may be discharged into the sinkhole through grassed swales and channels.

Swales and channels shall be designed for non-erosion velocities and appropriate temporary erosion control measures such as sodding or erosion control blankets provided.

f. Storage and Infiltration:

Storage and infiltration will be required in the following cases:

1). All areas having a high ground water contamination hazard.
2). Areas having a moderate ground water contamination hazard where concentrated inflow occurs.

Storage and infiltration basins shall be designed to capture the runoff from storms up to 1 inch in 6 hours and release runoff over a minimum period of 24 hours. Standard outlet structures for sedimentation and infiltration basins are shown in Appendix F.

K. PERFORMANCE STANDARDS/CONSIDERATIONS FOR DEVELOPMENT: Performance standards and considerations for various types of development in sinkhole areas are discussed in the following:

1. Roadways: Subdivision streets should be laid out to avoid sinkholes to the degree possible. Major arterials and highways, however, require specific alignments and, in many cases, it is not possible to create an alignment that avoids all sinkholes. Long term performance is usually the best indicator of future performance. Roadways produce a relatively light loading on soils and, if designed and constructed properly, should provide suitable structural stability. Any collapse sinkholes or solution sinkhole eyes should be stabilized prior to roadway construction. BMPs should be maintained during construction to prevent transport of sediment or other deleterious materials into sinkholes. Storm water conveyance structures should be designed to remove storm water from sinkholes as quickly as possible, and roadways should be designed to route roadway surface runoff away from, rather than into, sinkholes to the degree possible. If the storm water storage capacity (sinkhole volume) of the sinkhole is diminished as a result of roadway construction and post-construction flood routing shows an adverse effect on downstream landowners, additional storm water storage should be provided by either enlargement of the sinkhole by lateral excavation or construction of supplementary detention basins.

2. Utilities: Utilities that are constructed within twenty feet of sinkhole rims must be bedded in flowable fill rather than granular fill. At no time shall a structure be placed over utility lines. The installation of utilities within a sinkhole shall be limited to the sinkhole slope, since the sinkhole floor may be subject to subsidence, collapse, or prolonged ponding of storm water.

3. Residential Construction: Residential structures shall maintain a 10 foot setback from the rim of the sinkhole as identified by a qualified geologist. Residential construction should incorporate drainage swales to divert storm water runoff around sinkholes to the degree possible. Introduction of pesticides and fertilizers is problematic from the standpoint of groundwater quality.

4. Commercial and Industrial Construction: Larger structures that are supported by piers to bedrock can be constructed to the sinkhole rim, or even onto the sinkhole slope, Special considerations will be required, however, to address storm water management and groundwater protection.

5. Recreational use and Green Space: Solutional sinkholes are very appropriate for recreational use and preservation of green space. Sinkholes may be developed with benches, walking trails, playgrounds and plantings, provided they are done so with the understanding that flooding may periodically occur. Recreational uses that would not be appropriate include those that may

introduce hazardous materials to the sinkhole or that may cause excessive erosion (BBQ grills, gasoline-powered vehicles, etc) Recreational use will be considered and approved on a case-by-case basis.

6. Sinkhole Closure: Sinkhole closure will be considered an acceptable means of increasing the amount of useable land for development within the City of Nixa provided certain requirements are satisfied. An appropriate site investigation and development plan must be submitted to the City of approval which addresses structural integrity, storm water management, protection of groundwater quality, impact on groundwater recharge, and sustainability. In all cases, the owner/developer should retain the liability for private property and structures within the closed sinkhole, and must provide a bond to the City for maintenance and repair of any infrastructure that the City accepts. All closed sinkholes must be surveyed and legal descriptions submitted to the Christian County Recorder's Office.

L. DEVELOPMENT REQUIREMENTS:

1. Storm Water Detention in Sinkholes: Where flooding considerations set fort in Stormwater Management Goals and water quality considerations, as set forth in Sediment and Erosion Control, can be met, the volume of runoff storage in sinkholes can be counted toward storm water detention requirements, provided that proper sediment an erosion control measures are provided as set forth in Sediment and Erosion Control.

   The volume of required detention storage shall be determined as set forth in Detention.

   Excavation within the sinkhole flooding area to provide additional detention storage will not be allowed.

2. Modification of Sinkholes to Increase Outflow Rates: Increasing outflow rates in sinkholes by excavating the sinkhole eye or installing disposal wells for diverting surface runoff to the ground water system is prohibited, unless clear and imminent danger to the public health and safety can be demonstrated.

3. Setbacks and Use Restrictions:

   a. No new construction of any of the following shall be permitted within 10 feet of the sinkhole rim:

      - Residential, commercial or industrial structures within 10 feet of the rim of a sinkhole that has not been closed a s provided in the regulations.
      - Swimming Pools.
      - Streets, highways, or parking lots within 10 feet of the rim of a sinkhole that

has not been closed as provided in the regulations.

- Storage yards for materials, vehicles and equipment.

b. Use of pesticides and fertilizers within 30 feet of the sinkhole rim is prohibited.

c. Use of heavy construction equipment in unaltered sinkholes is prohibited.

d. Construction of underground utilities is prohibited within the sinkhole rim except as provided for in the regulations.

e. Recreational facilities such as hiking, jogging, and bicycle trails, playgrounds, exercise courses, and grass playing fields are permitted within the sinkhole area, provided they are not located within the eye of the sinkhole.

f. Golf courses are permitted subject to approval of a Management Plan for use of pesticides and fertilizers.

g. Clearing and pruning of trees and undergrowth, and limited grubbing of roots is permitted.

h. Landscaping and minor gardening is permitted outside of the sinkhole eye provided erosion and sediment discharge is limited through the use of minimum tillage and mulch.

i. Construction of light incidental landscaping and recreational structures such as gazebos, playground equipment, etc. is permitted except in the sinkhole eye.

4. Collapsed Sinkholes: Collapsed sinkholes may be stabilized and filled using approved techniques. A Grading Permit must be issued prior to performing the construction.

   The probable cause of the collapse and potential adverse impacts of filling the collapse shall be investigated and information submitted with the Grading Permit Application.

5. Altered Sinkholes: Filling or altering of sinkholes without a Grading Permit constitutes a violation of this ordinance. In such cases corrective measures must be proposed within the time period specified in the Land Development Code for enforcement of such violations. No corrective or remedial measures shall be undertaken until the proposed remediation plan has been reviewed by the City Planner and a Grading Permit issued.

   No Building Permits will be issued, or zoning or subdivision approvals granted until the remedial measures specified in the Grading Permit have been completed.

M. SINKHOLE CLOSURE REGULATIONS: An exemption may be granted to the policy of sinkhole avoidance, minimization, and mitigation upon approval of sinkhole closure application

and acquisition of a sinkhole closure permit. The sinkhole closure application shall include the following information:

- Reason for the sinkhole closure,
- Location and description of the sinkhole, including dimensions, depth, and a description of the sinkhole eye, and one-foot contour interval topographic map of the sinkhole and sinkhole drainage area.
- Geotechnical report describing the fill plan, source of clean soil fill, soil testing data, and specifications for compaction.
- Foundation design report detailing the design of any structures to be constructed on the closed sinkhole.
- Storm water management report that included pre-development and post-development flooding analysis and describes how storm water will be managed onsite.
- Groundwater report that assesses the impact of sinkhole closure on groundwater quality and goundwater recharge.
- Side development report that details site grading, roadway construction, utility construction, and erosion control (best management practices).
- The sinkhole closure application must be signed and sealed by a Missouri Registered Geologist, as appropriate, and must be accompained by a $250.00 review fee and performance bond in the amount of 110% of the cost of improvements. A maintenance agreement must also be provided detailing the continued maintenance of all infrastructure improvements.
- The sinkhole closure design must provide for engineered fill with a permeability of at least 1.0 X l0-6 cm/sec. bearing capacity. Any sinkhole eyes that exist must be stabilized by construction of a graded filter. A survey of the closed sinkhole must be recorded with Christian County Recorder or Deeds.

Sections 91 thru 94 Reserved

PART III - DRAINAGE STRUCTURES

Section 95. Inlets.

A. INLET LOCATION: Inlets shall be provided at locations and intervals, and shall have a minimum inflow capacity such that maximum flooding depths, as set forth in General Provisions and Drainage of Streets and Roadways , are not exceeded for the major or minor storm; and at all sump locations where ponding of water is not desired, and drainage cannot be released at the ground surface.

B. INLET INTERCEPTION CAPACITIES:

Inlet capacities shall be determined in accordance with the Federal Highway Administration HEC-12 or HEC 22 Manual.

Nomographs and methods presented in the Neenah Inlet Grate Capacities report (Reference 12) may also be used where applicable.

The use of commercial software utilizing the methods of HEC-12 is acceptable. It is recommended that software be pre-approved for use by the City Planner.

Clogging Factors. The inlet capacities determined as required in this section must be reduced as follows, in order to account for partial blockage of the inlet with debris:

Inlet Type and Location	Clogging Factor
Type SS Curb Opening	.08
Grated Inlets	
on grades	.06
in sumps	0.5

Inlet lengths or areas shall be increased as required to account for clogging.

C. INTERCEPTION AND BYPASS FLOW: It is generally not practical for inlets on slopes to intercept 100 percent of the flow in gutter. Inlets must intercept sufficient flow to comply with street flooding depths requirements. Bypass flows shall be considered at each downstream inlet, until all flow has entered approved storm sewers or drainage ways.

D. TYPES OF INLETS ALLOWED:

1. Public Streets:

   a. Curb Opening Inlets. Type "SS" standard curb opening inlets as shown in Drawing G-21 shall be used for public streets with curb and gutter.

   b. Grated Inlets. In general the use of grated inlets in streets, which require adjustments when streets are repaved, will not be permitted.

   Where conditions are such that curb inlets cannot intercept the required rate of flow necessary to control street flooding depth or to provide diversion of flow to detention,, sedimentation or infiltration basins, "trench inlets" with vaned grates may be specified with approval of the City Planner.

   Other types of inlets will not be permitted unless approved by the City Planner.

2. Outside of Public Right-of-Way: The type of inlets specified outside of public right-of-way is left to the discretion of the designer provided the following criteria are met:

   a. Maximum flooding depths for the major or minor storm, as set forth in Drainage of Streets and Roadways , are not exceeded.

   b. General safety requirements, as set forth in Stormwater Planning and Design , are met.

   c. All inlets shall be depressed a minimum of 2" below the surrounding grade to allow proper drainage to the inlet and prevent inadvertent ponding in the area around the inlet.

   d. Inlets in pavements shall be provided with a concrete apron.

E. GENERAL SAFETY REQUIREMENTS: All inlets openings shall:

1. Provide for the safety of the public from being swept into the storm drainage system; the maximum allowable opening shall not exceed 6" in width.

2. Be sufficiently small to prevent entry of debris which would clog the storm drainage system.

3. Be sized and oriented to provide for safety of pedestrians, bicyclists, etc.

Section 96. Storm Sewers.

A. PURPOSE: This section outlines acceptable methods of determining storm water runoff.

B. DESIGN CRITERIA:

1. Design Storm Frequency: The storm sewer system, beginning at the upstream and with inlets, is required when the allowable street capacity or overflow capacity is exceeded for the design storm. The "design storm" has two connections in the City of Nixa: The design storm for the minor system and the design storm for the major system, the 5-year and 25-year storm respectively, as noted in "Stormwater Runoff Calculations" (page 127). Thus, the storm sewer system should be designed for the larger of the following two events:

   The peak flow from a 5-year storm or;

   The difference in the peak flow from a 25-year storm and the allowable street capacity.

2. Construction Materials: Storm sewers may be constructed using reinforced concrete, corrugated metal (steel or aluminum) or plastic pipe. The materials, pipes, or appurtenances shall meet one or more of the following standards:

Pipe Material	Standard
Reinforced Concrete Pipe-Round M-170	ASTM C-76 or AASHTO
Reinforced Concrete Pipe-Elliptical M-207	ASTM C-507 or AASHTO
Reinforced Concrete Pipe Joints M-198	ASTM C-443 or AASHTO
Reinforced Concrete Pipe Arch M-206	ASTM C-506 or AASHTO
Pre-Cast Concrete Manhole M-199	ASTM C-478 or AASHTO
Pre-Cast Concrete Box Pipe	ASTM C-789/C-850 or AASHTO M259/M-273
Corrugated Steel Pipe-Metallic for Sewers and Drains	AASHTO M-36

Corrugated aluminum Alloy Pipe and Underdrains	AASHTO M-196
Bituminous Coated Corrugated Metal Pipe and Pie Arches	AASHTO M-190
Corrugated PVC Pipe F-679	ASTM D-3034 and ASTM
Corrugated Polyethylene Pipe	ASTM D-1248

3. Vertical Alignment: The sewer grade shall be such that a minimum cover is maintained to withstand AASHTO HS-20 loading on the pipe. The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall not be less than 1 foot from the top of the pipe to the finished grade at any point along the pipe. If the pipe encroaches on the street subgrade, approval is required.

   Manholes will be required whenever there is a change in size, direction, elevation grade and slope, or where there is a junction of two or more sewers. The maximum spacing between manholes for storm sewers (cross sectional are less than 25 square feet) shall be 400 feet. For large storm sewers (cross sectional area greater than 25 square feet), manholes for maintenance access need only be placed a minimum of every 500 feet; access to the lateral can be obtained from within the larger storm sewer.

   The minimum clearance between storm sewer and water main (for new construction), either above or below shall be 18 inches. In addition, when an existing sanitary sewer main lies above a storm sewer, or within 18 inches below, then sanitary sewer shall have an impervious encasement or be constructed of structural sewer pipe for a minimum of 10-feet on each side of the storm sewer crossing. Siphons or inverted siphons are not allowed in the storm sewer system.

4. Horizontal Alignment: Storm sewer alignment between manholes shall be straight except when approved by the Water & Sewer Superintendent. Approved curvilinear storm sewers may be constructed by using radius pipe. The radius requirements for pipe bends is dependent upon the manufacture's specifications. A minimum horizontal clearance of 10 feet is required between sanitary and water utilities and the storm sewer.

   The permitted locations for storm sewer within a street ROW are: a) on centerline; b) between centerline and curb; and c) behind the curb. Storm sewer shall not be placed on the area within the wheel lanes of the pavement.

5. Pipe Size: The minimum allowable pipe size for storm sewers is dependent upon a diameter practical from the maintenance standpoint. For storm sewers less than 50 feet in length the minimum allowable diameter is 15 inches. All other pipe shall have a minimum diameter of 18 inches.

6. Storm Sewer Capacity and Velocity: Storm sewers should be designed to convey the design storm (5-year) flood peaks without surcharging the storm sewer. The sewer may be surcharged during larger floods and under special conditions when approved by the City Planner.

   The capacity and velocity shall be based on then-values presented in Table 259-1. The maximum full flow velocity shall be less than 15 fps. Higher velocities may be approved by the City Planner if the design includes adequate provisions for uplift forces, dynamic impact forces and abrasion. The minimum velocity in a pipe based on full flow shall be 2.5 fps to avoid excessive accumulations of sediment.

   The energy grade line (EGL) for the design flow shall be no higher than six inches below the final grade at manholes, inlets, or other junctions. To insure that this objective is achieved, the hydraulic grade line (HGL) and the energy grade line (EGL) shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses will include friction, expansion, contraction, bend, manhole and junction losses. The methods for estimating these losses are presented in the following sections.

7. Storm Sewer Outlets: All storm sewer outlets into open channels shall be constructed with a headwall and wingwalls or a flare-end-section. Riprap or other approved material shall be provided at all outlets.

8. Hydraulic Evaluation: Presented in this section are the general procedures for hydraulic design and evaluation of storm sewers. The user is assumed to possess a basic working knowledge of storm sewer hydraulics and is encouraged to review the text books and other technical literature available on the subject (Reference -3, -4, -6, -7, -10, and -40).

9. Pipe Friction Losses: Pipe friction losses are estimated using Equation 259-1 and Manning's formula (Equation 259-2) which are expressed as follows:

(259-1)

$$H_f = Sf \times L$$

where Hf = head loss due to friction (feet)

Sf = Friction slope from Manning's equation (feet per foot)

$$Sf = \frac{n^2 x\ V^2}{2.22 x R^{3/4}}$$

L = length of pipe segment (feet)

(259-2)

and $V = \frac{1.49}{n} x\ R^{2/3} x\ S_f^{1/2}$

where V = velocity of flow (ft per second)

R = hydraulic radius = A/WP (feet)

S_f = friction slope (feet per foot)

A = area of flow (square feet)

WP = wetted perimeter (feet)

n = Manning's roughness coefficient (refer to Table 259-1)

10. Pipe Form Losses: Generally, between the inlet and outlet, the flow encounters, in the flow passageway, a variety of configuration such as changes in pipe size, branches, bends, junctions, expansions, and contractions. These shape variations impose losses in addition to those resulting from pipe friction. Form losses are the result of fully developed turbulence and can be expressed as follows:

(259-3)

$HL = K (V^2/2g)$

where HL = head loss (feet)

K = loss coefficient

$V^2/2g$ = velocity head (feet)

g = gravitation acceleration (32.2 ft/sec^2).

The following discussion of a few of the common types of form losses encountered in storm design. The reader is referred to Reference 1 and 6 for additional discussion.

11. Expansion Losses: Expansion losses in a storm sewer will occur when the sewer outlets into a channel. The expansion will result in a shearing action between the incoming high velocity jet and the surrounding outlet boundary. As a result, much of the kinetic energy is dissipated by eddy currents and turbulence. The loss head can be expressed as follows.

(259-4)

$$HL = Kx\ (V_1^2/2g) * (1-(A1/A2))^2$$

where A = cross section area in square feet

V_1 = average upstream pipe flow velocity, feet per second

Kx = expansion loss coefficient

Subscripts 1 and 2 denote the upstream and downstream sections respectively. The value of Kx is about 1.0 for a sudden expansion (such as an outlet to a channel) and about 0.2 for a well designed expansion transition. Table 259-2 presents the expansion loss coefficient for various flow conditions.

12. Contraction Losses: The form loss due to contraction is:

(259-5)

$$HL = Kc\ (V_2^2/2g)(1-(A2/A1)^2)^2$$

where Kc = contraction loss coefficient

Kc is equal to 0.5 for a sudden contraction and about 0.1 for a well designed transition. Subscripts 1 and 2 denote the downstream sections respectively. Table 259-2 presents the contraction loss coefficient for various flow conditions.

13. Bend Losses: The head losses for bends, in excess of that caused by an equivalent length of straight pipe, may be expressed by the relation:

(259-6)

$$HL = Kb\ (V^2/2g)$$

where Kb = Bend coefficient

The bend coefficient has been found to be a function of: a) the ratio of the radius of curvature of the bend to the width of the conduit; b) deflection

angle of the conduit; c) geometry of the cross section of flow; and d) the Reynolds Number and relative roughness. Recommended bend loss coefficients for standard bends, radius pipe, and bends through manholes are presented in Table 259-2.

14. Junction and Manhole Losses: A junction occurs where one or more branch sewer enters a main sewer, usually at manholes. The hydraulic design of a junction is in effect the design of two or more transitions, one for each flow path.

Allowances should be made for head loss due to the impact at junctions. The head loss at a junction for each pipe entering the junction can be calculated from:

(259-7)

$$HL = (V_2^2/2g) - \frac{Kj\,(V_1^2)}{2g}$$

where V2 = the outfall flow velocity

V1 = the inlet velocity

Kj = junction loss coefficient

Because of the difficulty in evaluating hydraulic losses at junctions (Reference-6) due to the many complex conditions involving pipe size, geometry of the junction and flow combinations, a simplified table of loss coefficients has been prepared. Table 259-2 presents the recommended energy loss coefficients for typical manhole or junction conditions encountered in the urban storm sewer system. The coefficients are based on a review of the available data in References -1, -3, -6 and -7.

Case I is for an inlet or a manhole with a straight-through sewer. The recommended loss under this condition is 5% of the velocity head, which typically will be between 0.05 and 0.1 feet. Cases II and III are for junctions with an additional branch line entering the inlet or manhole. For these cases, the losses are dependent on the entry angle of the branch line. The inlet condition, Case II, will have a slightly higher loss than the manhole, because of the flow entering from the top, which results in additional turbulence loss.

Case IV defines the losses for a lateral pipe in which the only flow is from the inlet itself. If a straight-through sewer makes a bend at the manhole, Case V, the losses are calculated from the figure portion of Table 259-3, Sheet 2 of 2. Case VI illustrates flow conditions of connector pipes.

15. Partially Full Pipe Flow: When a storm sewer is not flowing full, the sewer acts like an open channel and the hydraulic properties can be calculated using open channel techniques in Open Channels Section (page 156).

16. Storm Sewer Outlets: When the storm sewer system discharges into an open channel, additional losses, in the form of expansion losses, occur at the outlet. For a headwall and no wingwall, the loss coefficient Kx is 1.0. For a headwall with 45 degree wingwalls, the loss coefficient is about 1.14. For a flared-end-section (which has a Dc/D1 ratio of 2 and a theta angle of around 30 degrees) the loss coefficient is approximately 0.5.

17. Connection Pipe: Connector pipes are used to convey runoff from an inlet to the storm sewer. If, however, the storm sewer runs through the inlet, then a connector pipe is not needed. Connector pipes can connect a single inlet to the storm sewer or they can be connected in a series. Both cases are illustrated in Table 259-3.

    As is illustrated in Table 259-2(c), water has a vertically downward velocity component after entering the inlet. The water is conveyed in the connector pipe in a roughly horizontal direction and then travels roughly horizontally again through the storm sewer after making a sharp bend from the connector pipe.

(TABLE 259-1)

Recommended
MANNING'S n-VALUES

Closed Conduit	
Concrete pipe	.013
Corrugated steel pipe	.024
Open Channels	
gabions	.035
concrete	.015
riprap	.0395 $d_{50}^{0.17}$
grouted riprap	.027
gunite	.028
earth lined	.020 to .040
grass lined	.029 to .100
natural streams	.025 to .100

(TABLE 259-2)

LOSS COEFFICIENTS

a. Expansion Loss Coefficients:

Coefficient, KX

EXPANSION ANGLE	D2/D1=3	D2/D1=1.5.
10	.17	.17
20	.40	.40
45	.86	1.06
60	1.02	1.21
90	1.06	1.14
120	1.04	1.07
180	1.00	1.00

Where D2 = downstream diameter and D1 = upstream diameter

b. Contraction Loss Coefficients:

ENTRANCE	COEFFICIENT, Kc
Bell-mouthed	04
Square-edged	.50
Groove-edged	.20

D2/D1	COEFFICIENT. Kc
<.4	.4
.4	.4
.6	.3
.8	.1

c. Bend Loss Coefficients:

PIPE BENDS	DEFLECTION ANGLE	COEFFICIENT, KB
	90	.50
	60	.43
	45	.35
	22.5	.20

BENDS AT MANHOLES (no special shaping)

DEFLECTION ANGLE	COEFFICIENT, KB
90	1.30
60	0.68
45	0.44
22.5	0.14

BENDS AT MANHOLES (Curved or defection)

DEFLECTION ANGLE	COEFFICIENT, KB
90	1.04
60	0.48
45	0.32
22.5	0.10

These bends, turns, and flows through the connector pipe give rise to three hydraulic losses: a change from static to kinetic energy to get the water moving through the connector pipe, an entrance loss from the inlet to the connector pipe, and a friction loss along the length of the connector pipe. The total head loss in the connector pipe can be calculated from the following equation.

(259-8)

$$Hcp = Hv + Ke \times Hv = S_f \times L$$

Where Hcp = head loss in the connector pipe (feet)

Ke = Entrance loss coefficient

Hv = velocity head in the pipe, assuming full pipe flow (feet)

and the other variables are as previously defined. The value of the entrance loss coefficient is determined from Table 259-2.

If the connector pipes are connected in series, the head loss in each pipe is calculated from Equation 259-B and the total head loss is the summation of the individual head losses.

C. EASEMENTS: Easements shall be provided for all storm sewers constructed in the City of Nixa that are not located within public rights-of-way. The minimum easement widths are as follows:

For pipes 48 inches or less in diameter or width the required easement width is 15 feet.

For pipes and boxes greater than 48 inches in width the required easement width is 10 feet plus the width of the proposed storm sewer.

Storm sewers greater than 8 feet in depth to the flow line may require additional easement width.

All easements required for construction which are not included on the final plat shall be recorded and filed with the City prior to approval of the construction drawings.

Section 97. Bridges and Culverts.

A. PURPOSE: This section outlines the criteria for the allowable drainage encroachment within public streets.

B. GOALS & OBJECTIVES: Urban streets are a necessary part of the City drainage system. The design for the collection and conveyance of storm water runoff is based on a reasonable frequency and degree of traffic interference. Depending on the street classification, (i.e.: local, collector, etc.) portions of the street may be inundated during storm events. Drainage of streets are controlled by both the minor and major storm events. The minor system is provided to intercept and convey nuisance flow. Flow depths are limited for the major storm to provide for access by emergency vehicles during most flood events.

C. DESIGN STANDARDS FOR CULVERTS:

1. Structural Design: All culverts shall be designed to withstand an HS-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges". The designer shall also check the construction loads and utilize the most severe loading condition. The minimum allowable cover is one foot.

2. Design Capacity: Culverts shall be designed to pass the major storm with one foot of freeboard prior to overtopping the road or driveway.

3. Headwater: The maximum headwater for the major storm design flow shall be 1.5 times the culvert diameter for round culverts or 1.5 times the culvert rise dimension for shapes other than round.

4. Inlet and Outlet Protection: For road and driveway culverts larger than 15 inches, culverts are to be designed with protection at the inlet and outlet areas as provided in the “General Design Guidelines” Section (page 162) of this criteria. Headwalls or end sections are to be located a sufficient distance from the edge of the shoulder or the back of the walk to allow for

a maximum slope of 3H:1V to the back of the structure. The type of outlet protection required is as follows:

V < 7 FPS	7 FPS < V < 15 FPS	V > 15 FPS
Minimum Riprap Protection (Part V)	Riprap protection or Energy Dissipater	Energy Dissipater

5. Velocity Limitations: The maximum allowable discharge velocity is 15 feet per second.

6. Culvert Hydraulics: It is recommended that the procedures outlined in the publication "Hydraulic Design of Highway Culverts" reference 4, be used for the hydraulic design of culverts. Backwater calculations demonstrating the backwater effects of the culvert may be required.

D. DESIGN STANDARDS FOR BRIDGES:

1. Structural Design: All bridges shall be designed to withstand a HS-20 loading in accordance with the design procedures of AASHTO "Standard Specifications for Highway Bridges" Reference 13. The designer shall also check the construction loads and utilize the most severe loading condition.

2. Design Capacity: Bridges shall be designed to pass the major storm with one foot of freeboard between the water surface and the bridge low chord.

3. Backwater: Backwater is defined as the rise in the water surface due to the constriction created by the bridge approach road fills. The maximum backwater for the major storm design flow shall be one foot.

4. Velocity Limitations: Discharge velocities through bridge openings shall be limited to 15 feet per second. Abutment and channel scour protection shall be provided at all bridges.

5. Bridge Hydraulics: All bridge hydraulics shall be evaluated using the procedures presented in the publication "Hydraulics of Bridge Waterways" Reference 14. Backwater calculations demonstrating the effects of the bridge and approach fills compared to the existing flood stages shall be submitted for all bridges.

Section 98. Open Channels.

A. PURPOSE: Presented in this section are the technical criteria for the hydraulic evaluation and hydraulic design of open channels including natural channels, grass, concrete or rock lined channels, composite channels, and roadside ditches.

B. GOALS & OBJECTIVES: The open channel is generally the main facility of major drainage system. If the natural drainage path is preserved, the construction costs for the system can be minimized. The natural route along with minimum alteration of the existing channel is recommended for all drainage ways. In some instances, however, the land use of the property can be improved by relocation or straightening the natural drainage path. Altering the channel alignment and shape may require the addition of grade control structures to control the flow velocities and erosion resulting from increased flows due to urbanization.

C. GENERAL DESIGN GUIDELINES:

1. Natural Channels: The hydraulic properties of natural channels vary along the channel reach and can be either controlled to the extent desired or altered to meet the given requirements. Natural channels used as part of the drainage system must be evaluated for the effect of increased peak flow, flow duration and volume of runoff due to urbanization.

2. Lined Channels: Grass lined channels are the most desirable of the artificial channels. the channel storage, lower velocities, and the green belt multiple use benefits obtained create significant advantages over other artificial channels. Unless existing development restricts the availability of right of way, channels lined with grass should be given preference over other artificial types.

3. Concrete Lined Channels: Concrete lined channels are sometimes required where right of way restrictions within existing development prohibit grass lined channels. The lining must be designed to withstand the various forces and actions which tend to overtop the bank, deteriorate the lining, erode the soil beneath the lining and erode unlined areas.

4. Rock Lined Channels: Rock lined channels are constructed from ordinary riprap or wire enclosed riprap (gabions etc.) The rock lining permits higher design velocity than for grass lined channels. Rock linings will normally be used only for erosion control at culvert/storm sewer outlets, at sharp channel bends, at channel confluence and at locally steepened channel sections.

5. Other Lining Types: The use of fabrics and other synthetic materials for channel linings has increased over the past several years. Proposed

improvements of this type will be reviewed on an individual basis as for applicability and performance.

D. HYDRAULICS: An open channel is a conduit in which water flows with a free surface. The calculations for uniform and gradually varied flow are relatively straight forward and are based upon similar assumptions (e.g. parallel streamlines). The basic equations and computational procedures are presented in this section.

1. Uniform Flow: Open channel flow is said to be uniform if the depth of flow is the same at every section of the channel. For a given channel geometry, roughness, discharge and slope, there is only one possible depth, the normal depth. For a channel of uniform cross section the water surface will be parallel to the channel bottom for uniform flow.

   The computation of normal depth for uniform flow shall be based upon Manning's formula as:

   (261-1)

   $Q = AV$

   where

   Q = Discharge in cubic feet per second (cfs)
   V = Velocity in feet per second as determined by equation 259-2
   A = Cross sectional flow area in square feet

   For channels with a uniform cross section the EGL slope and the bottom slope are assumed to be the same.

2. Critical Flow. The design of earth or rock channels in the critical flow regime (Froude numbers from 0.9 to 1.2) is not permitted. The Froude number is defined as follows:

   (261-2)

   $F = V/(gD)^{0.5}$

   where

   F = Froude number
   V = Velocity in feet per second (fps)
   g = Acceleration of gravity, 32.2 ft/sec^2
   D = Hydraulic depth in feet = A/T
   A = Cross sectional flow area in square feet
   T = Top width of flow area in feet

The Froude number shall be calculated for the design of all open channels.

3. Gradually Varied Flow: The most common occurrence of gradually varied flow in storm drainage is the backwater created by culverts, storm sewer inlets or channel constrictions. For these conditions the flow depth will be greater than normal depth in the channel and the water surface profile must be computed using backwater techniques.

   Backwater computations can be made using the methods presented in Chow (Reference 1). Many computer programs are available for computation of backwater cures. The most widely used program is HEC-2, Water Surface Profiles, developed by the U.S. Army Corps of Engineers (Reference 2) and is the program recommended for backwater profile computations. Another program by the Federal Highway Administration is WSPRO (Reference 15) and is acceptable for use in backwater computations.

E. DESIGN STANDARDS:

1. Flow Velocity: Maximum flow velocities shall not exceed the following:

Channel Type	Max. Velocity
Grass lined*	5 fps
Concrete	15 fps
Rock Lined	10 fps

* Refer to "Grass Channels"

2. Maximum Depth. The maximum allowable channel depth of flow is three feet for the design flow.

3. Freeboard Requirements. Freeboard is defined as the vertical distance between the computed water surface elevation for the design flow and the minimum top of bank elevation for a given cross section.

   For all channels one foot minimum of freeboard is required.

   Freeboard shall be in addition to super elevation.

4. Curvature: The minimum channel centerline radius shall be three times the top width of the design flow.

5. Super Elevation: Super elevation shall be calculated for all cures. An approximation of the super elevation h, may be calculated from the following formula:

(261-3)

$h = V^2T/(gr)$

where

h = Super elevation in feet
V = Velocity in feet per second (fps)
T = Top width of flow area in feet
g = Acceleration of gravity, 32.2 ft/sec^2
r = radius of curvature in feet

6. Grass Channels: Side slopes shall be 3 (horizontal) to 1 (vertical) or flatter. Steeper slopes may be used subject to additional erosion protection and approval from the City Planner.

   For design discharges greater than 50 cfs, grade checks shall be provided at a maximum of 200' horizontal spacing.

   Channel drops shall be provided as necessary to control the design velocities within acceptable limits.

   Vertical drops may be used up to three feet in height. Drops greater than three feet shall be baffled chutes or similar structures.

   The variation of Manning's n with the retardance, and the product of mean velocity and hydraulic radius as shown in Figure 7.23 in Reference 17 shall be used in the capacity calculations. Retardance curve C shall be used to determine the channel capacity and retardance cure D shall be used to determine the velocity.

F. EASEMENTS: Shall be provided for all open channels constructed in the City of Nixa that are not located within public rights of way. The minimum easement width for open channels is the flow width inundated by a 25-year event plus 15 feet.

   All easements required for construction which are not included on the final plat shall be recorded and filed with the City prior to approval of the construction drawings.

Section 99. Drainage of Streets and Roadways.

A. PURPOSE: This section outlines the criteria for the allowable drainage encroachment within public streets.

B. GOALS & OBJECTIVES: Urban streets are a necessary part of the City drainage system. The design for the collection and conveyance of storm water runoff is based on a reasonable frequency and degree of traffic interference. Depending on the street classification, (i.e.: local, collector, etc.) portions of the street may be inundated during storm events. Drainage of streets are controlled by both the minor and major storm events. The minor system is provided to intercept and convey nuisance flow.

Flow depths are limited for the major storm to provide for access by emergency vehicles during most flood events.

When the depths of flow exceed the criteria presented in this section, a storm sewer or open channel system is required.

C. GENERAL DESIGN GUIDELINES:

1. Allowable Flow Depths: Flow in the street is permitted with allowable depths of flow as follows:

a. Local Streets: Top of curb for the runoff from a 5-year rainfall (minor storm), maximum of six inches at crown for a 25 year event (major storm).

b. Collector Streets: Top of curb for the minor storm, maximum of six inches at the crown for the major storm.

c. Arterials and Parkways: Top of curb for the minor storm. For the major storm, a maximum of 6 inches at the crown, depth at the gutter shall not exceed 1 inch

Where allowable depths are exceeded, a storm sewer system must remove the excess water.

2. Cross Flow: Cross flow at intersections is permitted up to the following depths:

STREET MINOR CLASSIFICATION	STORM MAJOR ALLOWABLE DEPTH	STORM ALLOWABLE DEPTH
Local `	6" in cross pan	12" at gutter flow line
Collector	6" in cross pan	12" at gutter flow line
Arterial or Parkway	No cross flow permitted	No cross flow permitted

D. HYDRAULICS: The allowable storm capacity of each street section with curb and gutter is calculated using the modified Manning's formula for both the minor and major storm event.

(262-1)

$$Q = 0.56(Z/n)S^{1/2}d^{8/3}$$

Where

Q = discharge in cubic feet per second

Z = reciprocal of the cross slope of the street in feet per foot

d = depth of flow at the gutter in feet

s = longitudinal slope of the street in feet per foot

n = Manning's roughness coefficient

Sections 100 thru 109 Reserved

PART IV- LAND DISTURBANCE, ILLICIT DISCHARGE & EROSION CONTROL

Section 110 Purpose, Goals and Objectives

A. PURPOSE: The purpose of this section is to protect the health, safety and general welfare of the citizens of Nixa and protect the Waters of the City and Waters of the State through the regulation to the maximum extent practicable of non-storm water discharges to the storm drainage system as required by federal and state law. This section establishes uniform requirements for land disturbance activities in order to control the introduction of pollutants into the municipal separate storm sewer system (MS4) in order to comply with requirements of the National Pollutant Discharge Elimination System (NPDES) permit process.

B. GOALS AND OBJECTIVES: The goal of the regulation is to effectively minimize erosion and discharge of sediment by application of Best Management Practices (BMP's).

This goal can be attained by meeting the following objectives:

1. Stabilize disturbed areas as soon as possible by re-establishing sod, other forms of landscaping, and completing proposed structures, pavements and storm drainage systems.
2. To regulate the contribution of pollutants to the MS4 by storm water discharges by any user.
3. To prohibit illicit connections and discharges to the MS4.
4. To establish legal authority to carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to ensure compliance with this ordinance.

Section 111 DEFINITIONS

For the purposes of this section, the following words shall have the definitions hereinafter set forth:

"Accepted" or "Acceptance" means a determination by the Director or designee that the documents under review meets the minimum applicable standards.

Authorized Enforcement Agency: City of Nixa.

Best Management Practices (BMPs): Schedules of activities, prohibitions of practices, general good housekeeping practices, pollution prevention and educational practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants directly or indirectly to storm water, receiving waters, or storm water conveyance systems.

BMPs also include treatment practices, operating procedures, and practices to control site runoff, spillage or leaks, sludge or water disposal, or drainage from raw materials storage.

Clean Water Act: The federal Water Pollution Control Act (33 U.S.C. δ 1251 et seq.), and any subsequent amendments thereto.

Construction Activity: Activities subject to NPDES Construction Permits. These include construction projects resulting in land disturbance of one acre or more. Such activities include but are not limited to clearing and grubbing, grading, excavating and demolition.

Director: Means the Director of Public Works of the City of Nixa, Missouri, or the Director's authorized representative.

Discharge: means any substance disposed, deposited, spilled, poured, injected, seeped, leached, pumped, dumped, leaked, or placed by any means such that it can reasonably be expected to enter, intentionally or unintentionally, into the Waters of the City or Waters of the State, or on any area draining directly or indirectly into the MS4.

Erosion: The wearing away of land due to the action of gravity, wind, water or other mechanical forces.

Hazardous Materials: Any material, including any substance, waste, or combination thereof, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Illegal Discharge: Any direct or indirect non-storm water discharge to the storm drain system, except as exempted in Section 25-116 of this ordinance.

Illicit Connections: An illicit connection is defined as either of the following:

- Any drain or conveyance, whether on the surface or subsurface that allows an illegal discharge to enter the storm drain system including but not limited to any conveyances that allow any non-storm drain system and any connections to the storm drain system from indoor drains and sinks, regardless of whether said drain or connection had been previously allowed, permitted, or approved by an authorized enforcement agency or,
- Any drain or conveyance connected from a commercial or industrial land use to the storm drain system that has not been documented in plans, maps, or equivalent records and approved by an authorized enforcement agency.

Land Disturbance Permit: The document issued by Public Works approving the SWPPP and sediment erosion control plan thus authorizing land disturbance activity in accordance with the SWPPP.

Land Disturbance: Any activity that exposes soil including clearing, grubbing, grading, excavating, filling and other related activities.

MS4: Municipal Separate Storm Sewer System.

Municipal Separate Storm Sewer System (MS4): The system of conveyances (including sidewalks, roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, berms, stream beds, open fields, parking lots, impervious surfaces used for parking, man-made channels, or storm drains) owned and operated by the City of Nixa and designed or used for collecting or conveying storm water, and that is not used for collecting or conveying sewage.

National Pollutant Discharge Elimination System (NPDES) Storm Water Discharge Permit: A permit issued by EPA (or by the State of Missouri under authority delegated pursuant to 33 USC δ 1342 (b)) that authorizes the discharge of pollutants to the waters of the United States, whether the permit is applicable on an individual, group or general area-wide basis.

Non-Storm Water Discharge: Any discharge to the storm drain system that is not composed entirely of storm water.

Person: Any individual, association, organization, partnership, firm, corporation or other entity recognized by law and acting as either the owner or as the owner's agent.

Pollutant: Anything which causes or contributes to pollution. Pollutants may include, but are not limited to: paints, varnishes, and solvents; oil and other automotive fluids; non-hazardous liquid and solid wastes and yard wastes; refuse, rubbish, garbage, litter, or other discarded or abandoned objects, ordinances, and accumulations, so that same may cause or contribute to pollution; floatables; pesticides, herbicides, and fertilizers; hazardous substances and wastes; sewage, fecal coli form and pathogens; dissolved and particulate metals; animal wastes; wastes and residues that result from constructing and building or structure; and noxious or offensive matter of any kind.

Premises: Any building, lot, parcel of land, or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.

Responsible party: The property owner or person authorized to act on the property owner's behalf; or any person allowing, causing or contributing to a violation of the Code.

Sediment: Mineral or organic matter generated as a result of erosion.

Sediment & Erosion Control Plan: A written plan (including drawings or other graphic representations) that is designed to minimize the accelerated erosion and sediment runoff at a site during construction activities.

Storm Drainage System: Publicly-owned facilities by which storm water is collected and/or conveyed, including but not limited to any roads with drainage systems, municipal streets,

gutters, curbs, inlets, piped storm drains, pumping facilities, retention and detention basins, natural and human-made or altered drainage channels, reservoirs, and other drainage structures.

Storm Water: Any surface or shallow subsurface flow, runoff, or drainage consisting entirely of water from rainstorm or frozen precipitation events.

Storm Water Pollution Prevention Plan (SWPPP): A plan developed by a qualified professional engineer or person certified in erosion and sediment control to establish controls to limit erosion and transport of sediment and other pollutants from the site. The plan shall include BMPs in accordance with the City's Technical Specifications, Land Development Code and City code of ordinances.

SWPPP: Storm Water Pollution Prevention Plan.

Wastewater: Any water or other liquid, other than uncontaminated storm water, discharged from a facility.

Watercourse: Any body of water, including, but not limited to lakes, ponds, rivers, streams, and bodies of water which are delineated by the City of Nixa.

Water Quality Standards: The standards, required under the Clean Water Act, which Missouri has adopted to control and remedy water pollution (10 CSR 20-7.031). Water quality standards have three parts: water used classifications, water quality criteria, and an antidegradation policy.

Waters of the City: Any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, sinkholes, springs, wetlands, wells and channels, and other bodies of surface or subsurface waters, natural or artificial, lying within the boundaries of the City of Nixa, Missouri.

Waters of the State: Any water, surface or underground, lying within the boundaries of the City of Nixa, Missouri over which the Missouri Department of Natural Resources has authority with respect to Clean Water Law.

Section 112 SCOPE AND AUTHORITY

This section shall apply to all water entering the storm drain system generated on any developed and undeveloped lands unless specifically exempted. The provisions in this section shall be administered and enforced by the Director. The Director shall have the authority to develop and implement procedures, forms, policies, design and construction standards and interpretations for administering the provisions of this section.

Section 113 COMPATIBILITY WITH OTHER REGULATIONS

This ordinance is not intended to modify or repeal any other ordinance, rule, regulation, or other provision of law. The requirements of this ordinance are in addition to the requirements of any other ordinance, rule, regulation, or other provision of law, and where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule,

regulation, or other provision of law, whichever provision is more restrictive or imposes higher protective standards of human health or environment shall control.

Section 114 EROSION AND SEDIMENT CONTROL

The Responsible Party shall control site erosion and the release of sediment and other pollutants resulting from land disturbance activities to the Maximum Extent Practicable (MEP) utilizing Best Management Practices (BMPs). The Responsible Party shall ensure that BMPs are designed, constructed and maintained during land disturbance activities.

Section 115 PERMIT REQUIRED

A. PERMIT REQUIRED: A Land Disturbance Permit is required for all land disturbance activity affecting one (1) acre or greater, cumulatively, throughout the duration of the development. The Responsible Party shall obtain a Land Disturbance Permit from the Public Works Director prior to commencing land disturbance activity. A Land Disturbance Permit is not generally required for land disturbance activity of less than one (1) acre, cumulatively, throughout the duration of the development. However, a Land Disturbance Permit may be required if the Director determines that there is significant potential for deposition of sediment that is in violation of this section or the land disturbance activity is within close proximity to valuable resource waters. Regardless of land disturbance size, a Land Disturbance Permit is required if the land disturbance is located twenty-five feet (25') or less from the boundary of a spring, rim of a sinkhole, cave entrance, wetland, watercourse, stream buffer or one hundred (100) year FEMA identified floodplain. The Director shall provide written notice of the need for a permit to the Responsible Party or person conducting the land disturbance activities. The Responsible Party shall obtain a Land Disturbance Permit from the Public Works Department prior to commencing or resuming land disturbance activity.

B. PERMIT PROCEDURES: The following items must be received prior to issuance of a Land Disturbance Permit:

1. An approved grading, SWPPP, and sediment and erosion control plan.
2. A performance bond or other security.
3. A copy of the General Operating Permit

The submittal and approval procedure is as follows: Subdivisions, Commercial and Other Sites; The sediment and erosion control plan shall be submitted for review along with the plans for the proposed improvements: and Land Disturbance permit for subdivisions will be issued by the Director after approval of the plans for the subdivision improvements.

In addition, 10 CSR 20-6.200 requires land disturbance activities of one acre or more to obtain a Missouri State Operating Permit to discharge stormwater. The permit requires Best Management Practices sufficient to control runoff and sedimentation to protect waters of the state. Land disturbance permits may only be obtained by means of the Department of Natural Resources ePermitting system available online at www.dnr.mo.gov/env/wpp/wpermit/help.htm. See www.dnr.mo.gov/env/wpp/wtormwater/sw-land-disturb-permits.htm for more information.

C. PLAN REQUIREMENTS: Plans must be prepared by and bear the seal of an engineer registered to practice in the State of Missouri.

Plan requirements are set forth in the Stormwater Planning and Design Section (page 123) and in this Section.
Plans will not be required in the following cases:

1. Grading associated solely with a single family residence and which is exempt from the permit requirement except as provided in Section 25-115
2. Grading or filling of less than 1 acre if located outside of allowable building areas and not located within 25 feet of a spring, sinkhole, wetland, or watercourse.

   In these instances, a Land Disturbance permit can be issued following an inspection of the site by a representative of the Planning Department if it does not reveal any conditions which would warrant preparation of a detailed plan in the opinion of the Planning Department.

D. SECURITY REQUIREMENTS: Upon approval of the Land Disturbance Permit and prior to issuance of a Land Disturbance Permit, the Public Works Department shall require the developer to post a security in the form of a cash bond, cash or equivalent approved by the Director of Finance of not less than 150% of the value of all work to be done under the grading plan and SWPPP. For land disturbance permits which do not include the construction of public improvements related to subdividing land under the jurisdiction of the Subdivision Regulations, chapter 23 of the Nixa City code, or construction of permanent building or structures, under jurisdiction of the Land Development Code, chapter 23, (i.e. where only grading work is included, such as a borrow pit or pond) the only type of security which will be accepted will be a cash bond. If the bond, letter or credit or other security document is placed in default, or the insurance is terminated or not maintained at a satisfactory level, then no further permits or approvals, including building permits, shall be issued for the developer's property located in the development for which the security was given, until the improvements are completed to the satisfaction of the City. Any portion of the deposit not expended or retained by the City hereunder shall be refunded when the land disturbance is completed and the soil and drainage conditions are stabilized to the satisfaction of the City.

Section 116 Work Exempt from Permit

A Land Disturbance Permit shall not be required in the following instances, provided that no change in drainage patterns or sedimentation onto adjacent properties will occur:

1. Grading of land for farming;
2. Nurseries;
3. Gardening or similar agricultural or horticultural use; and
4. Grading activities in quarries and permitted sanitary landfills.

No Land Disturbance Permit is required for the following activities, provided they are less than one (1) acre of cumulative land disturbance, are not located within twenty-five feet (25') of the boundary of a spring, rim of a sinkhole, cave entrance, wetland, watercourse, stream buffer or one hundred (100) year FEMA identified floodplain and do not cause a violation of the Missouri Clean Water Law or Water Quality Standards:

1. Grading and repair of existing roads or driveways;
2. Cleaning and routine maintenance of roadside ditches or utilities;
3. Utility construction where the width of the disturbed area for trench excavation and backfill is twenty feet (20') or less;
4. Emergency construction required to repair or replace roads, utilities, or other items affecting the general safety and well being of the public; and
5. Land disturbance for single family residences not part of an overall subdivision plan.

For emergency construction activities which would otherwise be required to obtain a permit and for which remedial construction will take more than fourteen (14) calendar days, application for the Land Disturbance Permit must be made within three (3) calendar days from the start of construction.

Section 117 General Design Guidelines.

The following items must be considered in preparing a sediment and erosion control plan.

A. TEMPORARY vs. PERMANENT CONTROLS: The greatest potential for soil erosion occurs during construction. Temporary controls are those which are provided for the purpose of controlling erosion and containing sediment until construction is completed.
Temporary controls include straw or hay bale dikes, silt fences, erosion control blankets etc., which are not needed after the area is stabilized.

Permanent controls consist of riprap, concrete trickle channels, detention basins, etc., which will remain in place through the life of the development.
It is possible for the same facility to serve both a temporary and permanent purpose. The difference between temporary and permanent erosion control should be clearly recognized in preparing a sediment and erosion control plan.

B. SHEET FLOW vs. CONCENTRATED FLOW: In areas where runoff occurs primarily as sheet flow, containment of sediment is relatively simple. In these areas straw or hay bales, silt fences and vegetative filter areas can be very effective.
Where concentrations of flow occur, containment of sediment becomes more difficult as the rate and volume of flow increases. In these areas more sophisticated controls such as sedimentation basins must be provided.

C. SLOPE: Control of erosion becomes progressively more difficult as the slope of the ground increases. Areas with steeply sloping topography, and cut and fill slopes must be given special consideration.

D. SOILS AND GEOLOGIC SETTING:
Area soils and the geologic setting must be considered in preparing the plan and any special considerations deemed necessary for a particular site provided.

E. ENVIRONMENTALLY SENSITIVE AREAS: Where construction occurs within the vicinity of permanent streams, springs, sinkholes, lakes or wetland, special attention must be given to preventing discharge of sediment.

Section 118 Design Standards and Criteria.

A. GRADING:

1. Maximum Grades: Cut or fill slopes shall not exceed 3:1; 4:1 slopes are preferred where possible.
2. Maximum Height: Cut or fill slopes shall not exceed 15 feet in vertical height unless a horizontal bench area at least 5 feet in width is provided for each 15 feet in vertical height.
3. Minimum Slope: Slope in grassed areas shall not be less than 1 percent.
4. Construction Specifications: Construction for streets must comply with specifications set forth by the City of Nixa Planning Department.

For all other areas, construction specifications stating requirements for stripping, materials, subgrade compaction, placement of fills, moisture and density control, preparation and maintenance of subgrade must be included or referenced on the plans, or accompanying specifications submitted.

5. Spoil Areas: Broken concrete, asphalt and other spoil materials may not be buried in fills within proposed building or pavement areas. Outside of proposed building and pavement areas, broken concrete or stone may be buried in fills, provided it is covered by a minimum of 2 feet of earth. Burying of other materials in fills is prohibited.
6. Stockpile Access: Location of proposed stockpile areas shall be outlined on the plans, and specifications for proper drainage included.
7. Borrow Areas: The proposed limits of temporary borrow areas shall be outlined in the plans and a proposed operating plan described on the grading plan. Temporary slopes in borrow areas may exceed the maximums set forth above. At the time that borrows operations are completed, the area shall be graded in accordance with the criteria set forth above, and reseeded.

B. SEDIMENT CONTAINMENT:

1. Existing Vegetative Filter Area: Existing vegetative filter areas may be used where:
   - Unconcentrated sheet flow occurs;
   - An area of existing vegetation a minimum of 25 feet in width can be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland or classified lake;
   - Existing ground slope is no greater than 5:1 (20 percent);

- The existing vegetative growth is of sufficient density and in sufficiently good condition to provide for filtration of sediment.

2. Containment areas constructed of hay or straw bales, or silt fence may be provided in areas where:
   - Unconcentrated sheet flow occurs;
   - An area of existing vegetation, a minimum of 25 feet in width cannot be maintained between the area to be graded and a property line, watercourse, sinkhole, spring, wetland or classified lake;
   - Existing ground slope is no greater than 5:1 (20 percent);
   - Concentration flow from an area no greater than 1 acre occurs and a minimum volume of 100 cubic feet per acre is contained behind the dike.
   - Either cereal grain straw or hay may be used for bale dikes.
   - Silt fence may be used in lieu of hay or straw bales.
   - Straw/hay bake dikes and silt fences are temporary practices.

3. Temporary Containment Berms: Temporary containment berms may be provided for areas where concentrated flow from areas greater than 1 acre and less than 5 acres occurs. Temporary containment berms must contain a volume of 1000 cubic feet per acre of drainage area.

   Temporary containment berms and accumulated sediment may be completely removed after the tributary area is stabilized, and must be removed prior to final acceptance and release of escrow.

4. Sedimentation Basin: Sediment basins shall be provided for all areas where concentrated flow occurs from an area of 5 or more acres. Sediment basins shall be designed to detain the runoff from 1 inch of rainfall, for a period of at least 24 hours. Runoff shall be calculated using the methods contained in Chapter 2 of TR-55 (Reference 11), using the recommended curve number for newly graded areas from Table 2-2a.
   Note: For construction sites in Nixa, an average value of runoff volume from 1 inch of rainfall is approximately 1000 cubic feet per acre, using a curve number of 90, as indicative of a Type B & C soils. This value may be used in sizing sediment basins or the runoff volume determined using the values from Figure 2-1 of TR-55.

   a. Sediment basins shall be provided with: an outflow structure consisting of:
      - A flow restriction device which provides for the required detention time,
      - An outfall pipe sized to carry the maximum estimated outflow rate,
      - protective structures at the pipe outlet to prevent crushing or damage of the end of the pipe,
      - Protective structures to prevent blockage of the pipe with debris,
      - Erosion protection at the pipe outlet.

   b. An overflow spillway capable of discharging the peak flow rate for the annual 4% annual probability (25-year) storm while maintaining a minimum freeboard of 1 foot.

      Overflow spillways may be sodded where the depth of flow at the crest is limited to

no greater than 6" and outlet channel velocities do not exceed 5 feet per second for the minor (5- year) storm.

Overflow spillways not meeting these restrictions must be constructed of riprap, concrete or other approved, non-erodible material.

C. EROSION PROTECTION:

1. Seeding and Mulching: (Also see "Seeding" in this Chapter)

   a. Permanent Seeding: Permanent seeding fertilizer and mulch shall be applied at the rate set forth in Drawing G-1 or according to other specifications which are approved with the Grading Permit. Permanent seeding seasons are from March 1 to May 15, and August 15 to October 15.

   b. Mulching: Where slopes are less than 4:1, cereal grain mulch is required at the rate of 100 pounds per 1000 square feet (4500 pounds per acre). Cereal grain mulch shall meet the requirements of Section 802 of the State Specifications (Reference 17) for Type 1 mulch.
   Where slopes are 4:1 or greater Type 3 mulch ("hydromulch") meeting the requirements of Section 802 of the State Specifications (Reference 17) shall be used.

   c. Temporary Seeding: Whenever grading operations are suspended for more than 30 calendar days between permanent grass or seeding periods all disturbed areas must be reseeded with temporary cover according to Drawing G-1. Temporary seeding season runs from May 15 to November 15.

   d. Overseeding: During the winter season (November 15 to March 1) temporary seed and mulch shall be placed on all completed areas or areas where grading is suspended for more than 30 days. During this period seed, mulch and soil amendments shall be applied at the following rates:

      Lime: 100% of specified quantity.*
      Fertilizer: 75% of specified quantity.
      Seed: 50% of specified quantity.
      Mulch: 100% of specified quantity.
      * Per Drawing G-1

   e. Maintenance: Seeded areas must be maintained for one year following seeding.

2. Cut and Fill Slopes: Cut and fill slopes shall be protected from erosion by construction of straw bale dikes, silt fences, diversion berms, or swales along the top of the slope.
   Where drainage must be carried down the slopes, pipe drains, concrete flumes, riprap chutes, or other impervious areas must be provided. Suitable erosion control measures such as riprap stilling basins, must be provided at the bottom of the slope.
   Diversions shall be maintained until permanent growth is firmly established on the

slopes.

3. Channels and Swales: Permanent channels and swales shall be provided with a stabilized invert consisting of one of the following materials:

   a. Sod: Where the average velocity of flow is 5 feet per second or less and there is no base flow, the channel shall be lined with sod.

      The remainder of the channel slopes shall be seeded and mulched as provided above.

   b. Erosion Control Blanket: Commercial erosion control blankets may be used in lieu of sod provided that samples are submitted and approved by the City Planner. The guaranteed maintenance period shall be one year.

   c. Non-erosive lining: In grass channels where base flow occurs, a non-erosive low-flow channel of riprap or concrete must be provided. Low flow channels shall have a minimum capacity of 5 cubic feet per second. Other suitable non-erosive materials may be specified with approval of the City Planner.

      For channels which have an average velocity of 5 feet per second or greater a non-erosive lining of riprap concrete or other approved material must be provided.

4. Storm Sewer and Culvert Outlets: Erosion protection shall be provided at storm sewer and culvert outlets. Minimum erosion protection shall consist of a concrete toe wall and non-erosive lining.

   Flared end sections and headwalls are not required, but may be provided at the discretion of the designer to meet grading or aesthetic requirements. The required length of non-erosive lining will not be decreased where flared end sections or headwalls are provided unless calculations and data to support the decrease in length are submitted and approved. Non-erosive lining shall consist of riprap, unless otherwise specified and approved. Field stone, gabions, or Riprap shall extend to the point at which average channel velocity for the peak flow rate from the minor (5-year) storm has decreased to 5 feet per second maximum

   The length of riprap to be provided shall be as follows:

   Average outlet velocity less than 5 feet per second: L = 3 times the pipe diameter or culvert width.

   Average outlet velocity less than 5-10 feet per second: L = 5 times the pipe diameter or culvert width.

   Average outlet velocity greater than 10 feet per second: Use MHTD standard energy dissipater headwall (Reference 17) or approved equal.

5. Curb Openings: Where drainage flows from paved areas to grass areas through curb openings erosion protection shall be provided.

6. Ditch Checks and Drop Structures: In grass channels, grades and velocities may be controlled by use of ditch checks and drop structures.
   Riprap ditch checks may be required in natural channels where average velocity for the peak flow rate from the minor storm exceeds 5 feet per second for post-development conditions.

7. Spillways: Erosion protection must be provided at spillways and outlet structures for detention ponds. Erosion protection shall extend to the point where flow has stabilized and average velocity in the outlet channel is 5 feet per second or less.

D. TEMPORARY VEHICLE TRACKING PAD: A minimum of one temporary vehicle tracking pad is required at each site. Additional tracking pad's may be provided if approved. The location of each tracking pad shall be shown on the plan. Only tracking pads designated on the sediment and erosion control plan may be used. Barricades shall be maintained if necessary to prevent access at other points until construction is complete.

Temporary Vehicle Tracking Pad's shall be constructed of crushed limestone meeting the following specifications.

- Temporary vehicle tracking pad's shall be a minimum of 25 feet wide and 50 feet long.
- Minimum thickness of crushed limestone surface shall be 2" to 4" inch diameter rock (rocks 6" and larger shall be avoided because they can become lodged between dual tires on trucks) is to be used, with a minimum thickness of 12 inches. Additional 2 inch lifts of crushed limestone shall be added at the discretion of the City if the surface of the initial drive deteriorates or becomes to muddy to be effective.

E. CLEANING STREETS: Streets both interior and adjacent to the site shall be completely cleaned of sediment at the end of construction and prior to release of security.

F. DUST CONTROL: The contractor will be required to use water trucks to water haul roads and construction areas to minimize dust leaving the site when conditions warrant.

G. SEQUENCING AND SCHEDULING: Costs of sediment and erosion control can be minimized if proper consideration is given to sequencing and scheduling construction.

Any special sequencing and scheduling considerations should be noted in the grading plan.

A detailed schedule must be received from the contractor at the Pre-Construction Conference.

Section 119: INSPECTION

A. By submitting a Land Disturbance permit the applicant consents to inspections of the proposed development site and all work in progress. The Director shall be allowed to enter the property of the responsible party as deemed necessary to make regular inspections.

B. A copy of the Land Disturbance permit and SWPPP must be available on site for inspection by the Director.

C. The Director shall make inspections as hereinafter required in Subsection D and shall either approve that portion of the work completed or shall notify the Responsible Party wherein the work fails to comply with the plan as approved.

D. In order to obtain required inspections, the responsible party shall notify the Director at least two (2) working days **before** the following required inspections:

1. Initial erosion and sediment control measures placement.
2. Site Clearing.
3. Rough Grading.
4. Removal or substantial modification of any erosion and sediment control measure or practice.
5. Final landscaping.

E. The Responsible Party shall provide a qualified inspector to conduct inspections on a weekly basis or within forty-eight (48) hours of a half inch (1/2") or greater rain event. The log of such inspections shall be maintained on site and available for review by the City upon request. Prior to final acceptance of the project a copy of the inspection log must be provided to the Director for permanent record.

F. The purpose of inspections will be to determine the overall effectiveness of the SWPPP plan and shall be used to identify the need for additional control measures. The need for changes to the plan as identified by the inspections shall be provided to the Responsible Party in writing.

G. In the event work does not conform to the permit or conditions of approval or to the approved plan or to any instruction of the Director, notice to comply shall be given to the Responsible Party in writing. After a notice to comply is given, the Responsible Party shall be required to make the corrections within the time period determined by the

Director. If an imminent hazard exists, the Director shall require that the corrective work begin immediately.

Section 120 ENFORCEMENT AND PENALTIES

A. Stop-Work Order; Revocation of Permit

1. In the event that the Responsible Party holding a Land Disturbance Permit pursuant to this ordinance violates the terms of the permit, or implements site development in such a manner as to materially adversely affect the health, safety, welfare, or safety of persons residing or working in the neighborhood or development site, the Director may suspend or revoke the Land Disturbance Permit and issue a stop-work order.

2. For the purpose of this ordinance, a stop work order is validly posted by posting a copy of the stop work order on the site of the land disturbance activity in reasonable proximity to a location where the land disturbance activity is taking place. A copy of the order, in the case of work for which there is a permit, shall be mailed to the address listed by the Responsible Party on the permit. In the case of work for which there is no permit, a copy of the order shall be mailed to the person listed as the owner of the property on the tax records of Christian County Missouri.

3. No person is permitted to continue or permit the continuance of work in an area covered by a stop work order, except work required to correct deficiencies with respect to an erosion or sediment control measure and as authorized by the Director.

4. Forty-eight (48) hours after posting a stop work order, the Director, if the conditions specified in the stop work order to resume work have not been satisfied, may issue a notice to the Responsible Party that the City of Nixa will perform work necessary to comply with this regulation. The City of Nixa may go on the land and commence work after forty-eight (48) hours from issuing the notice of intent. The costs incurred by the City of Nixa to perform this work shall be charged against the performance security.

B. Violation and Penalties

1. No Responsible Party, owner, or land user shall construct, enlarge, alter, repair, or maintain any grading, excavation, or fill, or cause the same to be done, contrary to or in violation of the terms of this ordinance.
2. Any Responsible Party, owner or land user violating any of the provisions of this ordinance shall be deemed guilty of a misdemeanor and upon conviction thereof, shall be fined not more than one thousand dollars ($500.00) for each offense, and

each day during which any violation of any of the provisions of this ordinance is committed, continued or permitted, shall constitute a separate offense.

3. Any waiver of a violation of this ordinance by the Director shall not be deemed or construed by the Responsible Party to constitute a waiver of any prior or succeeding violation of this ordinance.
4. The City Attorney may seek any appropriate remedy to cause the removal of such sediment including, but not limited to, an injunction, revocation proceedings or any and all permits, licenses, and termination of utility services.

Section 121 DISCHARGE PROHIBITIONS

A. Prohibition of Illegal Discharges: No person shall throw, drain, or otherwise discharge, cause, or allow others under its control to throw, drain, or otherwise discharge into the MS4 any pollutants or waters containing any pollutants, other than storm water.

The commencement, conduct or continuance of any illegal discharge to the storm drain system is prohibited except as described as follows:

1. The following discharges are exempt from discharge prohibitions established by this ordinance: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl spaces pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water.
2. Discharges or flow from firefighting, and other discharges specified in writing by the City of Nixa as being necessary to protect public health and safety.
3. Discharges associated with dye testing, however this activity requires a verbal notification to the City of Nixa Public Works Director prior to the time of the test.
4. The prohibition shall not apply to any non-storm water discharge permitted under an NPDES permit, waiver, or waste discharge order issued to the discharger and administered under the authority of the United States Environmental Protection Agency (EPA), provided that the discharger is in full compliance with all requirements of the permit, waiver, or order and other applicable laws and regulations, and provided that written approval has been granted for any discharge to the storm drain system.

B. Prohibition of Illicit Connections:

1. The construction, use, maintenance or continued existence of illicit connections to the storm drain system is prohibited.

2. This prohibition expressly includes, without limitation, illicit connections made I the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.
3. A person is considered to be in violation of this ordinance if the person connects a line conveying sewage to the MS4, or allows such a connection to continue.
4. Improper connections in violation of this ordinance must be disconnected and redirected, if necessary, to an approved onsite wastewater management system or the sanitary sewer system upon approval of the City of Nixa.
5. Any drain or conveyance that has not been documented in plans, maps or equivalent, and which may be connected to the storm sewer system, shall be located by the owner or occupant of that property upon receipt of written notice of violation from the City of Nixa Public Works Director requiring that such locating be completed. Such notice will specify a reasonable time period within which the location of the drain or conveyance is to be determined, that the drain or conveyance be identified as storm sewer, sanitary sewer or other, and that the outfall location or point of connection to the storm sewer system, sanitary sewer system or other discharge point be identified. Results of these investigations are to be documented and provided to the City of Nixa Public Works Director.

Sections 122 thru 124 Reserved

PART V - DETENTION

Section 125. Detention Facilities.

A. PURPOSE: Detention facilities are used to reduce storm water runoff rates by storing excess runoff.

The usual function of detention facilities is to provide sufficient storage such that peak runoff rates are not increased when development occurs.

B. POLICY: The primary goal of the City of Nixa storm water management program is the prevention of flood damage to residential, commercial and public property.

In adopting this policy, the City of Nixa recognizes that:

- There are many areas in the City where residential flooding occurs because of inadequately sized drainage ways;
- Flooding depths and frequency will increase as development occurs upstream of these areas; and
- Detention basins are the only effective "on-site" means, which can be used to control peak runoff storm water rates as areas develop.

City of Nixa further recognizes that:

- The best means to assure effective performance of a detention basin is to perform reservoir routing calculations using hydrographs;
-

Therefore, in order to provide a reasonable level of flood protection to homes and businesses, while maintaining a climate favorable for development and economic growth, the City of Nixa has established the following policy for design of detention facilities:

C. METHODS OF ANALYSIS: The method of analysis to be required for the design of detention facilities will be determined as follows:

1. Detailed Analysis will be required in most all cases. Stormwater runoff calculations shall be determined in accordance with Section 25-82.

2. Alternatives to Detention: In cases where channelization or other improvements can be shown to be more effective than detention in reducing the flooding hazard to downstream properties, and where no adverse effect to downstream properties will result from construction of such improvements, the City may, upon written recommendation by the Stormwater Engineer, and approval of the Planning Commission, enter into an agreement with the applicant to accept compensation in lieu of constructing on-site detention facilities. The fee would be paid to the City either when the development was completed and the final plat approved or when a performance bond is issued to the City for that development.

   The Planning Department has established the following formula for the fee in lieu of detention:

   (268-1)

   $$Fee = K \times Ia$$

   Where Ia is the increase in impervious area (roofs, pavement, driveways, patios, etc.) in acres and

   K = 7150 (amended #1366 8/05)

   K is a factor determined by the City Planner. This factor is determined based upon the net financial gain which the developer would realize if the detention facility is not built. This amount will generally be equal to the construction cost of the detention facility plus revenue from sale of additional lots or increased value of lots, less the cost of developing the lots, including utilities and streets, financing cost, sales costs, and reasonable profit. The City Planner shall evaluate this formula annually and make the appropriate adjustments.

3. Innovation in design: It is the desire of the City that detention facilities be designed and constructed in a manner to enhance aesthetic and environmental quality of the City as much as possible. City of Nixa therefore encourages designs which utilize and enhance natural settings, and minimize disturbance and destruction of wooded areas, natural channels, and wetlands.

4. Interpretation: Interpretations of the detention policy will be made by the City Planner in writing.

   Appeals of the decision of the City Planner may be made to the City Board of Aldermen. Request for appeals should be made in writing to the City Planner.

Section 126. Design Criteria.

A. GENERAL: Detention facilities shall discharge into a drainage easement or public right of way. In the event that neither of these property rights is in place and a drainage easement cannot be obtained, the points of discharge from the development shall be spread out to mimic the predevelopment drainage characteristics. This may involve creating a greater setback for the point(s) of discharge to the property line and other engineering methods as is appropriate for the site.

One foot of freeboard shall be provided between the maximum water surface elevation (maximum stage for a 1% annual probability event) and the minimum top of berm or wall elevation.

Embankment slopes steeper than three horizontal to one vertical (3H:1V) are not permitted. Preferred embankment slope is four horizontal to one vertical (4H:1V).

In certain instances, such as when the existing development conditions runoff from a watershed would exceed the capacity of the existing downstream facilities, retention basins (i.e., no outlet or with a release rate at the capacity of the downstream facilities) for the storm runoff may be required by the City Planner.

Dry detention basins shall maintain a minimum bottom slope of two feet per hundred feet (2 percent).

Trickle channels shall have a minimum slope of one half foot per hundred feet (0.5 percent).

The maximum allowable depth of ponding for parking lot detention is 12 inches.

Parking lot detention may not inundate more than 10% of total parking area.

All parking lot detention areas shall have a minimum of two signs posted identifying the detention pond area. The signs shall have a minimum area of 1.5 square feet and contain the following message:

WARNING

This area is a storm water detention pond and is subject to periodic flooding to a depth of 18 inches.

Any suitable materials and geometry of the sign are permissible, subject to approval by the City Planner.

B. DETAILED ANALYSIS: Detailed analysis shall be performed using hydrograph

methodologies and reservoir routing techniques.

The most common techniques are those developed by the Corps of Engineers and the Soil Conservation Service. These methods are preferred, however, other proven techniques will be accepted.

Detention basins designed by detailed methods shall be designed on the basis of multiple storm recurrence frequencies to ensure that they function properly for both frequent storms and large infrequent storms.

A minimum of three recurrences frequencies, the 50 percent, 10 percent and 1 percent annual probability storms (the "2-year, 10-year and 100-year" storms) must be considered.

The runoff model must include the entire drainage basin upstream of the proposed detention pond. The model shall be prepared in sufficient detail to ensure that peak runoff rates are reasonably accurate.

The runoff model shall be developed for the following cases:

Case 1: Existing conditions in the drainage basin prior to development of the applicant's property.

Case 2: Existing conditions in the drainage basin with developed conditions on the applicant's property.

Case 3: Fully developed conditions in the entire drainage basin.

Cases 1 & 2 are utilized to determine the required detention volume and the type of outlet structure to be provided, and shall be analyzed for the three storm recurrence frequencies required above.

The detention facility shall be designed such that peak outflow rates from the facility for Case 2 are no greater than the rates determined in Case 1 for each of the three storm recurrence frequencies required.

Case 3 is used to determine the size of the overflow spillway. Case 3 need only be analyzed for the 1% annual probability (100-year). The overflow spillway will, in most cases, be combined with the outlet structure.

C. SUBMITTALS: The following information must be submitted for detention ponds designed by detailed methods.

1. Information regarding analytical methods and software to be used, including:

- Name of software to be used.
- Type and distribution of precipitation input.
- Method of determining precipitation losses.
- Type of synthetic hydrograph.
- Method for routing hydrographs.
- Method used for reservoir routing.

2. Map(s) showing sub basin delineation, topography, presumed flow routes, and pertinent points of interest; soil types; existing basin development conditions used in the model; fully developed conditions used in the model.

3. Routing diagram for the runoff model..

4. A summary of sub basin characteristics used for program input.

5. Stage-area or stage-storage characteristics for the basin in tabular or graphic form.

6. Stage-discharge characteristics for the outlet structure and overflow spillway in tabular or graphic form; hydraulic data for weirs, orifices, and other components of the control structure.

7. A printout of the input data file.

8. A summary printout of program.

Sections 127 thru 135 Reserved