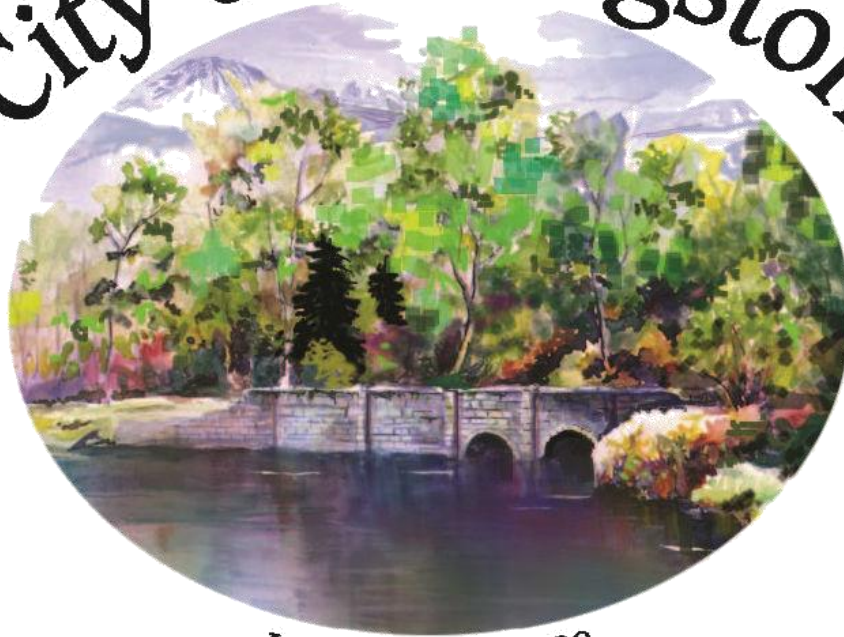


City of Livingston



Incorporated 1889

Public Works Design Standards and Specifications Policy

Revised August 2022

CITY OF LIVINGSTON PUBLIC WORKS DESIGN STANDARDS AND SPECIFICATIONS POLICY

Prepared by:

Public Works Department

Revised August 2022

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FOREWORD

This document has been prepared to assist design engineers, architects, developers, contractors, or other interested individuals with the preparation of plans and specifications for public infrastructure improvements so that they will meet the requirements of the City of Livingston (COL). The requirements specified herein have been established through the subdivision regulations, municipal code, or City policies.

It is the intent of the COL to revise this document on an as-needed basis as regulations and policies are modified. Written comments on this "Design Standards and Specifications Policy" are encouraged and may be submitted to the Public Works Director.

If any portion of this document is found to conflict with the Livingston Municipal Code (LMC), the provisions of the LMC shall supersede this Guide.

Abbreviations Used

AASHTO - American Association of State Highway and Transportation Officials
ADA - Americans with Disabilities Act
ASTM - American Society for Testing and Materials
AWWA - American Water Works Association
LMC - Livingston Municipal Code
LUDO – Livingston Unified Development Ordinance
COL - City of Livingston
DEQ - Department of Environmental Quality
ESAL - Equivalent Single Axle Load
FSP - Final Site Plan
MPWSS - Montana Public Works Standard Specifications
MUTCD - Manual of Uniform Traffic Control Devices
PUD - Planned Unit Development
RCP - Reinforced Concrete Pipe
WQB - Water Quality Bureau

**CITY OF LIVINGSTON
PLANS AND SPECIFICATIONS REVIEW POLICY**

A. Standard Process

1. Initial submittal of plans and specifications, and all subsequent correspondence and submittals for public infrastructure improvements including, but not limited to, sanitary sewer and water mains, stormwater mains, lighting, street and other transportation improvements, are to be made to the Public Works Director’s Office, 330 Bennett St., Livingston, Montana, 59047. Prior to submission of infrastructure plans and specifications, project approval (Preliminary Plat, Annexations, Site Plans), and in some cases Special Use Permits (SPU’s)) from the City Commission must be obtained.

2. The minimum number of complete sets of plans and specifications which must be submitted for each review are as follows:

<u>Type of Project</u>	<u>Number*</u>	<u>Reviewers</u>
Water and Sewer Main Extensions	1 Set + PDF	Eng., PW, P
Fire Service Lines	1 Set + PDF	Eng., PW, P, F
Streets and/or Stormwater	1 Set + PDF	Eng., PW, P
Water & Sewer Mains with Streets and/or Stormwater	1 Set + PDF	Eng., PW, P

<p>Eng. = City’s Engineer PW = Public Works Department P = Planning F = Fire Department PDF = Portable Document Format, or other approved digital format</p>	<p>* See Paragraph 7 below</p>
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3. The COL shall attempt to complete the initial review and provide written comments to the Engineer/Owner within 30 calendar days of receiving the initial submittal. A review meeting may be scheduled with the design Engineer and City representatives to discuss review comments if the design Engineer desires. Pre-design and interim meetings with the design Engineer and City Public Works staff are encouraged.

4. To expedite the review process each submittal of revised plans and specifications shall be accompanied by a written response from the Design Engineer which addresses each item in the COL review comment letter. The revised documents will be distributed and reviewed as described above in item 2. Generally, "red-lined" copies of the plans and specifications will be provided to the Design Engineer to facilitate revisions of the documents. Red-lines must be returned with each subsequent re-submittal.

5. The COL shall attempt to complete each review of revised plans and specifications within 14 calendar days of receiving the revisions. A review comment letter may be provided to the Engineer/Owner at the completion of each review. Subsequent reviews may be charged a fee to cover the costs of the City's review time.
6. All COL review comments must be adequately addressed and resolved before the final plans and specifications are approved by the City's Public Works Director for construction.
7. Once all COL review comments have been adequately addressed and resolved, the City's Public Works Director must be supplied with 1 complete set of the final plans and specifications, signed and stamped by a Professional Engineer licensed in the State of Montana. Specification manuals must be sent digitally and contain the most current version of the revised documents and plan sheets. The 1 final full-size set of plans and specifications submitted for City approval will be reviewed by the Public Works Director to ensure that all requested modifications are included. A digital version of the approved plans shall also be provided in either AutoCAD or PDF format. A digital version of the approved specifications shall also be provided in PDF format.
8. For projects subject to Department of Environmental Quality (DEQ) review and approval, a copy of the project approval letter from DEQ must be submitted to the Public Works Director prior to the preconstruction meeting.
9. The Public Works Director and the City's Engineer will either approve or disapprove the submitted documents. An approval or disapproval letter will be sent to the Engineer/Owner.
10. Final stamped and approved plans and specifications will be distributed as follows:
 - a. Approved digital PDF set returned to the Engineer/Owner.
 - b. Original set to the COL Public Works Department.
11. No work is to begin on the project prior to obtaining the COL's and DEQ's written approval of the plans and specifications, and the completion of a preconstruction meeting conducted by the Owner's Engineer and attended by the Contractor(s) and COL representative(s) and appropriate affected utility companies. A "Preconstruction Meeting Checklist" will typically be included with the approval letter specifying additional documents which must be submitted prior to scheduling a preconstruction meeting.

B. CONSTRUCTION COORDINATION

1. Pre-construction Meeting

Following approval of infrastructure plans and specifications, the Engineer shall schedule a pre-construction meeting with the City of Livingston, Contractor(s), and if applicable, other affected utilities or governmental agencies. A “Preconstruction Meeting Checklist” will be included with the letter of approval which lists submittals that must be received by the City of Livingston prior to scheduling a preconstruction meeting.

2. Shop/Fabrication Drawings

Any required shop/fabrication drawings shall be submitted by the Contractor to the Engineer. Upon approval, the Engineer shall submit the approved shop/fabrication drawings electronically to the Public Works Director a minimum of 2 days prior to the preconstruction meeting.

3. Bonding

All new infrastructure that will be publicly maintained shall be bonded. Prior to initiation of construction, a copy of the Contractor’s Maintenance Bond in an amount equal to 100% of the contract amount, in favor of the Owner, shall be filed with the Owner and the City of Livingston. This is to correct any deficiencies in workmanship and/or materials which are found within the two-year warranty period. The City of Livingston shall be named as a dual obligee on the bond. The City of Livingston expressly reserves the right to draft the Maintenance Bond for repairs not completed by the Property Owner, Developer, or Contractor within thirty calendar days of being advised that repairs are required. The Commencement Date for the Maintenance Bond shall be the date of acceptance by the City of Livingston on the Certificate of Completion and Acceptance. The Maintenance Bond shall remain in full force for the two-year period following this date, however if the expiration date of the Maintenance Bond falls after November 16, the expiration date of the Maintenance Bond shall be June 30 of the following year. Maintenance Bonds may be in the form of a Surety Bond or a Certified Check.

4. Engineer’s Status/Responsibility During Construction

The Engineer will furnish a qualified Resident Project Representative (RPR) and other field staff to assist the Engineer in observing the performance of the work. The RPR will act as directed by and under the supervision of the Engineer, and will confer with the Engineer regarding the RPR’s actions. The RPR shall not authorize any deviation from the approved plans and specifications or substitution of materials or equipment, unless authorized by the Engineer.

Duties of RPR. The RPR and/or other field staff of the Engineer will:

- Conduct extensive on-site observations of the work in progress and field checks of materials and equipment to provide protection against defects and deficiencies in the work of the Contractor.

- Perform construction observation, documentation, and required testing of all critical construction work including, but not limited to: all underground or buried work including placement and connection of utility lines and appurtenances, trench backfill and compaction, placement of geotextile fabric membranes, placement of fill or embankments; placement of curb and gutter and other surface drainage improvements; placement of pavement base and surface courses; and placement of sidewalks.
- Advise the Engineer and Contractor of the commencement of any work requiring Shop Drawings or sample if the submittal has not been approved by the Engineer.
- Report to the Engineer whenever RPR believes that any work is unsatisfactory, faulty, or defective or does not conform to the approved plans and specifications, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made.
- Advise the Engineer of work that the RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection, or approval.
- Verify that all tests are conducted in the presence of appropriate personnel, and observe, record and report to the Engineer appropriate details relative to testing procedures.
- Accompany visiting inspectors representing the City of Livingston or other public agencies having jurisdiction over the project.
- Maintain at the job site orderly files for correspondence, reports of job conferences, Shop Drawings and samples, reproductions of original Contract Documents including all Work Directive Changes, Addenda, Change Orders, Field Orders, additional Drawings issued subsequent to the execution of the contract or beginning of work, Engineer's clarifications and interpretations of the Contract Documents, and other Project related documents.
- Keep a detailed and accurate diary or log book, recording Contractor hours on the job site, weather conditions, prime and subcontractor daily work force, daily log of equipment onsite or standby, data relative to questions of Work Directive Changes, Change Orders, or changed conditions, list of job site visitors, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures.
- Furnish Engineer with periodic reports of progress of the work.
- Furnish Engineer and Contractor a list of observed items requiring completion or correction before Engineer may issue a Certificate of Substantial Completion, assess completion or correction of said items, advising Engineer on their status, and make recommendation to Engineer regarding issuance of a Certificate of Substantial Completion.

- Conduct final inspection of the project in the company of Engineer, Owner, Contractor, and City of Livingston, and prepare final list of items to be completed or corrected.
- Verify that all items on the final list have been completed or corrected and make recommendations to Engineer concerning final acceptance.

Duties of Engineer. The Engineer will:

- Issue written clarifications or interpretations of the requirements of the Contract Documents (i.e. plans and specifications).
- Disapprove or reject work which Engineer believes to be defective, and require special inspection or testing of the work whether or not the work is fabricated, installed, or completed.
- Review Shop Drawings and samples for compliance with the Contract Documents.
- Review proposed changes in work and submit such changes in writing to the City of Livingston or other public agencies having jurisdiction for review.
- Issue Certificate of Substantial Completion and Certificate of Completion and Acceptance.
- Issue final as-built plans of the completed work addressing all changes which occurred during construction.

5. Testing and Documentation Requirements for Infrastructure Improvements

In order to better document the inspection and certification of public infrastructure improvements, the Public Works Department and the City’s Engineer shall require the following information for all projects approved for construction. This documentation shall be required prior to final acceptance of sanitary sewer, water main, stormwater, Portland cement concrete, and bituminous pavement improvements within City right-of-way or easements.

A COMPLETED AND SIGNED “CERTIFIED CHECKLIST FOR TESTING & DOCUMENTATION REQUIREMENTS FOR INFRASTRUCTURE IMPROVEMENTS” MUST BE SUBMITTED TO THE PUBLIC WORKS DIRECTOR. THE FOLLOWING DOCUMENTATION SHALL BE REQUIRED ON ALL ACCEPTED PROJECTS:

- A. The Engineer shall submit a letter to the City certifying that the public improvements (i.e. sanitary sewers, water mains, drainage structures, lighting, streets, and active transportation improvements) were installed in accordance with the approved plans and specifications and shall be accompanied by Record Drawings for the project in both digital and hard copy format.

- B. Dates of acceptable tests for sanitary sewer and stormwater, which shall include a digital copy of the TV inspection, cleaning, exfiltration by air or water, and manhole testing, shall be included in the certification letter. This information shall be required for all public sewer main and stormwater main extensions.
- C. Dates of acceptable tests for water mains, which shall include hydrostatic and leakage testing, and bacteriological testing shall be included in the certification letter. This information shall be required for all public water main extensions.
- D. Benchmark elevations shall be established for all new hydrants on the project. Benchmarks shall be set on the hydrant bonnet bolt closest to the point of the operating arrow on Mueller and Kennedy hydrants. Said elevations shall be certified by a Land Surveyor (L.S.) registered in the state of Montana. Elevations shall also be provided for the top of the water main at 50-foot intervals. The datum used as the basis for the elevations on hydrants shall be NAVD 88. Level loop notes for setting elevations shall be provided.
- E. Verification that all thrust blocking was installed in accordance with the approved plans and specifications shall be included in the certification letter. If mechanical restraints are used in lieu of thrust blocks, verification that the restrained length as installed meets or exceeds the manufacturer's recommendations shall be included.
- F. An accurate record of the location of all sanitary sewer service connections as installed, and the length and slope of all service lines installed must be provided by the Engineer. Elevations at the end of dry service line stub-ins is required. Sanitary sewer service connections information shall be tied to manhole information. This information shall be required for all public sewer main extensions and service connections to existing mains.
- G. The Engineer shall furnish documentation of tests in accordance with methods prescribed by AASHTO for theoretical maximum density, optimum moisture content, and sieve analysis for the sub-base course, crushed base course, pit run, and native backfill and subgrade material within the right-of-way. This information shall be required for all public sewer main, water main, storm drain and street extensions.
- H. The Engineer shall furnish documentation of in-place field density tests. In-place density tests for trenches and embankments shall, at a minimum, be required for the first lift of backfill to set a pattern of compaction, shall be provided daily, and as backfill material changes. In-place density tests for roadways shall, at a minimum, be required at intervals of 50-feet. Tests for roadways shall be provided for subgrade, sub-base course and/or pit run, and crushed base course materials. A minimum of the top 6-inches of subgrade which are to be paved or covered with curb, gutter, or sidewalk, shall be field density tested. All trench backfill material in improved areas

and all embankments shall be compacted for the full depth and shall be compacted to 95% of the theoretical maximum proctor density as determined by AASHTO-T-180. This information shall be required for all public sewer main, water main, storm drain, and street extensions.

- I. The Engineer shall furnish a dated job-mix formula for hot plant mix bituminous pavement which conforms to the procedures of the Asphalt Institute's MS-2 manual. The job mix formula shall be no older than one year, and shall have the same aggregate and asphalt sources and grades as the mix used for the public improvements. The Engineer shall furnish certified results of a Marshall Test showing the bulk specific gravity determination, stability and flow data, and density and void analysis. The engineer shall furnish a minimum of one "field Marshall Test" per 4,000 tons of mixture placed to check for variations from the job-mix formula. In addition, test results of ASTM D 1075 for the effect of water on cohesion of compacted bituminous material shall be provided by the Engineer. This information shall be required for all public street extensions.
- J. The Engineer shall furnish asphalt core samples for bituminous pavement in the public right-of-way. Four core sample shall be required for every 1000 tons of mixture placed, with a minimum of three samples for projects that use less than 1000 tons. The location of the core samples shall be determined on a random basis using a system of random numbers, so that each ton of material has the same probability of being selected. For random locations falling near the pavement joints, obtain the core as close to the location as possible without having any part of the core circumference coming closer than 12 inches to the pavement edge or joint. The Engineer may take additional core samples at locations where he/she has, based on observations of the paving process and/or the results of nuclear density tests, reasonable belief that the in-place material is unsatisfactory. The Engineer shall submit the sampling plan to the Public Works Director upon completion of the paving, prior to taking cores. (An example for one method of determining random sample locations is included in the appendix of these Design Standards). The Engineer shall provide a certified laboratory report from the samples taken as to thickness and actual density. Testing laboratories shall meet the requirements of ASTM D3666 (Evaluating and Qualifying Agencies Testing and Inspecting Bituminous Paving Materials). The engineer shall certify that the core holes have been patched with hot plant mix asphalt. This information shall be required for all public street extensions.
- K. The Engineer shall furnish Portland cement concrete tests for concrete placed in the public right-of-way and concrete incorporated into public infrastructure improvements. One set of tests shall be required for every 50 cubic yards of concrete placed with a minimum of one set of tests per project. The concrete shall be sampled, specimens made, and compliance determined in accordance with the following:

Sampling Fresh Concrete	ASTM C-172
Slump	ASTM C-143 or AASHTO T119
Air Content	ASTM C-231 or C-173 or C-138 or AASHTO T152
Compressive Strength	ASTM C-39 or AASHTO T22
Making and Curing Test Specimens in the Field	ASTM C-31 or AASHTO T23

Sampling and testing shall be done by persons that are currently certified as ACI Concrete Field Testing Technicians, Grade 1. This information shall be required for all public street extensions.

6. Pre-Paving Inspection

The Engineer shall conduct a pre-paving inspection for any projects that have paved streets as part of the improvements. The Contractor and a representative from the City shall attend the inspection. Pre-pave inspection requests must be scheduled with the City a minimum of 24-hours in advance.

7. Acceptance/Correction of Deficient Pavement Improvements

Acceptance tests shall be evaluated by the Engineer for conformance with the specifications. Any results that indicate the in-place material does not conform with the specifications shall be immediately reported to the Public Works Director, along with a recommendation of corrective action to bring the material into compliance with the specifications. The Public Works Director shall determine what corrective action is necessary in order for the improvements to be accepted by the City of Livingston. Corrective action may include total removal and replacement of the deficient material, partial removal and replacement, placing additional material, or in lieu of corrective action, payment of a penalty to the City of Livingston in certain instances.

- A. Portland Cement Concrete: If an individual strength test (average of two cylinders tested at 28 days) falls below the specified strength by more than 500 pounds per square inch (psi), the in-place material represented by the failed test shall immediately be randomly cored for acceptance testing. A minimum of three and maximum of six cores shall be taken. If the average strength tests of the acceptance cores are deficient in strength by more than 500 psi but not more than 1000 psi, the Contractor shall remove and replace the deficient concrete or pay the City of Livingston 0.25 times the unit price bid times the area determined to be deficient in strength; if the average strength tests are deficient by more than 1000 psi, the area of the concrete determined to be deficient shall be removed and replaced.
- B. Asphaltic Concrete Pavement: The asphaltic concrete pavement shall be tested and evaluated for acceptance on a lot basis, with one lot being 1000 tons of material.

- C. Thickness. If the average thickness of the pavement cores is more than ¼-inch below the plan thickness, or if any one individual core is more than ½-inch below the plan thickness, corrective action or payment of a penalty will be required.
- D. Average Thickness Deficiencies. If the average thickness deficiency is between ¼-inch and ½-inch, corrective action such as placement of additional material (i.e. overlay or chip seal), as determined by the Public Works Director, will be required. In lieu of placing additional material, the Public Works Director may allow the payment of a penalty to the City of Livingston in the amount of 0.25 times the unit price bid of the asphalt pavement times the amount of pavement determined to be deficient. If the average thickness deficiency is more than ½-inch, an overlay will be required, along with cold milling of the existing pavement to provide for a minimum overlay thickness of 1.5-inch.
- E. Individual Core Thickness Deficiency. If anyone core thickness is determined to be more than ½-inch below plan thickness, additional cores shall be taken at 10-foot intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is found which is not deficient by more than ¼-inch, in order to determine the extent of the deficient pavement. If the thickness deficiency is more than ¾-inch, the area that is deficient shall be removed from pavement edge to pavement edge and replaced to bring the non-complying areas to planned thickness. If the thickness deficiency is not more than ¾-inch, the deficient area will either be removed and replaced to the planned thickness, or a penalty will be paid to the City of Livingston in the amount of 1.5 times the unit price bid times the amount of pavement that is deficient in thickness.
- F. Density. The average density of the pavement cores shall equal or exceed 93% of the maximum density as determined by ASTM D2041 (Rice's density). If the average density is less than 93% but more than 90.9%, the pavement that has deficient compaction shall be milled and overlaid (1.5-inch minimum depth), or a penalty in the amount of 0.10 times the unit price bid for the pavement material times the amount of pavement that has deficient compaction shall be paid to the City of Livingston. If the average density is 90.9% or less, the pavement area affected will be removed and replaced or overlaid as determined by the Public Works Director. If any 1 core is determined to have a density of less than 86%, additional cores shall be taken at 10-foot intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is found which has a density of at least 91%. The area that is determined to have deficient compaction shall be removed from pavement edge to pavement edge and replaced, or a penalty will be paid to the City of Livingston in the amount of 1.5 times the unit price bid times the amount of pavement that is deficient in density.

- G. Unit Prices: If unit prices for the project are unavailable, unit prices shall be as determined from time to time by the Public Works Director for the various items of work.

8. Project Close-out and Acceptance

Upon completion of the work, the following documentation shall be submitted to the City Public Works Director:

- A. An executed "Certificate of Completion and Acceptance" in digital PDF format.
- B. Project Inspection Record and Testing Records in digital PDF format.
- C. Certified Checklist for Testing and Documentation Requirements in digital PDF format.

Within 90-days of project completion, the Engineer shall sign and submit 1 full-size set and one digital (PDF) copy of the record drawings (as-built plans) to the Public Works Director. In addition, all coordinates of new water, sewer, and storm appurtenances (valves, hydrants, manholes, etc.) shall be provided in a GIS file (.SHP or .GDB) for incorporation into the City's GIS mapping. Failure to provide all of the necessary close-out documentation within the 90-day period may result in delaying approval for future projects submitted by the Engineer until such time as the necessary documents are provided.

9. Two-Year Warranty Inspection

The Project Engineer, or designated representative, shall conduct a two-year warranty inspection to be attended by a least one representative from the Public Works Department. The inspection shall take place not less than 75 or more than 120 days prior to the expiration date of the Maintenance Bond. The Maintenance Bond will be released when all deficiencies have been corrected to the satisfaction of the Public Works Director.

The Public Works Director, the Project Engineer, or the designated representative shall notify the Principal and Bonding Company as listed in the Maintenance Bond of any work found to be deficient. The Principal shall restore the work to meet the requirements of the approved construction documents prior to release of the Maintenance Bond. The City of Livingston expressly reserves the right to draft the Maintenance Bond for repairs not completed by the Owner, Developer, or Contractor within thirty calendar days of being advised that repairs are required.

DESIGN STANDARDS AND SPECIFICATIONS

I. CONSTRUCTION PLANS AND SPECIFICATIONS REQUIREMENTS

A. GENERAL REQUIREMENTS

1. Any required design reports may be submitted prior to or along with submittal of the plans and specifications.
2. Project plans and specifications will not be accepted until the project has been approved by the City of Livingston.
3. All project infrastructure plans must be submitted at the same time. Separate approval of infrastructure elements may be provided if necessary.
4. Where existing infrastructure is being extended, existing material, size, elevation, horizontal alignment, and grade shall be field verified, and all critical utility crossings shall be field verified, prior to plan and specification submittal.
5. All full-sized plans shall be on 24-inch by 36-inch plan sheets. Reduced scale plans may be submitted for review if approved by the City's Public Works Director, but all plans for final approval and all record drawings shall be full-size. All plans submitted for review and approval will be stamped, signed, and dated by a Professional Engineer licensed in the State of Montana.
6. Separate plans shall be submitted for water facilities and sanitary sewer facilities. Plans for stormwater facilities may be included with plans for street facilities.
7. All plans must have both plan and profile views of the proposed improvements. A general location map shall be provided showing the relationship of each page to the overall development.
8. Project datum and benchmarks shall be clearly identified on the plans. Vertical datum shall be NAVD 88 unless approval for a different datum is secured from the Public Works Director.
9. English units are required.

B. SPECIFICATIONS REQUIREMENTS

1. The City of Livingston has adopted “Montana Public Works Standard Specifications” (MPWSS) as the standard specifications for new construction. A separate document, “City of Livingston Modifications to MPWSS” has been adopted which supplements and supersedes MPWSS. All project manuals must incorporate, preferably by reference, MPWSS (latest adopted edition) and the “City of Livingston Modifications to MPWSS”, including any addenda.
2. Additions or changes to the above standard specifications must be done through Special Provisions or similar supplemental sections in the project manual.

C. DRAWING SCALES

The following scales are required. Other scales will be considered on a case by case basis if all information can be clearly shown.

1. Plan View: 1" = 50'
2. Profile View, Horizontal: 1" = 50' (or match plan view scale)
Profile View, Vertical: 1" = 5'
3. Stationing interval: 100 feet or 50 feet

D. PLAN REQUIREMENTS

The following items will be required on all plans. Existing features should be shown dashed or with a lighter shading than proposed new features. All construction will be tied to the centerline of a City right-of-way, to the centerline of a City easement, to a platted property line, or to section lines.

1. Plan View:
 - a. North arrow
 - b. Legend of symbols
 - c. Property lines and ownership or subdivision information
 - d. Street and trail names and easements with width dimensions
 - e. Project stationing
 - f. Limits of existing paved or graveled surfaces
 - g. Monument boxes
 - h. Culverts
 - i. Existing and proposed utilities and structures, including:
 - i. Line size and material where appropriate;
 - ii. Water lines (main lines and service lines), valves, and hydrants;

- iii. Sanitary sewer lines (main lines and service lines) and manholes;
- iv. Stormwater lines, manholes, and inlets;
- v. Gas lines;
- vi. Electric lines, poles, transformers;
- vii. Telephone lines, manholes, junction boxes;
- viii. Cable T.V. lines, junction boxes;
- ix. Internet lines, junction boxes;
- x. Irrigation ditches and structures;
- xi. Irrigation systems;
- xii. Fiber optic lines, manholes, junction boxes;
- xiii. Street lights;
- xiv. Proposed method of restoration of all areas disturbed during construction.

- 2. Profile View:
 - a. Vertical and horizontal grids to scales
 - b. Final grade (solid)
 - c. Existing grade (dashed)
 - d. Existing utility lines where crossed
 - e. Project stationing
 - f. Utility crossings

E. UTILITY PLAN REQUIREMENTS

- 1. The following general notes must appear on all plan sets:
 - a. All construction will conform to MPWSS, (Latest) Edition, and COL Modifications to MPWSS.
 - b. Any existing or new valves which control the COL's water supply shall be operated by COL personnel only.
 - c. The Contractor shall notify the Public Works Department a minimum of 24-hours prior to beginning any work.
 - d. Contractor shall field-verify line and grade of existing connections.
- 2. Plans for WATER facilities shall show the following:
 - a. Size, type and structural class of proposed new water line(s), including AWWA specifications.
 - b. Bedding class.
 - c. Type of excavation and backfill.
 - d. Existing water lines including size and material.
 - e. Proposed valves, fittings, fire hydrants, and service lines, with stationing.
 - f. Depth of cover from finish grade to proposed water line(s).
 - g. Requirements for pipe deflection, if necessary
 - h. Type of joint restraint, if required

- i. Size of gravity thrust blocks based on calculated design
 - j. Existing or proposed pressure reducing valves
3. Plans for SANITARY SEWER facilities shall show the following:
- a. Size, type, and structural class of proposed new sewer line(s), including:
 - i. American Society for Testing and Materials (ASTM) specifications
 - b. Slope of each proposed pipeline segment
 - c. Bedding class
 - d. Type of excavation and backfill
 - e. Existing sewer lines and manholes including size, material, field-verified:
 - i. invert elevations
 - ii. field-verified slopes
 - f. Proposed manholes with stationing and rim and invert elevations
 - g. Existing and proposed sewer service lines with size and stationing
 - h. Existing and proposed cleanouts
4. Plans for STORMWATER facilities shall show the following:
- a. Size, type, and structural class of proposed new stormwater line(s), including ASTM specifications
 - b. Slope of each proposed pipeline segment
 - c. Bedding class
 - d. Type of excavation and backfill
 - e. Proposed manholes with stationing and rim and invert elevations
 - f. Proposed inlets and inlet service lines with stationing and invert elevations
 - g. Points of stormwater discharge

F. ROADWAY PLAN REQUIREMENTS

1. Plans for streets or roadways shall show the following:
- a. Limit of cut or fill
 - b. Existing and proposed utilities, including manholes and valves
 - c. Proposed new construction, including paving width and limits, curb and gutter, crosspans, sidewalks, landscape boulevards and pedestrian ramps
 - d. Existing and finished grades, with finished grade slopes
 - e. Vertical and horizontal curves, with curve data:
 - i. Horizontal curves - R, Δ , L, PC and PT Stationing
 - ii. Vertical curves - K, L, Station of PT's
 - f. Profile of centerline
 - g. Profiles of left and right curb lines, if they are not the same

- h. Any required utility adjustments
- i. Existing and proposed signs and pavement markings
- j. Existing and proposed storm drainage facilities, including culverts, pipes, inlets, sidewalk chases, ditches and detention/retention ponds, snow storage areas, with invert and/or spot elevations
- k. Top of curb elevations at P.C.s, P.T.s, and inlets
- l. Existing and proposed street monuments
- m. Typical roadway section(s), dimensioned and drawn to scale, showing:
 - i. Right-of-way
 - ii. Backslopes
 - iii. Sidewalks
 - iv. Curb and gutter
 - v. Pavement thickness
 - vi. Base and sub-base thickness
 - vii. Compaction requirements
 - viii. Cross-slopes

II. DRAINAGE POLICY

A. GENERAL DESIGN CRITERIA

A Stormwater Drainage Plan is required for ALL new developments and re-development projects. The following criteria shall be used in the design of all Drainage Plans:

1. The stormwater drainage plan shall be designed to limit stormwater runoff from the development site to the pre-development runoff rates. The pre-developed rate calculations shall be included as part of the required Engineering Design Report. Adequate on-site stormwater detention shall be provided for design storm runoff exceeding the pre-development rate.
 - a. For existing developed lots planned for re-development, assume undeveloped conditions to calculate the pre-development runoff rates for the property.
2. The stormwater storage and treatment facilities shall be designed to remove solids, silt, oils, grease, and other pollutants. Where required, sand/oil separators shall be provided in the facility design.
3. Where the storm drainage plan includes stormwater infrastructure, it shall meet the following minimum requirements:
 - a. Alignment between manholes shall be straight.
 - b. All stormwater piping shall be uniformly sloped to maintain a minimum velocity of 3 feet per second at the design storm depth of flow, or when flowing full, to prevent sediment deposits.
 - c. Pond inlet and outlet piping shall be protected and designed to prevent erosion (i.e. splash pads, rip rap, etc.).
 - d. Publicly maintained stormwater mains located in the public right-of-way shall be constructed of reinforced concrete pipe (RCP) or solid-wall PVC pipe, complying and installed in accordance with the current edition of MPWSS as modified by the COL. PVC pipe may only be used for pipe sizes of 36-inch diameter or less. Other pipe materials may be considered for private stormwater facilities. Use 12-inch minimum pipe size for inlet structures and 15-inch minimum pipe size within the storm drain system.
 - e. All stormwater transport facilities shall be designed to handle a 25-year storm event.
 - f. Inlets and manholes shall have 18-inch sumps for sediment collection unless otherwise approved by the Public Works Director.
 - g. Drywells will only be considered on a case by case basis with approval from the Public Works Director.

4. For all new development or redevelopment projects greater than or equal to 1-acre, the drainage plan shall include an Initial Storm Water Facility to infiltrate, evapotranspire, and/or capture for reuse the runoff generated from the first 0.5-inches of rainfall on impervious surfaces. The required volume for the Initial Storm Water Facility may be included in the design of any proposed retention, detention, or infiltration facility. The equation to calculate the minimum size is:

$$V = \frac{0.5 \times A_{\text{imp}}}{12 \frac{\text{inches}}{\text{foot}}}$$

Where: V = Minimum facility volume (ft³)
 A_{imp} = Total on-site impervious area (ft²)

B. STORM DRAINAGE PLAN

A Storm Drainage Plan shall be submitted to the City's Public Works Department for ALL new developments or redevelopment projects. The plan shall include the following:

1. A map or plat showing building site(s), open areas, drainage ways, ditches, culverts, bridges, stormwater mains, inlets, storage ponds, snow storage areas, roads, streets, and any other drainage improvements. The map shall also include identification and square foot coverage of the various ground surfaces (i.e. vegetation, gravel, pavement, structures).
2. Topographic contours (one-foot intervals) and sufficient spot elevation data.
3. Description of the ultimate destination of stormwater runoff from the project site and an evaluation of its impact on downslope drainage facilities and water quality.
4. Design calculations determining runoff quantities and storage requirements.
5. A storm drainage facilities maintenance plan. The plan shall:
 - a. Identify ownership of all facilities.
 - b. Establish a schedule for maintenance activities necessary to keep the system operationally effective.
 - c. Identify the responsible party in charge of the specific maintenance duties.
6. Details and specifications (including invert and other pertinent elevation information) for all storm drainage improvements, such as stormwater mains, manholes, inlets, discharge structures; and retention/detention pond dimensions and volume, side slope, pond top, pond bottom, and maximum water surface.

C. STORAGE/TREATMENT FACILITIES

Detention is the storage and gradual release of runoff to a stormwater system, waterway, or a soil of high porosity. Detention facilities dampen peak runoff rates and provide treatment of runoff flows. On-site detention must capture runoff and release it at a flow rate equal to or less than the pre-development peak flow rate for the 2-year storm event.

Complete retention facilities may be provided or required where discharge from a detention facility is not feasible or desirable. Retention facilities are designed to store runoff for gradual release by evaporation, infiltration, or re-use.

Designs must show that a retention facility, or discharge from a detention facility, will not overtop roads during a 10-year storm event and will not inundate buildings during a 100-year storm event.

1. Retention Facilities: Retention facilities must be sized for the difference between the pre- and post-development runoff volumes. With no consideration for infiltration or designed outlet. Retention facilities must be sized based on a 10-year, 2-hour storm event. Retention facilities must be designed to infiltrate, evapotranspire, and/or capture for reuse stormwater within 72 hours.

2. Retention Volumes: Retention volumes shall be calculated using the following formulas:

$$Q = c_w \times I \times A$$
$$V = 7200Q \text{ (cfs)}$$

Where: c_w = Weighted average runoff coefficient (unitless)
 I = 0.51 in/hr (see figure I-2 for 10 year, 2 hr storm)
 A = Drainage area (acres)
 Q = Runoff rate (ft³)
 V = Volume (ft³)

3. Detention Facilities: Detention facilities utilize natural or manmade depressions or ponds for storage. Release of water is controlled by specially designed outlet structures (Figure A-2 in the Appendix of this Guide). Detention facilities must be designed to hold runoff for no more than 72 hours.
4. Basin Sizing: A minimum basin area of 145-square feet per 1-cfs release rate is required for sediment control. The controlling basin volume is determined by subtracting the total basin release volume from the runoff volume at different storm durations. The release rate is equivalent to the pre-development runoff rate at the piping system design frequency (Table I-3). The runoff rate is determined at the piping system design frequency using development runoff coefficients. Where the potential for major property damage exists due to downstream flooding and the terrain and availability of land permit the construction of a large detention basin, a 100-year design frequency should be

used for sizing the pond. A sample problem for sizing detention basins is included in the Appendix of this Policy.

5. Basin Location: Basins serving multiple lots shall be located in common open space owned by a Homeowners or Property Owners Association. Locating a basin within an easement on a lot will not be permitted unless approved by the governing body. Public park land shall not be used for storm water detention or retention ponds unless approved by the Public Works Director. Basins located in areas accessible to the public shall have a maximum water depth of 1½-feet. For areas protected by a fence, a maximum basin depth of 4-feet is allowed. Such deep basins designed only for stormwater detention shall be placed in remote areas and fenced.

6. Snow Storage: Seasonal heavy snowfall is typical in Livingston. A logical area must be designated or specified within the subject property that is reserved for storage or stockpiling of accumulated snow from within the property, when plowed, shoveled or removed from hardscape areas including but not limited to on-site driveways, sidewalks, parking areas, and trails.
 - a. Locate snow storage areas on-site and in a way to minimize pollutant and runoff impacts.
 - b. Size snow storage areas to accommodate approximately 20% of the anticipated plow area;
 - c. Snow storage areas cannot be located above storm drain inlets or grated inlet manholes;
 - d. Clearly identify the boundaries of the snow storage area to be visible in winter conditions;
 - e. Snow storage in landscaping:
 - i. Provide concave grading rather than mounded to contain snow;
 - ii. Plant native species tolerant to heavy snow loads (perennials that can be pruned back and shrubs or trees that can bend rather than break with snow weight);
 - f. Snow storage in detention or retention basins:
 - i. Snow storage area must be designed so as not to encroach upon a basin's inlet or outlet structures;
 - ii. Basin capacity must be designed to accommodate expected snow storage volumes in addition to the design storm. The basin must retain the capacity to hold the design storm at all times during snow storage operations;
 - iii. Stabilized access for snowplowing equipment must be provided;

- iv. Annual maintenance must be provided after spring snowmelt to remove material and debris from the basin, rehabilitate the infiltration capacity, and confirm conveyance facilities are functional.
7. Additional Requirements: The following additional requirements apply to the design of above ground earth formed detention basins:
- a. To prevent short circuiting, basin length shall be at least three times the width and inlet velocities should be dissipated;
 - b. Basin slopes shall be 3:1 or flatter;
 - c. Basins must be located where the increased runoff will naturally accumulate, or where runoff can be directed on the site;
 - d. Vegetative channels shall be utilized wherever possible to remove wastewater contaminants;
 - e. Basins in floodplains shall have adequate erosion protection on the embankments;
 - f. Overflows shall be provided to prevent overtopping of dike walls;
 - g. The outlet from a detention facility must be designed to provide a stabilized transition from the facility to the receiving area at non-erosive velocities;
 - h. Cross-sections and design details must be provided on the plans.

D. INFILTRATION FACILITIES

Infiltration facilities include features such as drainage swales, boulder pits, catch basins, and surface areas such as pervious pavers and lawns. Drywells or French drains are NOT allowed unless prior approval is received from the Public Works Director. Infiltration facilities collect and discharge stormwater runoff through infiltration into surrounding subsurface soils. They are normally dry during non-rainfall periods since they only temporarily impound runoff.

Some infiltration facilities may be classified as Class V EPA injection wells. These design standards do not replace or supersede the regulations and standards of the EPA.

Lawns and landscaping areas proposed as infiltration facilities must be sized using the appropriate runoff coefficient consistent with the proposed land use and as designated by the Modified Rational Method. Infiltration facilities, except lawns and landscaping, shall be designed with the following requirements:

1. Facility Sizing: Infiltration facilities must be sized based on infiltration rates in accordance with Table I-1 or according to results from a percolation test

performed within 25-feet of the proposed facility. Percolation test results or site-specific soil data must be submitted with the design. Facilities must be sized based on test data for the specified fill material or by assuming a fill material with 30% void space. Facilities must be sized to drain within 48 hours after a storm event;

2. Additional Requirements:

- a. Facilities must be constructed above the seasonal high groundwater level;
- b. Facilities must be lined with a minimum 30 mil filter fabric or other material approved by the reviewing authority when needed to prevent clogging;
- c. Must include a pre-treatment facility where sediment, trash, debris, or organic materials are likely to impact the operation of maintenance of the infiltration facility.

TABLE I-1
INFILTRATION RATES IN INCHES PER HOUR*

<u>TEXTURE</u>	<u>INFILTRATION RATE (IN/HR)</u>
Gravel, gravelly sand, or very coarse sand	2.60
Loamy sand, coarse sand	1.05
Medium sand, sandy loam	0.90
Fine sandy loam, loam	0.70
Very fine sand, sandy clay loam, silt loam	0.70
Clay loam, silty clay loam	0.07
Sandy clay	0.07
Clays, silts, silty clays	0.00

* Source: Montana DEQ Circular 8, Table 2

E. PRE-TREATMENT FACILITIES

Pre-treatment facilities are required where sediment, trash, debris, or organic materials are likely to impact the operation or maintenance of stormwater conveyance, storage, and infiltration facilities. Pre-treatment facilities preserve the longevity of all infiltration facilities, as well as reduce the maintenance demands on detention, retention, and conveyance systems.

Pre-treatment facilities must be selected and designed to effectively treat storm water

runoff for the purpose for which the facility was designed. Only the following pre-treatment facilities may be used, unless specifically approved by the Public Works Director:

1. Vegetative Filter Strips: Reduce the velocity of stormwater runoff, allowing settlement of sediment. They work best when receiving runoff as sheet flow, making them suitable alongside roads, parking lots, and other paved surfaces;
2. Vegetated Swales: An open channel conveyance facility designed with shallow slope and proper vegetation to allow sediment and trash to deposit;
3. Screens: Screens are used to prevent leaf litter and other debris from entering the stormwater system or pond;
4. Sand/Oil Separators: Sand/oil separators are specifically designed to remove petroleum hydrocarbons, grease, sand, and grit from stormwater runoff;
5. Proprietary Spinners/Swirl Chambers/Centrifuges: These facilities cause stormwater to move in a circular motion to promote settling of sediments, particulates, oils/grease, floatable sands, and debris. These must be installed in accordance with manufacturer specifications;
6. Drain Inlet Inserts: Drain inlet inserts are placed into storm drain curb inlets or catch basins to remove pollutants from runoff prior to entry into the stormwater system. They use an inert filter material, such as polypropylene, to enhance pollutant removal. Drain inlet inserts have the ability to remove debris, trash, and sediment. If a filter is present, they can also remove oils/greases and other pollutants from runoff.

F. DISCHARGE STRUCTURES

1. A design detail shall be provided including adequate elevation information. Discharge structures shall be adequately protected from damage. A typical discharge structure is shown in Figure A-2 in the Appendix of this Policy.
2. Orifice or weir calculations shall be provided for controlling the discharge to the pre-development rate. For discharge structures similar to that in Figure A-2 of the Appendix, the slot width shall be sized using the equation:

$$Q = CLH^{3/2}$$

Where: Q = Discharge (cfs)
C = Weir Coefficient = 3.33
L = Horizontal length (ft)
H = Head (ft)

3. Failsafe features shall be provided including:
 - a. An emergency free-flowing overflow for rates exceeding design storm events.
 - b. Discharge piping shall be a minimum of 6-inches in diameter for maintenance, and capable of conveying a 25-year storm event.
 - c. Ponds shall be designed so as to avoid long-term standing water in the pond.

G. ESTIMATION OF RUNOFF

1. GENERAL

The Rational Method is appropriate for estimating peak flow of storm water runoff for areas less than 200 acres in size. This method shall be used to determine peak runoff rates with a slight modification of the method to determine runoff volumes. The basic assumptions that apply to the Rational Method are:

- a. Rainfall is uniformly distributed over the area for the duration of the storm.
- b. The peak runoff rate occurs when the duration of the storm equals the time of concentration.
- c. The runoff coefficient for a particular watershed is constant for a similar land use.

The method is based on the Rational Formula:

$$Q = c_w \times i \times A$$

- Where:
- Q = Peak runoff rate (ft³)
 - c_w = Weighted average runoff coefficient (unitless)
 - i = Average rainfall intensity (in/hr) from IDF curves
 - A = Drainage area (acres)

2. RUNOFF COEFFICIENTS

The runoff coefficient (c) must be the weighted average (c_w) of the site conditions shown in Table I-2. Coefficients from other engineering texts may be considered for specific applications such as pervious pavers, pervious concrete, etc.

TABLE I-2
RUNOFF COEFFICIENTS (c) FOR USE IN THE RATIONAL FORMULA*

<u>LAND USE</u>	<u>RUNOFF COEFFICIENTS (c)</u>
Paved or other hard surface areas	0.90
Gravel areas	0.80
Undeveloped areas	0.20
Lawns or other landscaped areas	0.10

* Source: Montana DEQ Circular 8

3. TIME OF CONCENTRATION

A basic assumption of the rational method is that the peak runoff rate occurs when the duration of the storm equals the time of concentration. The time of concentration is the time required for runoff to travel from the hydraulically most distant point in the drainage area to the outlet. The hydraulically most distant point is the point with the longest travel time to the outlet point, but not necessarily the point with the longest flow distance to the outlet. It generally consists of overland flow time and channel flow time. Time of concentration will vary depending on slopes, the character of the drainage area, and the flow path.

Shallow concentrated flow is assumed to occur after sheet flow ends. Beyond that, channel flow is assumed to occur. Channel flow time in gutters, ditches, or pipes may be determined by estimating velocities using Manning's equation:

$$V = \frac{1.486 R^{\frac{2}{3}} S^{\frac{1}{2}}}{n}$$

Where: V = Mean velocity (ft/sec)
n = Manning roughness coefficient (typical values in Table I-3)
R = Hydraulic radius

$$R = \frac{a}{P_w}$$

a = Cross sectional flow area (ft²)
P_w = Wetted perimeter (ft)
S = Slope of the hydraulic grade line (ft/ft)

TABLE I-3
MANNING'S EQUATION - TYPICAL ROUGHNESS COEFFICIENTS ("n"
VALUES)*

<u>Channel Type</u>	<u>"n" Factor</u>
Regular Natural Channels (Streams <100-ft width)	0.038
Irregular Natural Channels (Streams <100-ft width)	0.095
Small Open Vegetated Channels	0.085
Small Concrete Open Channels	0.013
Small Riprap Open Channels	0.028
Pavement/Concrete Curb & Gutter	0.014
Concrete and RCP Pipe	0.013
Corrugated Metal Pipe	0.024
PVC pipe (Smooth)	0.012
PVC pipe (Corrugated)	0.022

* Source: Federal Highway Administration HEC-22

4. RAINFALL INTENSITY

The intensity of the storm is determined from the Intensity-Duration-Frequency (IDF) curve equations in Figure I-1. Duration is assumed to be equal to the time of concentration, but no less than 5-minutes. The values in Table I-4 are the City of Livingston design frequencies.

TABLE I-4
RAINFALL FREQUENCY FOR USE IN THE RATIONAL FORMULA

<u>Land Use</u>	<u>Design Rainfall Frequency</u>
Open Land	2-year
Residential	10-year
Commercial or Industrial	10-year

5. RUNOFF RATES AND VOLUMES

The Rational Method provides a peak runoff rate which occurs at the time of concentration. The Modified Rational Method approach shall be used to compute runoff volume for storm durations equal to or greater than the time of concentration. This method assumes the maximum runoff rate begins at the time of concentration and continues to the end of the storm. Maximum runoff rates for durations greater than the time of concentration are less than the peak runoff rate because average storm intensity decreases as duration increases. Total runoff volume is computed by multiplying the duration of the storm by the runoff rate.

6. RAINFALL INTENSITY DURATION FREQUENCY CURVE

In order to use the rainfall Intensity Duration Frequency (IDF) curves, the time of concentration must be known. This can be determined by the following equation:

$$T_c = \frac{1.87(1.1 - c \times C_f) D^{\frac{1}{2}}}{S^{\frac{1}{3}}}$$

- Where
- T_c = Time of concentration, minutes
 - S = Slope of basin, %
 - c = Rational Method runoff coefficient
 - D = Length of basin, feet
 - C_f = Frequency adjustment factor¹

Time of concentration calculations should reflect channel and stormwater velocities as well as overland flow times.

¹RATIONAL METHOD FREQUENCY ADJUSTMENT FACTORS

Storm Return Period (years)	Frequency Factors C_f
2 to 10	1.00
11 to 25	1.10
26 to 50	1.20
51 to 100	1.25

Note: The product of c times C_f shall not exceed 1.00.

RAINFALL INTENSITY - DURATION CURVES
LIVINGSTON, MONTANA

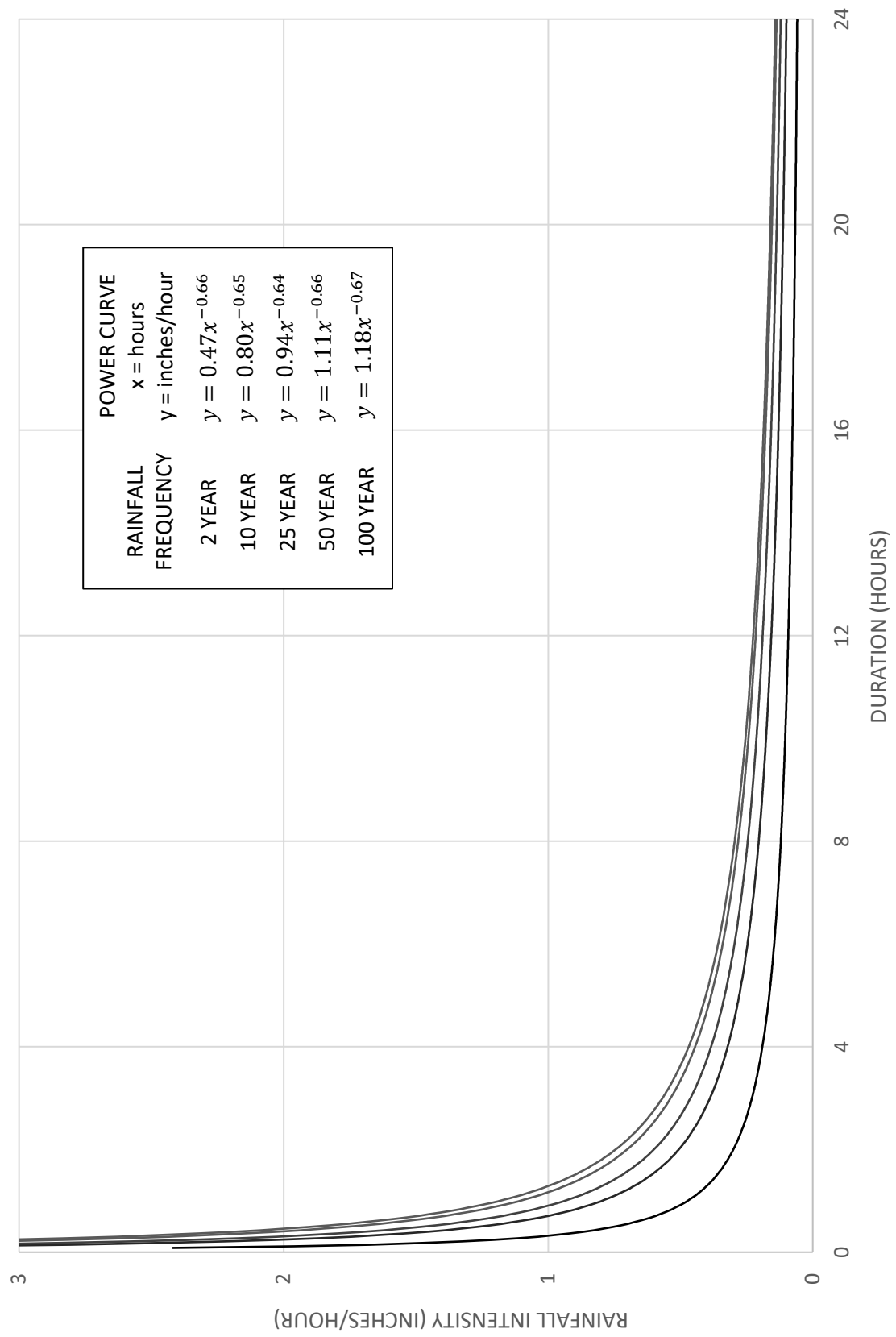


FIGURE I-1 RAINFALL INTENSITY - DURATION IN HOURS

III. FLOODPLAIN REGULATIONS

A. GENERAL

Floodplain regulations are detailed in Chapter 29 of the Livingston Municipal Code (LMC). These regulations are intended to protect the public health, welfare and safety in order that citizens and property owners can remain under the national flood insurance program. All proposed developments shall conform to the requirements of Chapter 29 of the LMC.

IV. ROADWAY DESIGN AND TECHNICAL CRITERIA

A. GENERAL.

This section sets forth the minimum design and technical criteria and specifications to be used in the preparation of all roadway plans. All roadway plans should also be designed in conformance with MPWSS; City of Livingston Modifications to MPWSS; Americans With Disabilities Act; and City of Livingston Sidewalk Policy.

B. SIDEWALKS, CURBS AND GUTTERS, AND DRIVEWAYS

1. Roadway typical sections are detailed in Figure A-1 in the Appendix of this Policy. Roadway typical sections shall conform to conditions of approval for the project. A City of Livingston Application for Sidewalk and/or Driveway and Curb Cut Permit must be obtained from the Public Works Department prior to installation of any sidewalk or driveway.
2. Concrete sidewalks shall be constructed on both sides of all roadways unless otherwise approved by action of the City Commission. Sidewalks shall be 6-inches thick across driveways, and 4-inches thick elsewhere and shall be constructed of concrete with a minimum compressive strength of 3,500 pounds per square inch (psi). Construction joints 1-inch deep shall be placed every 5-feet and expansion joints shall be placed every 25-feet. Sidewalk design and construction shall be in accordance with the most current edition of the Montana Public Works Standards and Specifications, and any modifications adopted thereto.
3. Sidewalks shall be uniformly graded to slope 1/4 -inch per foot from the property line, across the boulevard (if applicable), and to the top of the adjacent full-height curb. This uniform slope meets ADA requirements and ensures drainage to the street.
4. Standard sidewalk location shall be 1-foot from the property lines and within the public right-of-way.
5. Concrete sidewalks must be installed at the time of development, even if there is no sidewalk to connect to past the subject property line.

6. All sidewalks shall have a minimum width of 5-feet, except the minimum width shall be 12-feet on Park Street between 3rd Street and D Street and on Main Street between Park Street and Geysler Street, and 10-feet in the remainder of the central business district.
7. Integral curb and gutter shall be used on all roadways and paved parking areas. Curb and gutter shall be constructed of 4,000 psi compressive strength concrete with construction joints at 10-foot intervals. Expansion joints must be placed at all points of curvature and tangency, at curb returns, and where new curb abuts existing curb.
8. Pedestrian ramps shall be installed at all intersections and at certain mid-block locations for all new construction or reconstruction of curb and sidewalk. Pedestrian ramps shall be constructed in accordance with the most current editions of the Montana Public Works Standard Specifications and Americans with Disabilities Act (ADA) requirements. Pedestrian ramps may be shown at all curb returns or called out by a general note on the development plans.
9. Guardrails may be required in certain situations. Guardrails shall be designed and constructed in accordance with AASHTO Standards or as directed by the Public Works Director.
10. Drop-curbs for driveways may only be installed with the initial curb construction when the final building locations have been determined.
11. Curb transitions for curb bulbs shall be accomplished using 35-foot minimum radius curves to achieve the desired pavement narrowing. All curb bulbs shall be adequately marked with flexible roadway delineators and yellow curb paint as necessary. The minimum curb bulb throat width is 24-feet (back of curb to back of curb).
12. A representative from the City Building Department must inspect all forms and base course BEFORE concrete is poured in the public right-of-way. Inspections must be scheduled a minimum of 24-hours in advanced. Certificate of Occupancy will not be provided without completed sidewalk, curb, and gutter.

C. BIKE LANES, TRAILS, & PATHWAYS

1. Bike lanes, trails, and pathways constructed under these guidelines should create City-wide reasonably safe routes for people who walk, bike, and hike. The City's goal is for developers to connect neighborhoods to schools and gathering places, and create a transportation system that is reasonably safe and accessible for all modes of travel.
2. All new development and re-development projects must incorporate active transportation, unless it is specifically waived by public works and planning.

3. The design of all bike lanes, trails, and pathways constructed under these guidelines shall be in accordance with at least one of the following guide documents:
 - AASHTO Chapter 7: Multimodal Design Considerations;
 - AASHTO's Guide for Planning, Design, and Operation of Pedestrian Facilities;
 - AASHTO's Guide for the Development of Bicycle Facilities;
 - Montana Department of Transportation's Pedestrian & Bicycle Plan;
 - FHWA's Small Town & Rural Multimodal Networks Guide;
 - FHWA Designing Sidewalks & Trails for Access;
 - NACTO Urban Bikeway Design Guide & Urban Street Design Guide;
 - City of Livingston's Active Transportation Plan.
4. Bike lanes, trails, and pathways constructed under these guidelines shall be marked and signed in accordance with the FHWA Manual on Uniform Traffic Control Devices (MUTCD).

D. ACCESS

1. All lots must be provided with safe, legal and physical access to a public street, which may be via a legal alley. Drive accesses are required for commercial parking lots and parking lots for residential developments subject to the City of Livingston site plan review process.
2. A City of Livingston Application for Sidewalk and/or Curb Cut Permit must be obtained from the Public Works Department prior to the installation of an approach.
3. The minimum separation of 40-feet is required between private and/or public accesses on local streets, 150-feet on collector streets, and 315-feet on arterial streets.
4. Residential: Residential drive accesses are to be located off public alleys whenever possible. Where no alley is present, accesses may be located off local streets only.
 - a. Single-household uses are limited to one drive access per street or alley face.
 - b. Individual residential access facing the street may not exceed a width of 18-feet at the curb line for a single parking bay or 26-feet at the curb line for two or more parking bays.
 - c. No residential access may be located within 50-feet of a local street intersection or 150-feet of a collector or arterial street intersection, unless otherwise approved by the Public Works Director.
 - d. Drive accesses have a minimum setback of 5-feet to any side property line, unless a shared access with the adjoining property is approved.

5. Residential complexes with 25 or more dwelling units must meet commercial access requirements.
6. Commercial:
 - a. Commercial drive accesses cannot exceed 35-foot width at the curb line.
 - b. Industrial drive accesses cannot exceed 40-foot width at the curb line.
 - c. Commercial and industrial drive accesses must be a minimum of 24-foot wide for two-way access and 16-foot wide for one-way access.
 - d. Drive accesses for commercial or industrial use must be set back a minimum of 20-feet from the adjacent property line, unless a shared access with the adjoining property is approved.

E. VISION TRIANGLES

1. The reasonably safe operation of driveways, alleys, and street intersections constructed under these guidelines require enough sight distance in both directions for drivers and pedestrians to be reasonably safe to travel within the street right-of-way.
2. On the street side of all lots where an alley or driveway enters the street right-of-way, and on all corner lots, a triangular clear vision zone must be maintained. The vision triangle shall measure 10-feet into the lot as measured from the edge of the sidewalk nearest the property line, and 20-feet parallel to the street as measured from the edge of any alley, driveway, or street corner along the edge of the sidewalk nearest the property line. If no sidewalk exists, the point of reference for these measurements shall be determined by the Public Works Director.
3. No structure of any kind over 3-feet in height shall be erected or maintained within the prescribed vision triangle.
4. Trees:
 - a. Single-stem canopy trees are discouraged but may be permitted in street vision triangles as described in this section, provided that mature trees do not significantly affect safe driving conditions and are maintained such that no canopy foliage exists below a height of ten feet above centerline of intersecting streets.
 - b. Trees which are located in the street vision triangle and which preexisted the adoption of this policy, are permitted, provided the trees are trimmed such that no limbs or foliage exist below a height of 10-feet above centerline grades of intersecting streets.

F. DRAINAGE

Drainage systems shall be designed in accordance with these Design Standards and Specifications, Section II, Drainage Policy. Development plans, including a drainage report, for the drainage system are required for concurrent review with, and shall be considered part of, roadway design.

1. Crosspans. Crosspans (valley gutters) shall be constructed in accordance with City of Livingston Standard Drawings. Crosspans are not allowed across collector or arterial roadways, nor are they allowed on roadways with stormwater systems.

Crosspans may be used parallel with collector or arterial roadways to convey storm runoff across residential roadways. The use of crosspans elsewhere is discouraged, and will only be allowed after all other alternatives have been investigated.

2. Inlets:

- a. Inlets shall be located to intercept the major curb flow at intervals sufficient to ensure the depth of flow in the curb line is a maximum of 0.15-feet below the top of curb. This will result in a maximum spread width of approximately 9.5-feet. Inlets should be aligned with lot lines wherever possible.
- b. Inlets shall also be installed to intercept cross-pavement flows at points of transition in super elevation. Due to the presence of pedestrian ramps, inlets are not allowed in the curb return, but will be located at the tangent points of the curb returns. Justification must be provided to the Public Works Department if an inlet is not provided upstream of a pedestrian ramp to capture storm water before it crosses the pedestrian ramp.
- c. All inlets within the public right-of-way, or to be maintained by the City of Livingston, shall be constructed in accordance with the Montana Public Works Standards and Specifications (MPWSS) and the City of Livingston Modifications to the MPWSS.

3. Cross Slope: Except at intersections, or where super-elevation is required, roadways shall be level from top of curb to top of curb and shall have a 2% crown as measured from centerline to lip of curb, or lip of median curb to lip of outside curb on roadways with raised center islands. Parabolic or curve crowns are not allowed. Maximum pavement cross slope allowed is 5% at warped intersections, as measured above. In no case shall the pavement cross slope at warped intersections exceed the grade of the through street. When warping side streets at intersections, the crown transition should be completed within 75-foot horizontally for local streets, 100-foot horizontally for collector streets, and 150-foot horizontally for arterial streets. The crown of the through street shall be decreased to 1.5% through intersections, with the crown transitions being accomplished within 100-feet on either side of the intersections. Quarter

crowning may be accepted on a case by case basis needing prior approval from the Public Works Director.

4. Temporary Erosion Control: Temporary erosion control is required at the ends of all roadways that are not completed due to project phasing, subdivision boundaries, etc. Prevention of erosion at the roadway terminus shall be by methods approved by the Public Works Director.
5. Sidewalk Chases:
 - a. Storm waters from concentrated points of discharge shall not be allowed to flow over sidewalks, but shall drain to the roadway by the use of chase sections. The use of sidewalk chases is discouraged, and their use is limited to situations where it is not possible to use standard storm inlets and piping.
 - b. Chase sections shall not be located within a curb cut of driveway. Chase sections shall be identified by station and elevation.
 - c. Sidewalk chase sections are to be constructed in accordance with the City of Livingston Standard Drawings.

G. HORIZONTAL ALIGNMENT

1. Turning Radius: All roadways shall intersect at right angles as nearly as possible. In no case shall the angle of intersection be less than 75°.
2. Curb Return Radius: Minimum curb returns shall be as shown in Table IV-1 of these specifications. A larger radius may be used with the approval of the Public Works Director.
3. Design Speed: Design speed shall be as shown in Table IV-2 of these specifications.
4. Horizontal Curves: The minimum centerline radius for horizontal curves shall be as shown in Table IV-2 of these specifications. Variances from the requirements of Table IV-2 for local streets only may be considered on a case by case basis.
5. Two streets meeting a third street from opposite sides shall meet at the same point, or their centerlines shall be off-set at least 125-feet.

TABLE IV-1
CURB RETURN RADIUS AT INTERSECTIONS*

	<u>LOCAL</u>	<u>COLLECTOR</u>	<u>MINOR ARTERIAL</u>	<u>MAJOR ARTERIAL</u>
LOCAL OR PRIVATE ST.	15'	15'	15'	15'
COLLECTOR	15'	25'	25'	25'
MINOR ARTERIAL	15'	25'	**	**
PRINCIPAL ARTERIAL	15'	25'	**	**

* Measured from back of curb

** Per AASHTO Standards

**TABLE IV-2
MINIMUM STREET DESIGN STANDARDS FOR CITY STREETS**

STREET TYPE	PRINCIPAL ARTERIAL	MINOR ARTERIAL	COLLECTOR	LOCAL	RURAL
Right-of-way width	110' - 120' ³	100'	90'	60'	90' – 110' ³
Centerline radius on curves	1	1	300'	150'	300'
Tangent length between reverse curves	1	1	100'	50'	100'
Stopping sight distance	1	1	300'	200'	300'
Angle at intersection centerline	1	1	>75°	>75°	>75°
Curb radius at intersections	2	2	2	2	N/A
Length of tangent at intersection	1	1	150'	100'	150'
Back of curb to back of curb	82'	50', 63', 71' ³	45', 48', 52', 62' ³	31', 33', 35' ³	33', 39', 62' ^{3,4}
Length of cul-de-sac ⁵	N/A	N/A	N/A	500'	N/A
Outside radius on cul-de-sac right-of-way ⁵	5	5	N/A	50'	N/A
Grade – maximum	1	1	7%	10%	10%
Grade – minimum	1 %	1%	1%	0.7%	0.7%
Grade within 150 feet of intersecting centerlines	1	1	3%	3%	3%
Design Speed (MPH)	50	45	45	30	45
K Factor (minimum)					
Crest	1	1	105	50	105
Sag	1	1	65	35	65
Minimum VCL					
Crest	1	1	90	50	90
Sag	1	1	70	50	70

¹All design criteria shall meet AASHTO standards.

²See Table IV-1

³The specific right-of-way and back of curb to back of curb street width will be determined on a case by case basis through the subdivision review process, and will be based on the specific needs, impacts and context of the development proposal.

⁴The rural street standard does not include curb and gutter. The street width is measured from the edge of pavement to the edge of pavement.

⁵Cul-de-sacs are generally not allowed. The City's Public Works Director may consider and approve the installation of a cul-de-sac only when necessary due to topography, the presence of critical lands, access control, adjacency to parks or open space, or similar site constraints.

6. Super-elevation: Super-elevation may be required for arterial roadways and selected collector roadways. Horizontal curve radius and super-elevation shall be in accordance with the recommendations of AASHTO. Super-elevation shall not be used on local roadways.
7. Spiral Curves: Spiral curves shall not be used on roadways within the COL (State highways excluded) except by written approval of the City Public Works Director.
8. Railroad Crossing: All railroad crossings on streets shall be steel reinforced rubber for the full width of the roadway.
9. Barricades: Whenever roadways terminate due to project phasing, subdivision boundaries, etc., barricades are required in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) and City standards.

H. VERTICAL ALIGNMENT

Design controls for vertical alignment are shown in Table IV-2.

1. Permissible Roadway Grades: The minimum allowable grade for any roadway or alley is 0.7 percent. The maximum allowable grade for any roadway is shown in Table IV-2 of this Policy. The maximum grade for an alley is subject to the approval of the City's Public Works Director.
2. Changing Grades: Continuous grade changes or "roller-coastering" shall not be permitted. The use of grade breaks, in lieu of vertical curves, is not encouraged. Where the algebraic difference in grade (A) exceeds 1%, a vertical curve is to be used.
3. Vertical Curves: All vertical curves shall be symmetrical. Design criteria for vertical curves are found in Table IV-2. The minimum grade within a sag (sump) vertical curve is 0.5%. Minimum length of a vertical curve is shown in Table IV-2. All vertical curves shall be labeled, in the profile, with length of curve (L) and K ($=L/A$).
4. Intersections: The following additional criteria shall apply at intersections.
 - a. The grade of the "through" street shall take precedence at intersections. At intersections of roadways with the same classification, the more important roadway, as determined by the COL Public Works Department, shall have this precedence. Warp side streets to match through streets. See Section IV.C. 3 above;
 - b. The elevation at the point of tangency (PT) of the curb return on the through street is always set by the grade of the through street in conjunction with normal pavement cross slope;

- c. Carrying the crown of the side street into the intersecting through street is not permitted;
 - d. At an arterial-arterial intersection, a more detailed review of the entire intersection's drivability will be done.
5. Curb returns: Minimum fall around curb returns, when turning water, shall be 0.3-feet for a 15-foot radius; 0.4-feet for a 20-foot radius; ½-foot for a 25-foot radius. For all other curb return radii use a grade of 1.25-percent within the return to establish minimum fall when turning water. The maximum fall around a curb return is 3-percent. Show and label high point location, elevation and intersection of flow line in plan view if applicable.
 6. Connection with Existing Roadways: Connections with existing roadways shall be smooth transitions conforming to normal vertical curve criteria if the algebraic difference in grade (A) between the existing and proposed grade exceeds one percent (1.0%). When a vertical curve is used to make this transition, it shall be fully accomplished prior to the connection with the existing improvement. Field-verified slope and elevation of existing roadways shall be shown on the plans.
 7. Offsite Design and Construction: The design grade, and existing ground at that design grade, of all roadways that dead end due to project phasing, subdivision boundaries, etc., shall be continued in the same plan and profile as the proposed design for at least 300-feet or to its intersection with an arterial roadway. This limit shall be extended to 600-feet when arterial roadways are being designed. If the offsite roadway adjacent to the proposed development is not fully improved, the developer is responsible for the design and construction of a transition with a 4-foot road base shoulder for the safe conveyance of traffic from his improved section to the existing roadway. The following formula shall be applied to the taper or land change necessary for this transition:

Speed Limit

40 MPH or Less	$L = \frac{WS^2}{60}$
45 MPH or Greater	$L = W \times S$

Where: L = Length of transition in feet
W = Width of offset in feet
S = Speed limit or 85th percentile speed

The City of Livingston Public Works Department should be consulted for any unusual transition conditions. Grade breaks greater than 1-percent are not allowed when matching existing dirt or gravel streets.

8. The cost of offsite pavement transitions shall be borne by the developer.

I. MEDIAN TREATMENT

Median curbs should be integral curb and gutter (with spill curb) unless otherwise approved. Medians less than 8-feet wide should be capped with M-4000 concrete a minimum of 3-inches thick. Wider medians should be top soiled and seeded with an approved seed mix. The minimum median width is 4-feet. All medians or raised islands should be made clearly visible at night through the use of adequate reflectorization and/or illumination. Flexible delineators shall be placed at the beginning and end of all medians, and at the point of any horizontal alignment change. All median curbs and island curbs shall be painted yellow with epoxy paint.

J. ROADWAY SPECIFICATIONS

Following are the requirements of the minimum roadway surfacing standards:

1. Surfacing. The pavement thickness design will be based on the current AASHTO Guide for Design of Pavement Structures, or the current Asphalt Institute Manual Series No. 1 (MS-1) for thickness design.
2. A Pavement Design Report, based upon specific site soil data and design-year traffic loading conditions, prepared by a Professional Engineer, or other qualified professional approved by the City's Public Works Director, shall be submitted to the Public Works Director for approval prior to plan and specification submittal if using the self-certification process or with the plans and specifications if using the standard process.
3. The design shall be based on at least a 20-year performance period traffic volume; however, the minimum design lane Equivalent 18,000-lb Single Axle Load (ESAL) used in the pavement design shall not be less than 50,000-ESAL.
4. The minimum asphalt pavement thickness for any new local roadway shall be 3-inches. The minimum asphalt pavement thickness for any new collector or arterial roadway shall be 4-inches.
5. A minimum of 6-inches of high quality untreated aggregate base shall be provided for designs utilizing asphalt pavement over untreated aggregate base.
6. Where full-depth asphalt is designed, an adequate stabilizer lift shall be included, consistent with unpaved roadway design practices, to provide a suitable sub-base capable of withstanding the traffic required for the initial construction of the roadway.
7. The Public Works Director may require intersections with roundabouts or traffic circles to be constructed with Portland Cement Concrete surfacing.

K. SIGNS and MARKINGS

1. Street identification signs shall be installed at all new intersections in accordance with City of Livingston Modifications to MPWSS. The design Engineer should consider, and the Public Works Director may require, regulatory traffic control signs and pavement markings in accordance with the MUTCD. Stop signs shall be installed on local streets when they intersect with any collector or arterial streets.
2. Unless otherwise approved, all transverse markings, words and symbols, and 8-inch or larger lane line pavement markings shall be inlaid thermoplastic or preformed plastic tape. All other markings may be either inlaid or preformed thermoplastic or epoxy paint. The materials proposed for all markings shall be specified on the plans.
3. Crosswalk markings should not be used indiscriminately. An engineering study should be performed before they are installed at locations away from traffic signals or stop signs. Mid-block crosswalks are discouraged.
 - a. All marked crosswalks for designated school crossings shall be longitudinal white bars (“City of Livingston Type B” style). “School Crossing” signs and “School Advance Warning” signs shall be installed at all designated school crossings.
 - b. At stop or signal controlled intersections, marked crosswalks shall be two 8-inch white lines, 8-feet apart typically, installed transverse to traffic and in-line with sidewalks, if any (“City of Livingston Type A” style).
 - c. Marked crosswalks at uncontrolled intersections, and all mid-block crosswalks shall be “Type B”, with “Pedestrian Crossing” signs. “Pedestrian Crossing Advance Warning” signs should be installed if deemed warranted by engineering judgment.
 - d. Parking shall be restricted by the use of signs and curb markings within 20-feet of crosswalks at a minimum, or longer based on engineering judgment.
 - e. All crosswalk signs and advance crosswalk signs shall have a fluorescent yellow green background.
4. All signs shall comply with the “Standard Highway Signs” book (FHWA).
5. Street name signs shall consist of white letters on a green background.

L. MONUMENTATION

Monuments in monument boxes shall be provided in new or reconstructed streets at all section corners, quarter corners, and sixteenth corners.

M. LIGHTING

The design engineer shall consider the need for roadway lighting in the development of plans for any new or reconstructed roadways.

Lighting shall comply with the following requirements:

1. General.

- a. All street lighting shall be operated and maintained through the creation of a new Special Improvement Light District (SILD), through the annexation to an existing SILD or through some other equivalent means approved by the City of Livingston. The application to create or annex to an existing SILD shall be submitted to the City within 2 months of preliminary approval of the development. The approval to create or annex to an SILD shall be granted prior to final plat for a subdivision or Occupancy if a final plat is not required.
- b. Street lighting shall be installed according to the Night Sky Protection Act of the LMC.
- c. Individual yard lights on private property shall not be used for street lighting.
- d. Unless otherwise specified herein, installation of equipment for lighting shall conform to the requirements of "Standard Specifications for Road and Bridge Construction", latest edition, published by the Montana Department of Transportation.
- e. Conduit and wiring for street lighting shall be placed within the street, 3-feet in front of the curb.

2. Street Lights at Intersections.

- a. Non-Signalized Intersections. A street light shall be installed at each non-signalized street intersection with the exception of intersections where the width of one or more of the approaches is greater than or equal to 50-feet, as measured to the back of curb or edge of pavement, then two street lights shall be installed on diagonally opposite corners.
- b. Signalized Intersections. At signalized intersections where all approaches are narrower than 50-feet, as measured to the back of

curb or edge of pavement, two street lights shall be installed on the diagonally opposite corners. At signalized intersections where the width of one or more of the approaches is greater than or equal to 50-feet, four street lights shall be installed, one on each corner.

3. Street Light Location and Placement of Equipment. The following layout and spacing criteria shall be used:
 - a. When a street light location falls near an unlit intersection, the light shall be located at the intersection;
 - b. Street lights shall be located at property lines to the greatest extent possible, but not in conflict with other utility service providers;
 - c. Light poles shall be spaced 200-feet apart, on alternating sides of the street, and may vary by up to 15-percent. For the uniformity of appearance, the variance in spacing between adjacent spans should not be more than 15 percent;
 - d. All proposed streets within the proposed subdivision, having a curve of 300- feet or longer in length, shall have a street light in the middle of the horizontal curve or as required by the Public Works Director;
 - e. Wiring for street lights shall be underground and in 2-inch minimum diameter conduit. Conduits shall typically be placed 2-feet from back of curb. All wiring shall be installed to meet the National Electric Code. Pull boxes shall be reinforced concrete and shall be located to not impede access to properties.
 - f. Additional street lights may be required by the City when potential traffic hazards are identified during plan review;

4. Street Lights & Support Structures.
 - a. The City standard ballast for local streets is LUMEC S55-32W32LED4K-T-ACDR-LE3-240-SFX-BRTX. The City standard ballast for collector streets is LUMEC S55-55W32LED4K-T-ACDR-LE3-240-SFX-BRTX.
 - b. All street light poles shall be 12-foot LUMEC R80A-12-TBc1-BRTX poles with base covers.
 - c. Light poles shall be powder coated with a bronze textured (BRTX) finish color.
 - d. Pole shaft shall be 12-feet high, 4-inch diameter, 8 fluted round extruded 6061-T6 aluminum tubing with a 0.167-inch wall thickness, and welded to the pole base.
 - e. Pole base shall be a round fluted cast 356-T6 aluminum base with a 0.167-inch wall thickness. Base must include a cast-in anchor plate.

- f. LEDs shall be Philips Lumileds LUXEON T. Color temperature shall be Neutral White, 4000 Kelvin nominal (3985K +/- 275 or 3710K to 4260K), CRI 70 min. 75 typical per ANSI/NEMA.
- g. Gauge (#14) TEW/AWM 1015 or 1230 wiring, 6-inch minimum exceeding from luminaire.
- h. All exposed screws shall be coated with a ceramic primer-seal basecoat to reduce seizing of parts and offer a high resistance to corrosion.
- i. All street light poles shall be installed on a concrete foundation with breakaway bases. All poles, foundations, and breakaway bases shall meet the criteria set forth in the AASHTO publication Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.
- j. Street light poles shall be placed as far away from the edge of roadway as practical, typically no closer than 5-feet from back of curb.

5. Luminaires and service equipment.

- a. Luminaires shall be wired to match the voltage of the operating system.
- b. Street lighting circuits shall be automatically controlled with turn lock mounting delayed response photo cells. One photo cell shall be installed per circuit, mounted at the service panel.
- c. All street lighting systems shall be metered separately from other uses, with the exception of street lights installed in conjunction with traffic signal poles.
- d. Electric services shall use NEMA Type 3R cabinets with hinged, lockable covers and 3/8-inch holes for a padlock. Locks shall be supplied by the City for city-maintained systems. Meters shall be installed a minimum of 4-feet and maximum of 5-feet above grade.
- e. Services shall be equipped with 3-way switches for auto-on/on/off operation.

6. Record drawings shall be provided to the City for all new and re-constructed lighting systems that are to be maintained by the City.

V. UTILITY DESIGN CRITERIA

A. WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

1. All City properties where there is public use, occupancy, or employment located within 500-feet of the City's water supply system must be connected to the system. New private wells are not permitted, and will not be approved, within the City of Livingston and its Source Water Protection Area.
2. All additions or modifications to the COL water system will be designed in accordance with the criteria set forth in this and other sections of this Policy as approved by the Public Works Director. DR 18 (Class 235) PVC and Ductile Iron Pipe (DIP) shall be used unless special approval, in writing, of alternate materials is given by the City's Engineer. All additions to the water system will be designed and installed in accordance with the most current editions of the Montana Department of Environmental Quality (DEQ) Circular No. 1; MPWSS; COL Modifications to MPWSS; and COL Fire Service Line Standard.
3. Master Water Plan: A master water plan shall be submitted for each subdivision or other major development or re-development project prior to approval of any portion of the water system. An overall plan of the development, including all areas outside of the study area which would naturally be served through the study area shall be submitted.
4. A design report prepared by a professional engineer licensed in the State of Montana demonstrating compliance with these requirements shall be submitted with the plans and specifications for any new development. Design parameters and the critical conditions shall be shown on an overall plan of the study area. An overall plan of the development, including all areas outside of the study area which would naturally be served through the study area shall be included.
5. Main Size: The water distribution system shall be designed to meet the maximum demand plus fire flow and the peak hour demand. The design shall be based on a maximum hour to average day ratio of 5.28:1 (maximum day to average day ratio of 2.36:1 for an average daily usage of 127.5-gallons per day per person), plus fire flow demand as determined by ISO (Insurance Services Office) criteria. A "C" Factor of 130 shall be used in modeling system designs. The working residual water pressure shall not be less than 20-psi at any point in the water distribution system under maximum day plus fire flow. The velocity of the water in the system shall not exceed 10-feet per second through a public main line. The minimum diameter for any new main is 8-inch, unless specific approval in writing is obtained from the City of Livingston for smaller diameters.

6. Main Extensions: All main extensions shall be looped, where possible. All dead end 8-inch mains shall end with a fire hydrant or 2-inch blowoff. Larger diameter dead end mains shall end with a fire hydrant. Permanent dead-end mains shall not exceed 500-feet long. Temporary 8-inch dead-end mains scheduled for future extension may end with a blow-off in lieu of a fire hydrant.
7. Services
 - a. A water line is designated as either a service line or water main based on its use, not its size. Generally, a line serving a single building or facility is considered a service line; a line serving more than one building, or intended to serve more than one building or facility is generally designated a water main. The standard sizes of service lines are 1-, 1½-, 2-, 4-, 6-, or 8-inch. The minimum size of a fire service line is 2-inch. The minimum size of a domestic water service line stub is 1-inch;
 - b. For service pipe sizes less than 4-inch, the service pipe shall be polyethylene pressure pipe meeting AWWA Specification C901. Polyethylene services shall be a minimum size of 1-inch copper tubing size (CTS) Class 200 with a DR of 9. Polyethylene pipe shall be Phillips, Drisco, Ultraline 5100, or approved equal. Service pipe that is larger than 4-inch shall be PVC or ductile iron. Plans and specifications prepared by a Professional Engineer licensed in the State of Montana shall be submitted for 4-inch and larger service lines.
 - c. The service stubs shall be installed in accordance with the COL Standard Drawings for service lines. The service line stubs shall be installed at the center of each lot unless otherwise approved by the Public Works Director.
 - d. Backflow prevention devices as required by the Public Works Director shall be installed on each fire and domestic service line. Meters will be installed inside the building by the Water Department on all service lines except for fire service lines. Meter pits shall not be used unless specifically approved by the Public Works Director.
 - e. All service connections shall be uniform size from the service line tap to the building structure or structures unless otherwise approved or required by the Public Works Director. Water meters shall be the same size as the service unless approved otherwise by the Public Works Director. The Water Department shall reserve the right to require a larger service connection to any building, structure or development if the water requirements when calculated by the fixture unit method, as specified in the Uniform Plumbing Code, cause the service line velocity to exceed 10 feet per second. Each service line and meter shall supply a specific building.

- f. All service line stubs shall be sized to adequately serve the maximum anticipated demand for the property being served.
 - g. The Public Works Director may require the termination of any existing service stubs (either for domestic or fire service) that are not utilized for service upon the development of the lot. Lines to be terminated shall be capped or plugged at the main, and any curb boxes or valve boxes on the line shall be removed.
 - h. All fire sprinkler underground supply lines with fire department connections (FDCs) shall conform to NFPA 24, the most current edition of the International Fire Code as adopted by the City of Livingston, and the City of Livingston Fire Department requirements for underground fire lines.
 - i. All fire and FDC services 2-inches and larger must be flushed, bacteria tested, and pressure tested with a City of Livingston Water Department representative present. The completed Certificate of Inspection for Fire Service Line Installation must be submitted to the Public Works Department will all test results for final acceptance.
8. Valves: Valves shall be installed in accordance with the following unless otherwise approved or required by the Public Works Director:
- a. All connections to an existing water main will begin with a new valve.
 - b. Valves shall be located at not more than 500-foot intervals in commercial districts and at not more than one block or 800-foot intervals in other districts.
 - c. Every leg of a main intersection shall have a valve.
 - d. Valves shall be placed so that main shut-downs can be accomplished with only one fire hydrant being out of service at a time.
9. Hydrants: Hydrants shall be provided at each street intersection and at intermediate points so that hydrants are spaced from 250 to 500-feet depending on the area being served. Mid-block hydrants shall be installed in line with lot lines.
- a. Bollards shall only be required around hydrants located without the protection of concrete curb and gutter, and/or in areas where semi-truck traffic has the potential to hit the hydrant.
10. Air Relief: Air relief shall be provided at all high points in the line where air can accumulate by means of hydrants, services, or air relief valves.
11. Pressure Reducing Valves: Pressure reducing valves shall be installed

when the anticipated average-day line pressure exceeds 100 psi.

12. Thrust Restraint: All thrust restraint shall be designed to withstand the test pressure or the working pressure plus surge allowance, whichever is larger. Adequate factors of safety shall be employed in the design.

B. SANITARY SEWER SYSTEM DESIGN CRITERIA

1. All City properties where there is public use, occupancy, or employment located within 500-feet of the City's sanitary sewer system must be connected to the system. New septic systems are not permitted, and will not be approved, within the City of Livingston and its Source Water Protection Area.
2. All additions or modifications to the COL sanitary sewer system will be designed in accordance with the criteria set forth in this and other sections of this Policy as approved by the City's Public Works Director. All additions to the sewer system will be designed and installed in accordance with the most current editions of the Montana Department of Environmental Quality (DEQ) Circular No. 2; MPWSS; COL Modifications to MPWSS, and the Uniform Plumbing Code
3. A design report, prepared by a Professional Engineer licensed in the State of Montana, demonstrating compliance with these requirements shall be submitted with the plans and specifications for any new development or re-development project. Design parameters and the critical conditions shall be shown on an overall plan of the study area. An overall plan of the development, including all areas outside of the study area which would naturally be served through the study area shall be included. The design report must address sewer flows at full build-out of the proposed development.
4. New sewer lines shall be sized to flow at no more than 75-percent of full capacity at peak hour conditions upon the full build-out of the development. The effects of the proposed development's sewer loading on existing downstream sewer lines must be analyzed.
5. New sanitary sewer lines to serve residential areas shall be designed to accommodate an average daily flow rate of 100-gallons per capita per day. An average of 2.5 persons per living unit must be used to calculate total design flow unless the Public Works Director determines that a larger per-living-unit average is necessary for a given project. These figures, in conjunction with a peaking factor (below), are intended to cover normal infiltration for systems built with modern construction techniques. If the collection system is to serve existing development, the likelihood of I/I contributions from existing service lines must be evaluated and wastewater facilities designed accordingly.

6. New sanitary sewer lines shall be designed to accommodate the average daily flows as shown in Table V-1 of this Policy.

TABLE V-1 WASTEWATER FLOW RATE FOR ZONED UNDEVELOPED AREAS¹

Zoning Designation		Dwelling Unit per Acre	Gal./Acre/ Day
R I	Low Density Residential	4.5	1,125
R II	Medium Density Residential	12.4	3,100
R II (MH)	Med. Den. Res. (Mobile Home)	12.4	3,100
R III	High Density Residential	21.9	5,463
RMO	Mobile Home Residential	7.3	1,825
CBD	Central Business District	–	2,400
NC	Neighborhood Commercial	–	1,200
HC	Highway Commercial	–	MPUE ²
LI	Light Industrial	–	1,000
I	Industrial	–	960
P	Public	–	1,030

¹ The flow allocation in this table is based on gross area.

² MPUE = Maximum Property Use Estimate required; follow Tables 3.1-1 and 3.1-2 of Montana DEQ Circular 4 for typical wastewater flow estimates.

6. A Manning’s friction factor of 0.013 for PVC shall be used in designing new sewer piping.
7. A peaking factor shall be calculated for each pipe segment based on the following formula;

$$\frac{Q_{\max}}{Q_{\text{avg}}} = \frac{18 + P^{\frac{1}{2}}}{4 + P^{\frac{1}{2}}}$$

(P = Population/thousands)

For non-residential flows, an equivalent population shall be calculated for use in the peaking factor formula.

To evaluate future collection needs, wastewater loading needs to be assigned to areas based on anticipated future land use characteristics. In areas within the City limits the assigned zoning provides the best tool to approximate future wastewater loadings. Table V-1 shows the recommended wastewater flow rates based on a per acre basis for zoned areas. Detailed information on how the flow rates were developed may be requested from the Public Works Department.

8. Minimum Sewer Slopes: All sewers shall be designed and constructed to provide mean velocities, when flowing full, of not less than 2 feet per second based on Manning's formula. Oversized sewers will not be approved to justify using flatter slopes. If the proposed slope is less than the minimum slope of the smallest pipe size which can accommodate the design peak hourly flow, the actual depths and velocities at minimum, average, and design maximum day and peak hourly flows for each segment of the sewer must be calculated by the design engineer and included in the design report.

The following are the minimum allowable slopes; however, slopes greater than these are recommended:

<u>PIPE SIZE (INCHES)</u>	<u>MINIMUM SLOPE (FEET PER 100 FEET)</u>
6"	0.60
8"	0.40
10"	0.28
12"	0.22
14"	0.17
15"	0.15
16"	0.14
18"	0.12
21"	0.10
24"	0.08
27"	0.067
30"	0.058
36"	0.046

9. Steep Slope Protection: Where velocities greater than 15 feet per second are attained, special provisions must be made to protect against displacement by erosion or impact. Sewers on 20% slopes or greater must be anchored securely with concrete and anchors spaced as follows:

<u>GRADE</u>	<u>MINIMUM ANCHOR SPACING</u>
20% to 34%	36-ft
35% to 49%	24-ft
50% +	16-ft

10. Manhole Spacing: The maximum distance between manholes shall be as follows:

<u>PIPE SIZE</u>	<u>MAXIMUM DISTANCE</u>
8" to 15"	400'
18" to 30"	500'
Larger than 30"	600'

11. Barrel Size: The alignment and number of pipes into the manhole will determine the barrel size for the size of pipe used. All 48-inch manholes will have eccentric cone top sections if total manhole height is greater than six feet. All other manholes will have flat tops. All drop manholes shall be “inside drop” with a minimum barrel diameter of 60-inch. The internal diameter of the manhole barrel shall be typically as follows:

<u>PIPE SIZE</u>	<u>BARREL SIZE</u>
12" or less	48"
15" to 27"	60"
30" to 48"	72"

Manholes larger than seventy-two (72) inches may be allowed with specific approval by the Public Works Director.

12. Manhole Channels: All manholes shall have full-depth channels. When a smaller main is being connected to a larger main at a manhole, the manhole inverts shall be set so that the 8/10 depth of flow of each main is equal in elevation. The minimum drop across a manhole (invert in to invert out) is 0.2-feet (cut-in manholes are an exception).
13. Sanitary Sewer Mains: The minimum diameter of a sewer main is 8-inches. Main lines shall be sized for ultimate development design flow, not available slope. Oversized sewers will not be approved to justify using flatter slopes; however, nothing shall preclude the City from requiring the installation of a larger sized main if the City determines a larger size is needed to meet the requirements for future servicing. PVC pipe shall be used for all gravity flow main lines unless other materials are specifically approved.
14. Sanitary Sewer Services: The minimum diameter of a service is 4-inches. Services shall connect to the main with in-line gasketed wyes. The service line stub, from the main to the property line or easement line, shall be installed with a maximum slope of 1/2-inch per foot.
- a. The minimum slope of a 4-inch service line stub is 1/4-inch per foot. Upon approval from the Public Works Director, a 4-inch sewer service may be installed at 1/8-inch per foot;
 - b. The minimum slope of a 6-inch service line stub is 1/8-inch per foot;
 - c. Sewer service line stubs will typically be installed 15-feet from the downstream lot line;
 - d. Services are to be installed perpendicular to the main;
 - e. Services must maintain a minimum of 2-feet of separation between adjacent services.

15. Each building shall have a separate service line from the building to the sewer main, with the following exception: Accessory Dwelling Units (ADUs) may share sewer service with the service from the primary dwelling unit on the lot, provided that the service is television inspected at the owner's expense, and the Public Works Director determines that the service is in an acceptable condition for shared use.
16. Access Roads: A 12-foot wide all-weather gravel access road, with turn-arounds if needed, shall be constructed to provide access to all sanitary sewer manholes not located within a paved public or private street or parking lot.
17. Cut-in Manholes: Pre-cast manhole bases are preferred for cut-in manholes. Poured-in-place cut-in manholes may be used if approved by the Public Works Director.

C. LIFT STATION DESIGN CRITERIA

Lift stations must meet the requirements of Montana DEQ Circular 2 and the following additional requirements:

2. Submittals by the design engineer must include:
 - a. Structural plans;
 - b. Mechanical plans;
 - c. Electrical plans;
 - d. Heating and air circulation;
 - e. Design report.
3. A written design report shall be submitted for any development that will create a new sewage lift station or will contribute to an existing sewage lift station. The report shall provide the following information:
 - a. A description of the existing and/or proposed wet well, pumping system, and force main;
 - b. The capacity of the existing and/or proposed lift station service area;
 - c. A map showing the existing and/or proposed lift station service area;
 - d. A list of the existing and proposed users and their average design flows;
 - e. The existing and/or proposed peak design flow and reserve capacity;
 - f. The pump run and cycle times for the existing and/or proposed average and peak design flows;

- g. The hydraulic capacity of the existing and/or proposed force main(s);
 - h. The proposed average and peak design flows to the lift station;
 - i. The reserve capacity of the lift station with the proposed project at full capacity;
 - j. Recommendations for improvements to an existing lift station, if necessary, to enable the lift station to serve the proposed development.
4. COL owned and maintained lift stations shall have a minimum discharge pipe size of 4-inches.
 5. Permanent emergency backup power designed by a licensed electrical engineer will be required for all lift stations.
 - a. Where available, natural gas fuel type preferred;
 - b. Generac manufacturer preferred;
 - c. Shall be installed on a concrete pad per manufacturer recommendations;
 - d. Shall include an appropriately sized transfer switch, manufactured by the same manufacturer as the generator;
 - e. Shall include an O&M manual;
 - f. Manufacturer shall perform initial start-up and training.
 6. An alarm system compatible with the City's Micro-Comm SCADA system must be provided.
 - a. The alarm system shall be capable of detecting power interruptions, phase loss, low water, motor failure, 1st motor on/off, 2nd motor on/off, seal failure, high temperature, high water, and high high water;
 - b. The station should be equipped with a dual backup tip over float system for start and stop commands for dual pump run.
 - c. A security system alarm shall be included and capable of communication with the City's Micro-Comm system. The security system shall include an operator for a building key code.
 7. The lift station must be designed at a minimum as a dual pump system. Pumps shall be submersible manufactured by Flygt.
 - a. Each pump shall have an hour meter, suction pressure gauge tap and valve, discharge pressure gauge tap and valve, and variable frequency drive;

- b. The City may require a triplex system or require the lift station to be designed and built with the ability to add a third pump for large lift stations or specialty lift stations.
8. Bypass: The lift station shall have a dedicated bypass valve connected downstream of the lift station check valves. It shall be provided with a 4-inch cam-lock style connection with cap.
9. One full joint of Class 50, cement lined, ductile iron influent pipe shall be provided. The spigot end must extend 6-inches beyond the interior of the wet well wall.
10. Controls:
 - a. Pump run alternator;
 - b. Uninterrupted Power Supply (UPS) for lighting/surge protection for all power supply and other instrumentation. UPS must provide a minimum of 20 minutes of backup power and should not be hardwired but rather be of the 120 volt plug-in configuration for ease of changing out;
 - c. Primary level control – pressure transducer (submersible KPSI type with standard range of 0-23 feet and 0-10 psi). A wet well level indicator shall be provided on the drywell side or in above-ground controls;
 - d. Backup control – 5 float mercury system shall be installed and function if primary control is lost;
 - e. Transfer switch and control panels shall be located inside the lift station building;
 - f. Above ground controls must be equipped with a heat system to keep all electronics above 32° F.
11. Electrical:
 - a. An hour meter is required on each pump;
 - b. Amperage meters are required on each leg of the electrical wiring;
 - c. Cathodic protection is required for all lift stations having a metal exterior, which are only allowed with Public Works Director approval;
12. Enclosure:
 - a. The foundation shall be constructed of a minimum 4-inch thick monolithic concrete slab and include a treated sole plate anchored to the foundation;
 - b. The roof shall be gable style with trusses spaced at 24-inches maximum, 4:12 slope, 5/8-inch OSB sheathing, 30-year 3-tab shingles, and designed to meet wind and snow loads;

- c. Building walls shall be 8-foot high and constructed with 6-inch wall studs, R-19 insulation, ½-in OSB sheathing, and lap siding with 7-inch reveal or metal siding;
- d. Interior walls shall be T-111 siding;
- e. Interior ceiling shall be insulated with R-49 insulation and covered with 5/8-inch unfinished gypsum board;
- f. 6-foot high chain link security fencing with a 3-foot wide personnel gate and two 6-foot leaves for vehicle access. Gate placement shall promote maintenance vehicle access for pump removal and shall include duckbill style gate holders;
- g. Security fencing shall be installed such as to provide adequate room for access and maintenance, offset a minimum of 5-feet away from the structure and all appurtenances;
- h. 4-inches of clean 1-inch minus gravel or other landscaping rock as approved by the City of Livingston shall be placed around the structure and in all areas outside of public right-of-way;
- i. Other requirements:
 - i. 3068 steel door with deadbolt lock;
 - ii. Motion activated security light;
 - iii. Heating and air circulation system;
 - iv. Ceiling mounted industrial lights in protective cages;
 - v. All other necessary materials for a finished building.

D. STORMWATER COLLECTION & TREATMENT SYSTEM DESIGN CRITERIA

1. **Materials:** RCP (reinforced concrete pipe) or PVC pipe may be used, however PVC pipe may only be used for pipes sized 36-inch diameter and smaller. PVC pipe shall have a minimum stiffness of 46 PSI. Structural strength shall withstand HS-20 design load. If PVC pipe is used, all pipe exposed to sunlight shall be protected with concrete headwalls or prefabricated end sections in accordance with MPWSS Section 02725.
2. **Minimum Sizes:** Stormwater mains shall not be less than 15-inch diameter. Privately owned stormwater infrastructure may be smaller, but shall still be designed in accordance with section D.5 below.
3. **Manhole Spacing and Size:**

<u>Stormwater Pipe Diameter or Vertical Rise</u>	<u>Maximum Manhole Spacing (Ft.)</u>
12" - 36"	400
42" - 60"	500
66" and Larger	750

Stormwater Pipe Diameter	Barrel Size* (Ft.)
15" - 18"	4
20" - 28"	5
30" - 48"	6

* Multiple pipe penetrations may require larger manhole barrels

4. Storm Inlets

- a. Publicly owned storm inlets shall comply with the applicable standard drawing in the COL Modifications to MPWSS. Where inadequate overflow paths are provided, inlets must be oversized 50-percent to accommodate plugging.
- b. The size of outlet pipes from stormwater inlets shall be based upon the design capacity of the inlet, but shall not be less than 12-inches in diameter. The outlet pipes shall connect to the stormwater main with a manhole.
- c. Computations for stormwater design and storm inlet designs shall be submitted with the plans and specifications. Adequate details of inlets, manholes and other appurtenances shall be included in the overall drainage plan submitted for approval.
- d. Combination manhole/inlets may be used where approved as detailed in the City of Livingston Modifications to MPWSS.

5. Hydraulic Design

Stormwater infrastructure shall be designed to convey the 25-year storm event with no surcharging (i.e. pipe full with no head). Inlets and sidewalk chases shall be designed to convey the 25-year storm flow with a maximum water surface elevation of 0.15-feet below the top of curb.

Drainage reports shall include hydraulic grade line calculations including losses from friction and transitions. Approved erosion control shall be designed and installed at all outlets.

6. Alignment

- a. Manholes are required wherever there is change in size, direction, elevation, grade or at stormwater main junctions.
- b. The minimum vertical clearance between a potable water main and a stormwater main is 1.5-feet. The minimum horizontal clearance between a potable water main and a stormwater main is 10-feet.
- c. Horizontal alignment between manholes shall be straight.

7. Culverts

- a. A culvert is considered to be any structure which connects two open channels. The culvert is to be designed to convey the 25-year frequency flow of the tributary drainage basin. The headwater depth will be limited by upstream conditions, but in no case shall exceed 1.5 times the culvert diameter. Excessive ponding above culvert entrances will not be acceptable if damage appears likely to surrounding property or to the roadway.
- b. Culverts shall be designed with an emergency overflow path. The emergency overflow capacity shall be 100-percent of the whole culvert for the major storm for culverts with area less than twenty square feet and for culverts with area greater than or equal twenty square feet, the overflow capacity shall be 100-percent of the capacity provided by the first twenty square feet plus 20-percent of the capacity provided for the additional area as established by the formula:

$$\% \text{ overflow} = (110\%) \times \frac{20 + (A - 20) \times 0.20}{A}$$

where "A" is the area of the culvert opening

If the culvert is located in a low point in the road the required overflow capacity can be provided by overtopping the road, as long as this does not result in more than 50-feet of street being flooded. Where the culvert is not in a low point, or where more than 50-feet will be flooded, the overflow capacity shall be provided by either increasing the culvert size, or additional culverts.

8. Culvert Hydraulics

- a. The culvert including inlet and outlet structures shall convey water, sediment and debris at all stages of flow.
- b. End Treatment: Flared end sections or headwalls with wingwalls are required. Inlets are to be designed to minimize head losses. Approved erosion control is to be provided at all culvert outlets and inlets. Trash racks should be used for culverts greater than 100-feet in length.
- c. Slopes: Culvert slopes shall prevent silting, yet avoid excessive velocities. Generally, the minimum culvert slope is 0.50-percent. Minimum barrel velocity is 3-fps and maximum is 12-fps.

- d. Hydraulic Analysis: Inlet and outlet control conditions shall be analyzed. Calculations shall be submitted with the design report.
- e. Minimum Size: Culverts crossing a roadway shall not be smaller than 24-inch equivalent diameter. Driveway approach culverts shall not be smaller than 15-inch equivalent diameter. Culvert length shall be adequate to provide back slopes of 4:1 or less from pipe inverts to finished street section, including existing or future sidewalks. Materials: Culverts shall be RCP unless otherwise approved by the City.
- f. All culverts shall be designed to withstand HS-20 loading in accordance with American Association of State Highway and Transportation Officials (AASHTO) "Standard Specifications for Highway Bridges" and with the pipe manufacturers recommendation.

9. Utility Culverts

Conduits placed in right-of-way to facilitate placement of future gas, electric, communication, or other utility lines shall have the structural strength to withstand HS-20 loading. Conduits shall have a minimum stiffness of 46 PSI. Conduits shall be adequately sized to accommodate all anticipated utility lines.

E. ALIGNMENT, DEPTH, AND EASEMENTS

- 1. General: Water mains, sanitary sewers, and stormwater mains within the proposed development shall be arranged to allow the suitable development of any adjoining un-developed land, and shall be constructed to the boundary lines of the tract being developed, unless prevented by topography or other physical conditions, in which case a variance must be approved by the City of Livingston. The alignment of all water, sanitary sewer, and stormwater mains and services lines shall be arranged so that there is a minimum of 10-feet of horizontal separation between these lines and with any gas lines, power lines, communication lines, utility poles or other above-grade utility structures, and street lights.
- 2. Water Mains:
 - a. Water mains located in public street right-of-way shall be placed 19-feet off the north or west right-of-way lines for streets 35-feet in width or greater (back of curb to back of curb). For streets less than 35-feet in width, water mains shall be placed 5.5-feet west and north of the street centerline. On curvilinear street alignments, water mains will be a minimum of 2-feet from the edge of the concrete gutters at all locations.

- b. A minimum depth of cover of 6 ½-feet below final grade will be maintained over all water mains.
- c. When water mains cross sanitary sewer or stormwater mains, the water line must have an 18-inch minimum vertical separation, with all water pipe joints no closer than 10-feet horizontal from the sewer and/or stormwater pipe centerline, and the crossing will be perpendicular to the sewer/stormwater line. A minimum of 10-feet horizontal separation shall be maintained between any water main and any sewer or stormwater main. The vertical separation may be reduced to a minimum of 6-inches IF either the water, sewer or stormwater main is encased in a watertight carrier pipe which extends 10-feet on both sides of the crossing or the mains must be encased in a minimum of 6-inches of flowable fill for a minimum of 10-feet each side of the crossing.

3. Sanitary Sewer Mains:

- a. Sanitary sewer mains located in public street right-of-way shall be placed along the centerline of the street for streets 35-feet in width or greater (back of curb to back of curb). For streets less than 35-feet in width, sewer mains shall be located 5.5-feet east and south of the street centerline. On curvilinear street alignments, sewer mains will be a minimum of 2-feet from the edge of the concrete gutters at all locations.
- b. Sewer mains shall have a minimum depth of cover of 5-feet below final grade. Sewer mains may be designed to a shallower depth of 4-feet below final grade upon approval from the Public Works Director. All sewer mains and services with less than 5-feet of cover must be adequately insulated.
- c. Where streets are curvilinear, manholes should be located in the center of the street wherever possible, however non-centerline locations that are not in vehicle wheel paths are acceptable if it will reduce the total number of manholes required.

4. Stormwater Mains

- a. Stormwater mains located in public street right-of-way shall typically be located on the opposite side of the street from the water main. Stormwater may be located beneath curb and gutter if combination inlet/manholes are used.
- b. Stormwater mains shall have a minimum depth of cover of 3-feet below final grade, provided that the pipe material shall withstand the

design load. Stormwater shall be placed to maintain a minimum horizontal clearance of 5-feet and a vertical clearance of 6-inches from any sanitary sewer main.

- d. Manholes shall not be located in vehicle wheel paths.

5. Easements:

- a. A "utility easement" granted to the public is required for all public utility mains not located within public street right-of-way. An easement shall be a minimum of 20-feet wide for one utility main. An additional 10-feet is required for each additional main that occupies the easement. Wider easements may be required at the discretion of the City of Livingston for large utility lines. Easements not established by plat will be executed on standard forms available from the City Planner.
- b. At no time will the utility line in question be less than 9-feet from the edge of the easement or less than 10-feet from a parallel utility line. Utility easements will also be required for all meter pits and fire hydrants maintained by the City of Livingston.
- c. No permanent structures shall be placed within a utility easement unless an encroachment permit has been obtained. Trees and other significant landscaping features shall not be placed within 10-feet of any utility main or service lines, including water, sewer, stormwater, gas, electric, and communications utilities.
- d. All easements documents must conform to City of Livingston requirements and must meet the formatting requirements of the Park County Clerk and Recorder's office.

APPENDIX

- A. *City of Livingston Fire Service Line & FDC Standard*
- B. *Backflow Prevention & System Classification*
- C. *Certificate of Inspection for Fire Service Line Installation*
- D. *Contractor's Material & Test Certificate for Underground Piping*
- E. *Certificate of Completion and Acceptance*
- F. *Sample Detention Basin Sizing Problem*
- G. *Pre-Construction Meeting Criteria Checklist*
- H. *Certified Checklist for Testing and Documentation Requirements*
- I. *Random Number Sampling Example*

CITY OF LIVINGSTON
FIRE SERVICE LINE & FDC STANDARD

AUGUST 2022

These guidelines are to be followed when an underground water supply serving an automated fire sprinkler system is to be installed or modified within the City of Livingston. All fire supply lines shall conform to the current edition of the International Fire Code, as adopted by the City of Livingston, and NFPA 24. These guidelines are not intended to replace nor supersede any codes and/or ordinances adopted by the City of Livingston.

General Requirements:

1. The City of Livingston will only accept fire service lines which are 2-inch, 4-inch, 6-inch, or 8-inch in diameter, unless specifically approved by the Public Works Departments.
2. All underground fire service lines shall begin at the point of connection to the underground circulating public water main. A valve shall be provided at the point of connection such that the fire service line can be isolated from the public distribution system.
3. Fire service lines 4-inch in diameter and larger shall be installed, tested, and disinfected by a single Contractor from the point of connection at the City water main (or existing stub) to the first control valve (OS&Y) inside of the building.
4. For all 2-inch fire service lines, a licensed contractor shall install the line from the main up to and including the first control valve (OS&Y) and double check valve inside the building. The Water Department shall tap the main at the owner's expense and inspect the line under pressure before it is backfilled. A curb stop and box shall be installed at a point 8-feet past property line unless otherwise directed by the City's Water Foreman. Installation of the fire service line will not begin until the plans for the project have received City of Livingston approval and a City of Livingston water service application has been completed.
5. When tapping tees are used for the fire service line connection to the main, the Contractor shall install the tapping tee and valve and the City of Livingston shall make the actual tap to the main at the Owner's expense.
6. The fire service line connection to the City water main without the use of a tapping tee will be made by the Contractor installing the appropriately sized tee in the water main. The City will operate all valves for the shutdown of the line to install the tee and must be provided with a minimum of 24 hours advance notice before work is scheduled to begin. The Contractor shall notify all affected water customers of the water shut down a minimum of 24 hours before the work begins. Temporary water service shall be provided to all affected water customers if the shutdown period is anticipated to exceed four hours. The City of Livingston reserves the right to determine the likely extent of the main shut down based on the proposed work and Contractor experience, and require the installation of temporary water services by the Contractor.
7. Fire Service piping shall have a 10-foot minimum separation from all other utilities and placed within a separate trench. Piping within 5-feet of the building may be combined with other utilities for entrance into the building.

8. All fire service lines shall terminate at the top of the spigot no more than 5-feet inside the building and 1-foot above the finished floor.
9. All ductile iron, retaining rods, and other non-corrosive resistant components shall be externally coated for corrosion or externally wrapped.
10. All piping shall be a minimum of Class 200 DR18 or greater. For service lines which are 3-inch and larger, Class 51 ductile iron pipe is required within 10-feet of building foundations.
11. Water supply shall be provided in conformance with the requirements of the respective standards, however, every fire protection system shall be designed with a minimum 5 psi safety factor at 20 psi residual pressure of City water mains.
12. All fire service lines not installed by the City of Livingston Water Department shall be designed, inspected, and certified by a Professional Engineer.
13. All water tests shall be witnessed and inspected by the Design Engineer and witnessed by the Public Works Department.

Fire Department Connections (FDC):

1. A FDC shall be a separate and independent service line from the fire service line to the building.
2. FDCs for automated sprinkler systems and/or standpipe systems for new buildings shall be equipped with a 2-1/2 Siamese connection.
3. The water line serving the FDC must be designed with a drain to prevent stagnant water in the pipe after use.
4. Check valves shall be accessible for a 5-year inspection. If located underground, valves shall be installed within a meter can/valve box.
5. FDC shall be facing and visible from the fire lane, with an alarm horn/strobe mounted on the exterior wall above it. The preferable wall-mounted location for the FDC is right outside the water riser (mechanical) room.
6. FDC will be within 35-feet of a fire hydrant.
7. FDC installed in a "yard" should have a 12-inch by 12-inch concrete pad placed at the base to provide additional stability.
8. The FDC shall be clean and unobstructed with a minimum of 5-foot clearance all-weather path from the fire lane.
9. The FDC shall be installed 36-inches above finished grade.
10. Fire hose threads shall be national standard hose thread.
11. Underground piping shall be designed and constructed as required for all underground fire services using NFPA 24, Standard for Installation of Private Fire Service Mains and Their Appurtenances.
12. Where the FDC is subject to vehicular damage, the connection shall be protected. Protection shall not be closer than 36-inches to the connection and shall not interfere with the connection.

13. The pipe size and arrangement of the FDC should conform to the latest edition of NFPA 13, Standard for the Installation of Sprinkler Systems.

Inspection Requirements:

1. Visual: All underground piping, joints, and thrust blocks must be uncovered and exposed with labeling of the pipe visible from grade. All ductile iron, retaining rods, and other plastic components shall be externally coated for corrosion and poly wrapped.
2. Hydrostatic Test: Visual inspection must be approved prior to hydrostatic testing. The test will be at 200 psi or at 50 psi in excess of the maximum static pressure when the maximum static pressure exceeds 150 psi, for a minimum of 2 hours. Testing to be performed from the gate valve to the top of the spigot. No pressure drop or gain is allowed.
 - a. HDPE pipe testing in warm weather: The test will be performed at 150 psi for a minimum of 2 hours. Contractor must pressure up 30% and allow the pipe to stabilize, then pressure up another 30% and allow it to stabilize, and finally pressure up to the final testing pressure. This method allows the warm HDPE to expand and stabilize in order to conduct the test.
3. Flush: Upon completion of the hydrostatic test, the piping must be flushed. The flushing must be witness by the Design Engineer and the Public Works Department. All piping used to flush must be properly secured or restrained. The flushing must be completed prior to stacking the riser to the overhead piping.

Submittal Requirements:

1. Plans for all fire service lines will be reviewed by the City of Livingston Public Works Department. The review and subsequent approval or denial will be for that portion of the proposed fire service line that starts at the point of connection to the City of Livingston distribution system up to and including the backflow preventer and the flow detection device. The plans will be reviewed by the City of Livingston Public Works Department and Fire Marshall. Upon satisfactory completion of the review process, the plans will be forwarded to the Public Works Director with a recommendation for approval. The Public Works Director will review the plans and either approve or deny the project. ***Installation of the fire service will not begin until the plans have been approved by the City of Livingston and a City of Livingston water service application has been completed.*** For maintenance of the fire service line after City of Livingston's final acceptance, refer to Item 16 of this Standard. The Owner shall be completely responsible for assuring the fire service line is properly/adequately sized to provide the flows necessary for the fire protection system being serviced by the proposed fire service line.
2. Plans for all proposed fire service lines shall be drawn to scale on 24" x 36" plan sheet(s) and shall include all essential details such as:
 - a. Size and location of all water supplies.
 - b. Size and location of all piping indicating, where possible, the class, type and depth of existing pipe, the class and type of new pipe to be installed, and the depth to which it will be buried. For proposed fire service liens 4" in diameter and larger the plans

must include a profile drawing of the proposed fire service line from the point of connection at the existing main up to and including the system riser. The profile drawing must show the finished grade, depth of cover for the line, and if applicable, all other utilities which the fire service line will cross or be adjacent to.

- c. Size, type, and location of valves.
 - d. Classification of the system (See Attachment A).
 - e. Sprinkler and standpipe riser to be supplied by the system.
 - f. Location of fire department connections.
 - g. Size of orifice necessary to achieve the flushing flows required under NFPA 24.
3. Material and installation of fire service lines shall comply with the following standards:
- a. **Montana Public Works Standard Specifications, latest edition.**
 - b. **City of Livingston Modifications to the Montana Public Works Standard Specifications, latest edition.**
 - c. **City of Livingston Fire Service Line Standard.**
 - d. **NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances, (latest edition).**
4. The City of Livingston's requirements for the installation of double check valve assemblies and reduced pressure backflow prevention assemblies are as follows:
- a. The first fitting inside of the building shall be a UL listed flanged American Flow Control, Kennedy or Mueller OS&Y valve the same size as the fire service line, for lines 4" and larger. For lines 2" and smaller, the first fitting inside the building shall be a NIBCO T-104-0 OS&Y valve.
 - b. All double check valve assemblies and reduced pressure backflow prevention assemblies shall be:
 1. UL or FM listed
 2. Approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCCHR) for operation in the proposed position (vertical or horizontal) as shown on the approved plans.
 3. Installed as shown on the approved plans.
 - c. A flow detection device shall be installed immediately following the double check valve assembly or the reduced pressure backflow prevention assembly (alarm check valve, flow/sensor alarm, meter, etc.) as shown on the approved plans.
 - d. A double detector check valve assembly may be used with a standard City of Livingston meter (for Class I, II and III systems only). The meter loop of the double detector check valve shall have a double check valve assembly installed which

- meets the same installation criteria specified above in requirement b.
- e. Horizontal installations must be a minimum of 2 feet clear above the finished floor.
 - f. The fire service riser must be a minimum of 2 feet clear from any outside wall.
 - g. The incoming fire service line shall be a minimum of 6.5 feet and a maximum of 7.5 feet below the finished grade.
 - h. All fire service lines appurtenances shall have a minimum pressure rating of 175 psi.
 - i. All fire service lines 3-inches and larger shall be Class 51 ductile iron pipe within 10-feet of building foundations.
 - j. Line Sizing: The double check valve assembly or reduced pressure backflow prevention assembly shall be equal in size to the outgoing pipe diameter (downstream).

Additional Requirements:

1. Prior to the City of Livingston's initial acceptance of the new fire service line (4" in diameter and larger) the line must be disinfected in accordance with Montana Public Works Standards and Specifications, and City of Livingston requirements. Flushing and pressure testing of the line shall be done in accordance with NFPA 24. Two (2) copies of the bacteriological tests results are to be submitted to the Public Works Department.
2. Prior to the City of Livingston's initial acceptance of the new fire service line the "Contractor's Material and Test Certificate for Underground Piping" (See Appendix) must be completed and two (2) copies submitted to the Public Works Department.
3. Prior to the City of Livingston's initial acceptance and activation of the fire service line (i.e., putting the line into service) a final inspection will be conducted by the City of Livingston Water Superintendent, or his designated representative, to confirm that the installation is in accordance with the approved application and the approved plans. A Certificate of Inspection (see Appendix) will be completed by the Public Works Department, or designated representative, upon completion of the final inspection, with copies of the Owner, Contractor, and Public Works Department. Installations that are in conformance with the approved plans for the project and have passed all required tests will be initially accepted by the City of Livingston as noted on the Certificate of Inspection. Installations that are not in conformance with the approved plans for the project will not be initially accepted by the City of Livingston and the line will not be activated (i.e., placed in service) until the installation is in conformance with the approved plans and all required tests have been taken and passed.
4. The required two-year warranty period for the fire service line begins on the date of initial acceptance as noted on the Certificate of Inspection completed by the City of Livingston Public Works Department.
5. Upon the City's initial acceptance of the fire service line, the following must be submitted by the Project/Design Engineer to the Public Works Director within thirty (30) days:

- a. Two (2) sets of accurate record drawings and one (1) digital set signed by the Engineer.
 - b. A letter of certification from the project Engineer stating that the fire service line was installed in accordance with the approved plans.
 - c. The City of Livingston's final acceptance of the fire service line will be based on the letter of certification, record drawings, and correction of any deficiencies noted during the two-year warranty period.
6. Following the expiration of the two-year warranty period, the City of Livingston will maintain, at its expense, the fire service line from the main up to the curb stop or curb valve, or to the property line or easement line, whichever is more. Any maintenance or repairs to the fire service line or its appurtenances beyond the point of City of Livingston responsibility specified above shall be by a licensed contractor at the Owner's expense. The building owner shall also be responsible for maintenance, repairs, and testing of all fire service line piping and appurtenances beyond the first control valve (OS&Y) inside the building.
 7. The building owner may operate the first control valve (OS&Y) inside of the building when necessary for maintenance or repairs. When the first control valve (OS&Y) inside of the building is shut off for any reason, the City of Livingston Fire Department must be notified immediately and informed of the shutdown date, time and duration. **The building owner is completely responsible to ensure that this valve remains open at all times (except for maintenance or repairs) for the proper operation of the building's fire protection system.**
 8. Use of the fire service line shall be restricted to firefighting use, emergency use and approved auxiliary (e.g., closed loop heating/cooling systems) including routine testing and flushing. Combined use lines (i.e., domestic and fire) are not acceptable for all buildings except single-family residences (SFRs). Separate service lines must be installed for individual domestic and fire services, except for SFRs. Fire sprinkler systems for SFRs may connect to the domestic supply inside the residence. Such connection must be made downstream of the backflow preventer. The backflow preventer must be a testable backflow preventer approved by the City of Livingston's Backflow Prevention Specialist.

Bonding Requirements.

The Owner shall require the Contractor to furnish a Maintenance Bond in favor of the Owner in an amount equal to one-hundred percent (100%) of the Agreement amount.

The bond shall be signed by a surety company authorized to do business in the State of Montana, and acceptable as a surety to the Owner and countersigned by a Montana Resident Agent.

The bond shall be filed with the Owner and the City of Livingston and shall include a copy of Power of Attorney certified to include the date of the bond.

Insurance Requirements.

The Owner shall require the Contractor to secure and maintain such insurance from and insurance company (or companies) authorized to write insurance in the State of Montana, with a minimum "A.M. Best Rating" of B+, VI, as will protect himself, his subcontractors, the Owner, and the City of Livingston and their respective agents and employees from claims for bodily injury, death, or property damage which may arise from operations and completed operations under the Agreement. The types and limits of coverage shall comply with the current edition of "Montana Public Works Standard Specifications". The Owner shall not authorize, nor shall the Contractor commence work under the Agreement until such insurance has been obtained and certificates of insurance, with binders, or certified copies of the insurance policy, have been filed with the Owner and the City of Livingston.

All insurance coverages shall remain in effect throughout the life of the Agreement, except that the Contractor shall maintain the Commercial General Liability coverage for a period of at least one year following the substantial completion date for property damage resulting from occurrences during the Agreement period.

Each insurance policy shall contain a clause providing that it will not be cancelled by the insurance company without 30 days written notice to the Owner, and the City of Livingston, of intention to cancel.

Warranty Period.

If, within two years after initial acceptance of the work by the City of Livingston, any of the work is found to be defective or not in accordance with the Contract Documents, and upon written notice from the City of Livingston, the Owner shall cause the Contractor to correct any work within seven (7) calendar days of said written notice. Should the Owner or Contractor fail to the written notice within the designated time, the city of Livingston may correct the work at the expense of the Owner/Contractor.

BACKFLOW PREVENTION & SYSTEM CLASSIFICATION

The City of Livingston requires that plans for the proposed fire service line include a description of the system including the “Class” of the system and the backflow prevention to be installed with the system. This Attachment provides standards for determining the Class of the proposed system and the required backflow protection to accompany the specific system. The standards in this Attachment are based on recommendations in American Water Works Association Manual M14, *Recommended Practice for Backflow Prevention and Cross-Connection Control*, and City of Livingston requirements.

Classification for Backflow Protection

Class 1. Direct connections from public water mains only; no pumps, tanks, or reservoirs; no physical connection from other water supplies; no antifreeze or other additives of any kind; all sprinkler drains discharging to atmosphere, dry wells or other safe outlets.

Class 2. Same as Class 1 except that booster pumps may be installed in the building after the first interior control valve (OS&Y).

Class 3. Direct connection from public water supply mains, plus one or more of the following: elevated storage tanks, fire pumps taking suction from aboveground covered reservoir or tanks; and pressure tanks. (All storage facilities are filled or connected to public water only, the water in the tanks is to be maintained in a potable condition. Otherwise, Class 3 systems are the same as Class 1.)

Class 4. Directly supplied from public mains, similar to Class 1 and Class 2, with an auxiliary water supply dedicated to fire department use and available to the premises, such as an auxiliary supply located within 1700 feet of the pumper connection.

Class 5. Directly supplied from public mains and interconnected with auxiliary supplies, such as pumps taking suction from reservoirs exposed to contamination, or rivers and ponds; driven wells; mills or other industrial water systems; or where antifreeze or other additives are used.

Class 6. Combined industrial and fire protection systems supplied from the public water mains only, with or without gravity storage or pump suction tanks.

Required Protection

All systems regardless of Class require a means of flow detection which must be approved by the City of Livingston.

Class 1. Minimum backflow protection requirement for a Class 1 system is an approved testable double check valve assembly to prevent water from back flowing into the public potable water system. The double check valve assembly should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to City of Livingston Standard Drawing 02660-13 for specific

requirements.)

Exception: Special conditions may exist on the site of Class 1 fire systems such that actual or potential contamination hazards are presented to the domestic water supply. Under these conditions an approved reduced pressure backflow prevention assembly, or an appropriately sized air gap, may be warranted and/or required by the City of Livingston.

Class 2. Minimum backflow protection requirement for a Class 2 system is an approved testable double check valve assembly to prevent water from back flowing into the public potable water system. The double check valve assembly should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to City of Livingston Standard Drawing 02660-13 for specific requirements.)

Exception: Special conditions may exist on the site of Class 2 fire systems such that actual or potential contamination hazards are presented to the domestic water supply. Under these conditions an approved reduced pressure backflow prevention assembly, or an appropriately sized air gap, may be warranted and/or required by the City of Livingston.

Class 3. Minimum backflow protection requirement for a Class 3 system is an approved testable double check valve assembly to prevent water from back flowing into the public potable water system. The double check valve assembly should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plan. (Refer to city of Livingston Standard Drawing 02660-13 for specific requirements.)

Exception: Special conditions may exist on the site of Class 3 fire systems such that actual or potential contamination hazards are presented to the domestic water supply. Under these conditions an approved reduced pressure backflow prevention assembly, or an appropriately sized air gap, may be warranted and/or required by the City of Livingston.

Class 4. The type of backflow protection for Class 4 systems will depend on the quality of the auxiliary supply. The type of backflow protection will be one of the following approved by the City of Livingston: air gap or reduced-pressure backflow-prevention assembly. Reduced-pressure backflow-prevention assemblies should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to city of Livingston Standard Drawing 02660-14 for specific requirements.)

Class 5. The type of backflow protection for Class 5 systems will be either a reduced-pressure backflow-prevention assembly or an air gap. Reduced-pressure backflow-prevention assemblies should be the same size as the fire service line to the building and installed immediately following the first interior OS&Y control valve as shown on the approved plans. (Refer to City of Livingston Standard Drawing 02660-14 for specific requirements.)

Class 6. Class 6 system protection would depend on the requirements of both industry and fire protection and could only be determined by a survey of the premises.

CERTIFICATE OF INSPECTION FOR FIRE SERVICE LINE INSTALLATION

DATE	TIME	BUILDING ADDRESS
CITY OF LIVINGSTON WATER DEPARTMENT INSPECTOR		
THIS IS THE <input type="checkbox"/> 1 ST <input type="checkbox"/> 2 ND <input type="checkbox"/> 3 RD INSPECTION FOR THIS INSTALLATION		
FIRE SERVICE LINE INSTALLED FOR:	OWNER OF BUILDING:	
	OWNER'S ADDRESS:	
	OWNER'S PHONE:	
	BUILDING NAME:	
	BUILDING PHONE:	
FIRE SERVICE INSTALLED BY:	NAME OF CONTRACTOR:	
	CONTRACTOR'S ADDRESS:	
	CONTRACTOR'S PHONE:	
	CONTACT PERSON:	
THE FOLLOWING WERE PRESENT DURING THE INSPECTION:		

The fire service line is installed in accordance with City of Livingston requirements for the project:

YES NO

Bacteriological tests have been completed and passed:

YES NO

The "Contractor's Material & Test Certificate for Underground Piping" has been completed and submitted to the City Public Works Director (i.e. pressure tests have been conducted and have passed):

YES
 NO

If the answer to ALL of the above is "YES" then the City of Livingston initially accepts the fire service line and the two year warranty period begins on the date of this inspection.

The fire service line was activated (placed into service) during this inspection:

YES NO

(If "NO", indicate the reason and the date it is to be activated in the comments section below)

The first interior valve (OS&Y) was left in the OPEN CLOSED position at the completion of the inspection.

OWNER NOTE: When the first control valve (OS&Y) inside of the building is shut off for ANY reason, the City of Livingston Fire Department must be notified immediately and informed of the shut down date, time, and duration.

Comments:

Cc: Owner
 Contractor
 Public Works Director

CONTRACTORS' MATERIALS & TEST CERTIFICATE FOR UNDERGROUND PIPING

PROCEDURE

Upon completion of work, inspection and test shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

PROPERTY NAME		DATE	
PROPERTY ADDRESS			
PLANS	ACCEPTED BY APPROVING AUTHORITIES (NAMES)		
	ADDRESS		
	INSTALLATION CONFORMS TO ACCEPTED PLANS		<input type="checkbox"/> YES <input type="checkbox"/> NO
	EQUIPMENT USED IS APPROVED		<input type="checkbox"/> YES <input type="checkbox"/> NO
IF NO, STATE DEVIATIONS			
INSTRUCTIONS	HAS PERSON IN CHARGE OF FIRE EQUIPMENT BEEN INSTRUCTED AS TO LOCATION OF CONTROL VALVES AND CARE AND MAINTENANCE OF THIS NEW EQUIPMENT? <input type="checkbox"/> YES <input type="checkbox"/> NO		
	IF NO, EXPLAIN		
LOCATION	SUPPLIES BUILDINGS		
	PIPE TYPES AND CLASS	_____	TYPE JOINT _____
PIPES AND JOINTS	PIPE CONFORMS TO	_____	STANDARD <input type="checkbox"/> YES <input type="checkbox"/> NO
	FITTINGS CONFORM TO	_____	STANDARD <input type="checkbox"/> YES <input type="checkbox"/> NO
	IF NO, EXPLAIN		
	BURIED JOINTS NEEDING ANCHORAGE CLAPPED, STRAPPED, OR BLOCKED IN ACCORDANCE WITH	_____	STANDARD <input type="checkbox"/> YES <input type="checkbox"/> NO
	IF NO, EXPLAIN		
TEST DESCRIPTION	<p>FLUSHING: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flow not less than 390 GPM (1476 L/min) for 4-inch pipe, 610 GPM (2309 L/min) for 5-inch pipe, 880 (GPM 3331 L/min) for 12-inch pipe. When supply cannot produce stipulated flow rate, obtain maximum available.</p> <p>HYDROSTATIC: Hydrostatic tests shall be made at not less than 200 psi (13.8 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.3 bars) for two hours.</p> <p>LEAKAGE: New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qts. per hr. (1.89 L/h) per 100 joints, irrespective of pipe diameter. The amount of allowable leakage specified above may be increased by 1 fl oz. per in. valve diameter per hr. (30 mL/25 mm/h) for each metal-seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open, so the hydrants are under pressure, an additional 5 oz. per minute (150 mL/min) leakage is permitted for each hydrant.</p>		
FLUSHING TESTS	NEW PIPING FLUSHED ACCORDING TO _____ STANDARD BY _____ (company) <input type="checkbox"/> YES <input type="checkbox"/> NO		
	IF NO, EXPLAIN		
	HOW FLUSHING FLOW WAS OBTAINED: <input type="checkbox"/> PUBLIC WATER <input type="checkbox"/> TANK OR RESERVOIR <input type="checkbox"/> FIRE PUMP	THROUGH WHAT TYPE OPENING: <input type="checkbox"/> HYDRANT BUTT <input type="checkbox"/> OPEN PIPE	
	LEAD-INS FLUSHED ACCORDING TO _____ STANDARD <input type="checkbox"/> YES <input type="checkbox"/> NO		
	HOW FLUSHING FLOW WAS OBTAINED: <input type="checkbox"/> PUBLIC WATER <input type="checkbox"/> TANK OR RESERVOIR <input type="checkbox"/> FIRE PUMP	THROUGH WHAT TYPE OPENING: <input type="checkbox"/> Y CONNECTION TO FLANGE & SPIGOT <input type="checkbox"/> OPEN PIPE	

HYDROSTATIC TEST	ALL NEW PIPING HYDROSTATICALLY TESTED AT _____ PSI FOR _____ HOURS			BURIED JOINT COVERED <input type="checkbox"/> YES <input type="checkbox"/> NO
	LEAKAGE TEST TOTAL AMOUNT OF LEAKAGE MEASURE NO LEAKAGE ALLOWED FOR VISIBLE JOINTS _____ GALS. _____ HOURS ALLOWABLE LEAKAGE (BURIED) NO LEAKAGE ALLOWED FOR VISIBLE JOINTS _____ GALS. _____ HOURS			
HYDRANTS	NUMBER INSTALLED	TYPE AND MAKE		ALL OPERATED SATISFACTORILY <input type="checkbox"/> YES <input type="checkbox"/> NO
	CONTROL VALVES WATER CONTROL VALVES LEFT WIDE OPEN <input type="checkbox"/> YES <input type="checkbox"/> NO IF NO, STATE REASON _____ HOSE THREADS OF FIRE DEPARTMENT CONNECTION AND HYDRANTS INTERCHANGEABLE WITH THOSE OF FIRE DEPARTMENT ANSWERING ALARM <input type="checkbox"/> YES <input type="checkbox"/> NO			
REMARKS	DATE LEFT IN SERVICE _____			
	ADDITIONAL COMMENTS _____			
SIGNATURES	NAME OF INSTALLING CONTRACTOR _____			
	TESTS WITNESSED BY			
	FOR PROPERTY OWNER (SIGNED)	TITLE	DATE	
	FOR INSTALLING CONTRACTOR (SIGNED)	TITLE	DATE	
ADDITIONAL EXPLANATION AND NOTES				

CERTIFICATE OF COMPLETION & ACCEPTANCE

PROJECT OWNER: _____
PROJECT TITLE: _____
PROJECT NUMBER: _____
DATE OF ACCEPTANCE: _____
PROJECT LOCATION: _____
CONTRACTOR: _____
ENGINEER: _____
SUBSTANTIAL COMPLETION DATE: _____
TWO-YEAR WARRANTY EXPIRATION DATE: _____

The Work performed under the Contract for the above Project has been inspected by a representative of the Owner, Contractor, Engineer, and City of Livingston and has been found to substantially comply with the approved Contract Documents and is hereby declared complete. Acceptance by the Owner and City of Livingston and recommendation thereto by the Engineer does not affect the “Contractor’s Continuing Obligation” as described in Article 14.15 of the Standard General Conditions of the Construction Contract, or the Owner’s contractual obligations.

Maintenance Bond with the City of Livingston named as dual obligee is attached.

ENGINEER’S RECOMMENDATION

On the basis of observation of the Work during construction, final inspection, and review of project testing, final application for payment and accompanying documents, the Engineer is satisfied and hereby certifies that the Work has been completed in accordance with the approved Contract Documents. This acceptance shall not relieve the Contractor of its obligations under the Contract Documents.

Engineer

By: _____
Printed Name: _____
P.E. #: _____
Date: _____

CONTRACTOR’S CONCURRENCE WITH ENGINEER’S RECOMMENDATION

Contractor

By: _____
Printed Name: _____
Title: _____
Date: _____

OWNER’S ACCEPTANCE AND GRANT OF POSSESSION

On the basis of independent observations and inspection and the recommendation of the Engineer, the Owner accepts the Project as complete. This acceptance does not relieve the Contractor of continuing obligations as described above. The Contractor is reminded this Project is under warranty beginning _____ and that bonds shall remain in effect for two years after the Date of Acceptance specified above. The Owner hereby grants possession of all public infrastructure improvements completed by this Project to the City of Livingston and warrants against defects in these improvements for a period of two years from the Date of Acceptance as specified above.

Owner

By: _____
Printed Name: _____
Title: _____
Date: _____

CITY OF LIVINGSTON ACCEPTANCE

The City of Livingston hereby accepts possession of all public infrastructure improvements, subject to the above indicated warranty. This acceptance does not relieve the Owner or Contractor of its continuing obligations for this work as described above or otherwise required through Improvements Agreements, Conditions of Plat Approval, or other contractual commitments.

City of Livingston _____

By: _____
Title: _____
Date: _____

SAMPLE DETENTION BASIN SIZING PROBLEM

(Rational Method)

Given: Existing Land Use:	Agricultural
Proposed Land Use:	Industrial
Drainage Area:	5 Acres
Slope:	1%
Overland Travel Distance to Channel:	120 feet
Channel Time:	4 minutes
Max. Basin Water Depth Allowable:	1 foot

Problem:

Size a detention basin to control runoff to pre-development levels and to remove sediment (40-micron particle).

Solution:

Existing Situation

Land Use:	Agricultural
Area:	5 Acres
C =	0.20 (Table I-1)
Time of Concentration:	16 minutes (Figure I-1) + 4 minutes = 20 minutes
Design Storm Frequency:	10 year (Table I-3) (Based on Future use Design Frequency)
Intensity at T _c :	1.3071 in/hr (Figure I-3)
Peak Runoff Rate:	$(0.20) (1.3071) (5) = 1.31$ cfs

Future Situation

Land Use:	Industrial
Area:	5 Acres
C =	0.80 (Table I-1)
Time of Concentration:	6 minutes (Figure I-1) + 4 minutes = 10 minutes
Design Storm Frequency:	10 year (Table I-3)

Detention Basin Sizing

Design Release Rate:	1.31 cfs
----------------------	----------

MINIMUM VOLUME

Storm Duration (Minutes)	Intensity (in/hr)	Future Runoff Rate (Q = CiA) (cfs)	Runoff Volume (cf)	Release Volume (cf)	Required Storage (cf)
25	1.1306	4.52	6780	1965	4815
27	1.0755	4.30	6966	2122	4844
29	1.0266	4.11	7175	2279	4872
31	0.9831	3.93	7310	2437	4873
33	0.9439	3.78	7484	2594	4890*
35	0.9085	3.63	7623	2751	4872

* Minimum Volume Required – 4890 cf

- Note: 1. If controlling volume falls at a storm duration less than the future time of concentration, use the volume at the time of concentration.
 2. Based on Minimum Volume and using 1-foot depth, Surface Area = 4890 sf.

MINIMUM AREA

Assumptions:

1. Non-flocculant particles.
2. Settling velocity of 40-micron particles = 0.0069 ft/sec.

Design Release Rate: 1.31 cfs

Minimum Area Required: $1.31 \text{ cfs} \div 0.0069 \text{ ft/sec} = 190 \text{ sf}$

(Since 4890 > 190 sf, use 4890 sf)

BASIN SIZING

Water Depth: 1 foot
 Surface Area: 4890 sf
 Volume: 4890 cf
 Length: 123 ft.
 Width: 40 ft.

PRECONSTRUCTION MEETING CRITERIA CHECKLIST

Project Name: _____

Project Type: _____
(water, sanitary sewer, storm sewer, streets)

Owner/Developer: _____

Engineer: _____

Contractor: _____

SUBMITTALS CHECKLIST

REQUIRED SUBMITTAL	REQUIRED?	DATE RECEIVED	COMMENTS
Approved Plans & Specifications	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Executed Easements	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Abandoned Easements	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Shop/Fabrication Drawings ¹	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Traffic Control Plan ²	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Electronic Plans on CD ³	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Copy of Contractor's Bonds	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Copy of Contractor's License	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Dewatering Discharge Permit (MPDES/MGWPCS)*	<input type="checkbox"/> YES <input type="checkbox"/> NO		
310 Permit (SCS/FWP)*	<input type="checkbox"/> YES <input type="checkbox"/> NO		
404 Permit (Corps)*	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Stormwater Control Permit*	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Street Cut Permit (COL)*	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Utility Occupancy Permit*	<input type="checkbox"/> YES <input type="checkbox"/> NO		

¹ Due 2 days prior to preconstruction meeting; shop/fabrication drawings shall bear Engineer's approval when submitted.

² Due 1 week prior to preconstruction meeting

³ Due 2 days prior to preconstruction meeting

* To be determined by design engineer

PRECONSTRUCTION MEETING DATE: _____

(Will not be scheduled until ALL above applicable submittals are received)

**CERTIFIED CHECKLIST FOR TESTING & DOCUMENTATION REQUIREMENTS
FOR INFRASTRUCTURE IMPROVEMENTS**

All sections of the certified checklist must be completed. The answer “YES” may be checked when all the requirements of the section being addressed are satisfied. Where a “YES” answer cannot be given, a deviation must be requested or the applicant must explain why that section of the testing and documentation requirements is not applicable. All deviation requests must be justified by the design engineer and supported with appropriate documentation. All infrastructure certified checklists must be signed and stamped by the design Professional Engineer licensed in the state of Montana.

A.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
B.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
C.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
D.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
E.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
F.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
G.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
H.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
I.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
J.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:
K.	<input type="checkbox"/> YES	<input type="checkbox"/> Deviation Requested:
	<input type="checkbox"/> NA	Explanation:

Certified By: _____
(Signature of Professional Engineer)

Date: _____

Montana P.E. Number: _____

SAMPLING MATERIALS BY RANDOM NUMBER SAMPLING

1. SCOPE - This method provides a procedure, in the form of several examples, for selecting samples on an approximately random basis using a system of random numbers. To accomplish this selection, choose the random sample so that each unit of material (i.e., cubic yard, square yard, ton, etc.) has the same probability of being selected. Divide each material sampled into lots, and establish a frequency of sampling.
2. PROCEDURE -
 - 2.1. Random numbers can be generated by some calculators by planting a seed number such as date, time of day, etc., expressed as a decimal between 0 and 1. Included in this method are two tables of random numbers for use. Enter the table in a random method, such as a blind placement of a pencil. After choosing the first random number in this manner, choose consecutive numbers, following a column (or row), until the entire table has been used. At that time, repeat the initial process of random entry into the table of numbers. This method will reduce the possibility of using a value from the table more than once.
 - 2.2. Following are examples related to particular phases of highway construction:
 - 2.2.1. EXAMPLE NO. 1

In this example, select station numbers for density coring of a 0.75-in. nominal-maximum mixture. Specifications require four density cores for each 1 000 tons of mixture placed. The subplot size is 1000 tons with a frequency of four cores per subplot. The subplot of mixture in question will be placed on a 12-ft.-wide lane that is 4545 ft. long. The lift thickness of the 0.75-in. nominal-maximum mixture is 3.0 in. The job starts at Station No. 0+00.

Since four density cores are required for the entire 4545-ft. length, obtain one core for each 1136.25 ft. of pavement. Use the following steps to determine the station number and offset for each density core:

- 2.2.1.1. Refer to the random number table (see p. 5 for example).
- 2.2.1.2. Enter the table at any point. Select four consecutive numbers from the random number table. Use these numbers for finding the station number of the core site in each 1136.25-ft. section.

Multiply each random number by 1136.25 to determine the station number at which to obtain the density core. After determining the

location of the first core, for each of the remaining cores, add increments of 1136.25 ft., increasing with each core, to provide locations throughout the entire subplot length.

SAMPLE NO.	RANDOM NUMBER CALCULATION	STATION NUMBER
1	$0.420 \times 1136.25 = 477.23 + 0.00 = 477$	4 + 77
2	$0.859 \times 1136.25 = 976.04 + 1136.25^* = 2112$	21 + 12
3	$0.011 \times 1136.25 = 12.50 + 2272.50 = 2285$	22 + 85
4	$0.762 \times 1136.25 = 865.82 + 3408.75 = 4275$	42 + 75

*1136.25-ft. increments, as determined by the subplot length, provide resultant numbers throughout the entire subplot length.

According to Subsection 402.03.02 of the *Standard Specifications*, obtain cores no closer than three inches from the pavement edge or joint. To select the transverse distance from the pavement edge (left or right), select four additional consecutive numbers from the random number table (see p. 5 for example), and multiply each random number by 11.5 (12-ft. lane width minus the 0.25-ft. offset from each side). For this example, calculate the distance from 0.25 ft. inside of the right edge of the pavement.

SAMPLE NO.	RANDOM NO. CALCULATION	OFFSET FROM RIGHT EDGE
1	$0.062 \times 11.5 + 0.25 =$	1.0 ft.
2	$0.100 \times 11.5 + 0.25 =$	1.4 ft.
3	$0.409 \times 11.5 + 0.25 =$	5.0 ft.
4	$0.784 \times 11.5 + 0.25 =$	9.3 ft.

Therefore, from the calculations above, conform to the coring schedule given below for this subplot:

SAMPLE NO.	STATION NUMBER	OFFSET FROM RIGHT EDGE
1	4 + 77	1.0 ft.
2	21 + 12	1.4 ft.
3	22 + 85	5.0 ft.
4	42 + 75	9.3 ft.

With respect to this example, in other cases, the paving length and width will vary, but use the same procedure for obtaining random locations.

2.2.2. EXAMPLE NO. 2

In this example, select trucks to sample for running air content, slump, and concrete cylinders on Class AA Concrete for a bridge deck pour.

The pour will consist of 250 cubic yards of concrete. The trucks will be hauling 10 cubic yards each. The testing frequency is one test for each 50 cubic yards; therefore, perform five tests. There will be at least five tests required. Use the following steps to select the trucks to sample:

2.2.2.1. Refer to the random number table (see p. 5 for example).

2.2.2.2. Select five consecutive numbers from the random number table. Use these numbers to determine which trucks to sample. Multiply each number by 50 (a lot size of 50 cubic yards), and divide the answer by 10 (cubic yards per truck) to determine which trucks to sample.

SAMPLE NUMBER	RANDOM NUMBER	CALCULATED VOLUME (cubic yards)	TRUCK SAMPLED
1	0.007	$x 50 = 0.35 + 0 = 0.35 \div 10 = 0.04^*$	1st
2	0.922	$x 50 = 46.1 + 50^{**} = 96.1 \div 10 = 9.6$	10th
3	0.729	$x 50 = 36.5 + 100 = 136.5 \div 10 = 13.7$	14th
4	0.949	$x 50 = 47.5 + 150 = 197.5 \div 10 = 19.8$	20th
5	0.606	$x 50 = 30.3 + 200 = 230.3 \div 10 = 23.03$	24th

*When this answer contains a decimal, always round upward to the next highest whole number to determine the truck number.

**Add increments of 50 cubic yards (lot size), increasing with each sample, in order to provide sampling throughout the full 250 cubic yards.

2.2.3. EXAMPLE NO. 3

In this example, select the accumulated tonnage of Crushed Stone Base for gradation testing. The frequency for gradation testing of aggregate bases is one test per 2000 tons of material. Plan quantities show 10,000 tons of Crushed Stone Base exist on this project. This quantity will require five gradation tests.

Again, select five consecutive random numbers from the random number table (see p. 5 for example). Use these numbers to determine the accumulated tonnage at which to select the sample.

Multiply each number by 2000 to determine the accumulated tonnage for sampling. Add increments of 2000 tons (lot size), increasing with each sample, in order to provide sampling throughout the full 10,000 tons.

SAMPLE NUMBER	RANDOM NUMBER CALCULATION	ACCUMULATED TONNAGE
1	$0.658 \times 2000 = 1316 + 0 =$	1316
2	$0.747 \times 2000 = 1494 + 2000 =$	3494
3	$0.270 \times 2000 = 540 + 4000 =$	4540
4	$0.715 \times 2000 = 1430 + 6000 =$	7430
5	$0.418 \times 2000 = 836 + 8000 =$	8836

Obtain samples as near the above-listed accumulated tonnages as possible.

- 2.3. The system of selecting random samples can be related to periods of time, number of pieces, tons, etc. The key to randomness, using this method, relies heavily on the manner of entering the table. Do not use the same set of numbers repeatedly.

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TABLE 1
RANDOM NUMBERS

.600	.504	.248	.230	.996	.462	.422	.054	.224	.121
.116	.227	.802	.349	.241	.956	.079	.632	.126	.677
.098	.726	.507	.607	.963	.410	.572	.777	.237	.851
.147	.867	.802	.416	.370	.377	.775	.256	.348	.148
.644	.067	.001	.158	.702	.148	.667	.217	.421	.149
.310	.531	.520	.560	.888	<i>E.287</i>	.567	.251	.593	.571
.493	.235	.886	.178	.490	<i>X.007</i>	.640	.343	.894	.079
.788	.272	.484	.487	.277	<i>A.922</i>	.435	.716	.924	.304
.652	.523	.317	.601	.705	<i>M.729</i>	.669	.435	.984	.239
.816	.045	.423	.943	.227	<i>#.949</i>	.395	.931	.887	.242
.086	.585	.177	.851	.513	<i>2.606</i>	.911	.253	.669	.328
.689	.755	.027	.183	.024	<i>E.658</i>	.041	.512	.518	.910
.117	.029	.309	.017	.926	<i>X.747</i>	.584	.570	.212	.504
.700	.989	.980	.532	<i>E.640</i>	<i>A.270</i>	.610	.257	.996	.978
.321	.431	.370	.814	<i>X.420</i>	<i>M.715</i>	.548	.148	.953	.450
.515	.775	.759	.438	<i>A.859</i>	<i>#.418</i>	.689	.924	.350	.724
.543	.575	.633	.097	<i>M.011</i>	<i>3.170</i>	.357	.429	.899	.087
.629	.502	.503	.036	<i>#.762</i>	.280	.605	.518	.275	.017
.221	.882	.206	.415	<i>1.776</i>	.548	.520	.417	.253	.808
.751	.446	.189	.776	.465	.936	.970	.467	.371	.077
.553	.160	.464	.309	.298	.304	.613	.512	.816	.270
.384	.778	.284	.435	.246	.319	.078	.695	.152	.637
.969	.740	.102	.093	.055	.155	.225	.782	.226	.250
.085	.125	.750	.900	.991	.887	.993	.183	.096	.542
.667	.355	.784	.803	<i>E.072</i>	.206	.508	.385	.691	.127
.076	.968	.527	.749	<i>X.062</i>	.075	.526	.292	.176	.310
.788	.943	.091	.141	<i>A.100</i>	.040	.750	.870	.249	.345
.165	.422	.601	.095	<i>M.409</i>	.897	.963	.271	.770	.100
.472	.201	.558	.725	<i>#.784</i>	.025	.943	.040	.984	.011
.668	.708	.776	.490	<i>1.270</i>	.868	.658	.954	.916	.955

TABLE 1
RANDOM NUMBERS

.600	.504	.248	.230	.996	.462	.422	.054	.224	.121
.116	.227	.802	.349	.241	.956	.079	.632	.126	.677
.098	.726	.507	.607	.963	.410	.572	.777	.237	.851
.147	.867	.802	.416	.370	.377	.775	.256	.348	.148
.644	.067	.001	.158	.702	.148	.667	.217	.421	.149
.310	.531	.520	.560	.888	.287	.567	.251	.593	.571
.493	.235	.886	.178	.490	.007	.640	.343	.894	.079
.788	.272	.484	.487	.277	.922	.435	.716	.924	.304
.652	.523	.317	.601	.705	.729	.669	.435	.984	.239
.816	.045	.423	.943	.227	.949	.395	.931	.887	.242
.086	.585	.177	.851	.513	.606	.911	.253	.669	.328
.689	.755	.027	.183	.024	.658	.041	.512	.518	.910
.117	.029	.309	.017	.926	.747	.584	.570	.212	.504
.700	.989	.980	.532	.640	.270	.610	.257	.996	.978
.321	.431	.370	.814	.420	.715	.548	.148	.953	.450
.515	.775	.759	.438	.859	.418	.689	.924	.350	.724
.543	.575	.633	.097	.011	.170	.357	.429	.899	.087
.629	.502	.503	.036	.762	.280	.605	.518	.275	.017
.221	.882	.206	.415	.776	.548	.520	.417	.253	.808
.751	.446	.189	.776	.465	.936	.970	.467	.371	.077
.553	.160	.464	.309	.298	.304	.613	.512	.816	.270
.384	.778	.284	.435	.246	.319	.078	.695	.152	.637
.969	.740	.102	.093	.055	.155	.225	.782	.226	.250
.085	.125	.750	.900	.991	.887	.993	.183	.096	.542
.667	.355	.784	.803	.072	.206	.508	.385	.691	.127
.076	.968	.527	.749	.062	.075	.526	.292	.176	.310
.788	.943	.091	.141	.100	.040	.750	.870	.249	.345
.165	.422	.601	.095	.409	.897	.963	.271	.770	.100
.472	.201	.558	.725	.784	.025	.943	.040	.984	.011
.668	.708	.776	.490	.270	.868	.658	.954	.916	.955

TABLE 2
RANDOM NUMBERS

.605	.973	.319	.294	.236	.572	.216	.973	.931	.870
.720	.497	.679	.634	.299	.578	.743	.835	.062	.200
.918	.295	.295	.777	.854	.281	.867	.864	.374	.748
.294	.396	.441	.321	.655	.191	.205	.899	.807	.186
.089	.927	.802	.530	.937	.257	.530	.005	.539	.999
.591	.409	.668	.967	.993	.920	.812	.018	.578	.618
.494	.808	.410	.097	.633	.149	.547	.895	.829	.953
.021	.699	.597	.286	.982	.953	.913	.422	.291	.979
.926	.085	.758	.624	.491	.694	.496	.490	.949	.457
.351	.709	.461	.093	.498	.377	.639	.801	.388	.334
.329	.857	.949	.550	.095	.906	.596	.462	.891	.758
.126	.525	.834	.677	.045	.699	.568	.147	.902	.664
.572	.101	.066	.147	.069	.006	.979	.259	.765	.460
.728	.374	.402	.679	.601	.492	.002	.512	.529	.089
.524	.346	.698	.133	.013	.907	.992	.453	.883	.684
.176	.870	.306	.179	.071	.854	.086	.414	.973	.785
.031	.437	.512	.107	.842	.507	.458	.018	.881	.506
.826	.110	.065	.878	.182	.460	.442	.504	.075	.027
.945	.640	.283	.330	.163	.496	.767	.543	.921	.923
.948	.890	.677	.328	.075	.752	.207	.692	.268	.204
.232	.639	.425	.434	.795	.329	.941	.026	.867	.035
.896	.502	.074	.092	.203	.625	.541	.505	.835	.021
.643	.838	.357	.294	.592	.440	.676	.186	.304	.212
.552	.892	.843	.851	.685	.847	.963	.189	.604	.634
.623	.955	.024	.718	.534	.978	.962	.208	.645	.811
.988	.648	.182	.983	.128	.784	.606	.138	.208	.337
.326	.500	.874	.958	.826	.523	.462	.823	.955	.773
.130	.545	.756	.164	.418	.817	.707	.882	.984	.903
.907	.419	.705	.597	.655	.566	.546	.738	.614	.373
.859	.365	.476	.351	.154	.458	.645	.303	.631	.832