# CITY OF LEBANON SPECIFICATIONS FOR STORM WATER DRAINAGE AND RETENTION

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Revision 12-16-93 Part D

STORM WATER DRAINAGE AND DETENTION REQUIREMENTS
FOR PUBLIC IMPROVEMENTS

## A. GENERAL

Storm water runoff and the velocity of discharge are considerably increased through development and growth of the City.

Prior to the development of the land, surface conditions provide a higher percentage of permeability and longer time of concentration. With the construction of buildings, parking lots, etc., permeability and the time of concentration are significantly decreased, resulting in an increase in both the rate and volume of runoff.

## B. STORM WATER COLLECTION DESIGN

Systems shall be designed to protect against flooding of property of all classes, and maintain the required level of service for public facilities. Storm sewer systems shall be designed as a coordinated unit and may include any or all of the following elements:

a. Enclosed storm sewers and appurtenances
b. Open channels
c. Swales on property lines and/or back lot lines

STREETS & ENCLOSED STORM SEWERS-Enclosed storm sewers shall be used to collect and convey drainage on, across, and through public street rights-of-way. Outfall drains shall extend at least 60' feet to the rear of the front building line or 20 feet past the back line of the structure, whichever is greater.

OPEN CHANNELS-Open channels are acceptable only to carry storm water runoff from tributary areas exceeding 100 acres, or from smaller tributary areas otherwise requiring an enclosed storm sewer pipe 48 inches in diameter or larger, except enclosed drainage structures shall be provided where open channels cross public right-of-way.

SIDE DITCHES-Side ditches are generally not acceptable and may be used to convey drainage along public right-of-way only in rural areas when designated by the City. Culverts and appurtenant drainage facilities shall be designed to permit their incorporation into a future enclosed storm sewer system when possible. Side and rear property line ditches shall be by City approval only and shall be designed in accordance with Section 4.0.

1.0 ULTIMATE DEVELOPMENT-Compute the estimated ultimate density and impervious surfaces of the area. Information may be obtained from the City Engineer's office of the Planning and Zoning Department.

1.1 INTENSITY

"I" is intensity of rainfall in inches per hour and shall be determined for the yearly frequency specified in Section 3 and as specified from the intensity duration curves attached to this criteria:

1.1.0 10 year (return period). Residential areas.

1.1.1 25 year (return period). Commercial property, arterial street culverts, and open channel slopes.

1.1.2 50 year (return period). Critical areas, flood plains in commercial areas and natural flood plains in residential area.

2.0 STREET AND PIPE DESIGN CRITERIA.

2.1 VELOCITY-Discharge velocity shall be controlled to prevent both erosion and siltation at and immediately downstream from the point of discharge. Energy dissipating structures shall be used if required.

2.2 INLETS-When calculations indicate that curb capacities are exceeded at a point, no further allowance shall be made for flow beyond that point and basins shall be used to intercept flow at that point. All flow shall be picked up by an inlet, except as noted in Section-Inlets. Paved gutters may be used to intercept flow and drained to an approved outfall on approval of the engineer.

2.3 MAXIMUM DEPTH-Drainage water must not exceed the depth of curb at any intersection.

2.4 COEFFICIENTS OF FRICTION

The coefficients of friction allowed for-the-various kinds of pipe are as follows:

| | |
|---|---|
| Portland Cement Concrete | N=0.013 |
| Corregated Metal | N=0.023 |
| Corregated Metal with Paved Invert | N=0.021 |
| Smooth Flow Corregated Metal | N=0.013 |
| Vitrified Clay-Pipe | N=0.013 |
| Asbestos Cement | N=0.012 |

2.5 PIPE SIZING

MANNING FORMULA-Pipe sizes in integrated underground systems will normally be determined in accordance with the Manning Formula, $\frac{V=1.5}{N}$ r 2/3 s 1/2.

MINIMUM PIPE SIZE-The minimum size storm sewer shall be 12 inches in diameter except under roadways where 15 inches shall be a minimum.

VELOCITY-All storm drainage systems shall be designed so as to maintain a minimum velocity of flow of 3 feet per second and a maximum velocity of 15 feet per second when flowing full.

2.6 LOCATION

Storm drainage lines shall generally be located in the parkway area and shall be placed as shown on the approved submitted plans.

2.7 DEPTH

All storm drainage lines shall have a minimum cover of 1.8 inches where practical. Cover may be decreased to avoid conflicts or on short laters. Special bedding or protection shall be required where cover is decreased below 18 inches.

2.8 INLETS

2.8.1 LOCATION-Provide inlets to maintain a reasonable level of vehicular and pedestrian traffic service.

2.8.2 GENERAL-Contain all flow within street curbs during the following design storms:

2.8.3 ARTERIAL STREETS

A. Limit gutter flow width to prevent encroachment on the center 24 feet of street during runoff occurring at 63 percent of peak design rates of 10-year storms or 55 percent of peak design rates of 25-year storms.

3.0 OPEN CHANNELS

3.1 GENERAL-Open channels shall be sized to carry design rates of flow without significant damage or erosion to the channel. Channels shall be fenced, sloped, or otherwise protected to prevent injury to the public.

3.2 CONNECTIONS-Pipe culverts, box culverts, and other structures entering channels shall not project into the normal waterway area.

3.3 VELOCITY-Channel design shall include lining or treatment of the invert and sides as required to minimize erosion, in accordance with the following table:

| Mean Flow Velocity | Type of Lining |
|---|---|
| 3 F.P.S. & Less | Seeded |
| 3-8 F.P.S. | Sod |
| 8-15 F.P.S. | Riprap or Concrete |
| Overt 15 F.P.S. | Concrete paved |

Lining materials having equivalent erosion control properties to those shown in the foregoing table may be used in lieu thereof.

3.4 CAPACITY-Open channels shall be sized to carry design flow rates with 1.0 foot of freeboard.

3.5 SECTIONS-Channel sections shall be compatible with the type of lining and maintenance practice to be used. Side slopes shall not be steeper than 2 horizontal to 1 vertical. Channels lined with sod, grass, or other vegetative ground cover and having slopes steeper than 3 horizontal to 1 vertical are not readily susceptible to mowing. Friction factors used in design shall consider type of lining.

3.6 NATURAL CHANNELS-Natural channels of adequate capacity and having stable banks and invert may be used without modification.

4.0 SIDE DITCHES-Side and rear property line ditches in residential developments may be used only as follows:

For grass lined ditches:
Maximum velocity - 3 feet per second
Maximum volume - 3 cubic feet per second
Maximum water depth - 6 inches

Enclosed storm sewer requirements may be waived by the City on request.

For ditches with a concrete lined invert:
Maximum velocity - 5 FPS
Maximum water depth- 1 foot

For ditches which are totally concrete lined:
Maximum velocity - 12 feet per second
Maximum water depth - 1 foot

5.0 DESIGN DETAILS

5.1 PLAN-The plan view of all storm sewer details shall indicate the proper location of the storm sewer, appurtenances, size of line, capacity, and other details relating to the storm drainage system. The plan shall show sufficient detail to include exact locations, proper ties into existing permanent reference points, property angles, and distances from other utilities to be placed or presently in the street right-of-way. Easements shall be a minimum of 14 feet for enclosed structures and 20 feet for open paved channels where they cross private property or as designated by the City Engineer.

5.2 PROFILE- The profile of all storm sewers shall show the necessary slope, existing and proposed street grades, locations of angles and appurtenances, and proper elevations for existing outfall ditches. The profile shall indicate the size of line and the capacity of each line as determined by the design engineer. The total area draining to each basin and the Q that will be required to be dissipated at that point shall also be indicated, on either plan or profile.

C. STORM WATER DETENTION PLANS

When required by the City, a complete set of storm water detention plans and calculations shall be provided for new developments which increase storm water runoff, quantity or velocity.

1. METHOD OF EVALUATION-Differential runoff evaluation consists of the determination of the rates of runoff, before and after development, determination of required volume of detention and verification of adequacy of discharge and control structures. The 50 year (frequency) runoff coefficients shall be used. Differential runoff rates shall be evaluated by equation:

$$R = (Cd \times I_{50}) - (Cu \times I_{50})$$

Where:

R= Differential Runoff Rate

Cd=Runoff Coefficient for developed conditions

Cu=Runoff Coefficient for the undeveloped condition shall be 0.20 for the total area to be developed regardless of prior improvement unless paid for previously under this ordinance. Credit will then be given for prior payments.

$I_{50}$ =Intensity of 50 year storm

"C" values shall be determined from the following table:

RUNOFF COEFFICIENTS

| "C" Value | Surface Conditions |
|---|---|
| .10- | Tall grass, brush |
| .20- | Park, golf courses, farms, and one acre single family residences |
| .35- | Single family residences on lots of not less than 15,000 sq. ft. |
| .45- | Single family residences on lots of not less than 10,000 sq. ft. |
| .47- | Single family residences on lots of not less than 7,500 sq. ft. |
| .51 | Single family residences on lots of not less than 6,000 sq. ft. |
| .90 - | Gravel surfaces. |
| .95 - | Asphalt and concrete surfaces. |
| 1.00 - | Buildings and other structures. |

Use the Chart included as Page A-7 to find time of concentration (t) then use Chart included as Page A-6 to determine intensity (I). A 5 minute time of concentration is the minimum permitted.

2. VOLUME OF DETENTION

Total volume of detention shall be computed by the equation:

V=R x A X tc (min.) x 60 (sec./min.) V=Total volume of detention (cu. ft.)
R=Differential Runoff Rate
A=Area of project in acres
tc=Time of concentration as determined for use with differential runoff rates.

NOTE: Sites larger than 20 acres may use alternate formulas upon approval of the City Engineer. Detention for any revised, upgraded, or changed site shall be designed assuming the site was undeveloped.

3. METHOD OF DETENTION

The following conditions and limitations shall be observed in the selection and use of method of detention.

3.1 GENERAL LOCATION. Detention facilities shall be located within the parcel limits of the project under consideration, with the following exceptions:

a. No detention or ponding will be permitted within public road rights-of-way without specific written approval of the City Engineer and State authority, if applicable.

b. Location of detention facilities immediately downstream of the project will be considered by special request if proper documentation is submitted with reference to practicality, feasibility, proof of ownership or right-of-use of the area proposed, and provisions are made for perpetual maintenance.

3.2 DRY RESERVOIRS. Wet weather ponds or dry reservoirs shall be designed with proper safety, stability and ease of maintenance feature and should completely drain soon after the end of the storm.

3.3 OPEN CHANNELS. Normally permitted open channels may be used as detention. No pending will be permitted within public rights-of-way without specific written approval of the City Engineer. Maximum depth of detention in open channels shall be four (4) feet. Minimum flow line grade shall be 0.5 percent.

The entire reservoir area of the open channel shall be seeded, fertilized, and mulched, sodded or paved.

The hydraulic elevations resulting from channel detention shall not effect adversely adjoining properties.

3.4 PERMANENT LAKES. Permanent lakes with fluctuating volume controls may be used as detention areas.

Maximum fluctuation from permanent pool elevation to maximum ponding elevation shall be three (3) feet.

Special consideration is suggested to safety and limiting accessibility of small children in design of permanent lakes in residential area.

The entire fluctuating area of the permanent reservoir shall be seeded, and fertilized and mulched, or sodded or concrete paved. Any area susceptible to or designed as overflow shall be paved with concrete.

3.5 PARKING LOTS. Detention will not be permitted in primary parking lots. A primary parking lot will be considered to be the most accessible 80 percent of total parking for a facility.

In non-primary parking lots, detention will be permitted to a maximum depth of twelve (12) inches and designed to self drain soon after the storm.

When detention is being affected on parking lots by means of retaining wails or curbs, these retaining walls and curbs must be constructed of reinforced concrete.

OTHER METHODS. Other methods of detention such as seepage pits, french drains, etc., will not be approved.

## 4. VERIFICATION OF ADEQUACY

Analysis of all elements of design is always performed by the Engineer. The following outline is provided to ascertain that certain critical elements of design are in workable compliance to the aims of design

1. Volume of detention for the total project
2. Tributary (Q) peak runoff to basin
3. Sizing of detention dikes
4. Stability of detention dikes
5. Safety Features
6. Maintenance features

Runoff calculations shall be submitted in legible tabulated form. Proof of adequacy of the volume of detention and sizing computation for low-flow structure shall also be submitted. Features of stability and safety will also need to be documented if the scope of the project requires special attention in the area of design.

Spot elevations shall be included in sufficient detail on the site plan so that the final direction of water flow can be determined, and so that the volume of detention can be ascertained.

5. CONTROL STRUCTURES

Detention facilities shall be provided with obvious and effective outlet control structures. These outlet structures may include v-notch weirs or rectangular weirs, as well as pipe. Plan view and sections of the structure with adequate detail shall be included in plans.

The design-discharge (Q) for the low-flow outlet shall not exceed the existing runoff for the 1 year storm. The maximum discharge shall be designed to take place under total anticipated design-head conditions

Low-flow pipes shall not be smaller than four (4) inches in diameter to minimize maintenance and operating problems, except in parking lot and roof detention where minimum size and configuration of opening shall be designed specifically for each condition. The low-flow pipe shall be provided with a bar-screen on a minimum 2:1 slope to reduce blockage by debris.

Overflow spillways will be required on all detention facilities which have storage volumes of 1,000 or more cubic feet.

The overflow opening or spillway shall be designed so that the combination flow of the low-flow outlet and flow over the spillway will not exceed the total peak runoff for the improved area. The total peak runoff is to be determined from a 50 year frequency rain.

The overflow spillway shall exit into a natural or improved drainage way. If the drainage way does not provide for public access, then topographic detail along with a profile of the centerline of the drainage way shall be provided from the overflow spillway to the point of public access. This detail shall show all topography within 10 feet of the centerline of the drainage way, centerline profile, typical cross section, and capacity of the drainage way.

If the capacity of the existing drainage way is inadequate to carry the total peak runoff, necessary improvements to the drainage way may be required to provide for the total peak runoff.

6. EASEMENT

Two types of easements shall be provided for storm water detention.

1. ACCESS EASEMENT. All detention reservoirs with the exception of parking lot and roof detention shall be enclosed by an access easement. The limits of the easement shall extend ten (10) feet beyond the maximum anticipated pending area. The limits and designation of detention facilities shall be shown on the project plans of final plat.

2. DRAINAGE EASEMENT. A minimum ten (10) feet wide drainage easement shall be provided within the reservoir area, connecting the tributary pipes and the discharge system, along the most direct possible routing of a piping system for possible future elimination of detention. The limits of the drainage easement shall be shown on the project plans of final plat.

## 7. MAINTENANCE

Detention facilities are to be built in conjunction with the storm sewer installation and/or grading. Since these facilities are intended to control increased runoff they must be fully operational soon after the clearing of the vegetation. Silt and debris connected with early construction shall be removed periodically from the detention area and control structure in order to maintain full storage capacity.

The responsibility of maintenance of the detention facilities in commercial and industrial development projects shall remain with the general contractor until final inspection of the development is performed and approved, and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention facilities shall be vested with the Owner of the project or property.

The responsibility of maintenance of the detention facilities for multi-family development projects where the detention facilities are located on the site of the multi-family units shall remain with the general contractor until final inspection of the development is performed and approved and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention facilities shall be vested with the Owner of the project or property.

The responsibility of maintenance of the detention facilities for multi-family development projects and single family development projects where the detention facility is located on private property within a subdivision shall be maintained by the developer of the subdivision, the trustees, or property owner of the subdivision, whichever is applicable.

If the trustees or owner fail to provide a reasonable degree of maintenance and the facilities become inoperative or ineffective, and after written notice that the facilities have become inoperative or ineffective from the City Engineer and the trustees or owner fail to take action to remedy the situation within the time stated in the notice, Lebanon Public Works crews may perform remedial work and assess the trustees or owner for the cost of repair and maintenance.

8. OFF-SITE DETENTION CONCEPTS

1. Off-Site Detention. Storm water detention facilities designed and constructed off-site outside the limits of the proposed development will be considered for approval. This approval is contingent upon documentation being furnished to verify that drainage easements have been obtained for the channel area from the proposed development to the detention facility and including the detention area. The drainage easements must clearly set out provisions for maintenance.

D. STORM WATER DETENTION BUYOUT

At the discretion of the City, payment for increased storm water runoff may be required in lieu of on site detention facilities required in Section C.

Criteria used to consider buyout will be as follows:

* Development size and location

* Direction of storm water runoff and affects on neighboring properties.

* Suitability of the site for detention facilities.

* Plans for regional storm water facilities in the water shed.

Payment shall be on the basis of the square footage of constructed impervious (nonabsorbent) surfaces such as buildings, parking lots and driveways, but shall not include any improvement built on a public right-way. No credit will be given for existing development except as previously paid for under this specification.

Payment shall be made at the rate of $0.10 per square foot of impervious surface constructed. Payment for gravel and rocked surfaces shall be made at the rate of $ .05 per square foot.