

**CITY OF SAN BERNARDINO
DEPARTMENT OF PUBLIC WORKS/CITY ENGINEER
STORM DRAIN DESIGN POLICY**

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DIVISION I-AUTHORITY

This policy paper has been prepared to provide a guide and establish the acceptable practices and criteria used in the design and construction of storm drainage facilities within the City of San Bernardino. It is intended to serve as a basis for the preparation of computations on hydrology and hydraulics as well as provide the basic information required on plans submitted for checking and approval. It incorporates the requirements of the Municipal Code and City Standards along with acceptable design criteria to be used.

The purpose of the storm drain policy is to establish to minimum protection levels from storm waters that the City will permit and insure the safety and security of the citizens of the City of San Bernardino. It is the Intent of the City to maintain all storm waters within the underground drain system (except for street flows reaching interception points) for a 10-year frequency storm in all areas. Major drains and larger should maintain all storm waters in the system for a 25-year event as the minimum criteria with higher criteria set elsewhere in this policy paper. Storm water should not be carried in the arterial or collector street system more than 1000 feet before interception with lesser intervals recommended. Storm waters should not cross arterial or collector intersections or cause any localized flooding for the design storm event.

Storm drains will be required of all subdivisions, commercial/industrial development and for all residential development that is deemed to have a significant impact on the overall drainage system. It is the responsibility of each citizen and development within the community to contribute to the effective storm water protection of the entire community and to lessen the impact on the downstream recipient of the waters if practical to do so. In all cases, the test of reasonableness shall apply to both up and downstream parties.

Authority for storm drain design, construction and fees is contained in the City of San Bernardino Municipal Code in the following Sections:

Section 3.38 Planned Local drainage Facilities Fund

Section 12.28 Improvements

 Subsection 12.28.060 through 12.28.110

Section 12.48 Bridges

Section 15.72 Flood Control Measures

Section 18.44 Improvements

In addition to the Municipal Code sections, the City has on file Comprehensive Storm Drain Plans designated Project #3, Plan #6, and Plan #7. These plans are the same plans referenced by the San Bernardino County Flood Control District and surrounding agencies. There are also studies and reports made by the Corps of Engineers and the Santa Ana River Authority as well as capital improvement program lists on file in the Department of Public Works.

Many of the Code citations make reference to resolutions and ordinances adopted by the Mayor and Common Council in which fees are established and additional criteria set.

The above authority is established as the minimum requirement of the City of San Bernardino with all design subject to the review and approval of the Director of Public Works/City Engineer for conformance to acceptable design practices and sound engineering judgment. All plans must receive approval by the Director of Public Works prior to construction and for the recordation of Final Maps. The Director of Public Works may solicit input from the County Flood Control Agency at any time during the review process and may or may not incorporate their requirements. Permits must be obtained and inspection given for all Public Works improvements. Inspection is provided by the Division of Public Works.

DIVISION II--DESIGN CRITERIA

- A. **Major Drains.** In general, major drains are systems using 36-inch, or larger, diameter pipes (or equivalent channels) and are identified on the comprehensive storm drain plans or are of regional significance in that they provide additional capacity for flows originating outside the bounds of the subject development. Major drains in fully developed areas with all streets and downstream systems in place have slightly different requirements than for foothill areas having no street system or downstream systems in place.
1. Major drains in developed areas shall have a pipeline capacity for containment of a 25-year storm frequency, provided that a 100-year storm frequency will be contained within the confines of the street right-of-way and a 50-year storm frequency is contained between the curbs. In foothill areas where downstream systems are lacking and street systems are not present, regional drains shall be designed to contain a 100-year storm frequency. Drains that outlet to debris basins in foothill areas shall also provide for 100-year storm frequency in the pipe/channel.
 2. Hydrology shall be calculated by the unit hydrograph method or an approved equivalent method. Rational formulas using data consistent with area soils are acceptable but are known to provide slightly higher quantities of runoff. No allowance shall be made for the increased runoff numbers from the rational method. Bulking factors must be used when debris potential exists.
 3. Pipes shall, where practical, be designed to flow full. Full shall mean the hydraulic grade line at the soffit of the pipe. Pressure flow shall be avoided.
 4. In open channel flow, a minimum of 2 feet of freeboard shall be provided, increasing to 2.5 feet in curved sections.
 5. Hydraulic grade lines shall be calculated from the downstream control and shall be a free water surface for the storm frequency of design, or the calculated hydraulic grade line of the down stream system for the correct storm event.
 6. For major drains, full 100-year storms shall be contained within the street right-of-way. 100-year storm shall be contained in the pipeline for foothill areas.

7. Major drains shall connect to other regional systems or established river channels or natural drainage courses. They shall not connect into local systems except as a receptor of waters.
8. Maximum design velocity shall be 20 fps unless special circumstances are present and prior written approval is obtained from the Director of Public Works/City Engineer.
9. Minimum grade on any storm drain shall be .0010. In unusual conditions lesser grades may be considered upon written approval by the Director of Public Works/City Engineer.
10. In general, the angle of confluence between main line and lateral shall not exceed 45 degrees and, as an additional requirement, shall not exceed 30 degrees under any of the following conditions:
 - a. Where the flow in the proposed lateral exceeds 10% of the main line flow.
 - b. Where the velocity of the flow in the proposed lateral is 20 fps or greater.
 - c. Where the size of the proposed lateral is 60 inches or greater.
 - d. Where hydraulic calculations indicate excessive head losses may occur in the main line due to the confluence.

Connector pipe may be joined to main line pipe at angles greater than 45 degrees up to a maximum of 90 degrees provided none of the above conditions exist. If, in any specific situation, one or more of the above conditions does apply, the angle of confluence for connector pipes shall not exceed 30 degrees. Connections shall not be made to main line pipe that may create conditions of adverse flow in the connector pipes.

11. Calculations on debris generation shall be made for all foothill areas where natural flows enter into the system or into a debris basin. Standard methods (Corps of Engineers "Tatem Method") of debris generations calculations shall be used and must consider total burn on the adjacent hillsides.

12. Sump conditions shall be avoided. Should they be completely unavoidable, a secondary surface outlet shall be provided such that there will be no flooding of habitable structures in a 100-year event and that the storm drain is able to contain a 50-year event.
13. Debris basins shall be required for all natural drainage courses exiting undeveloped hillside areas. Trash racks are required at the inlet to the storm drain and debris basins shall be sized to accommodate 100-year storm flows and debris. Water shall not be impounded behind embankments greater than 5 feet above the dry toe of the embankment or exceed 50 acre-feet of water.
14. Storm drains shall be constructed of reinforced concrete pipe . Other materials may be considered upon written request when special conditions exist to justify their use. In general, no materials other than reinforced concrete pipe will be considered for pipes of 48 inches in diameter or larger.
15. Catch Basins shall be located to accept the greatest inflow and sumps should be avoided. System design shall allow for entrance and head loss in the catch basin connector pipe and a minimum of 1.5 feet of freeboard as measured to the flow line at point of interception.
16. Minimum pipe size shall be 18 inches. Minimum pipe used in any part of the system shall be 18 inches.
17. Manholes shall have the following spacing:
 - a. For conduits 30 inches or less manholes shall be spaced at 300 feet intervals unless there are numerous bends or angle points in which case spacing shall be as directed by the Director of Public Works/City Engineer.
 - b. On conduit larger than 30 inches but 45 inches or less, spacing shall be 400 feet.
 - c. For conduit larger than 45 inches, spacing shall be 500 feet.
18. Should velocity of flow exceed 20 fps or become super critical in a partial full pipe, exceed 5 degrees 45 minutes.
19. In general, storm drains shall be designed with sizes increasing in the

downstream direction. However, if studies indicate it may be advisable to decrease the size of a downstream section, the conduit may be decreased in size in accordance with the following:

- a. For slopes of 0.0025 or less, only conduits 75 inches and greater may be decreased. Reduction is limited to a maximum of 6 inches.
 - b. For slopes of more than 0.0025, only conduits 33 inches and greater may be reduced. Each reduction is limited to 3 inches for conduits 48 inches and smaller and 6 inches for pipes greater than 48 inches.
20. Storm drains shall be located in street right-of-ways where possible. They shall be located both horizontally and vertically so as to provide the least obstruction to other utilities and future uses. Where necessary to be located outside the right-of-way, they shall be in easements dedicated to the City and shall have a minimum width of 10 feet. Generally, the easement shall be the diameter of the pipe plus 8 feet for conduits 60 inch or larger.
21. Curve alignments shall have minimum radius of 90 feet for pipes 36 inches or larger and 45 feet for 36 inches and smaller laterals.

B. **LOCAL DRAINS.** In general, local drains are systems using conduits smaller than 36 inches in diameter, are not identified on the master plans and serve the needs of the project itself or isolated small drainage areas. They eventually connect to regional drains or may discharge directly to natural channels or streams. They are contained entirely within the street right-of-way and have a limited number of catch basins or collection points.

1. Local drains in developed areas shall have a pipeline capacity for containment of a 10-year storm frequency, provided that 100-year storm frequency will be contained within the confines of the street right-of-way and a 50-year storm frequency is contained between the curbs. In foothill areas where downstream systems are lacking and street systems are not present, local drains shall be designed to contain a 25-year storm frequency.
2. Hydrology shall be calculated by the unit hydrograph method or an approved equivalent method. Rational formulas using data consistent with area soils are acceptable but are known to provide slightly higher

quantities of runoff. No allowance shall be made for the increased runoff numbers from the rational method. Bulking factors must be used when debris potential exists.

3. Pipes shall, where practical, be designed to flow full. Full shall mean the hydraulic grade line at the soffit of the pipe. Pressure flow shall be avoided.
4. Open ditches shall be avoided. Concrete or gunite swales or small channels shall not be permitted for local drainage systems. Brow ditches, terrace drains etc., are private drains and are permitted.
5. Hydraulic grade lines shall be calculated from the downstream control and shall be a free water surface for the storm frequency of design, or the calculated hydraulic grade line of the downstream system for the storm event design on the downstream system.
6. For local drains, full 100-year storms shall be contained within the street right-of-way and pipe system.
7. Local drains shall connect to other systems or established river channels or natural drainage courses.
8. Maximum design velocity shall be 20 fps. In unique situations, if invert protection is provided, higher velocities may be accepted upon written request and written approval of the Director of Public Works/City Engineer.
9. Minimum grade on any storm drain shall be .0010. In unusual conditions lesser grades may be considered upon written approval by the Director of Public Works/City Engineer.
10. In general, the angle of confluence between main line and lateral shall not exceed 45 degrees and, as an additional requirement, shall not exceed 30 degrees under any of the following conditions:
 - a. Where the flow in the proposed lateral exceeds 10% of the main line flow.
 - b. Where hydraulic calculations indicate excessive head losses may occur in the main line due to the confluence.

Connector pipe may be joined to main line pipe at angles greater than 45 degrees up to a maximum of 90 degrees provided none of the above conditions exist. If, in any specific situation, one or more of the above conditions does apply, the angle of confluence for connector pipes shall not exceed 30 degrees. Connections shall not be made to main line pipe which may create conditions of adverse flow in the connector pipes.

11. Sump conditions shall be avoided. Should they be completely unavoidable, a secondary surface outlet shall be provided such that there will be no flooding of habitable structures in a 100-year event and that the storm drain is able to contain a 50-year event.
12. Debris basins shall be required for all natural drainage courses exiting undeveloped hillside areas. Trash racks are required at the inlet to the storm drain and debris basins shall be sized to accommodate 100-year storm flows and debris. Water shall not be impounded behind embankments greater than 5 feet above the dry toe of the embankment, nor exceed 50 acre feet.
13. Storm drains shall be constructed of reinforced concrete pipe. RCP is the preferred material, however, other materials may be considered upon written request depending on the pipe size, soils conditions or physical constraints of the system. Economics will not be considered valid justification for other materials in lieu of RCP.
14. Catch basins shall be located to accept the greatest inflow and sumps should be avoided. System design shall allow for entrance and head loss in the catch basin connector pipe and a minimum of 1.5 feet of freeboard measure from the flow line at the interception point.
15. Minimum connector pipe size shall be 18 inches. Minimum pipe used in any part of the system shall be 18 inches.
16. Manholes shall have the following spacing:
 - a. For conduits 30 inches or less, manholes shall be spaced at 300-foot intervals unless there are numerous bends or angle points, in which case spacing shall be as directed.
 - b. On conduit larger than 30 inches but 36 inches or less, spacing shall be 400 feet.

17. Should velocity of flow exceed 20 fps or become super critical in a partially full pipe, the total horizontal angle of divergence or convergence between the walls of the manhole and its centerline shall not exceed 5 degrees 45 minutes.
18. In general, storm drains shall be designed with sizes increasing in the downstream direction. However, if studies indicate it may be advisable to decrease the size of a downstream section, the conduit may be decreased in size in accordance with the following:
 - a. For slopes of 0.0025 or less, no reduction is permitted.
 - b. For slopes of more than 0.0025, only conduit 33 inches and greater may be reduced. Each reduction is limited to 3 inches for conduit 36 inches and smaller.
19. Storm drains shall normally be located in street right-of-ways. They shall be located both horizontally and vertically so as to provide the least obstruction to other utilities and future uses. Where necessary to be located outside the right-of-way, they shall be in easements dedicated to the City and shall have a minimum width of 10 feet.
20. Curve alignments shall have minimum radius of 45 feet.
21. Flap gates may be required at connections to regional drains or into natural drainage courses.

C. Detention Basins. Detention basins are temporary holding areas for excess waters and are used to delay the peak discharge into the downstream system. Their use as a part of the system is strongly discouraged and the developer must make arrangements for the maintenance of all such facilities by way of homeowner's associations or assessment districts. All such facilities, if permitted, must be approved in writing by the Director of Public Works/City Engineer prior to design or construction. Additionally, they must be screened from the public and secure. Weeds, debris and insects must be controlled.

Detention facilities differ from retention facilities in that a detention facility will discharge all collected waters in a very short time after the storm and no waters are ever retained more than 24 hours. The City of San Bernardino does not permit retention facilities.

Following proper design criteria, it is permissible to have detention facilities perform dual functions. That is it may be used for open recreation space or passive park area. In general, the requirements for such use are that all waters must be discharged within 8 hours of the storm, must not be impounded more than 15 feet deep, may not cause berms higher than 24 inches above the curb grade and must meet the approval of the Department of Parks and Recreation as a suitable park area. Turf, trees and other amenities may be required for such use and are the responsibility of the developer to install at his cost.

Design of detention facilities shall follow the guidelines as set forth by the San Bernardino County Flood Control District. Basically, it requires the facility to reduce downstream discharge to 90% of pre-development levels, provide a controlled rate of discharge and not disrupt the downstream peak loading from other such facilities.

- D. Private On-site Drains. Private on-site drains are drainage systems installed wholly on private property and maintained by the owners. Private on-site systems may discharge into local d-rains or regional drains, but only in a prescribed manner. On-site drains should and must provide for all on-site drainage for the design storm, and the site must be protected from flooding habitable structures. Good engineering practice shall govern the design, and it is recommended that similar criteria to local drains be employed. Pipe size less than 4 inches will not be permitted. Consideration to operation, cleaning and maintenance must be considered.

Although the system is private and the responsibility is to the owner, its primary function is to protect the property from flooding and be reasonably free from clogging or failure. Secondary outlets are required for any inlets subject to clogging. In general, on-site drains will have capacities less than 5 cfs total discharge for a 10-year storm event.

DIVISION III--- GUIDELINES FOR HYDROLOGY AND HYDRAULIC CALCULATIONS

The City of San Bernardino recognizes the unit hydrograph method as currently used by the San Bernardino Flood Control. Computer generated data following this method is acceptable as a part of the overall submittal.

Hydrology shall consider topography, geology/soils, land use, rainfall intensity, and runoff characteristics (mountain/valley). Hydrology reports shall contain drainage area maps which may be based on current U.S.G.S. quad sheets or other suitable map bases, shall have tabular detail on the rainfall intensity, runoff coefficient, time of concentration, Q, and junction calculations. Computer output may be substituted but the drainage or watershed area must be shown and the basic assumptions on rainfall intensities and runoff detailed.

Hydraulic calculations shall include Q's, velocity, rates of grade, elevations for the water surface and hydraulic grade line, conduit size, area, wetted perimeter, slope and losses associated with bends, junctions, manholes, transitions, grade changes, etc. Backwater curves and jumps must also be detailed should they occur. Final plans must show the hydraulic grade line in relation to the conduit.

All materials should be submitted in an 8-1/2 by 11" report form with the required map on 8-1/2 x 11" or folded to fit inside the packet. Hydrology and hydraulics must be submitted with the first check plans and any required written approvals for deviations from the policy should also be included. Calculation of street capacity should also be a part of the report.

In the case of regional drains or detention facilities, copies of the hydrology/hydraulics may be sent to the County Flood Control for additional review and comment. Flood control recommendations shall be reviewed by the City prior to incorporation into the design. The City has ultimate authority and responsibility for approval of all systems in the City.

An executive summary or short synopsis of the study should be attached to the front of the report. It should briefly give the watershed area, storm frequency used for design, total Q to be intercepted, capacity of the conduit and the streets reviewed and stated and the overall impact of the system on the downstream facilities stated.

DIVISION IV - GUIDELINES AND FORMAT FOR PLAN PREPARATION

A. Plan Requirements

- 1. Sheet size is 24 x 36 inches (plan and profile)**
- 2. Plan to show the following (minimum)**
 - a. Vicinity map**
 - b. North arrow**
 - c. Horizontal and vertical scales**
 - d. Profile of existing ground over drain line**
 - e. Proposed conduit**
 - f. Hydraulic grade line of proposed system**
 - g. Legend - topography and construction**
 - h. General notes**
 - i. Engineer's signature and stamp**
 - i. Engineer's license number and expiration date**
 - k. Right-of-way**
 - l. Existing improvements and proposed construction**
 - m. Join elevations on conduits and hydraulic grade lines**
 - n. Sections and details**
 - o. Stationing on centerline of conduit - ties to street stationing**
 - p. Utilities**
 - q. Bench mark**

r. Pipe "D" loading

3. Submit 2 sets of plans for checking, hydrology/hydraulics or other design data may be requested.

B. General Notes (On all Plans)

1. All work shall be in accordance with the Standard Specifications for Public Works Construction (Green Book) latest edition and all supplements.
2. Approval of this plan by the City of San Bernardino does not constitute a representation as to the accuracy of the location or of the existence or non-existence of any underground utility pipe or structure within the limits of this project. The Contractor shall assume full responsibility for the protection of all utilities within the limits of the project.
3. Inspection shall be by the City of San Bernardino, Department of Public Works. All requests for inspection shall be made at least 24 hours in advance of the proposed construction.
4. During the period of construction, the Contractor shall furnish, erect and maintain such warnings, signs, stop signs, barricades and other safety measures as directed by the City of San Bernardino, Division of Public Works with reference to W.A.T.C.H. manual.
5. Contractor shall not open more trench than can be properly constructed and filled in a day's operation. Any trench unavoidably left open during the hours of darkness or over a weekend shall be fenced with 6-foot chain link fencing and properly lighted.
6. Contractor shall reinstall pavement markings and striping that has been disturbed by his operations.
7. OSHA permit required for trenches over 5 feet in depth.
8. Contractor shall contact Underground Service Alert prior to beginning work.

Additional Notes (To be used only as required by specific projects)

1. The Contractor shall provide safe and continuous passage for local pedestrian and vehicular traffic at all times.
2. Traffic signal functions shall be the responsibility of the City. However, the Contractor is required to give 48-hour notice prior to construction that will damage or affect any buried traffic detectors.
3. Should any of the existing utilities or any other facilities conflict with the proposed storm drain line, the Contractor shall notify the Engineer and await the relocation and/or alternate design.
4. The Contractor shall so conduct his operations as to offer the least possible obstruction and inconvenience to the public, and he shall have under construction no greater length or amount of work than he can prosecute properly with due regard to the rights of the public.

Convenient access to driveways, houses, and buildings along the line of work shall be maintained, and temporary crossings shall be provided and maintained in good condition. Not more than one crossing or intersecting street or road shall be closed at any one time without the approval of the Engineer.

The Contractor shall provide and maintain such fences, barriers, directional signs, lights, and flagmen as are necessary to give adequate warning to the public at all times of any dangerous conditions to be encountered as a result of the construction work and to give directions to the public.

5. The Contractor shall exercise due care to avoid injury to existing improvements or facilities, utility facilities, adjacent property, and trees and shrubbery that are not to be removed. Contractor shall notify USA prior to entering project site.
6. In accordance with generally accepted construction practices, the Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work, and the Contractor shall fully comply with all state and federal laws, rules, regulations, and orders relating to safety to the public and workmen.

7. **Street cut permits must be obtained from the Public Works Division of the City.**
8. **All removals in paved areas shall be saw cut on a neat, straight line parallel to the pipeline. The cut edge shall be protected from crushing and all broken edges shall be re-cut prior to paving operations.**
9. **Dust shall be controlled at all times by approved methods.**
10. **Public streets shall be kept clean and free from dirt and/or debris. The Contractor shall be responsible for all costs incurred in street cleaning necessitated by his operation.**
11. **Full street closure will not be permitted unless prior written approval is obtained from the Director of Public Works/City Engineer. 48-hour notice will be required to the City and affected property owners prior to any closure.**

DIVISION V-TESTING AND INSPECTION

Testing and inspection shall be per the Standard Specifications for Public Works Construction (Green Book), and the provisions of the City of San Bernardino Municipal Code.

In addition to the above requirements, the following will apply:

1. All trench backfill shall be tested and certified by a soils engineer prior to acceptance.
2. 24 hours advance notice is required for inspection. Arrangements for inspection can be made by calling (909) 384-5111 between 7:30 a.m. and 4:30 p.m. weekdays.
3. Normal inspection hours are 7:30 a.m. to 4:30 p.m. Monday through Friday except legal holidays. Requests for inspection at other times or on other days must be submitted to the Division of Public Works a minimum of 48 hours before the inspection is required. The Contractor must bear the cost of such overtime inspections and will be billed accordingly. Normal overtime rates are 1.5 times the base rate plus overhead. Overtime inspections will be made solely at the discretion of the City and based on staff availability.
4. Contractors will be required to obtain City business licenses, insurance and provide evidence of same to inspection staff upon request.
5. The Contractor shall not place concrete or asphalt on the project without first having submitted compaction tests to the Division of Public Works.
6. All plan revisions shall be submitted to the Land Development Section for review and approval prior to making field revisions. Construction, other than shown on the approved plans will not be permitted without approval of revisions.
7. Certificates of Occupancy or utility clearance will not be issued until all work and safety items have been satisfactorily completed.

DIVISION VI---STORM DRAIN PLAN CHECK LIST

____ 1st submittal
____ 2nd submittal
____ 3rd submittal

Project Name _____
Owner _____ Checked by _____
Engineer _____ Phone _____

- ____ OK
- ____ Needs Correction
- ____ No Requirement

Submittal Completion

- ____ 2 sets of plans
- ____ 2 copies of preliminary soils reports
- ____ 2 sets Hydrology submitted
- ____ 2 sets Hydraulics submitted
- ____ Engineer's cost data and itemized quantity estimate complete
- ____ Permit or clearance needed from _____
- ____ Condition # _____ from Review Committee/Commission needs to be satisfied.
- ____ Plans signed by RCE with expiration date shown
- ____ Return check prints from previous plan checks

Show on Plans:

- Vicinity map
- North arrow
- Horizontal and vertical scales
- Profile of existing ground over drain line
- Proposed conduit
- Hydraulic grade line of proposed system
- Legend - topography and construction
- General notes Engineer's signature
- Engineer's license number and expiration date
- Right-of-way and Existing improvements
- Join elevations on conduit and hydraulic grade lines Sections and details
- Stationing on centerline of conduit - ties to street stationing
- Utilities
- Bench mark
- Pipe "D" loading
- Street names in conformance with approved maps
- Minimum/maximum grades within limits
- Joins detailed and elevations shown
- Horizontal curves within design criteria
- Quantity/cost estimates provided
- Street hydraulics checks
- Standard drawings referenced
- Assessment district provided (if required)
- Drainage pattern acceptable with outlet to correct location
- Benchmark provided
- Traffic control, signing and striping shown

FEEES AND PERMITS

- Pay plan check fee
- Pay permit fee
- Inspection fee
- Plans signed and approved by City Engineer
- Permit issued
- Other departments notified