TABLE OF CONTENTS

1. Public Storm Drain Design Standards

2. Public Storm Drain Standard Drawings

3. Public Storm Drain Construction Standard Specifications

4. Engineer's List of Approved Items

APPENDIX A                             STORM DRAIN DESIGN REVIEW SUBMITTAL CHECKLIST
PUBLIC STORM DRAIN STANDARDS
1. PUBLIC STORM DRAIN DESIGN STANDARDS

PREFACE

QUICK REFERENCE SHEET—HYDROLOGY
QUICK REFERENCE SHEET—HYDRAULICS
QUICK REFERENCE SHEET—DESIGN REQUIREMENTS

Purpose .................................................................................................................. 1
Policy ..................................................................................................................... 1
Hydrology Concepts ............................................................................................ 1
  Runoff Coefficient ............................................................................................ 2
  Rainfall Intensity ............................................................................................... 2
  Time of Concentration ....................................................................................... 2
Hydrologic Design ............................................................................................... 3
Hydraulic Design Criteria .................................................................................... 4
  General .............................................................................................................. 4
  Open Channels ................................................................................................. 6
  Closed Conduits ............................................................................................. 7
Detention Basins ................................................................................................. 7
Design Requirements .......................................................................................... 9
  1. Connection to the Existing Storm Drain System ......................................... 9
  2. Materials ..................................................................................................... 9
  3. Size .............................................................................................................. 10
  4. Alignment .................................................................................................. 10
  5. Slope .......................................................................................................... 11
  6. Cover ......................................................................................................... 11
  7. Manholes and Structures ........................................................................... 11
  8. Catch Basins ............................................................................................. 12
  9. Easements .................................................................................................. 13
  10. Access Road ............................................................................................. 13
  11. Maintenance ............................................................................................. 14
  12. Water Quality ............................................................................................ 14
  13. Other Requirements .................................................................................. 14
Table I-1 Rational Method Runoff Coefficients (C) ........................................... 15
Figure I-1 Intensity-Duration-Frequency Graph .................................................. 16
Figure I-2 Mean Seasonal Precipitation .............................................................. 17
Table I-2 Formulas .............................................................................................. 18
Table I-3 Loads on Buried Pipes ........................................................................ 19
Quick Reference Sheets

These standards have been prepared to assist developers and their engineers in the design of public storm drain facilities. To assist those engineers who are familiar with these standards, quick reference sheets are provided in this Preface section. The quick reference sheets contain design criteria and data from the standards which are most commonly used in the design of public storm drain facilities. Unless otherwise noted, hydrological and hydraulic standards are consistent with the Sonoma County Water Agency Flood Control Design Criteria Manual, Revised August 1983.

Quick reference sheets are provided for the following subjects:

1. Hydrology
2. Hydraulics
3. Design Requirements
### Waterway Classification

<table>
<thead>
<tr>
<th>Waterway classification</th>
<th>Drainage area, square miles</th>
<th>Recurrence interval, years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>≥4</td>
<td>100</td>
</tr>
<tr>
<td>Secondary</td>
<td>1–4</td>
<td>25</td>
</tr>
<tr>
<td>Minor</td>
<td>≤1</td>
<td>10</td>
</tr>
<tr>
<td>Diversion</td>
<td>Not applicable</td>
<td>100</td>
</tr>
</tbody>
</table>

\[ Q = CIAK \]

where:

- \( Q \) = flow (cubic feet per second)
- \( C \) = runoff coefficient from Table I-1 (dimensionless)
- \( I \) = rainfall intensity from Figure I-1 (inches per hour)
- \( A \) = drainage area (acres)
- \( K \) = mean seasonal precipitation from Figure I-2 \( ÷ \) 30 inches

### Initial Time of Concentration (Tc)

<table>
<thead>
<tr>
<th>Land use</th>
<th>Tc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial/industrial/residential with more than 8 units per acre</td>
<td>7 minutes</td>
</tr>
<tr>
<td>Residential, 2 to 8 units per acre</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Residential, less than 2 units per acre</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Open Space</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

### Pages

- Rational Method Runoff Coefficients (C) 15
- Intensity-Duration-Frequency Chart 16
- Mean Seasonal Precipitation Map 17
QUICK REFERENCE SHEET
HYDRAULICS

<table>
<thead>
<tr>
<th>Design waterway classification</th>
<th>Downstream waterway classification</th>
<th>Design flow in downstream waterway, years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary</td>
<td>Major</td>
<td>25</td>
</tr>
<tr>
<td>Minor</td>
<td>Major or secondary</td>
<td>10</td>
</tr>
<tr>
<td>Surface (ground)</td>
<td>Major or secondary</td>
<td>100</td>
</tr>
<tr>
<td>Diversion</td>
<td>Not applicable</td>
<td>100</td>
</tr>
</tbody>
</table>

Manning's formula

\[ Q = (1.486/n)AR^{2/3}S^{1/2} \]

Manning's formula coefficient (n)

<table>
<thead>
<tr>
<th>Material</th>
<th>Mannings &quot;n&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm drain pipe [high density polyethylene pipe (HDPE), cast-in-place concrete (CIPP), and reinforced concrete pipe (RCP)]</td>
<td>0.014</td>
</tr>
<tr>
<td>Concrete-lined channel</td>
<td>0.015</td>
</tr>
<tr>
<td>Asphalitic concrete</td>
<td>0.017</td>
</tr>
<tr>
<td>Grouted rock rip rap</td>
<td>0.030</td>
</tr>
<tr>
<td>Loose rock rip rap</td>
<td>0.035</td>
</tr>
<tr>
<td>Grass-lined channel</td>
<td>0.035 minimum</td>
</tr>
<tr>
<td>Constructed natural waterway</td>
<td>0.050 minimum</td>
</tr>
</tbody>
</table>

Minimum design flow velocity = 2.5 feet per second

<table>
<thead>
<tr>
<th>Waterway classification</th>
<th>Waterway type</th>
<th>Minimum freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Open channel</td>
<td>1.5 feet or 20 percent of specific energy (whichever is greater)</td>
</tr>
<tr>
<td>Major and secondary</td>
<td>Closed conduit</td>
<td>0.2 x diameter</td>
</tr>
<tr>
<td>Minor</td>
<td>Closed conduit</td>
<td>1 foot below top of curb or adjacent ground surface</td>
</tr>
<tr>
<td>Gutter</td>
<td>Open channel with 6-inch curb</td>
<td>0.4 feet maximum depth</td>
</tr>
</tbody>
</table>
**QUICK REFERENCE SHEET**

**DESIGN REQUIREMENTS**

- **Minimum pipe diameter:** 15 inches
- **Pipe materials:** reinforced concrete pipe (RCP), cast-in-place concrete pipe (CIPP) or high-density polyethylene (HDPE) pipe that conforms to these specifications
- **Horizontal separation from sewer lines:** 5 feet clear
- **Horizontal separation from water lines and other utilities:** 4 feet clear
- **Vertical curves:** not allowed
- **Horizontal curves:**
  - RCP and CIPP: 300 feet minimum radius (allowed at catch basins and when pipeline is installed under the pavement parallel to the concrete gutter)
  - HDPE: 765 feet minimum radius for 20 foot sections
- **Pipe slope:** \(\leq 15\%\)
- **Minimum cover:** 12 inches for class III RCP and HDPE (outside of pipe to road subgrade).
- **Maximum distance between structures:** 400 feet

New development and redevelopment projects may be required to implement storm water quality source and treatment controls. Refer to the Santa Rosa Area Standard Urban Storm Water Mitigation Plan (SUSMP) for design criteria.
PUBLIC STORM DRAIN DESIGN STANDARDS

PURPOSE:

The purpose of this document is to provide standards for design of public storm drain system improvements in the City of Santa Rosa (City). These standards consist of:

1. hydrologic design criteria,
2. hydraulic design criteria, and
3. physical design requirements.

These standards do not include (but may reference) additional requirements established by other departments of the City and other government agencies. These standards are intended to impose minimum acceptable design criteria. More stringent requirements may be imposed by the City Engineer based on specific project conditions. Developers and their design engineers are responsible for complying with these standards and all other requirements for design of storm drain facilities within the City. Design engineers are responsible for initiating written requests for approval of any design concepts that differ from these standards, verifying additional requirements set forth by other departments of the City or other government agencies, performing any necessary calculations or studies, and resolving any problems with the appropriate department or agency. Developers and design engineers should be aware that Section 402(p) of the federal Clean Water Act establishes requirements for National Pollutant Discharge Elimination System permits for certain industrial and construction-related storm water discharges.

POLICY:

The policy of the City is to safely collect and convey storm water to the nearest public flood control facility in a storm drain system approved by the City of Santa Rosa Public Works Department (PWD), while achieving water quality objectives to the maximum extent practicable in the City's creeks as defined in the City’s Storm Water Management Plan.

HYDROLOGY CONCEPTS:

The Rational Method is widely used for determining design flows in urban and small watersheds. The method assumes that the maximum rate of runoff for a given rainfall intensity occurs when the duration of the storm is such that all parts of the watershed are contributing to the runoff at the interception point. The formula used is an empirical equation that relates the quantity of runoff from a given area to the total rainfall falling at a uniform rate on the same area and is expressed as:

\[ Q = CIAK \]

in which

- **Q** is the design flow in cubic feet per second.
- **C** is a dimensionless runoff coefficient based upon type of ultimate development (i.e., land use) from Table I-1 for the drainage area.
- **I** is the intensity of rainfall in inches per hour from Figure I-1 or computed as:
\[ I = 5.12 \times Y^{0.1469} \times t^{-0.528} \]

in which

- \( Y \) = recurrence interval (10, 25 or 100 year, etc.)
- \( t \) = time of concentration (duration in minutes)

- \( A \) is the tributary drainage area in acres.

- \( K \) is the dimensionless ratio of the average annual rainfall for the drainage area to the average annual rainfall for the overall area for which the rainfall intensity/duration/recurrence interval relationships have been established.

\[ K = \frac{\text{average annual rainfall in inches from Figure I-2}}{30 \text{ inches}} \]

The runoff coefficient (C), the drainage area (A), and the average annual rainfall ratio (K) are all constant for a given area at a given time. (Note that some agencies do not include the factor K when using the Rational Method.) Rainfall intensity (I), however, is determined by using an appropriate storm frequency (i.e., recurrence interval) and duration which are selected on the basis of economics and engineering judgment. Storm drains are designed on the basis that they will flow nearly full during the design storms. Storm frequency is selected through consideration of the size of drainage area, probable flooding, possible flood damage, and anticipated future development for the drainage area.

**Runoff Coefficient.** The runoff coefficient (C) normally ranges between 0.30 and 0.90. The soil characteristics, such as porosity, permeability, and whether or not it is saturated from preceding storms are important considerations. Another factor to consider is ground cover, i.e., whether the area is paved, grassy or wooded. In certain areas, the coefficient depends upon the slope of the terrain. Duration of rainfall and shape of area are also important factors in special instances. Of primary importance is the percent of land covered with impervious surfaces such as asphalt.

**Rainfall Intensity.** Rainfall intensity (I) is the amount of rainfall measured in inches per hour that would be expected to occur during a storm of a certain duration. The storm frequency is the time in years in which a certain storm would be expected again and is determined statistically from available rainfall data. (See Figure I-1.)

**Time of Concentration.** The time of concentration at any point in a storm drain segment is the time required for runoff from the most hydraulically remote portion of the drainage area to reach that point. The most hydraulically remote portion provides the longest time of concentration but is not necessarily the most distant point in the drainage area. Since a basic assumption of the Rational Method is that all portions of the area are contributing runoff, the time of concentration is used as the storm duration in calculating the intensity. The time of concentration consists of the initial time of concentration, which depends on the anticipated future land use for the drainage area, plus the sum of the additional overland flow time, if any, and the times of travel in street gutters, roadside swales, storm drains, drainage channels, and other drainageways. The time of concentration is affected by the rainfall intensity, topography, and ground conditions.
HYDROLOGIC DESIGN:

Hydrologic design shall be based on the ultimate development and slope of the tributary watershed. All storm drain facilities shall be designed for flows resulting from 100 percent build-out of the land uses designated in the latest adopted edition of the City's General Plan in effect at the time the proposed development is approved by the appropriate City approval body. Drainage boundaries and basin slope shall be determined from the most current topographic information available. In flat areas, drainage basin boundaries shall be verified with those for other adjacent developments to eliminate gaps or overlaps and maintain consistency. Only areas which do not flow towards the proposed development may be excluded. The design must demonstrate that the excluded areas do not flow into the proposed development.

Flows from tributary areas upstream of the proposed development shall be included in the hydrologic design for the proposed development. The hydrology for the proposed project will be based on a pattern of upstream development which delivers the ultimate development storm runoff to the proposed project. Upstream area flows shall be based on 100 percent build-out of the land uses designated in the latest adopted edition of the City's General Plan in effect at the time the project is designed. Rezoning often results in significantly higher densities than were used in design calculations for existing downstream storm drain facilities. The design of the storm drain system for the proposed development shall be based on the assumption that storm flows from upstream areas will be conveyed in conduits, thereby resulting in lower times of concentration than for undeveloped conditions. The design of the storm drain facilities for the proposed development shall be such that the design flow from the proposed development and the upstream areas is less than or equal to the hydraulic capacity of the downstream storm drain facilities unless otherwise approved. In cases where the design flow exceeds the hydraulic capacity of the downstream storm drain facilities, improvements to the downstream facilities may be required as part of the development.

Developed public areas, including but not limited to public parks and golf courses, may be considered to be vegetated to the extent that they are actually vegetated, unless publicly proposed plans indicate that the governing body having jurisdiction over the area intends to alter the existing use of the area so as to make the surface less pervious. The developer shall confirm future plans for park lands with the City Recreation and Parks Department Park Planner. Other public lands must be considered developed for the intended use (e.g., Caltrans right-of-way for extension of Highway 12 will be considered paved).

Drainage systems shall be designed to accommodate flows from storms with specific recurrence intervals. Recurrence interval is defined as the average number of years, over a long period of time, in which the magnitude of discharge from a given flood event is equaled or exceeded. Flows to be used for the design of waterways shall be calculated using the following minimum recurrence intervals:

<table>
<thead>
<tr>
<th>Waterway classification</th>
<th>Drainage area, square miles</th>
<th>Recurrence interval for design flow, years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>≥4</td>
<td>100</td>
</tr>
<tr>
<td>Secondary</td>
<td>1–4</td>
<td>25</td>
</tr>
<tr>
<td>Minor</td>
<td>≤1</td>
<td>10</td>
</tr>
<tr>
<td>Diversion</td>
<td>NA</td>
<td>100</td>
</tr>
</tbody>
</table>
A given waterway, therefore, will be classed as minor in its upper reaches, then change to the secondary classification at a point where the drainage area exceeds 1 square mile, and then change again to the major classification at a point where the drainage area exceeds 4 square miles.

Design flow shall be determined by the use of the Rational Method formula: \( Q = CIAK \)

To use Figure I-1, determine the proper duration of the design storm event. The proper duration is equal to the time of concentration, which is the time required for flow from the most distant location in a drainage basin to reach the point of discharge from the basin.

Drainage areas larger than 2 acres are too large for application of the Rational Method formula in an initial step. The designer shall compute the time of concentration by determining the initial time of concentration. This is the time of concentration at the basin(s) which is furthest upstream. It is based on land use according to the table below. The Rational Method formula shall be applied to each subarea, step by step, and the flow shall be hydraulically routed from subbasin to subbasin to properly accumulate the design discharge for the entire watershed. For further details and sample calculations, refer to the latest edition of the SCWA Flood Control Design Criteria Manual.

<table>
<thead>
<tr>
<th>Land use</th>
<th>Initial time of concentration*, minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial, industrial, and residential with more than eight units per acre</td>
<td>7</td>
</tr>
<tr>
<td>Residential, two to eight units per acre</td>
<td>10</td>
</tr>
<tr>
<td>Residential, less than two units per acre</td>
<td>15</td>
</tr>
<tr>
<td>Open Space</td>
<td>15</td>
</tr>
</tbody>
</table>

*initial basins shall be of two acres or less

**HYDRAULIC DESIGN CRITERIA:**

**General.** For hydraulic design for commonly encountered situations, refer to the latest edition of SCWA Flood Control Design Criteria Manual and supplemental information. For hydraulic design for situations not covered by the SCWA manual, the design engineer shall provide specific references, model study reports, or prototype test results, as necessary to confirm the hydraulic design. Design engineers shall submit design calculations for all public storm drain facilities. As a minimum, the submittal shall include the items shown on the checklist in Appendix A. Examples of acceptable calculations are included in the appendix to the SCWA Flood Control Design Criteria.

Secondary waterways discharging into major downstream waterways shall be designed to operate while discharging into a 25-year flow in the major downstream waterways. Minor waterways discharging into secondary downstream waterways shall be designed to operate while
discharging into a 10-year flow in the secondary downstream waterways. In such cases, the ground elevation along the secondary or minor system shall be above the 100-year water surface elevation in the major or secondary downstream waterway.

If a closed conduit (i.e., pipe or culvert) is used as a secondary or minor waterway, sufficient additional surface routes for flood flows shall be made available to carry the added flow increment up to the 100-year design flow with no more than nuisance damage to improvements or proposed improvements and with no flooding of finished floor of present and proposed future buildings. If such surface routes cannot be made available, the secondary or minor conduit shall be designed to carry the 100-year design flow.

The Manning equation shall be used for hydraulic design of storm drain facilities. The Manning equation is stated as follows:

\[
Q = \frac{1.486}{n} A R^{2/3} S^{1/2}
\]

where

\(Q\) = flow in cubic feet per second

\(A\) = cross-sectional area of flow in square feet

\(R\) = hydraulic radius in feet

\(S\) = slope of the pipe or channel (dimensionless)

\(n\) = Manning equation roughness coefficient (dimensionless)

The values of the Manning equation roughness coefficient "n" shall be as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm Drain Pipe: Smooth walled high density polyethylene, reinforced concrete, or cast-in-place</td>
<td>0.014</td>
</tr>
<tr>
<td>Concrete-lined channel</td>
<td>0.015</td>
</tr>
<tr>
<td>Asphalitic concrete</td>
<td>0.017</td>
</tr>
<tr>
<td>Sack concrete and grouted rock rip rap</td>
<td>0.030</td>
</tr>
<tr>
<td>Loose rock rip rap</td>
<td>0.035</td>
</tr>
<tr>
<td>Grass-lined channels</td>
<td>0.035 minimum</td>
</tr>
<tr>
<td>Constructed natural waterways</td>
<td>0.050 minimum</td>
</tr>
</tbody>
</table>
For materials other than those stated above, "n" values shall be those presented in the latest edition of the *Handbook of Hydraulics* by King and Brater. The use of \( n = 0.012 \) may be allowed for smooth walled high density polyethylene pipe (HDPE) design purposes when the construction drawings clearly indicate the pipe material shall be HDPE and there is no suitable substitute.

Storm drains shall be designed for a minimum velocity of 2.5 feet per second at design flow rates unless otherwise specifically authorized by the City Engineer.

**Open Channels.** The maximum allowable depth for flows with 10-year recurrence interval in gutters is 0.4 feet. Valley gutters are unacceptable across through streets. Valley gutters may be authorized for use in alleys on a case-by-case basis.

The use of berms, levees, or other facilities along the channel that create potential hydraulic gradelines higher than abutting lands are unacceptable unless specifically authorized by the City Engineer. This requirement is intended to prevent the need for storm water pump stations.

Open channels shall be designed to SCWA design criteria standards with minimum freeboard between design water surface and the top of bank of 1.5 feet or 20 percent of the specific energy, whichever is greater. Where this minimum freeboard does not provide the necessary differential head to allow gravity flow for the projected development of the tributary areas, the design water surface shall be lowered sufficiently to allow such areas to drain by gravity.

Roadside ditches shall be designed so that the water surface for the design discharge will be at or below the outside edge of the road shoulder such that there is no flood water in the normal travel-way of the road and below adjacent ground level.

The design flow in natural creeks and constructed natural waterways may be allowed to overflow into an area above the defined banks provided that the flow is contained within a defined overflow area. Freeboard shall be provided, as specified above, between the design water surface and the adjacent ground surface or finished grade of lots or areas on which improvements are to be constructed. Less than 1.5 feet of freeboard may be considered for small natural swales and creeks through open space such as parks and golf courses. In any event, sufficient freeboard shall be provided to retain the 100-year design flow within the right-of-way of the channel.

Prior to computing the required freeboard, the superelevation of the water surface on curves shall be determined by use of formulas listed in Table I-2, and the design water surface shall be adjusted accordingly. Open channels shall not be designed with a slope in the range of plus or minus 20 percent of critical slope unless added freeboard for instability waves is provided as determined from the formula listed in Table I-2. Channels designed for supercritical flow shall have their sequent (normal) depth below the top of bank.

Channels shall be designed taking into account the energy losses due to existing and proposed future road crossing structures or other obstructions within the channel. Refer to the latest edition of the SCWA Flood Control Design Criteria Manual for required allowances and other design considerations for obstructions within open channels.

Bridges, culverts and utility crossings which span major and secondary open channels and which are existing, planned or projected at the time of channel design shall have a minimum clearance from soffit to design water surface of 1.0 foot and shall cause no encroachment on the specified minimum freeboard in the upstream channel or waterway.
Constructed natural waterways shall be excavated as required to pass the design flow through interim and ultimate conditions of natural plant and tree growth and of other natural channel characteristics. Trees and other plants and grasses shown on the proposed development plans shall be planted as a part of initial construction to promote and encourage ultimate natural appearance.

Constructed natural waterways, in their final development and growth stages, shall satisfy the freeboard requirements for open channels described above. Constructed natural waterways are appropriate in any situation where right-of-way space can be provided.

Open channels which will be maintained by the SCWA must be designed as specified in the SCWA Flood Control Design Criteria Manual.

**Closed Conduits.** The design depth in circular conduits shall not exceed 0.80 of the diameter of the conduit for major and secondary waterways. Closed conduits used as minor waterways may be designed to flow full or surcharged. The hydraulic entrance condition at a closed conduit used as a minor waterway will be designed so that the required freeboard in the upstream channel is provided for the 10-year design flow and the 100-year design flow is contained within the banks of the upstream channel. The entrance to the closed conduit may be submerged provided the above criteria are satisfied.

At inlets, catch basins, and nonpressure-type manholes within a closed conduit system, the design flow hydraulic gradeline shall be at least 1.0 foot below the top of curb or of adjacent ground surface if the area is unpaved unless otherwise approved. At locations where conduits are stubbed out for future extension, the design hydraulic gradeline shall be low enough to allow proper drainage of the future tributary area and shall be a minimum of 1.5 feet below general existing ground level unless otherwise approved. For closed conduits designed for supercritical flow, the energy gradeline shall not be above ground level at inlets, catch basins, and nonpressure-type manholes. Where the energy grade line is above the existing ground elevation bolt down manhole covers shall be used.

Energy losses due to debris load caused by splitting flow at the entrance to or within a closed conduit system shall be computed in the same manner as obstruction losses in open channels. In addition to normal friction losses, energy losses due to entrance and exit conditions, bends, and transitions shall be computed and considered.

**DETENTION BASINS:**

The following section on detention basins is not included in the Sonoma County Water Agency Flood Control Design Criteria.

Detention basins are natural or constructed basins that receive and hold storm water runoff to reduce downstream peak flows for flood control purposes and/or to enhance water quality. Detention basins are allowed only with the approval of the City Engineer. Publicly maintained storm water ponds with permanent pools of water are prohibited. However, approval may be granted provided the applicant/developer executes a binding agreement to provide funding, in perpetuity, for the maintenance costs associated with these facilities.

Detention basins should be designed to be multipurpose wherever possible and designed to enhance storm water quality. Detention basins whose primary purpose is water quality enhancement will be considered during planning for storm drain system improvements and in
accordance with the current approved Standard Urban Storm Water Mitigation Plan (SUSMP) unless approved otherwise by the City Engineer. Flows in excess of the detention basin design flows will be diverted around the detention basin.

Publicly maintained detention facilities for flood control purposes may be permitted, with the approval of the City Engineer, when it is more cost-effective than providing storm drains. An analysis, which justifies the financial need for the detention basin by presenting both the estimated capital cost and the estimated annual operation and maintenance costs of the basin as well as comparable costs for an underground closed conduit storm drain system, shall be prepared under the direction of a civil engineer and submitted for approval by the City Engineer prior to approval of a tentative map with the City Community Development Department. The City Engineer may prohibit or restrict the use of detention basins based on specific site conditions such as insufficient depth to bedrock; extreme community disruption; need for extensive relocation of existing improvements and utilities; or lack of sufficient, available, suitable land.

The design of detention basins for flood control purposes shall be based on the size of the basin; the maximum allowable depth of temporary ponding; the recurrence interval of the storm being considered; the peak rate, total volume, and timing of the inflow; the maximum allowable outflow rate; and the length of time water is allowed to remain in the basin. The design shall be accomplished through the development of three items: an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. These three items shall be combined in a routing routine to obtain the outflow rate, depth of stored water, and volume of storage at any specific time as the design storm flow passes through the detention basin. The design considerations and procedures are discussed in Design and Construction of Urban Stormwater Management Systems, Chapter 6, WEF Manual of Practice FD-20, 1992. Pumped discharges from publicly maintained detention facilities are prohibited.

The design considerations cited above determine the detention basin volume required for flood control purposes only. Design of detention basins should also take into consideration other benefits that can be achieved, such as water quality enhancement, recreational opportunities, and open space aesthetic enjoyment. Public health and safety needs should be considered, such as the need for vector control and fencing in particular applications. Detention basin designs must promote personal safety by locating basin along public streets to assure visual access to basin area. Site, street and basin design should be coordinated to orient buildings and streets for good surveillance of basin area.

The geometry of the basin should be designed to reduce dead zones and increase detention times. Inlet and outlet structures must be carefully designed to reduce turbulence that could resuspend settled solids. Consideration should be given to installation of energy dissipators, stilling basins, berms, and separation walls.

To prevent erosion during large storm flows, unprotected side slopes should be no steeper than 3 horizontal:1 vertical. Steeper banks will only be allowed with the approval of the City Engineer and shall be protected by vegetation and/or rip rap.

Detention basins shall be designed and constructed for easy access to the basin itself and all inlet and outlet structures. Access to the bottom of the basin is necessary. Basins to be maintained by City staff must meet City accessibility criteria discussed below under "Design Requirements."
DESIGN REQUIREMENTS

1. CONNECTION TO THE EXISTING STORM DRAIN SYSTEM

A. New storm drain systems must connect to an existing City or County of Sonoma storm drain facility, a channel or creek maintained by the SCWA, or an approved natural waterway. Storm drain designs shall incorporate the design of any off-site storm drain improvements required to accommodate flow from the storm drain system for the proposed development. A structure must be installed at each connection (i.e., no "blind" connections) except as otherwise approved by the City Engineer.

B. Where public storm drains must traverse private property, inlets necessary to drain the private property are permitted to connect to the public storm drain. These inlets and connecting pipes shall be clearly delineated as private on the improvement plans.

C. Sump pumps for non-residential or mixed land uses shall not discharge to gutters or sidewalk drains. Sump pumps shall discharge into closed conduit systems or open channels, if permitted by the North Coast Regional Water Quality Control Board. Sump pumps for nonresidential land uses shall discharge at a structure (i.e., no blind connections). Sump pumps which may discharge liquids other than uncontaminated water (e.g., oil, grease, solvents, etc.) shall discharge to sanitary sewers, if approved by the City's Utilities Department; industrial pretreatment of these discharges may be required. Sump pumps for single-family residences shall be allowed to discharge to sidewalk drains or gutters by gravity flow only. (For instance, by pumping to a box and then allowing the water to gravity flow through curb into the gutter.)

D. Concentrated drainage flows in pipe systems from private property shall not flow over public sidewalks. Sidewalk drains or other means of collection and conveyance to a proper discharge location shall be provided.

2. MATERIALS

A. Storm drain pipes 15 inches in diameter or larger shall be reinforced concrete pipe (RCP), cast-in-place concrete pipe (CIPP) or annular high density polyethylene (HDPE) pipe.

B. RCP shall be Class III, IV, or V as specified in Part 3, Public Storm Drain Construction Standard Specifications, of these standards.

Typical total effective loads on buried pipe, expressed in pounds per linear foot of pipe, are shown in Table I-3. The design engineer shall determine the D-load for the depth and diameter of pipe from the table and select the class of RCP with a D-load rating equal to or greater than the value in Table I-3. The design engineer shall interpolate between the values in Table I-3 for conditions not presented in the table.
C. Designers see Section 63 Cast-In-Place-Concrete Pipe Special Inspections for use with CIPP.

D. HDPE pipe shall be smooth interior, corrugated exterior pipe with bell-and-spigot joints, Type S, per AASHTO Designation M294. HDPE pipe shall only be used in sizes of 36-inch or smaller diameter with cover of less than 30 feet. The design engineer shall determine flotation restraint per manufacturer’s recommendations. Minimum cover over pipe shall be 12 inches from the outside top of pipe to subgrade. HDPE pipe shall only be used under pavement areas.

E. Sidewalk drains shall be per Standard 406.

3. SIZE

A. Storm drain pipe diameters within the public right-of-way, including driveway culverts, shall be 15 inches or larger, except sidewalk drains shall be per Standard 406.

B. In new portions of the storm drain system, pipe sizes shall not decrease in the downstream direction.

4. ALIGNMENT

A. Storm drains shall be located within public streets unless otherwise authorized by the City Engineer.

B. Storm drains traversing private property shall be straight between manholes (i.e., no horizontal curves) except when installed in a private street parallel to the centerline of the private street.

C. In general, storm drains shall be installed parallel to the centerline of the street or right-of-way.

D. Horizontal separation of storm drain line from sanitary sewer shall be a minimum of 5 feet clear (i.e., outside of pipe to outside of pipe), except at pipe crossings.

E. Horizontal separation from water mains and other utilities, gas, underground electric, underground television cable, etc., shall be a minimum of 4 feet clear.

F. Vertical curves are not allowed unless specifically authorized by the City Engineer.

G. Horizontal curves with a minimum radius of 300 feet for RCP and CIPP shall be provided at catch basins installed at curbs and gutters so as to locate as much of storm drain as possible under asphaltic concrete paving rather than concrete curbs and gutters.

H. Horizontal curves concentric with public or private street centerlines may be permitted with RCP provided the radius is 300 feet or greater. The minimum allowable radius used with 20 foot sections of HPDE pipe is 765 feet.

I. Horizontal curves can be installed in RCP by pulling pipe joints if the resulting deflections are not greater than the pipe manufacturer’s recommendations. The design engineer shall use the following equation in designing horizontal curves.
for RCP with a diameter over 48 inches:

\[ R = \frac{L}{2(\tan \frac{1}{2} \Delta N)} \]

where:

- \( R \) = radius of curvature of the centerline of the pipeline in feet
- \( L \) = laying length of pipe section in feet, measured along centerline
- \( \Delta \) = total deflection angle of curve in degrees
- \( N \) = number of pipe sections with pulled joints
- \( \Delta/N \) = deflection angle of each pipe in degrees

5. **SLOPE**

Maximum slope for storm drains shall be 15 percent or 15 feet per 100 feet.

6. **COVER**

Minimum cover over storm drains shall be 12 inches (Class III RCP, HDPE and CIPP). Cover is defined as the distance from the outside top of the pipe to the final subgrade (bottom of the structural section) in paved areas or finished grade in unpaved areas. See Table I-3.

7. **MANHOLES AND STRUCTURES**

A. A manhole or accessible structure shall be installed at every change in pipe size.

B. The maximum distance between manholes and/or accessible structures shall be 400 feet.

C. A manhole or accessible structure shall be installed at every horizontal angle point or vertical change in alignment.

D. Sufficient drop shall be provided through manholes and accessible structures to compensate for energy loss caused by change of alignment.

E. Manholes shall be 48 inches in diameter with storm drain pipes of 36 inches diameter or less, and shall be 60 inches in diameter with storm drain pipes larger than 36 inches in diameter. Manholes shall be designed to be large enough to accommodate all pipes connected to manhole with a minimum of 3 inches of manhole wall on both sides of all pipes. Reducer slabs may be provided as shown on Standard 401 in Section 2.

F. An accessible structure shall be provided to connect private storm drains to the public storm drains (i.e., no blind connections) except as otherwise approved by the City Engineer. Structures shall be installed on the private side of the property.
line to distinguish the public system from the private system. Public and private storm drain facilities shall be clearly identified on the improvement plans. For residential land uses only, no structure is necessary for sump pump connections to public storm drain systems. Accessible structures are required for sump pump connections from nonresidential land uses.

G. Headwalls or structures shall be provided where open ditches, channels, and creeks discharge into closed pipe conduits. Refer to Caltrans Standard Plans.

8. CATCH BASINS

A. Catch basins shall be Type II (Standard 402) except as listed below or as otherwise approved by the City Engineer. Galleries per Standard 404 may be used on the upstream side of a Type II catch basin to increase inlet interception capacity or if their use reduces the number of catch basins requiring maintenance.

B. Catch basins shall be installed at the following locations:

- Such that gutter flows do not cross intersections except where valley gutters are allowed.

- Upstream of bridge abutments.

- The beginning of every roadway superelevation that reverses the cross-slope of the pavement.

- The sags (i.e., bottoms) of vertical curves

- The low points of downhill cul-de-sacs

- As required so that water depth in gutter does not exceed 0.4 feet during the design storm event.

- As required to maintain the following number of 8-foot-wide traffic lanes unimpeded by flowing or standing water during a design storm:
  - Two lanes for all regional streets.
  - One lane for transitional and industrial streets. This lane may be in the middle of the road, spanning the crown. This requirement does not apply to local streets.
  - One lane in each direction for transitional streets that are divided roads or roads with a median strip.

- As required so that carry over flows (bypassing catch basins) shall not exceed 2 cubic feet per second.

- At a maximum spacing of 400 feet from another catch basin or manhole.

C. Catch basin size and spacing shall be computed by the methods in Drainage of Highway Pavements, Federal Highway Administration, Hydraulic Engineering
9. EASEMENTS

A. An easement must be provided over any public storm drain when it is installed outside a public right-of-way.

B. The easement must be a minimum of 15' wide if it only contains a publicly-maintained storm drain or 20' wide (or wider) if it contains another facility, such as water, sewer, or other utility. The easement will be dedicated as a "public drainage easement" if it contains storm drain only. It will be dedicated as a "public utilities easement" if it contains other facilities as well.

C. Easements must be configured to encompass all publicly-maintained appurtenances and will be generally centered over the facility. Separate access easements may be required depending on site conditions. When storm drains are to be installed along a property line the easement will be wholly contained on one parcel.

D. All property restrictions placed as a result of dedication of easements will be so noted on the supplemental sheet of the Subdivision Map, or on the Easement Deed if the easement is not dedicated as part of a subdivision. Typical required notes as applicable are:

1. No structures may encroach on, above, or below the surface of the ground in any public easement. This includes footings of foundations, eaves from the roof of any adjacent structure, pools, ponds or outbuildings on slabs or foundations.

2. No trees may be planted in a public storm drain easement without first obtaining approval of the Director of Public Works. Trees may be allowed to the extent that damage to the drainage system does not occur from root intrusion and adequate access can be provided for maintenance and repair vehicles.

3. The Public Works Department will take due caution when performing maintenance or repair of drainage systems in easements, but will not be responsible for repairs or replacement of trees, landscaping or structures not specifically approved by the Director of Public Works.

10. ACCESS ROADS

A. Clear access must be provided and maintained to all public structures on the drainage system.

B. All-weather vehicle access roads are required to every structure on the storm drain system. Access roads must be a minimum of 12' in width and must be provided with turnarounds per City Standard 206 when the back-up distance for any maintenance vehicle exceeds 100'.

C. The design of access roads must be included with the drainage system design plans. At a minimum, the design will conform to the requirements of Standard 216. Include adequate drainage measures in the design to prevent damage to the
access roads from storm water.

D. Gates must be provided for access through any fence crossing a public storm drain easement. Where vehicular access is required for maintenance, minimum 14’ wide gates must be provided with sliding gates preferred. Where vehicular access is not required, 4’ wide gates for pedestrian access must be provided and will be located to permit visual access between storm drain structures.

E. The maximum grade allowed at any point on an access road is 15%. The maximum cross-slope for any access is 5%.

11. MAINTENANCE

A. Storm drains that convey public water, are designed and constructed to City standards, and are in a dedicated public easement or right-of-way accepted by the City shall be maintained for hydraulic capacity by the City. All other storm drains, including driveway culverts, shall be privately maintained.

B. Sidewalk drains shall be privately maintained by the owners of the frontage property.

12. WATER QUALITY TREATMENT

A. Source controls designed or constructed to reduce the discharge of pollutants from the storm water conveyance system shall be designed and maintained in accordance with the Santa Rosa Area Standard Urban Storm Water Mitigation Plan (SUSMP).

13. OTHER REQUIREMENTS

A. Sanitary sewer laterals and industrial process or waste pipelines shall not be connected to storm drains or allowed to discharge to waterways. Sanitary sewer laterals and industrial waste pipelines shall be connected to sanitary sewers in conformance with the latest edition of the City’s Sewer Standards; pretreatment of industrial wastes may be required.

B. Driveway culverts shall be designed under the direction of a civil engineer to convey anticipated flow from future development and ensure hydraulic adequacy.
Table I-1  Rational Method Runoff Coefficients (C)

<table>
<thead>
<tr>
<th>Land use</th>
<th>0–2</th>
<th>&gt;2–7</th>
<th>&gt;7–15</th>
<th>&gt;15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential, Rural (1 unit per 5+ acres)</td>
<td>0.35</td>
<td>0.39</td>
<td>0.43</td>
<td>0.45</td>
</tr>
<tr>
<td>Residential, Very Low Density (1 unit per .5 to 5 acres)</td>
<td>0.40</td>
<td>0.43</td>
<td>0.46</td>
<td>0.50</td>
</tr>
<tr>
<td>Residential, Low Density (2 to 4 units per acre)</td>
<td>0.45</td>
<td>0.49</td>
<td>0.56</td>
<td>0.59</td>
</tr>
<tr>
<td>Residential, Medium-Low Density (4 to 8 units per acre)</td>
<td>0.50</td>
<td>0.56</td>
<td>0.64</td>
<td>0.70</td>
</tr>
<tr>
<td>Residential, Medium Density (8 to 18 units per acre)</td>
<td>0.70</td>
<td>0.74</td>
<td>0.77</td>
<td>0.80</td>
</tr>
<tr>
<td>Residential, Medium-High Density (18 to 30 units per acre)</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>Business, Commercial, Institutional and Schools</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>General Industrial</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>Parks and Recreation</td>
<td>0.31</td>
<td>0.37</td>
<td>0.42</td>
<td>0.45</td>
</tr>
<tr>
<td>Agricultural and Open Space</td>
<td>0.30</td>
<td>0.35</td>
<td>0.41</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Note:  Coefficients for developments with more than one land use shall be weighted in proportion to the areas of each land use using either the values from Table I-1 or the following formula in on-site design calculations. Off-site design calculations shall use the values from Table I-1.

\[ C = C_v \frac{A_v}{A_t} + 0.9 \frac{A_p}{A_t} \]

Where:
- \( C_v \) = value from the vegetated area curve, SCWA Plate No. B1
- \( A_v \) = vegetated area
- \( A_p \) = impervious area
- \( A_t \) = total area
NOTE:
ISOHYETAL LINES IN MOUNTAINOUS AREAS, AND IN OTHER AREAS WITH LOW RAINGAGE DENSITY ARE BASED ON OROGRAPHIC CONSIDERATIONS. ALL AVAILABLE DATA FROM BOTH LONG-TERM AND SHORT-TERM STATIONS HAVE BEEN USED IN COMPILING THIS MAP.

LEGEND:
LINE OF EQUAL MEAN SEASONAL PRECIPITATION IN INCHES. —— 40 ——

Table I-2  Formulas

Superelevation:
1. Rectangular channels
   a. Subcritical flow \[ S = \frac{3V^2 b}{4gR} \]
   b. Supercritical flow \[ S = 1.2 \frac{V^2 b}{gR} \]
2. Trapezoidal channels
   a. Subcritical flow
      \[ S = \frac{V^2(b + 2Zd)}{2(gR - 2ZV^2)} \]
   b. Supercritical flow

Instability Waves:
\[ H_w = 0.25 d_c \left[ 1 - 11.1 \left( \frac{S^2}{S_c^2} - 1 \right)^2 \right] \]

Definitions:
\[
\begin{align*}
S & = \text{superelevation above normal water surface (feet)} \\
V & = \text{average velocity (fps)} \\
b & = \text{channel bottom width (feet)} \\
R & = \text{centerline radius (feet)} \\
g & = \text{acceleration due to gravity (fps}^2) \\
Z & = \text{cotangent of bank slope} \\
d & = \text{normal depth (feet)} \\
d_c & = \text{critical depth (feet)} \\
S_c & = \text{critical slope} \\
S_o & = \text{channel bottom slope} \\
H_w & = \text{height of wave above normal depth (feet)}
\end{align*}
\]

Source: Sonoma County Water Agency
**Table I-3  LOADS ON BURIED PIPES**

**POUNDS PER LINEAR FOOT**

<table>
<thead>
<tr>
<th>Cover to Subgrade</th>
<th>Pipe Diameter In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>in feet</td>
<td>15</td>
</tr>
<tr>
<td>-------</td>
<td>----</td>
</tr>
<tr>
<td>1</td>
<td>*</td>
</tr>
<tr>
<td>2</td>
<td>1632</td>
</tr>
<tr>
<td>3</td>
<td>931</td>
</tr>
<tr>
<td>4</td>
<td>857</td>
</tr>
<tr>
<td>5</td>
<td>878</td>
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<td>6</td>
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<td>7</td>
<td>974</td>
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<td>8</td>
<td>1029</td>
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</tr>
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<td>10</td>
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<tr>
<td>11</td>
<td>1191</td>
</tr>
<tr>
<td>12</td>
<td>1236</td>
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<tr>
<td>13</td>
<td>1315</td>
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<tr>
<td>14</td>
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<td>15</td>
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<td>16</td>
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<td>17</td>
<td>1542</td>
</tr>
<tr>
<td>19</td>
<td>1613</td>
</tr>
<tr>
<td>20</td>
<td>1632</td>
</tr>
<tr>
<td>21</td>
<td>1644</td>
</tr>
</tbody>
</table>

**Allowable Loads:**
- Class III 1,350 pounds/linear foot
- Class IV 2,000 pounds/linear foot
- Class V 3,000 pounds/linear foot

The area within the heavy black line indicates situation where Class III RCP is acceptable.

* Exceeds the capacity of Class V RCP. Special design required to be submitted to City Engineer.

Reference: Ameron Reinforced Concrete Pressure Pipe, 1971, for covers of 2 feet or greater. Loads are interpolated for covers of 1 foot.
2. PUBLIC STORM DRAIN STANDARD DETAILS

<table>
<thead>
<tr>
<th>Std.</th>
<th>Title</th>
<th>Approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>Standard Precast Concrete Storm Drain Manhole</td>
<td>April 2005</td>
</tr>
<tr>
<td>401</td>
<td>Precast Concrete Storm Drain Manhole Reducer Slabs</td>
<td>April 2005</td>
</tr>
<tr>
<td>402</td>
<td>Type II Catch Basin</td>
<td>April 2005</td>
</tr>
<tr>
<td>403</td>
<td>Type I Catch Basin</td>
<td>April 2005</td>
</tr>
<tr>
<td>404</td>
<td>Storm Drain Gallery</td>
<td>April 2005</td>
</tr>
<tr>
<td>405</td>
<td>Precast Catch Basin Cover</td>
<td>April 2005</td>
</tr>
<tr>
<td>406A</td>
<td>3&quot; Sidewalk Drain</td>
<td>April 2005</td>
</tr>
<tr>
<td>406B</td>
<td>3&quot; x 12-1/2&quot; Cast Iron Sidewalk Drain</td>
<td>April 2005</td>
</tr>
<tr>
<td>407</td>
<td>Loose Rock Rip-Rap Storm Drain Outlet</td>
<td>April 2005</td>
</tr>
<tr>
<td>408</td>
<td>Precast Side Opening Field Drain</td>
<td>April 2005</td>
</tr>
<tr>
<td>409</td>
<td>Storm Drain Labels</td>
<td>April 2005</td>
</tr>
</tbody>
</table>
NOTES:

1. When manholes are installed in unimproved areas, the top of the cover shall be a min. of 1 foot above adjacent finished grade.

2. Min. of one 3” grade adjustment ring. Max. height of grade adjustment rings = 20”. Alternatively, contractor may cast grade adjustment rings in place.

3. Set all sections in 1:3 mortar bed. Wet both tongue and groove before applying mortar. Wipe inside of joint smooth and plaster outside of joint with 1/2” layer of mortar. Ram–nek gaskets or approved equal may be used instead of mortar.

4. Cone section (taper) may be concentric or eccentric unless otherwise specified by the Engineer.

5. All precast manhole sections per ASTM C478.

6. Class “A” conc. collar shall be 2” below top of manhole cover in improved surface areas.

7. Poured–in–place base shall be poured full thickness to undisturbed sides of excavation, sloped at 1:1 or shall be formed. Precast base shall be from City Engineer’s approved list and be placed on 6” thick 3/4” drain rock sub–base installed against undisturbed earth.

APPROVED 48” & 60” PRECAST STORM DRAIN MANHOLE COMPONENTS

See Engineer’s approved list

CITY OF SANTA ROSA
STANDARD CONCRETE STORM DRAIN MANHOLE

SCALE: None DATE: 04/2005
OWN: DIT CHK. APPROVED
STD– 400
#5 lifting eye (TOTAL 2). Lifting eye to be located at balance point.

Standard manhole frame and cover, see STD. 512. Cover to be labeled "STORM DRAIN". Pick holes may be open or closed.

NOTES:

1. Reducer slab shall be designed to withstand H2O loading and conform to ASTM C478.

2. All inside joints to be grouted smooth.

3. Class A concrete collar shall be poured to 2" below finished grade.

4. Reducers shall be concentric. Eccentric reducers can be used if it would place the opening in a more desirable location or improve access.

For detail and specifications of barrel section and base see City of Santa Rosa Std. 400.

CITY OF SANTA ROSA

PRECAST CONCRETE STORM DRAIN MANHOLE REDUCER SLABS

APPROVED 48" and 60" MANHOLE REDUCER SLAB
See Engineer's approved list

SCALE: none        DATE: 04/2005
DWN. DPT APPROVED
CHK.

STD-401
NOTES:
1. Catch basin box shall be constructed to withstand H2O loading.
2. Concrete shall have a compressive strength of 4000 psi in 28 days.
3. Wall thickness shall be 6" unless depth is greater than 8", then wall thickness shall be 8".
4. Install label per City Std 409.
TOP TO BE PREFAB OR POURED IN PLACE USING FIBERGLASS INLET LINER.

PLAN

SECTION B-B

SECTION A-A

NOTES:
1. Concrete shall have a compressive strength of 4000 psi in 28 days.
2. Grate and noding angle shall be hot dipped galvanized after fabrication per ASTM A-123.
3. Grate frames shall be installed tight against gutter flowline.
4. Catch basin box and grate shall be constructed to withstand H2O loading.
5. Install label per City Std 409.

ONLY TO BE USED WHERE SPECIFICALLY APPROVED BY VARIANCE.

APPROVED TYPE I CATCH BASINS
See Engineer’s approved list

CITY OF SANTA ROSA

TYPE I CATCH BASIN

SCALE: none  DATE: 04/2005
DWN.DIT  CHK.  APPROVED
STD-403
PRECAST CATCH BASIN WITH GALLERY (RIGHT OR LEFT). SEE STDS 402, 405 AND 409.

DEPRESS GUTTER FLOWLINE (BOTH SIDES)

BLOCKOUT OPENING IN CATCH BASIN TO DRAIN GALLERY.

ISOMETRIC VIEW

3-1/2"x3-1/2"x1/4"
ANGLE NOSING

TOP OF CURB

1-1/2" NOTCH

ANCHORS

5" MIN.
FIBERGLASS LINER

WOVEN WIRE REINFORCING

TYPICAL SECTION INSTALLED

NOTES:
1. Nosing assembly shall be hot dipped galvanized after fabrication per ASTM A-123

2. Concrete shall be class A.

3. Install label per City Std 409.

CITY OF SANTA ROSA

STORM DRAIN GALLERY

APPROVED STORM DRAIN GALLERY FORM
See Engineer’s approved list
Precast lid 26-3/4" X 2" with cast iron lid ring.

3-1/2" X 2-1/2" X 1/4" Galv. nosing angle.

5" radius fillet

ISOMETRIC

NOTES:
1. Concrete shall have a compressive strength of 4000 PSI at 28 days.

2. Nosing angle shall be galvanized in accordance with ASTM specification A-123.

3. Exposed concrete surface shall have broom finish.


5. Apply label per City Std 409.

6. Frame ring inside diameter to be 5/16" to 3/8" greater than lid ring outside diameter.

ELEVATION

SECTION A-A

CITY OF SANTA ROSA

PRECAST CATCH BASIN COVER

SCALE: None DATE: 04/2005

OWN. DIT APPROVED
CHK. STD-405

APPROVED PRECAST CATCH BASIN COVERS
See Engineer’s approved list.
NOTES

1. Wire mesh shall be full width of sidewalk minus 2". Length of wire mesh shall, at a minimum, equal the width and be centered over the pipe.

2. On-site drainage and location of curb outlets shall be by owner to the satisfaction of the City Engineer.

3. Drain pipe shall be installed so that the top of pipe is $2\frac{1}{2}''$ (min.) below finished grade at back of sidewalk.

4. Sidewalk shall be removed to the nearest scoremark.

5. If sidewalk and gutter are not contiguous, curb may be cored or curb and gutter removed and replaced a minimum of one foot on each side of the drain pipe. Dowel new gutter to existing curb and gutter with (2) 12" #4 rebars, place one dowel in curb and one in gutter pan using epoxy.

6. If sidewalk and gutter are contiguous, pour monolithic with wire fabric extending into curb.
NOTES
1. Wire mesh shall be full width of sidewalk minus 2". Length of wire mesh shall, at a minimum, equal the width and be centered over the pipe.

2. On-site drainage and location of curb outlets shall be by owner to the satisfaction of the City Engineer.

3. Drain pipe shall be installed so that the top of pipe is 2½" (min.) below finished grade at back of sidewalk.

4. Sidewalk shall be removed to the nearest scoremark.

5. If sidewalk and gutter are not contiguous, remove curb and gutter a minimum of one foot on each side of the drain pipe. Dowel new gutter to existing curb and gutter with (2) 12" #4 rebar, place one dowel in curb and one in gutter pan using epoxy.

6. If sidewalk and gutter are contiguous, pour monolithic with wire fabric extending into curb.
TOP OF BANK

PIPE DIAMETER + 4 FT
MINIMUM WIDTH.

LOOSE ROCK
RIP-RAP COLLAR
WITH 4" EARTH
COVERING TO FILL
VOIDS

DITCH FLOWLINE

L - 18" MINIMUM

STORM DRAIN OUTLET
ELEVATION

2' EACH SIDE OF PIPE. MINIMUM.

18" THICK LOOSE ROCK COLLAR W/ 4" EARTH COVER
CUT PIPE TO CONFORM WITH DITCH SIDE SLOPE

(2) #4 BARS

HDPE, RCP or CIPP

6" MIN.

C.M.P. or HDPE 20' LENGTH =

CONCRETE COLLAR FOR DISSIMILAR MATERIALS

D + Y + 2'

WHEN D < 24" Y = 2'
WHEN D ≥ 24" Y = 1'

SECTION "A - A"

NOTES:

1. CMP shall conform with Section 66-3 of the Standard Specifications.

2. HDPE pipe shall conform with Section 64 of the Standard Specifications for type S pipe.

CITY OF SANTA ROSA

LOOSE ROCK RIP-RAP STORM DRAIN OUTLET

SCALE: None DATE: 04/2005

CHK: STD- 407
ROCK SLOPE PROTECTION

MATERIALS

Rocks shall be angular and well graded from an average diameter of four (4) inches to an average diameter of fifteen (15) inches with approximately fifty (50) percent by weight smaller than nine (9) inches in average diameter. Not more than ten (10) percent of the rock riprap by weight shall be less than four (4) inches average diameter. Not more than ten (10) percent of the rock riprap by weight shall be greater than fifteen (15) inches in average diameter and none shall exceed an average diameter of twenty 20" inches.
GROUT ALL VOIDS BETWEEN PIPE AND BOX

1/4" GALVANIZED CHECKER PLATE COVER

24" SQUARE (MINIMUM)

5" MIN.

SECURE WITH ANCHOR BOLTS IN EACH CORNER

SIDE OPENINGS AS NEEDED
SET TO FLOWLINE OF DITCH

NOTES:
1. Field drain box shall be constructed to withstand H2O loading.

2. Concrete shall have a compressive strength of 4000 psi in 28 days.

CITY OF SANTA ROSA

PRECAST SIDE OPENING FIELD DRAIN

See Engineer's approved list

SCALE: NONE \n\nDATE: 04/2005

DWN.DIT CHK. APPROVED STD- 408
NOTES:

1. Affix decal to center of catch basin lid ONLY if catch basin is not part of the sidewalk.

2. If the catch basin lid is cast iron AND the catch basin is not part of the sidewalk affix label in this location, oriented to be read from the street.

3. Affix label on the curb face right of the catch basin if catch basin is part of the sidewalk. The left side may be used if the right side curb is damaged or painted.

APPROVED STORM DRAIN LABELS

See Engineer's approved list.
3. PUBLIC STORM DRAIN CONSTRUCTION STANDARD SPECIFICATIONS

CONTENTS

Section 51 Concrete Structures
Section 63 Cast-in-Place Concrete Pipe
Section 64 Plastic Pipe
Section 65 Reinforced Concrete Pipe
Section 79 Video Inspection of Storm Drains
Section 90 Portland Cement Concrete
SECTION 51. CONCRETE STRUCTURES

51-1.02 Minor Structures

Catch basins shall be constructed to the details and at the locations shown on the plans and in accordance with these Specifications. Catch basin covers shall be concrete with cast iron frame.

Storm drain manholes and drop inlets shall be constructed in conformance with the details and at the locations shown on the plans and in accordance with these Specifications.

51-1.04 Structures

Storm drain manholes shall be standard 48" diameter precast concrete manholes or 60" diameter precast concrete manhole at the locations shown on the plans and in accordance with City Standard Details.

Concrete for manhole bases shall be Class A portland cement concrete conforming to the applicable requirements of Section 90 of the Standard Specifications and shall be poured full thickness against the sides of the manhole excavation or shall be formed.

Manhole barrels and taper sections shall be precast concrete sections using Type II portland cement complying with ASTM Designation: C150. The barrel and taper sections shall be constructed in accordance with the applicable provisions of ASTM Designation: C478.

Top of manhole frames and covers shall be set accurately to the final finished grade in paved streets and to the elevation shown in unimproved areas.

Concrete for catch basins shall be Class “A” portland cement concrete conforming to the requirements of Section 90 of the Standard Specifications.

In lieu of the inspection of reinforcing steel as provided under Section 52-1.04 of the Standard Specifications, upon request the Contractor shall furnish the Engineer with a certificate from the supplier of the reinforcing steel stating that the steel delivered complies with the requirements of Section 52-1.02 of the Standard Specifications.

Bar reinforcing shall conform to and be placed in accordance with Section 52 of the Standard Specifications.

Connections to existing storm drain structures shall be made with care to avoid unnecessary damage to any existing curb and gutter or sidewalk. Any damaged section shall be removed and replaced in accordance with City Standards and as approved by the Engineer. Pipe connections to the existing structures shall be sealed with cement mortar.

Drop inlets and grates shall be bicycle-safe and designed for H20 loading. Frame and grate shall be hot-dipped galvanized after fabrication.
51-1.135 Mortar

51-1.135A Description

Mortar shall consist of a mixture of Type II Portland Cement complying with ASTM C150, sand, and water. Sand for mortar shall be clean, dry, well-graded sand, free of organic or other deleterious matter, silt or other objectionable matter, and shall be of such size as determined by laboratory sieves, that all will pass a No. 30 sieve size, square openings.

Mortar shall consist of one part by volume of cement and three parts by volume of sand. The mortar shall contain only enough water to permit placing and packing. Mixed mortar shall be used before initial set and in no case will retempering with additional water be permitted.

Mortar shall conform to the requirements of Section 51-1.135 of the State Standard Specifications.

51-1.135B Admixtures

No admixtures will be permitted unless authorized by the ENGINEER.

51-1.135C Curing

After placing, all surface of mortar shall be cured by the water method in accordance with Section 90-7, "Curing Concrete" of the State Standard Specifications, for a period of not less than 3 days.
SECTION 63. CAST-IN-PLACE CONCRETE PIPE

63-1.02 Materials

Consistency of the concrete shall be determined in accordance with ASTM C143. Maximum slump shall be 2-inches.

63-1.03 Inspection

For private development projects, full time inspection of all public cast-in-place concrete pipe shall be provided by the project developer. The name and contact information for the specialty inspector shall be submitted to the City Public Works Department two weeks prior to commencement of pour. No pipe shall be poured without the presence of the specialty inspector onsite. Within 30 days of completion of pour, the private inspector shall submit to the City an inspection report listing dates, locations, measured wall thickness, and other details of the inspection. The private inspector’s report shall certify that the pipe meets the requirements of the specifications and shall be stamped and signed by a registered civil engineer. No paving or other construction over the pipe, except backfilling, shall proceed prior to City approval of the private inspector’s report. The private inspector shall comply with OSHA requirements for permit-required confined spaces per Federal Register 29 CFR part 1910.146.

63-1.05A Structures

Where shown on the plans, inlet and outlet structures shall be constructed or installed in connection with cast-in-place concrete pipe. Where such structures are constructed or installed, the ends of pipes shall be placed flush or cut off flush with the structure face, unless otherwise directed by the Engineer.

A starter section shall be used where the beginning of a run of cast-in-place concrete pipe is at a structure, and a closing section shall be used where a run cannot be completed because of lack of clearance ahead in the trench. Starter sections, as required, shall be 6 feet in length and of the same inside diameter as the cast-in-place concrete pipe. Manhole bases and or structures may be formed by opening and troweling the cast-in-place concrete pipe on continuous runs.

Structures shall be as described in Section 65-1.04 of the City of Santa Rosa Construction Specifications for Public Improvements.

63-1.06 Curing and Protecting Concrete.
(The following shall apply in lieu of Sec. 63-1.06.)

Backfill shall be placed in accordance with STD 215 of the City of Santa Rosa Design and Construction Standards, except that the pipe bedding specifications shall not apply.

Curing and protecting concrete shall comply with the following requirements:
The concrete shall be cured by placing trench backfill complying with the specifications contained in STD-215 to an approximate depth of 0.5 foot following application of either a waterproof membrane or a pigmented curing compound as provided in Section 90-7, "Curing Concrete."

Hand spraying of the curing compound will be permitted. During the period following the placement of the concrete, the ends of the pipeline shall be covered with suitable material to maintain a humid condition within the pipe for a minimum of 7 days.

Initial backfill placement shall be made immediately after the concrete has hardened sufficiently to prevent damage to the pipe during backfill operations.

The concrete pipe shall be protected as provided in Section 90-8, "Protecting Concrete."

After the pipeline has been completed, but not prior to 7 days following the placement of the concrete, the Contractor shall backfill the pipe trench in accordance with the requirements of STD-215.

In all cases, the Contractor shall be responsible for correcting any damage to cast-in-place concrete pipe caused by premature or excessive loading prior to the end of a 7-day curing period.

63-1.07 Television Inspection of Cast-in-Place Concrete Storm Drain Pipe

Television inspection of cast-in-place concrete storm drain pipe shall be as described in Section 79 of these Specifications.
SECTION 64. PLASTIC PIPE

64-1.01 Description

All plastic storm drain pipe shall be type S corrugated polyethylene pipe.

64-1.02 Size and Materials

Plastic pipe for use in public storm drain systems shall be Type S, smooth interior wall, corrugated exterior wall, high density polyethylene pipe (HDPE) as specified in AASHTO designation M294. Pipe shall be manufactured from virgin compounds with no plasticizers. HDPE compounds used in the manufacture of plastic pipe shall be per the Standard Specifications.

64-1.04 Couplings and Fittings

Pipe couplings and fittings shall be a bell and spigot joint with a rubber gasket on the spigot meeting ASTM F-477 and shall provide a soil-tight seal and be made of the same material and from the same manufacturer as the pipe. The method of joining pipes and fittings shall be as recommended by the pipe manufacturer. Pipes and fittings coupled together shall have no more than one corrugation distance of separation between them.

64-1.05 Excavation and Backfill

Excavation and backfill shall be as shown on STD 215 of the City of Santa Rosa Design and Construction Standards and the following provisions.

The space between the pipe and trench wall shall be wider than the compaction equipment used in the pipe zone, regardless of the dimensions shown on the STD 215 unless self-compacting backfill material is used.

Pipe bedding will be placed in 6" (maximum) lifts to 6" above the top of pipe with each lift hand or mechanically tamped. The final lift may be compacted with a plate type vibrating compactor.

During construction, heavy equipment vehicle loads shall be avoided over the pipe or additional cover shall be placed at vehicle crossings.

64-1.07 Laying Pipe

Plastic storm drain pipe shall be installed in accordance with the Standard Specifications, generally accepted practice and on the alignment and grade as shown on the plans. When long radius curves are permitted, adjustments in horizontal alignment will be achieved through adjustments at each coupling, within manufacturer’s specification, and not by bending of the pipe.

Pipe shall be centered in the trench.
Unless otherwise specifically permitted by the Engineer, all pipe shall be laid upgrade.

Where ground water or surface drainage occurs, pumping shall continue until backfilling has progressed to a sufficient height to prevent flotation of the pipe.

64-1.10 Television Inspection of Plastic Storm Drain Pipe

Television inspection of plastic storm drain pipe shall be as described in Section 79 of these Specifications.

64-2.01 Trench Shoring and Bracing - Storm Drain

All bracing and shoring shall conform to Section 65-2 of these Specifications.
SECTION 65. REINFORCED CONCRETE PIPE

65-1.01 Description

Reinforced concrete pipe shall be installed on the alignment and grade as shown on the plans and in accordance with the applicable provisions of Section 65 of the City of Santa Rosa Construction Specifications and as directed by the Engineer. Reinforced concrete pipe shall be Class III, Class IV, or Class V, as shown on the plans, and shall conform to the provisions of ASTM C76.

65-1.02 Materials

All concrete pipe shall conform to the provisions of Section 65-1.02 of the Standard Specifications prior to shipment from the manufacturer.

65-1.03 Earthwork

Excavation and backfill shall conform to the City of Santa Rosa Construction Specifications. Backfill shall be in accordance with STD 215 and as shown on the plans.

If, during excavation for any culvert or structure, material is encountered which is unsuitable as a foundation for such culvert or structure, such unsuitable material shall be removed to a depth as required by the Engineer and the resulting space shall be refilled with approved material.

Trenching operations shall be conducted in such a manner as not to disturb the existing curb and gutter and existing utilities.

Trenching operations for pipelines and structures shall be conducted in such a manner to minimize damage to existing tree roots. Hand digging shall be used where necessary to protect tree roots. Where tree roots are encountered, root pruning shall be accomplished by use of sharp tools appropriate for the size of root to be cut. Each cut shall be clean with no torn bark or splintered wood remaining on the tree. All tree work shall be performed by a certified arborist from the list approved by the City.

All raised pavement markers, street striping, chatter bars or any other traffic markings disturbed during work shall be replaced in kind by the Contractor to the satisfaction of the Engineer.

Excavation and backfill shall be as shown on STD 215.

65-1.07 Laying Culvert Pipe

Unless otherwise specifically permitted by the Engineer, all pipe shall be laid upgrade. No pipe shall be laid which is cracked, checked, spalled, or damaged and which, in the opinion of the Engineer, is unsuitable for use.

Proper implements, tools, and facilities satisfactory to the Engineer shall be provided and used by the contractor for the safe and efficient execution of the work. All pipe, fittings, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. The pipes and accessories shall be inspected for visible defects prior to lowering into the trench. Any visibly-defective or unsound pipe shall be replaced.

The line and grade of existing utilities designated to remain shall not be altered. Any leakage
caused in existing utilities by reason of the Contractor’s operations shall be immediately repaired at the Contractor’s expense.

Existing water lines shall be supported in place maintaining service during construction. The Contractor shall be responsible for any damage to the water lines during construction and any damage resulting from improper backfilling techniques. Water services shall be relocated where encountered during construction and as shown on the plans.

Existing sewer lines shall be supported in place maintaining service during construction. The Contractor shall be responsible for any damage to the sewer lines during construction and any damage resulting from improper backfilling techniques.

65-1.08 Television Inspection of Reinforced Concrete Storm Drain Pipe

Television inspection of cast-in-place concrete storm drain pipe shall be as described in Section 79 of these Specifications.

65-2 Trench Bracing and Shoring - Storm Drain

65-2.01 Description

All bracing and shoring shall conform to Section 5-1.02A and Section 7-1.01E of the Standard Specifications and the Division of Industrial Safety Construction Safety Orders which are currently in use.

The Contractor shall take all necessary measures to protect the workers and adjacent areas and structures from the hazards of the trenching or excavation operations.
SECTION 79. VIDEO INSPECTION OF STORM DRAINS

79-1.01 Description

Television inspection of all new and modified storm drain pipes and structures is required.

The contractor shall hire an independent pipe video inspection service to perform the inspection. The camera used shall be self-propelled or pulled, be able to pan and tilt and shall be equipped with high-intensity lights. A VHS video tape or digital video on CD or DVD in an acceptable format of the television inspection shall be produced along with a printed log of the inspection and delivered to the Engineer. The pipe video inspection service shall be pre-approved by the City.

The pan and tilt color camera used for the inspection shall be specifically designed and constructed for such inspection. The camera shall be mounted on adjustable skids or tractor to keep it in the center of the pipe. Lighting for the camera shall be supplied by a lamp(s) on the camera, capable of being dimmed or brightened remotely from the control panel. The lighting system shall be capable of illuminating the entire periphery of the pipe. The color camera shall be operative in 100% humidity conditions and shall have a minimum of 330 lines of resolution but must be capable of discerning small, hairline cracks and other minor defects.

The pan and tilt color camera shall be moved through the line at a uniform slow rate of 30 feet per minute maximum. A 2-inch depth gauge shall be pulled or pushed in front of the camera.

All pipe cleaning prior to the video inspection will be at the contractor’s expense. All cleaning water and debris shall be captured, removed and properly disposed. Cleaning water will not be allowed to discharge to the storm drain system.

The contractor is responsible for all stuck, broken or lost equipment and shall bear all necessary cost to retrieve said equipment including dig ups.

All work performed must meet quality and clarity standards set by the City of Santa Rosa and are subject to Public Works review. A pan and tilt color camera will be used for all video inspections of storm drains within the jurisdiction of the City of Santa Rosa.

The following conditions shall exist prior to the television inspection:

• All storm drain pipes shall be installed, grouted, backfilled to 5 feet over the top of the pipe or to subgrade, and compacted;

• Conduits or pipelines for all underground utilities (sewer, water, cable television, telephone, electrical, gas, street light) that cross storm drain trench shall be installed;

• The bases of all structures shall be in place and grouted;
• The system shall be cleaned and all debris removed;

• Street shall be unpaved;

When the above work has been completed, the contractor shall notify the Engineer 48 hours in advance of the date for television inspection. Immediately before inspection the system shall be flushed with clean water. During this inspection, the contractor or authorized representative shall be present to observe the video as provided by the television camera.

At the beginning of each run of storm drain pipe the video shall display:

1. The project name;
2. Date;
3. Company performing the inspection;
4. Run number (unique designation for each section of pipe);
5. Street name (if applicable);
6. Pipe size;
7. Pipe material;
8. Structure numbers (as labeled on the plans) at each end of the pipe;
9. Direction of the camera;
10. Type of structure.

The video tape shall display the following information continuously during the run:

1. The camera’s location via a continuously updated footage counter measuring the distance from point of entry;
2. Project name;
3. Structure numbers (as shown on the plans) at each end of the run;
4. Run number.

The camera shall stop at all structures, connections or defects (sags, bad joints, etc.) for a period of at least 10 seconds and be noted on the log sheet. The camera will be panned or tilted toward the connection or defect so that any portion of the connection or defect that is visible from within the pipe or structure can be completely inspected.

A printed record shall be made for each pipe run and shall clearly show the:

1. Run number;
2. Structure number at each end of the run;
3. Direction of camera travel;
4. Location and description of each defect discovered by the camera;
5. Line size;
6. Length of run;
7. Structure depths;
8. Location of blind connections.
The video inspection disk or tape and report shall be delivered together to the Engineer and become the property of the City of Santa Rosa.

The following video tape observations shall be considered defects in the construction of the storm drain system and will require corrections prior to acceptance:

- Off grade - 0.08' or more deviation from grade;
- Joint separations;
- Offset joints;
- Cracked or damaged pipe or evidence of the presence of an external object bearing upon the pipe (rock, root, etc.);
- Debris or other foreign objects;
- Pipe deflections greater than 7.5% of base diameter, measured inside the pipe;
- Other obvious deficiencies when compared to approved Plans and Specifications, these Standards and City Design and Construction Standards.

The contractor will be notified in writing of any deficiencies revealed by the television inspection that will require repair, following which the contractor shall excavate and make the necessary repairs and request a television re-inspection. Television re-inspection shall be at the contractor’s expense.

Any subsequent televising of the lines, if deemed necessary by the City, shall be completed at the City’s expense. Any defects found prior to or during the warranty period shall be corrected by the contractor.
SECTION 90. PORTLAND CEMENT CONCRETE

90-1.01 Description

Class A concrete shall be truck-mixed, ready-mixed concrete consisting of a mixture of Type II Portland Cement complying with ASTM C150, sand, fine aggregate, coarse aggregate, and water. The proportions of the water, sand, and aggregate shall be regulated so as to produce a plastic, workable, and cohesive mixture. All materials required, and the procedure of mixing, shall conform to the provisions of Section 90 of State Standard Specifications.

Class A concrete shall contain 564 pounds (six sacks) of Portland Cement per cubic yard and shall have a 28-day compressive strength of 4000 pounds per square inch.

90-1.03 Steel Reinforcement

Reinforcing bars, where required, shall be deformed billet steel in conformance with ASTM A615, including supplementary requirements, Grade 60. Wire fabric, where required, shall be welded steel mesh conforming to ASTM A185.

90-1.04 Mix Designs

Reports of concrete mix designs shall be provided for review by the Engineer.

90-1.05 Placement and Curing

Placement, consolidation, and curing of concrete shall conform to the provisions of Section 90 of State Standard Specifications.
ENGINEER’S LIST OF APPROVED ITEMS
FOR USE WITH STORM DRAIN SYSTEM CONSTRUCTION
VERSION DATE APRIL 1, 2019

Standard 400 - Standard Precast Concrete Storm Drain Manhole
Oldcastle Precast Drawing No. 20-48C, 20-48E and 20-60EC
Cook Concrete Products Inc.

Standard 401 - Precast Concrete Storm Drain Manhole Reducer Slabs
Oldcastle Precast Drawing No. 20-48ERS, 20-60ERS and 20-60CRS
Cook Concrete Products Inc. 48” & 60” reducers.

Standard 402 and 405 - Type II Catch Basin
Oldcastle Precast Model No.4A and 3L
Cook Concrete Products Inc. 24x48 curb inlet

Standard 403 - Type I Catch Basin  Note: Approval required by variance.
Oldcastle Precast Type A

Standard 404 - Storm Drain Gallery
Oldcastle Precast Model 6Y and 12Y

Standard 406B - 3” x 12-1/2” Sidewalk Drain
Alhambra Foundry Model A-470 size - 3” x 12-1/2”

Standard 408 - Side Opening Drop Inlet
Oldcastle Precast Drawing No. DI -SO (model 2K or larger) H20 rated with side openings
and 1/4” galvanized checker-plate cover.
Cook Concrete Products Inc. drop inlet with side opening.

Standard 409 - “No Dumping” Labels
DAS Curb Marker part No. 5.0 SR-DC

APPROVED:

JASON NUTT
DIRECTOR OF TRANSPORTATION AND PUBLIC WORKS
APPENDIX A

STORM DRAIN DESIGN REVIEW SUBMITTAL CHECKLIST
FLOOD AND DRAINAGE REVIEW
PLAN SUBMITTAL CHECKLIST

Project Name:__________________________ Date:____________________
City File #:____________________________

All of the following items must be submitted before a flood and drainage review can be completed.
Please submit the following items or indicate why they are not necessary.

☐ Transmittal Letter
☐ Explanation of Analysis Approach
☐ Submittal Information Sheet
☐ Plan Check Fee (minimum of 1/2 due; remainder due prior to final approval)
☐ Improvement Plans
☐ Final Map or Parcel Map (if applicable)
☐ Hydrology Map
☐ Establish Factors used in Analysis
☐ Hydrology Calculations ☐10-year Storm and ☐100-year Storm
☐ Hydraulic Calculations
☐ Establish Starting HGL
☐ ☐EGL and ☐HGL Plots
☐ 100-year Storm Routing
☐ 100-year Storm Elevations vs. Finished Floor Elevations
☐ Inlet Capacity Calculations
☐ Curb Water Depth Calculations
☐ Assessor Parcel Map with Site Outlined
☐ Copy of the conditions of approval for the project