CHAPTER 3. POLICIES AND DESIGN CRITERIA

The Master Plan is based on the City's Drainage Design Criteria supplemented by South San Joaquin Irrigation District's requirements and standards and San Joaquin County's Improvement Standards and the County Hydrology Manual. These standards are supplemented by design practices of other cities and counties and by the California Stormwater Quality Association Stormwater Best Management Practice Handbook.

The policies and criteria included in this chapter are designed to guide not only the master plan but all drainage related design in the City. Updates to the City Drainage Design Criteria are expected as conditions warrant and likely more frequently than updates to the master plan. It is imperative to check with the City for any changes in policies and criteria before initiating drainage design activities.

The policies offer overall guidance and the criteria are specific targets to be met in drainage design. They will continue to be updated in the future as conditions change. For example, it has taken years for the public to embrace concepts of stream restoration and habitat enhancement compared to the drainage ditches of the '50s and 60s. Stormwater quality requirements of the Clean Water Act and permitting requirements of the National Pollutant Discharge Elimination Program cause significant impacts to stormwater management programs.

POLICIES

The City is guided by policies related to stormwater, drainage and flood control.

General

Drainage and flood control infrastructure should be available and properly phased to support existing needs and planned growth.

The General Plan and the Public Facilities Implementation Plan (PFIP) program should guide drainage infrastructure planning.

At all stages of development of a newly developing area, 10-year storm drainage protection will be provided by diverting all storm runoff to a detention basin before being discharged to a drain.

Drainage

Where feasible, drainage facilities should be utilized to accomplish open space requirements of the Manteca General Plan and the San Joaquin County Multi-species Habitat Conservation and Open Space Plan, and to provide opportunities for public education.

All stormwater improvements shall comply with the requirements of the SSJD agreement with the City.

Operation of stormwater facilities shall comply with SSJID requirements to eliminate uncontrolled inflows to drains and laterals.

The City shall assure an adequate level of service in drainage systems to accommodate runoff from existing and projected development.

Construction of drainage facilities will continue to fill gaps in the drainage system in existing developed areas.

Design of storm drain systems within new developments shall consider the use of open drainage corridors where feasible as an alternative to an underground pipe drainage system. Open drainage corridors may provide short-term detention storage and storm water quality treatment.

Open drainage corridors can also be used for bike trails and pedestrian paths and should provide visual open space within neighborhoods. Pedestrian paths should connect residential neighborhoods with parks and open space.

New developments are encouraged to minimize impervious areas and incorporate principles of low impact design (LID) and minimize directly connected impervious areas (DCIA) by limiting impervious land coverage and by diverting runoff to pervious areas for infiltration, detention/retention or filtration.

LID design breaks the hydraulic connectivity and reduces the peak runoff. Buffers are an excellent means to accomplish this and when buffers are provided between water courses and urban land uses, they may break the connection between impervious areas reducing peak runoff and provide water quality benefits.

Where feasible, natural stream watercourses should be protected and restored for flood control, water quality, recreation, habitat and open space.

Development should minimize soil erosion and deposition in waterways and basins.

Where feasible, drainage channels should be integrated into the City's bicycle and pedestrian trail system.

Buffers, grassy swales and landscaped areas may all be used to break the hydraulic connectivity of runoff across paved surfaces and reduce downstream peak flows.

Where feasible, drainage channels should be designed as multi-use facilities, incorporating a "natural" appearance, providing habitat, open space and a range of mixed use.

Where feasible, drainage facilities should incorporate interpretive and educational trails.

Stormwater Detention Storage

Stormwater detention storage shall be provided for all new developments as specified in the Master Plan.

Detention basins should be designed for the joint purposes of attenuating runoff and providing water quality benefits.

Regional detention basins designed to serve several developments are preferred over smaller, individual basins.

Water quality treatment should be constructed into detention storage basins to maximize the benefits of the basin.

Basins should be designed as multi-purpose facilities when practical.

Percolation basins may be used only as an interim disposal facility when a receiving creek or drain is not available and with the approval of the Director of Public Works.

All basins shall have positive shut-off control as required by SSJID.

Stormwater Quality

The quality of stormwater runoff is an inherent component of the City's stormwater management program.

All stormwater facilities shall comply with the provisions of Chapter 6.

Water quality treatment is to be incorporated into all new storm drainage facilities, such as detention basins.

Water quality programs should minimize pollution of waterways, surface water and groundwater from urban runoff.

The requirements of the City's NPDES permit, including Attachment 4, and stormwater management program will be addressed in all drainage planning.

Stormwater projects shall use the California Stormwater Quality Association (CASQA) Best Management Practice Handbook as a guide in the design of detention basins to provide both attenuation of peak runoff and water quality treatment. Each basin shall be designed to meet the specific requirements of the site including the proposed multiple uses for the basin and surrounding land.

Flood Protection

Structures should be protected from damage in a 100-year flood.

Zoning and land use entitlements will be used to regulate development on Special Flood Hazard Areas (SFHA) as defined on the National Flood Insurance Program (NFIP) Flood Insurance Rate Map (FIRM).

The City will seek regional solutions to flood issues.

Flood control shall be combined with recreation, water quality, open space, public outreach and public education and environmental habitat when feasible.

Existing structures in the 100-year Federal Emergency Management Agency (FEMA) SFHA should have adequate flood-proofing protection from flood hazards

Future development should be restricted from construction in a 100-year SFHA without adequate mitigation and flood proofing.

New construction in a SFHA shall have the lowest floor at least one foot above the 100-year flood elevation.

Non-residential development in a SFHA shall be flood-proofed or constructed with the lowest floor at least one foot above the 100-year flood elevation.

Existing structures shall comply with these policies when improvements are made with a value of 50 percent or more of the current market value of the existing structure.

The City should continue participation in the National Flood Insurance Program and City ordinances and regulations should comply with standards of FEMA.

Finance

The City is in the process of performing a fee study with the goal of establishing a Storm Water Management Utility as a separate utility enterprise to operate, maintain, and fund the City's storm and surface drainage system. The City's interest in establishing storm water fees stems form the need to adequately fund its existing drainage system facilities and to fund the programs that are required in order for the City to comply with the NPDES storm water regulations required under the Clean Water Act.

In setting storm water fees in California, the City must comply with Articles XIII C and D of the State Constitution[1]. Under Articles XIII C and D, certain storm water related fees may be considered to be "property-related fees" for a "public service having a direct relationship to property ownership" and may require voter approval. Agencies that already have funding form storm water fees that pre-date the passage of Proposition 218 can maintain those fees without voter approval. Any new "property related" taxes, assessment, or fees must conform to the following provisions:

- Revenue from fees must not exceed the funding requirements (i.e., operating and capital expenditures plus allowances for adequate reserves).
- Revenue from fees must be used for the purpose collected (i.e., the revenue must not be transferred for use in other unrelated funds or for activities that are unrelated to the purpose for which they were collected).
- Fees must not exceed the proportionate cost of service (i.e., the amount paid must be proportionate to the benefit received or the burden placed on the system).

These provisions are standard rate making provisions that existed prior to the passage of Proposition 218 and should be followed in setting fees for any utility service, such as water, wastewater, or solid waste, as well as for storm water. Hence, the storm water fees that have been set outside California and before the passage of Proposition 218 can still serve as relevant information in setting storm water fees today in California's post-Proposition 218 legal environment.

[1] This legislation was enacted by Proposition 218 in November 1996.

Currently, there is legislation that is being promulgated, ACA 13, which will exempt storm water fees from the requirements of Proposition 218. The process of this legislation is being carefully monitored as the Storm Water Management Utility study is being completed. The recommended capital improvement program identified in this Master Plan Update, but not funded under the PFIP, will be included in the storm water utility fee structure and rates.

DESIGN CRITERIA

The Design Criteria presents guidelines and minimum standards for the design of storm drainage conveyance, retention facilities and drainage pump stations within the City. Design engineers are welcome and encouraged to comment and make suggestions. It is expected that there will be engineering issues that will require unique solutions not specifically covered by these criteria. Design criteria will be updated to present new ideas, products or practices.

These design criteria reference and will be used in conjunction with Standard Plans and Specifications, Department of Public Works. This information is intended to be used as design guidelines, and the appropriate review of this information and its application to specific design is the sole responsibility of the design engineer.

1.0 General

1.1 Master Plan

Storm drain design shall conform to the City's current Master Plan and the City's Standard Plans and Specifications.

1.2 Drainage Studies

A drainage study that includes the entire tributary area of the subject property must be submitted and accepted by the Public Works Department prior to the completion of a final subdivision or parcel map. The proposed drainage plan may be evaluated by the City using the master XP-SWMM model to assure that proposed facilities conform to the master plan. The Master Plan also provides for Best Management Practices (BMPs) to address stormwater quality problems. The drainage plan should include the following:

1. Topographic map of the drainage shed and adjacent area showing existing and proposed ground elevations and sub-shed areas
2. 10-year and 100-year design flows at key locations
3. Preliminary pipe sizes and typical drainage channel geometry with hydraulic grade lines, inverts and proposed ground elevations
4. Map showing analysis points, proposed street grades, and storm drain facilities
5. Configuration and elevations of proposed retention basins including a preliminary grading plan
6. Information on proposed pumps and stage, storage and discharge information for retention basins under design conditions
7. Requirements for stormwater quality treatment BMPs

8. Preliminary site plan for each basin and site and equipment layout for the pump station

1.3. Geotechnical / Groundwater Information

Geotechnical and groundwater information must be submitted with the drainage study. At a minimum, the following information should be provided.

- Preliminary geotechnical analysis
- Description of groundwater conditions
- Limitations on depth of retention basins

1.4 Subsurface Percolation

The use of subsurface percolation of runoff will not be permitted unless approved by the Director of Public Works for an Interim Facility.

1.5 Phasing of Drainage Facilities

If phasing of drainage facilities is proposed, a phasing plan should be submitted prior to approval of improvement plans or map recordation. Design criteria should provide required protection at each phase. Triggering mechanisms should be clearly identified for constructing subsequent phases of drainage facilities.

2.0 Design Runoff

Criteria for computing design runoff are consistent with established City design criteria and with the San Joaquin County Hydrology Manual. The two methods accepted by the City are discussed below; other methods may be acceptable subject to prior approval by the City Public Works Department.

Rational method – A basic methodology appropriate for drainage systems upstream of basins as defined below.

SWMM modeling – A dynamic computer model used in the formulation of the master plan and recommended for the sizing of detention basin discharge facilities. The SWMM model utilizes the San Joaquin County Hydrology Manual.

For analysis of on-site storm drain systems that do not include storage or pumping, methodologies such as spreadsheet analysis, StormCAD, HYDRA and Rational Method based solutions may be used. The use of any hydraulic method is subject to approval by the Department of Public Works.

2.1 Rational Method

The Rational Method was developed to estimate runoff from small urban and developed areas. The Rational formula relates rainfall intensity, a runoff coefficient and drainage area to the direct peak runoff from the drainage area. The relationship can be expressed as:

$$Q = CIA$$

where, Q = the runoff rate from a drainage area in cubic feet per second (cfs)
C = a runoff coefficient that represents the ratio of runoff to rainfall
I = the time averaged rainfall intensity corresponding to the time of concentration expressed in inches per hour
A = tributary drainage area in acres

The values of the runoff coefficient and the rainfall intensity are determined based on study of drainage area characteristics. The drainage area is determined by computing the area tributary to the point where flow is to be determined based on a topographic map.

2.1.1 Runoff Coefficient, C – The runoff coefficient is the ratio of the rate of runoff to the rate of rainfall at an average rainfall intensity (I). The value of the runoff coefficient is dependent on rainfall intensity, drainage area slope, vegetative cover, infiltration and other factors. Suggested coefficients for use in the City of Manteca are shown in Table 3-1. Coefficients shown in the table are for typical developments. When Low Impact Development (LID) techniques are used for flow attenuation and water quality, the design engineer should adjust “C” values. A more vigorous method to compute coefficients is contained in the San Joaquin County Hydrology Manual (Hydrology Manual). Runoff coefficients for typical surfaces are shown in Table 3-2.

Table 3-1. Runoff Coefficients for the City of Manteca

Land Use	Runoff Coefficient, C	Minimum Overland Flow Time, minutes
Commercial	0.75	15
Industrial	0.70	15
Multi Family Residential	0.45	20
Single Family Residential	0.30	25
Schools	0.25	25
Parks & Agricultural	0.10	30

Table 3-2. Typical Runoff Coefficients for Various Surface Types

Surface	Runoff Coefficient
Pavement	0.95
Roof	0.80
Compacted Earth	0.75
Lawns and Open Area	0.15

2.1.2 *Rainfall Intensity* – Rainfall intensity is determined by using the intensity-duration-frequency curves in the City's Standard Plans and Specifications. The critical duration of the storm rainfall used to enter the intensity curves is based on the time of concentration of the drainage area under study. The time of concentration, Tc, is defined as the interval of time required for the flow at a given point to reach a peak with a uniform rainfall intensity. It is common to define the time of concentration as the time from the beginning of rainfall for runoff from the most remote part of the drainage area to reach the point where flow is to be determined.

The time of concentration is computed as the initial overland flow time (tI) plus the travel time (tt) in conveyance facilities such as pipes and channels. Minimum values for this initial time are shown in Table 3-1.

$$T_c = t_l + t_t$$

2.1.3 *Drainage Area* – The area of the drainage basin to the point of interest is measured using the capability of AutoCAD with the shed map or manually using a planimeter and a map. The drainage area is expressed in acres.

2.2 XP-SWMM Model

The system wide XP-SWMM model prepared as part of the Master Plan will be used in the hydrologic analysis when there is a detention basin, or when there is a proposed change in channel or conduit downstream of the basin, or when the designer wants to utilize the benefits of dynamic modeling. The City will establish procedures for XP-SWMM model analyses and will analyze the results and the impacts of the proposed project. The developer shall be responsible for all costs associated with this modeling.

2.3 Other Methodologies

StormCAD and HYDRA – Additions to the storm drain system can be analyzed and designed using models such as StormCAD and HYDRA. StormCAD models were used in the preparation of the Master Plan to analyze gravity flow pipe networks and to size new or replacement drains. A HYDRA model was used to size the South Drain.

2.4 Stormwater Runoff Quality

All stormwater projects shall be consistent with the City's NPDES permit and shall be designed using the CASQA Best Management Practices Handbooks for new development and redevelopment or other acceptable design standards.

3.0 Design of Conveyance Facilities

Section 3 presents design criteria for stormwater conveyance facilities including:

- Piped storm drains
- Pump discharge lines
- Street flow

- Overland release
- Open drainage channels

Storm drain facilities should be constructed in accordance with the City's Standard Specifications and Standard Plans.

3.1 Piped Storm Drains

3.1.1 Size

The minimum pipe diameter of storm drains shall be 12 inches. Laterals that connect catch basins to manholes shall have a minimum diameter of 10 inches.

3.1.2 Pipe Flow

Storm drains shall normally be designed with the hydraulic grade line (HGL) below the crown of the pipe on all facilities downstream of detention basins. When necessary, storm drains may be designed with the HGL above the crown of the pipe if the HGL is a minimum of six (6) inches below the lowest drain inlet.

The hydraulic grade line in storm drains upstream of the detention basin shall be not less than six inches below any drain inlet in the drainage area. The starting elevation in the basin shall be the result of 2.65 inches of runoff. This criterion is based on a 10-year, 12-hour storm plus one-half of a 10-year, 6-hour storm as being representative of the water surface in the detention basin or interim percolation basin when peak flows occurred in the storm drains.

3.1.3 Roughness Coefficients

Storm drains are primarily reinforced concrete pipe (RCP) with rubber gaskets. Polyvinyl Chloride (PVC) plastic pipe may also be used, especially for on-site drainage and where high groundwater is not a problem. The following design values for the Manning's "n" coefficient shall be used:

Reinforced concrete pipe (RCP)	0.013
Polyvinyl Chloride (PVC)	0.013
Corrugated Polyethylene HDPE (corrugated interior)	0.02
Corrugated Polyethylene HDPE (smooth interior)	0.012

3.1.4 Minor Losses

Minor losses in storm drains are defined as local losses of energy other than friction losses and include losses at transitions, junctions, manholes and control devices. Minor losses are computed as a percentage of the change in velocity head upstream and downstream of the manhole or other feature.

$$H_L = K\,(V1^2/2g - V2^2/2g)$$

The losses by definition are minor, but accumulated throughout the drainage system can become substantial. The following K values are recommended for common design conditions with pipe velocities about 2.5 feet per second. The design engineer shall modify these recommendations as appropriate.

	K
Expansion Losses:	
$H_L = K (V_1^2/2g - V_2^2/2g)$	
Increase in one pipe size	0.11
Increase in two pipe sizes	0.18
Manhole losses:	
$H_L = (V^2/2g)$	
Straight throughout, no change in pipe size	0.05
Contraction losses where:	
$H_L = K (V_1^2/2g - V_2^2/2g)$	0.03

3.1.5 *Flow Velocity*

The minimum velocity at design flow in pipes shall be 2.5 feet per second (fps) in pipes 30 inches in diameter and larger. The maximum design velocity shall be 10.0 fps except where the pipe is below the HGL. The velocity requirement does not apply upstream of basins where the pipe is below the hydraulic grade line.

3.1.6 *Storm Drains that Discharge through Drain Levee Embankments*

A storm drain that discharges to a Drain through a levee designed to protect adjacent land from flooding shall be constructed in accordance with the criteria of Section 3.3.

3.1.7 *Installation*

3.1.7.1 Placement

All storm drains shall be placed within rights of way dedicated for public streets unless use of easements is specifically approved by the Department of Public Works. Storm drain lines shall be placed north and east of the centerline of streets in areas of new development. The distance that drain lines are placed from the street centerline varies according to the width of the street right of way and is shown in the Table 3-3. Alternate locations may be allowed if approved by the Director of Public Works.

Table 3-3. Drain Line Placement

Width of Street Right-of-Way, feet	Distance from Centerline, feet	Width of Median, feet
46 & 50	5	N/A

60, 70 & 84	5	N/A
84-110	10	12

3.1.7.2 Cover

Storm drains shall have a minimum cover of 30 inches. Exceptions must be approved by Public Works.

3.1.7.3 Manholes

3.1.7.3.1 Location

Manholes shall be located at junction points, changes in gradient, changes in alignment and changes in conduit size. Manholes shall not be spaced more than 300 feet apart on lines 21 inches or smaller and 500 feet on lines larger than 21 inches without prior approval.

3.1.7.3.2 Types

City Standard Plan D-6 shall be used for drain lines smaller than 33 inches in diameter Saddle manholes shall be used on drain lines 33 inches or larger in diameter. A saddle manhole may be required at intersections of more than three pipes regardless of size. . Eccentric cones shall be used on manholes greater than 8 feet in depth. A special structure may be required for confluences of pipelines 48 inches in diameter and larger.

3.1.7.4 Catch Basins

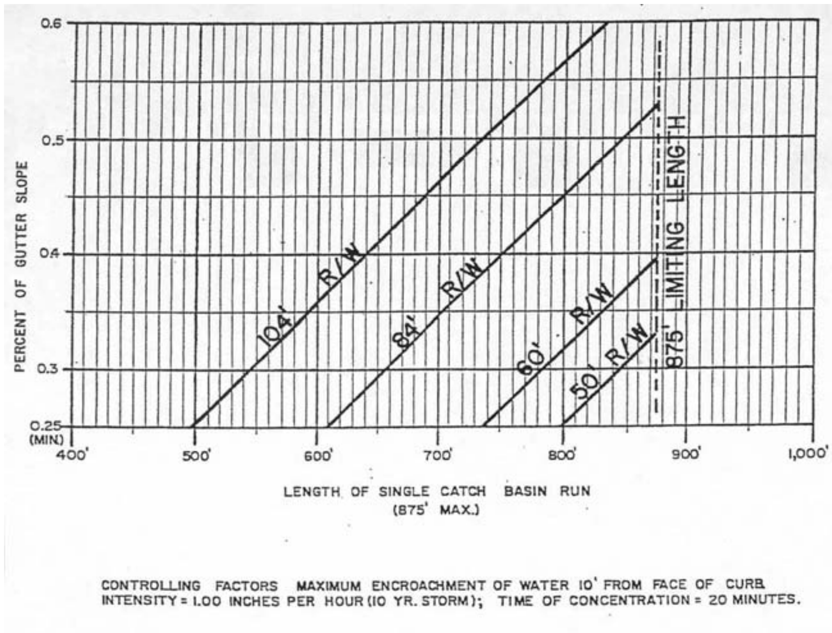
3.1.7.4.1 Location

Catch basins shall be connected by laterals to storm drains at manholes only unless approved by the Director of Public Works. Catch basin laterals shall have a minimum diameter of 10 inches and a slope of 0.005 ft/ft to connect the catch basin to a manhole.

Length of catch basin run: Maximum gutter length per catch basin shall be as shown on Figure 3-1.

Taps to the back of curb inlets for private connections shall be allowed only if adjacent property has sufficient grade to be above any street flooding should the drop inlet become blocked. Also, the curb inlet lead to the main drain line must have adequate capacity for the flows from private property. Calculations must be provided to support the use of taps into the back of the drop inlet box.

Figure 3-1. Length of Catch Basin Run



3.1.7.4.2 Types

Curb inlets shall be constructed as shown on D-9 and D-10 of the Standard Plans.

3.1.7.4.3 Access Control

Trash racks at inlets and access control structures are required and shall be located in areas with public access. Structures are to be constructed consistent with City Standards or as approved by the Department of Public Works.

3.1.7.4.4 Utility Conflicts

Conflicts with existing water lines should be avoided by alignment selections where possible. Where such conflicts cannot be avoided, relocation of the water line will be required. When conflicts between drainage and sewer lines are unavoidable, separation should be obtained by means of an inverted siphon in the drain line. A manhole should be provided to separate pipes when one drain pipe passes through another pipe.

3.1.7.4.5 Private Non-Residential Connections

Parcel sizes of one acre or larger that do not drain to a regional basin are required to drain to a basin prior to connecting to the street drainage system.

3.1.8 Design Hydraulic Grade Line

The hydraulic grade line in storm drains upstream of the detention basin shall be not less than six inches below any drain inlet in the drainage area as discussed in Chapter 3, Section 3.1.2, Pipe Flow.

3.2 Pump Stations

Pump design shall be undertaken with close coordination between the City staff and the design engineer and they are expected to meet prior to initiating design work. City review of design and meetings with the design engineers are required at the 10 percent completion, 50 percent completion and 100 percent completion.

3.2.1 Site Design

The pump station site shall provide adequate space to accommodate the pump structure, support structures, maintenance activities and parking.

The finished pad area at the pump station site shall be at least two feet above the 100-year flood elevation.

3.2.2 Pump Discharge

Detention basin pump stations shall be designed to discharge the 10-year, 48-hour storm volume from the basin during a period of not less than 48 hours. Pumps will be alternated to balance operating hours.

3.2.3 Standby Pump

Pump stations shall be designed with a minimum of one standby pump

3.2.4 Telemetry

Pumps shall be monitored and controlled by the City telemetry system

3.2.5 Trash Racks

Pump stations shall be designed with trash racks and a sediment dam.

3.2.6 In-line Lift Station

When a storm drain requires a lift station other than for a detention basin, the pump shall be designed for a 10-year storm.

3.3 Pump Discharge Lines

3.3.1 Hydraulic Grade Line

The flow line of the pump discharge pipe shall be installed above the 100-year frequency flood elevation or a backwater protection deviceshall be installed.

3.3.2 Pipe Material

Discharge pipe shall be steel pipe or High Density Polyethylene Pipe (HDPE). The joints of the steel pipe shall be welded. Joints in the HDPE shall be made by the thermal butt fusion process, or other processes where the joints develop the full tensile capability of the pipe.

3.3.3 Pipe Wall Thickness

The minimum pipe wall thickness for steel pipe shall be ¼-inch. Steel pipe shall conform to AWWA C-200. The pipe shall be double wrapped, tape coated, 50 mm minimum thickness. Linings shall be a coal tar epoxy, 16 mm minimum dry film thickness.

3.3.4 HDPE Pipe

HDPE pipe shall be DR 32.5 (51 psi), and shall comply to AWWA C906. Special inspection is required for installation and bedding.

3.3.5 Cover

The minimum cover for the pipeline shall be 24 inches under a roadway and 19 inches where there is no road over the pipe.

3.3.6 Relief Valves

Adequate air and vacuum relief valves shall be installed at the crown of the discharge pipe. Air and vacuum relief valves shall be enclosed in a reinforced concrete vault located outside any road travel way. A galvanized steel cover that is hinged, and can be locked, shall be installed on the vault. The top of the vault shall be extend six (6) inches about the travel way. The vault cover shall be vented.

3.3.7 Outfall

The discharge pipe to an open channel shall exit through a reinforced concrete outfall structure. Adequate stone protection or concrete apron shall be provided as needed to protect ground slope from erosion.

3.3.8 Backwater

The discharge pipe shall be protected from backwater conditions by a device approved by the Director of Public Works. The backwater protection device, such as flap gate or pinch valve, shall be mounted to the concrete outfall structure.

3.3.9 Gravity Discharge

Gravity discharge from basins shall be provided with a positive shut-off valve as required by SSJID.

3.3.10 Erosion Protection

Erosion protection consisting of angular stone, reinforced shotcrete, or other types of revetment shall be placed on the adjacent and opposite canal bank. The erosion protection shall be extended at least ten feet upstream and downstream of the outfall structure. Angular stone shall be Facing class as specified in Section 72 of the State Standard (CALTRANS) specifications or an approved equal. A suitable geotextile fabric shall be placed beneath the angular stone. The minimum thickness of angular stone shall be 12 inches.

3.3.11 Approval of Drawings by SSJID

Drawings of any proposed crossing of storm drains discharging to or passing under SSJID Drains or Laterals must be submitted for approval by SSJID prior to construction.

3.4 Street Flow

3.4.1 New Storm Drain System

The 10-year design HGL in new storm drains shall be at least 6 inches below the adjacent catch basin grate.

3.4.2 Gutters

Minimum gutter slope is 0.0025 ft/ft. Minimum gutter slope around radius corners is 0.0070 ft/ft.

3.4.3 Valley Gutters

Valley gutters will not be permitted for street drainage unless approved by the Director of Public Works.

3.4.4 Inverted siphons

Inverted siphons will not be permitted for street drainage.

3.5 Off-Street Parking Area Impervious Surface Drainage Design

Minimum cross-slope on asphalt concrete is 2 percent.

Minimum cross-slope on asphalt concrete in ADA areas is 1 ½ percent.

Minimum cross-slope on concrete is 1 percent.

Maximum cross-slope on concrete is 5 percent.

Minimum slope for concrete curb is 0.0025 ft/ft.

3.6 Open Channels

Open channels are sometimes the most feasible and preferred stormwater conveyance. Alternatives, such as rectangular culverts, are an option provided they meet or exceed the hydraulic requirements of the SWMM model. Two approaches to open channels may be used:

1. Open Drainage Corridors are the preferred approach to drainage channel design when feasible and appropriate for the situation. The open drainage corridors are a multi-use and more natural design incorporating the principles of stream restoration with conveyance, habitat, and recreation in a “natural” setting.
2. Open Drainage Channels are used with permission and when land availability and other constraints make a drainage corridor infeasible. They are usually unlined and trapezoidal in shape.

The basic open channel criteria are included in 3.6.1. Criteria specific to the traditional trapezoidal drainage channel are included in 3.6.2.

3.6.1. Open Drainage Corridors

3.6.1.1 General

When space allows and where feasible and appropriate, open drainage channel corridors are preferred. Open drainage channel corridors provide an opportunity to provide open space, vegetation and habitat while providing recreational opportunities with pedestrian and bicycle trails. Interpretive and educational experiences will also be included in the corridors as possible.

The City supports open drainage corridors where feasible because open corridors provide a more natural solution to the conveyance of stream flows. The open drainage corridors will have aesthetic values and increase environmental benefits. If designed correctly, the corridor will improve stormwater treatment and replace lost riparian and wetland habitat. They are an amenity that sparks environmental awareness of the citizens. And, with good design, they can reduce channel maintenance costs.

Channel storage and water quality treatment within the corridor will help to reduce the land area devoted to detention basins in some areas.

These multi-use or multi-functional drainage corridors require a more thoughtful design process than the traditional flood control channel. The City encourages the effort because of the myriad benefits that will accrue to landowners, residents and the City. Typical sections for drainage corridors are shown in Figure 3-2.

Design of open drainage corridors should also meet the technical criteria for open drainage channels in Section 3.6.2.

Open channels in lieu of piped storm drains are appropriate in situations where stormwater runoff exceeds the capacity of a 72 inch diameter pipe.

Open drainage corridors shall be designed with adequate width to accommodate the channel and parkland, trails, habitat, vegetation and maintenance needs. Open drainage corridors could be up to 200 feet wide.

In keeping with the spirit of the open drainage corridors, concrete lined channels will be permitted with special permission only in those areas where there is not sufficient space for an open drainage corridor. In areas of limited right of way, a proposed concrete lines channel requires the approval of the Director of Public Works.

The conveyance portion of a drainage corridor shall be located in excavation so that the design water surface is below ground level. Above ground water surface elevations shall not be used except in special situations when a levee is specifically approved by the Director of Public Works.

3.6.1.2 Design Discharge

Channels shall be designed to safely confine the peak 100-year discharge.

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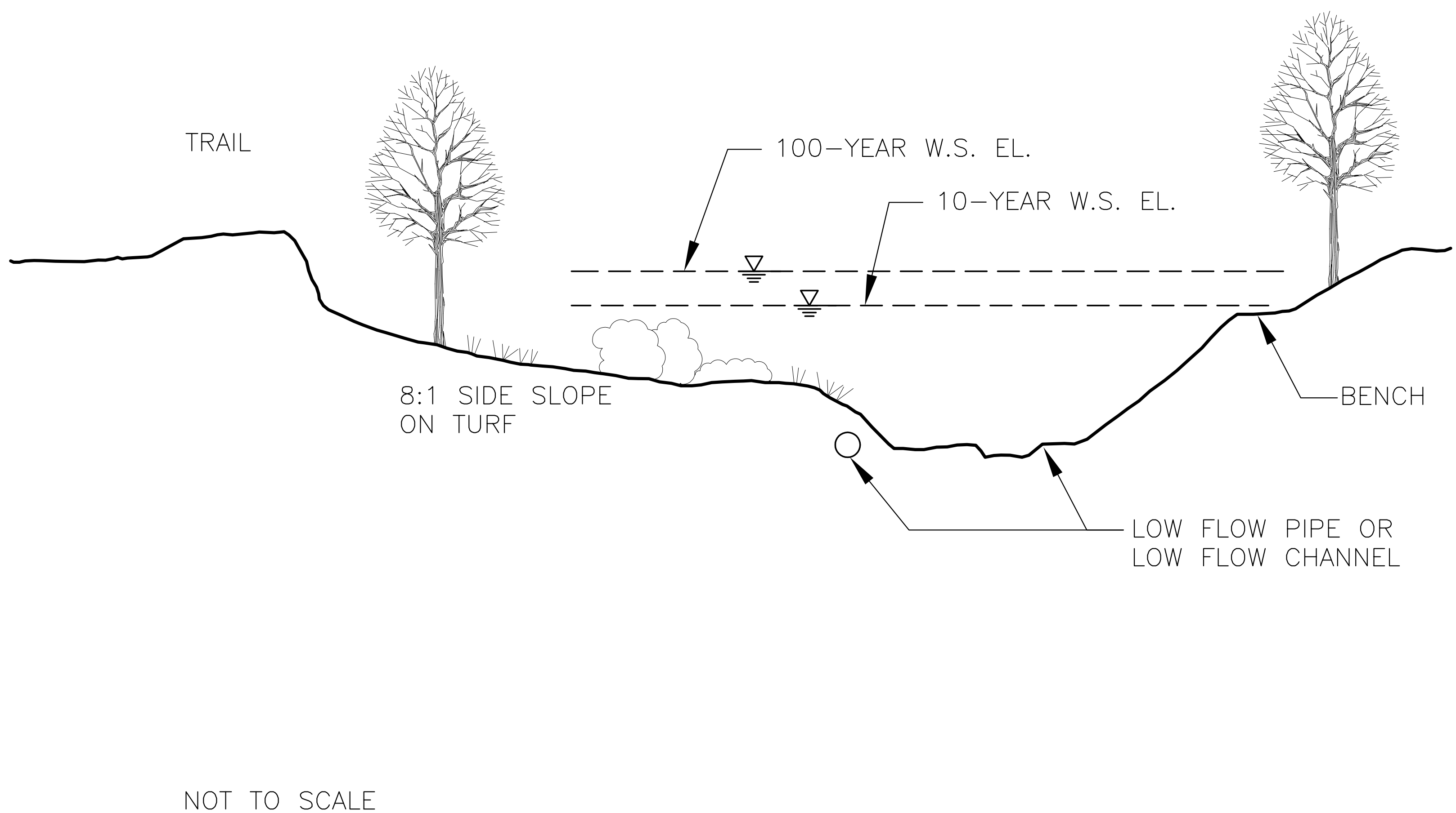

Figure 3-2

City of Manteca
Storm Drain Master Plan
OPEN DRAINAGE CORRIDOR
TYPICAL CROSS SECTION

WEST YOST & ASSOCIATES

3.6.1.3 Configuration

Open drainage corridors shall have varying side slopes to emphasize the appearance of a “natural” channel. The preferred configuration is a meandering channel when possible.

3.6.1.4 Hydraulic Design

Open drainage corridors can be simple trapezoidal conveyance channels or more complex meandering streams that are an amenity to the property and the City. The engineer is encouraged to recommend concepts that will provide the best solution for the individual site. Minimum criteria for open drainage corridors are presented for guidance.

Hydraulic design includes the corridor shape and size, slope, depth, roughness coefficients compatible with the design and planned corridor vegetation.

Shape - Side slopes must be laid back to accommodate vegetation, maintenance and safety. A slope of 3 horizontal to 1 vertical (3:1) is the steepest side slope allowed unless otherwise approved by the Director of Public Works. This slope is usually used with shrubbery and with erosion control measures. Generally, slopes of 8:1 should be used where there will be public access, passive recreation and large turf areas. Benches will be used to break up long slopes and reduce the maximum vertical distances to about four feet. Low flow channels may have steeper side slopes.

Channel bottoms shall be a minimum of 8 feet wide to provide maintenance vehicle access.

Slope - Channel slopes will be limited by the elevation difference available within the length of open channel. In general, drainage corridors should have a minimum velocity at design discharge of 2 feet per second. The maximum permissible velocity is 6 feet per second without providing special protection. When high velocities occur in low flow channels, protection should be provided.

Depth - Maximum water depth shall be 5 feet at design storm (100-year), not including the low flow channel. The total channel depth shall be equal to the depth of water at design discharge plus two feet of freeboard.

Roughness Coefficient - The hydraulic design of drainage corridors should, to the extent practical, be based on a roughness coefficient, “n” value, of 0.10 or higher, Table 3-4. Designing for a higher “n” will provide the flexibility needed for location and selection of vegetation. The design roughness coefficient is computed as a composite value across the channel section taking into account changes in channel roughness and vegetation.

Table 3-4. Open Drainage Corridor Roughness Coefficients

Channel Vegetation	Roughness Coefficient
Earth	0.035
Tules	0.08
Cottonwood / Willows	0.10
Low growing perennials	0.05
Scrubs	0.08
Grasses	0.03 – 0.05

Vegetation - Vegetation planted and or allowed to grow in an open drainage corridor shall take into account the objectives of the corridor, the available corridor width, the highest potential "n" value and the adopted maintenance plan. Planting can range from mowed turf to scrubs and trees.

3.6.1.5 Other Design Considerations

Freeboard - For channels that are located with their design water surface below ground level, one feet of freeboard shall be provided from the water surface to the ground surface.

Trails - Pedestrian and bicycle trails shall be built into the drainage corridor to the extent feasible. Trails should be constructed to CalTrans Class I bicycle trail standards.

Retaining Walls - When space is severely limited, retaining walls may be needed to provide a physical corridor boundary. When used, retaining walls shall be located on one side of the open drainage corridor to allow ease of access on the side of the drainage corridor opposite the wall. Corridors should be designed to minimize the need for retailing walls.

Maintenance Access - A maintenance access road shall be provided along one side of the open drainage corridor. Bike paths may be used as maintenance access roads.

Fencing - Open drainage corridors will not generally be fenced but will remain open for public access. Low flow, "wet", areas may be fenced where potential safety concerns exist. Fencing shall be provided along the top of retaining walls.

Right-of-Way - Open drainage corridors shall have adequate right of way to accommodate the multi-functions and multi-uses of the corridor including the conveyance section, maintenance road and maintenance activities, plantings and trails.

3.6.1.6 Low Flow

Provision shall be made for conveying low flows in the open drainage corridor by construction of a low flow channel. The low flow channel within the corridor provides water quality and habitat benefits but will cause a continuously “wet” channel throughout the open corridor. A low flow pipe may be allowed for all or a part of the low flow channel flow.

3.6.1.6.1 Low Flow Channel

Two types of low flow channels may be used within the open drainage corridors. The use of low flow channels or pipe should be discussed with City staff and the choice shall be approved by the Director of Public Works. When approved for use, low flow channels may be concrete lined or unlined.

Concrete lined low flow channel - A lined low flow channel should be located at the low point of the open drainage corridor. The lined channel shall be capable of conveying low flow, “nuisance” flows. Low flow channels should also have capacity for SSJID flows when applicable.

Unlined low flow channel - The channel should have a depth of 1 to 1.5 feet and a width that provides capacity for the nuisance flows. Channels should have bottom widths in the range of two to eight feet. Low flow channels should also have capacity for SSJID flows when applicable.

3.6.1.6.2 Low Flow Pipe

A low flow pipe may be used within an open drainage corridor with the approval of Public Works. When a low flow pipe is proposed, provisions must be made for access and maintenance.

3.1.6.1.3 Bridges

The open drainage corridor can be narrowed and flow transitioned under bridges and road crossings to reduce the length of bridge or culvert structure required. Bridges, culverts and utility crossings shall have a minimum clearance from soffit to water surface of one foot and not cause backwater.

3.6.2 Open Drainage Channels

These criteria apply to major drainage channels and not to roads, ditches or drainage swales.

Unlined trapezoidal channels, while not the preferred drainage conveyance solution, are sometimes required because of space limitations or other reasons. Design of channels will follow the general open channel criteria in 3.6.1. above supplemented by the criteria in this section.

An alternative of a totally concrete lined channel will be permitted with special permission only especially in areas of limited right of way. Earth channels with concrete bottoms are permitted where drainage channels are approved for use.

3.6.2.1 Design Flow

Drainage channels shall be designed to convey the 100-year peak flow with one foot of freeboard.

3.6.2.2 Side Slopes

Drainage channel side slopes should be 3:1 or flatter. Slopes of 2:1 may be used in special situations with the approval of the Director of Public Works.

3.6.2.3 Levees

Levees will be allowed only in specific situations with the permission of the Director of Public Works. Leveed channels will be designed to convey the 100-year peak flow with three feet of freeboard.

3.6.2.4 Roughness Coefficients

Channel roughness coefficients, Manning's "n", are shown in Table 3-5.

Table 3-5. Channel Roughness

Type of Channel	Design Manning's "n"
Open channel with gunite lining	0.018
Open channel with paved bottom	0.030
Earth channel	0.035
Stream Restoration Channel	0.06-0.1

3.6.2.5 Bottom Widths

Channel bottom widths shall be at least eight feet wide, not including the low flow channel, to permit maintenance activities.

3.6.2.6 Curvature

The center line radius shall be a minimum of 35 feet or at least twice the bottom width, whichever is greater.

3.6.2.7 Fencing

Single purpose drainage channels shall be fenced when safety conditions dictate.

3.6.2.8 Access

A 12-foot all weather maintenance road will be required on one side of the channel. The access road may be combined with a bike trail and/or pedestrian path. When an access road will also be used for a bike trail, the road will be constructed to CalTrans standards for Class 1 bike paths. A maintenance road is not required adjacent to a City street.

3.6.2.9 Road Crossings

Crossing of South San Joaquin Irrigation District facilities shall conform to requirements of the District.

4.0 Stormwater Storage Basins

4.1 Introduction

Stormwater storage is needed to reduce runoff to meet limitations imposed by SSJID on the use of SSJID's Drains and Laterals and to provide treatment of stormwater runoff. Two primary types of stormwater storage basins are used in the City:

- Detention Basins
- Interim Percolation Basins

An interim percolation basin is designed to detain all or a portion of the volume of a storm thereby reducing the peak outflow. After a period of time, the stored runoff is discharged to downstream drains.

An interim percolation basin is designed to hold the entire volume of a storm with no provision for discharge. Percolation basins are used only as an interim measure until discharge capability to a Drain is available and require the approval of the Public Works Department.

Basins are also used as a best management practice in the treatment of stormwater quality in conformance with NPDES permit requirements. When basins are used as a BMP in conformance with the CASQA handbooks, they are usually constructed in combination with stormwater storage facilities.

4.2 General Criteria

The design of stormwater storage basins shall include considerations for the following attributes:

- Sustainable dual and multi-uses including parks, ponds, open space, recreation and nature areas
- Water quality enhancement
- Low maintenance
- Accessibility

Basins and their ancillary uses shall be an amenity to the City community.

4.3 Detention Basins

4.3.1 Capacity

The design capacity of a stormwater detention basin shall be determined based on the following relationship.

$$V = \frac{C\ A\ R}{12}$$

where:

V = The basin volume in acre feet

C = Runoff coefficient for the basin tributary shed (See Section 2.1, Table 2-1.

A = Tributary shed area in acres

R = Total rainfall in inches for a design storm (See Section 2.1, Table 2-2).

Urbanized shed	- 3.56 inches (10-year, 48-hour duration storm)
Rural shed	- 2.63 inches (10-year, 24-hour duration storm)

The volume of detention shall be computed with no allowance for percolation or outlet facilities. The maximum water surface elevation in the basin shall be 12 inches below the lowest drain inlet elevation in the tributary shed.

4.3.2 Outflow

Detention basins shall empty, either by gravity or by pumps, over a 48-hour period. Positive control by pumps or valves is required via telemetry.

4.3.3 Basin Side Slopes

Detention basins shall have maximum side slopes of 8 horizontal to 1 vertical with turf and up to 5:1 with other materials.

4.3.4 Bottom Elevation

The bottom elevation of a basin shall be a minimum of two feet above the groundwater elevation except the Director of Public Works may approve less if the basin is lined.

4.3.5 Bottom Slopes

The bottom of the basin shall have minimum slopes of ½ percent or as approved by the Director of Parks and Recreation.

4.3.6 Maximum Depth

The maximum depth of water in the basin shall be five feet.

4.3.7 Hydraulic Grade Line

The hydraulic grade line in storm drains upstream of the detention basin shall be not less than six inches below any drain inlet in the drainage area as discussed in Chapter 3, Section 3.1.2, Pipe Flow.

4.4 Interim Percolation Basins

Percolation basins are only to be used as an interim facility. In those areas that will not receive drainage service from a major drain with sufficient capacity for additional retention basin discharge by the time development occurs, percolation basins may be used as an interim measure for retention and disposal of urban storm waters. When discharge capability to a major drain becomes possible, the basins should be exchanged for or converted to retention basins with discharge facilities. Therefore, percolation basins should be designed to facilitate this transition, as well as in accordance with the following recommended design criteria:

- The basin should be designed to store the runoff volume from two (2) 10-year, 48-hour storms, using the storage volume formula of Section 4.3.1. The volume of the basin should be calculated with no allowance for percolation or outlet facilities.
- The ground surface of the basin, defined as the area within the boundaries of the maximum water surface, must be able to percolate the design volume within 72 hours.
- The percolation rate should be determined by the procedure described below. At least one percolation test per acre of ground surface, equally spaced, but not less than three borings for any basin shall be conducted. The average percolation rate shall be calculated from the test results as described below.
- The basin should consist of two distinct storage areas, one for low flow runoff and one for high flow runoff. The low flow region should be designed lower than the high flow region such that it receives the first runoff from a storm event.
- The low flow runoff area should be designed to store and percolate the runoff resulting from 0.5-inch of rainfall over the entire drainage area, without overflowing into the high flow runoff area.
- The low flow area should be fenced to restrict public access. Landscaping may be used in lieu of a fence to impede access with the approval of the Director of Public Works.
- Where the distance from the bottom of the basin to groundwater is less than 10 feet, the length of time that a percolation basin is in use shall not exceed 10 years in commercial and industrial areas, and 15 years in residential areas, or, the stormwater shall be treated prior to entering the basin to reduce the possible containment load.
- If at any time the Director of Public Works determines that the stormwater discharge into the percolation basin is a threat to groundwater quality, a treatment system shall be installed upstream of the basin.
- The bottom of the basin should be turf.
- The hydraulic grade line in storm drains upstream of the detention basin shall be not less than six inches below any drain inlet in the drainage area. The starting elevation in the basin shall be the result of 3.56 inches of runoff. .

- Side slopes are to be designed to maintain stability under saturated conditions, but in no case shall the slopes be steeper than 5:1.
- For basins that are intended to be used as parks, the low flow area shall be fenced or separated by landscaping to restrict public access, and the entire basin shall be turf.
- For basins that are not intended to be used as parks, the entire basin shall be fenced to restrict public access, and the ground surface of the basin, defined as the area within the boundaries of the maximum water surface, shall be seeded with an annual-type ground cover.
- For private basins, maintenance of the basin is the responsibility of the owner. An agreement is required between the developer and the City that gives the City the authority to cause repairs or maintenance to be done on the basin in the event that the developer does not complete said work at the City's request. The developer will be responsible for the cost of any such work.
- Both personnel and vehicular access to the fenced areas is required for maintenance purposes.
- As this basin is temporary until such time as access to a positive drainage system becomes available, the developer shall either construct the pump station and appurtenances at the time of construction of this basin or set up the funding mechanism for future construction.
- When a positive drainage system to serve this basin becomes available, the basin shall be converted to a retention basin with discharge facilities designed in accordance with City Standards.
- If infiltration exceeds 2.4 inches per hour, pretreatment to protect groundwater is required.
- The basin bottom should be deep-ripped at least 24 inches deep at no less than 36 inches O.C.
- Necessary piping and structures shall be installed in the basin bottom.
- An 85% relative compaction should be provided as indicated on subdivision improvement plans.
- Once compaction is complete no further construction work, other than park improvements, may be made in the basin bottom.

<u>Percolation Testing</u>

- The number of percolation tests to be performed should be determined as described above. Before any percolation test is made, the water table elevation shall be determined. Each test shall be conducted according to the following steps:
    - Each test shall be made in a one-foot diameter test hole terminating five feet above the water table and in undisturbed soil.
    - The test hole shall be refilled at least twice after dropping to five feet above the bottom of the pit and then allowed to soak overnight. Percolation rate measurements shall be taken on the day following the saturation process.

- Water level readings shall be taken at 30-minute intervals from fifteen feet above the bottom to five feet above the bottom before refilling. Design shall be based on rates taken at seven feet from the bottom, and the test shall be repeated until successive rates do not vary more than twenty percent. The slowest rate measured within 6 inches of the seven-foot level shall be considered as the average rate of percolation for that test pit.

4.5 Stormwater Quality

This section addresses criteria for integrating BMPs into regional stormwater solutions. Stormwater source control and treatment control measures shall be designed consistent with principles set forth in the California Stormwater Quality Association Stormwater Best Management Practice Handbook (CASQA Handbook), January 2003 or later edition.

4.5.1 The Extended Detention Basin, (CASQA. Handbook TC-22), or a variant thereof, is the BMP that appears to have the most potential as part of a regional solution in Manteca, Figure 3-3. When this BMP is selected, it is recommended that the water quality storage act in concert with operational detention storage. There are other potential facilities, regional and local, that will provide treatment of stormwater runoff. These should be developed by the design engineer when appropriate in a close working relationship with City staff.

4.5.1.1 Extended Detention Basin

Extended detention basins are likely to be selected for most regional applications. These basins will be designed with an outlet that will detain the water quality volume for 48 hours to allow adequate settling time. Dry extended basins should be designed together with needed stormwater detention basins to have a single coordinated basin that will accomplish the dual objectives.

Basins used as a BMP in the treatment of stormwater quality shall be designed using the methodology and procedures of the CASQA Handbook. Volume-Based BMP design treats 85 percent of annual runoff as presented in the CASQA Handbook. The 48-hour draindown Capture/Treatment Analysis curves for the Fresno Yosemite International Airport included in Appendix D of the CASQA Handbook should be used to size the basin.

4.5.1.2 Multi-functional Basins

Functionally, basins will have water quality function and a stormwater detention function to reduce peak flows. Basins will also function as parks with recreation and trails and will provide habitat, vegetation and open space. Figure 3-3 shows a plan and cross section of a typical basin. Each basin comprises a low flow area that is frequently wet even during non-storm days, a broad turfed area with flatter side slopes that provides storage during large storm events, and recreation facilities including trails and pathways. These multi-use basins should also follow the criteria of Section 4.3. Depending on the design, some of the lower areas of the basin may have to be fenced or protected from intrusion with a vegetation barrier.

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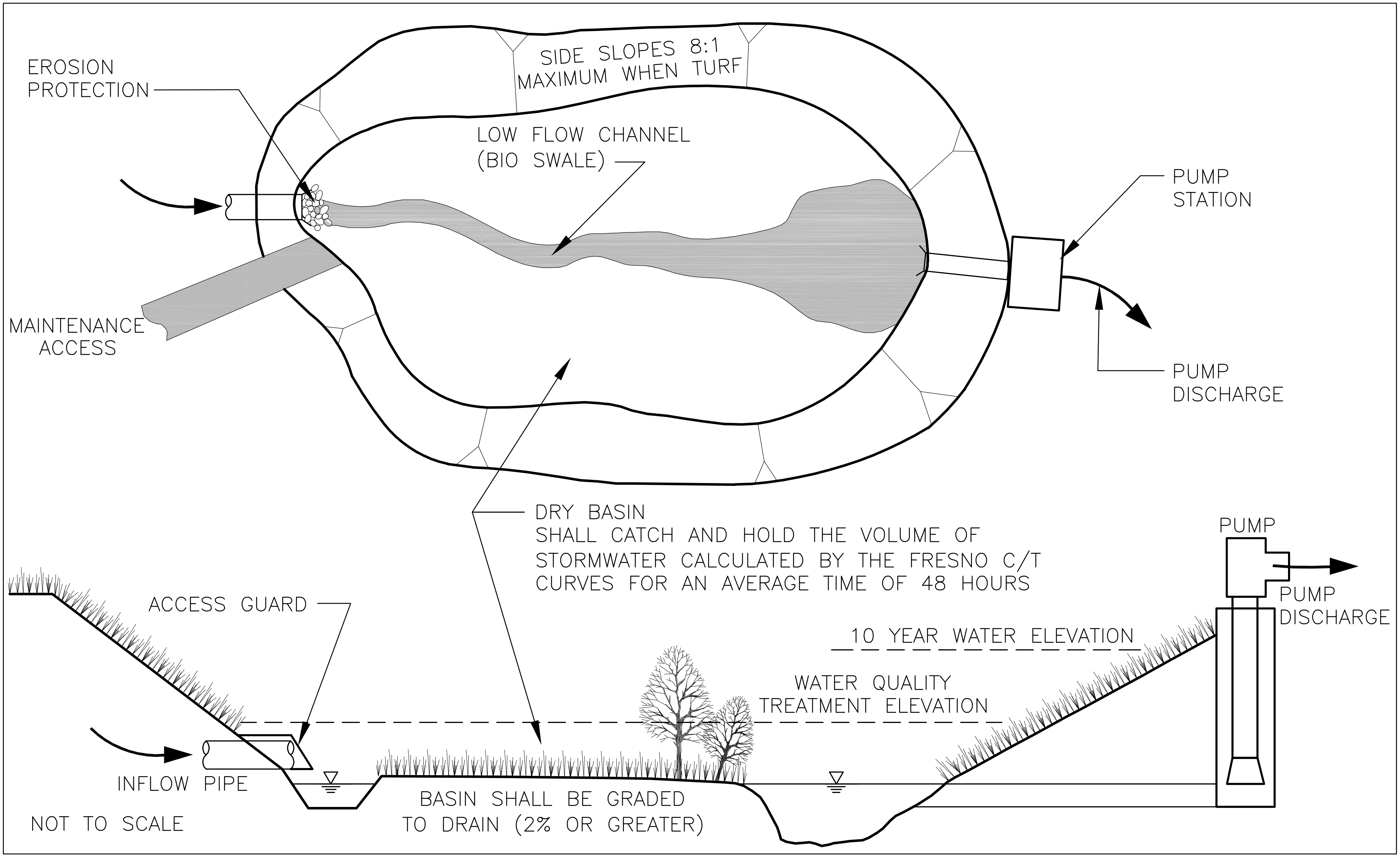

Figure 3-3

City of Manteca
Storm Drain Master Plan
DRY EXTENDED DETENTION BASIN

WEST YOST & ASSOCIATES

4.5.2 Flow Based Treatment

Flow based treatment including vegetated swales and open drainage corridors, Section 3.6.1, may be part of a stormwater quality plan. Design of vegetated swales are discussed in the CASQA Handbook as BMP TC-30. When using a vegetated swale as a part of stormwater treatment, the swale should be designed with a minimum travel time of 10 minutes with side slopes of 3:1 or flatter. Swales as BMPs are designed to be shallow with design depths that do not exceed two thirds of the grass height. Grasses selected should be dense and close growing varieties to maximize treatment.

Other flow based treatment include underground vaults and vortex separators and other proprietary devices. Many of these devices have not been thoroughly tested and the design engineer has the burden of installing facilities that will achieve the City's quality objectives. There are several wet vault systems available, BMP MP-50. Vortex Separators, BMP MP-51, are a specific configuration of wet vault that uses the centrifugal movement of water to increase the removal of suspended sediment and attached pollutants.

Flow-Based BMP design treats 85 percent of annual runoff as presented in the CASQA Handbook. The Cumulative Frequency Hourly Rainfall curves for the Fresno Yosemite International Airport included in Appendix D of the CASQA Handbook should be used to size the treatment device. This amount shall be doubled to provide for a safety factor as recommended in the Handbook, so for the City of Manteca an intensity of 0.185 inches per hour shall be used.

4.5.3 NPDES Permit Attainment Requirements

Manteca's NPDES permit requires implementation of certain education, public involvement, ordinances, development standards and implementation designed to reduce pollutants from stormwater discharge. Attachment 4 to the permit outlines design standards and the City's Stormwater Management Program presents a plan through which the City can attain the water quality goals. The CASQA Handbook provides information on the selection and design of treatment measures. Chapter 13.28 of Title 13 Public Services establishes minimum stormwater management requirements for development in the City. Development applications must be responsive to each of these directives.