CITY OF MT. ANGEL
Public Works Design Standards

Division 3

Stormwater Management

DIVISION 3
STORMWATER MANAGEMENT

3.1 PURPOSE

a. In addition to the purposes outlined under Division 1 of these Design Standards, the purpose of these Standards is to ensure the development of a stormwater management system which will:

1) be of adequate design to safely manage all volumes of water generated upstream and on the site to an approved point of disposal;

2) provide points of disposal for stormwater generated by future upstream developments;

3) prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property;

4) prevent the capacity of downstream channels and storm drainage facilities from being exceeded;

5) have sufficient structural strength to resist erosion and all external loads which may be imposed;

6) maximize the use of the City's natural drainage system;

7) be designed in a manner to allow economical future maintenance;

8) require the use of design and materials to provide a system with a minimum practical design life of not less than 50 years.

Alternate materials and methods will be considered for approval on the basis of these objectives.

b. These Standards cannot provide for all situations. They are intended to assist but not to substitute for competent work by professional design engineers.

3.2 APPLICABILITY

a. These Standards shall govern all construction and upgrading of all public and private drainage facilities in the City of Mt. Angel and applicable work within its service areas. This standard shall apply to all drainage facilities which impact any public storm drain system, public right-of-way or easement dedicated to or located within the City of Mt. Angel and within all off-street parking and loading areas.

Copyright 1996
Westech Engineering, Inc

b. All storm water runoff shall be conveyed to a public storm drain or natural drainage channel having adequate capacity to carry the flow without overflowing or otherwise causing damage to public and private property. In the case of private development, the developer shall pay all costs associated with designing and constructing the facilities necessary to meet this requirement.

c. Permanent storm drain facilities shall be provided to all properties within the City of Mt. Angel in accordance with these Standards. This shall generally be interpreted to mean that permanent storm drainage facilities shall be provided for the following types of development:

1) Existing legal lots of record at the time development occurs;

2) All partitions and subdivisions;

3) Developments entailing construction which will change the point of discharge of surface waters, the quantity of discharge, or will discharge water at a higher velocity than that of the preconstruction discharge rate.

4) Construction or reconstruction of public or private streets and temporary detours;

5) Developments entailing construction in or adjacent to any existing stream or watercourse including intermittent streams.

3.3 SPECIAL ITEMS

a. The design of the following are considered special items and are not covered in detail in these Standards:

1) Stormwater Pump Stations and Force Mains

2) Siphons

3) Water Quality Facilities

4) Energy Dissipators

5) Flow Measurement Devices

6) Bore Crossings

b. Review and approval of the above special items by the City Engineer and the Public Works Superintendent shall be required. When requested by the City, full design calculations shall be submitted for review prior to approval.

Copyright 1996
Westech Engineering, Inc

3.4 APPROVAL OF ALTERNATE MATERIALS AND METHODS

a. Any alternate material or method not explicitly approved herein will be considered for approval on the basis of the objectives set forth in Paragraph 2.1, Purpose. Persons seeking such approval shall make application in writing to the City Engineer and Public Works Superintendent. Approval of any major deviation from these Standards shall be in written form. Approval of minor matters will be made in writing, if requested.

b. Any alternate must meet or exceed the minimum requirements set forth in these Design Standards.

c. The written application is to include, but is not limited to, the manufacturer's specifications and testing results, design drawings, calculations and other pertinent information.

d. Any deviations or special problems shall be reviewed on a case-by-case basis and approved by the City Engineer and the Public Works Superintendent. When requested by the City, full design calculations shall be submitted for review with the request for approval.

3.5 CONSTRUCTION DRAWINGS

a. Construction drawings shall conform to the requirements of Division 1 of these Design Standards.

b. Detail drawings shall be included on the construction drawings for all storm drain appurtenances including manholes, catch basins, junction boxes, ditch inlets, service lateral connections, outlet structures, riprap outlets, etc.

3.6 STANDARD DETAILS

a. Standard details included in the Appendix are supplemental to the text of these design standards and show the City's minimum requirements for the construction of standard structures and facilities.

b. In the case of conflicts between the text of these design standards and the standard details, the more stringent as determined by the City Engineer and Public Works Superintendent shall apply.

c. As required by Division 1 of these standards, all applicable standard details shall be included on the construction drawings.

Copyright 1996
Westech Engineering, Inc

3.7 DEFINITIONS AND TERMS

a. In addition to the definitions contained in Division 1 of these Standards, the following definitions may apply particularly to stormwater systems. Unless otherwise defined in these Design Standards, the following definitions and abbreviations shall apply whenever used. Other definitions as outlined in the Uniform Plumbing Code shall also apply.

1) Abbreviations: Acceptable abbreviations for showing types of new and existing pipe materials and facilities on the plans are as follows:

a) AC - Asbestos Cement

b) CAP - Corrugated Aluminum Pipe

c) CI - Cast Iron

d) CHDPE - Corrugated High Density Polyethylene

e) CMP - Corrugated Metal Pipe (Aluminum)

f) CP - Non-reinforced Concrete Pipe

g) DI - Ductile Iron

h) HDPE - High Density Polyethylene

i) PVC - Polyvinyl Chloride

j) RCP - Reinforced Concrete Pipe

2) Building Drain: The building drain is that part of the lowest piping of the drainage system which receives the discharge from stormwater drainage pipes inside or within 5 feet of the outside walls of the building and conveys it to the building sewer, which begins five (5) feet outside the building wall or building foundation.

3) Building Storm Drain: That part of the piping of a stormwater drainage system which begins at the connection to the building drain and conveys stormwater to an approved point of disposal.

4) Catch Basin: An approved receptacle designed to receive surface drainage and direct it to a stormwater collection system.

5) Creek: Any and all surface water generally consisting of a channel having a bed, banks, and/or sides in which surface waters flow to drain higher land to lower land, both perennial and intermittent, excluding flows which do not

Copyright 1996
Westech Engineering, Inc

persist for more than 24-hours after the cessation of ½-inch of rainfall in a 24-hour period from October through March.

6) Detention: The holding of runoff for a short period of time while releasing it to the downstream drainage system at a controlled rate.

7) Drainage Facilities/System: Pipes, ditches, detention basins, creeks, culverts, etc. used singularly or in combination with each other for the purpose of conveying or storing stormwater runoff.

8) Impervious Areas/Surfaces: Those hard surface areas located upon real property which either prevent percolation of water into the land surface or reduce the percolation rate which existed under natural conditions prior to development. Also surfaces which cause water to run off the land surface in greater quantities or at increased flow rates than under natural conditions which existed prior to development. Common impervious surfaces include but are not limited to rooftops, driveways, parking lots or storage areas, sidewalks, patios, etc.

9) Natural Location: The location of those channels, swales, and other non-man-made drainage conveyance systems as defined by the first documented topographic contours existing for the subject property either from maps or photographs.

10) On-site Detention: The storage of excess runoff on the development site and gradual release of the stored runoff into a public storm drain system after the peak of the runoff has passed.

11) Peak Discharge: The maximum water runoff rate determined for the design storm.

12) Private Storm Drain: A storm drain located on private property serving parking lot catch basins or more than one structure on the same premises, and not operated or maintained by the City.

13) Public Storm Drain: Any storm drain in a public right-of-way or easement operated or maintained by the City.

14) Receiving Body of Water: Creeks, streams, lakes, and other bodies of water into which runoff is naturally or artificially directed.

15) Release Rate: The controlled rate of release of drainage and runoff water from property, storage ponds, detention basins, or other facility during and following a storm event.

16) Retention Facility: Facilities which hold water for a considerable length of time and then consume it by evaporation, plant transpiration, or infiltration

Copyright 1996
Westech Engineering, Inc

into the soil.

17) Sedimentation: Deposition of erosional debris and soil sediment displace by erosion and transported by water from a higher elevation to an area of lower gradient where sediments are deposited as a result of slack water.

18) Terrace: A relatively level step constructed in the face of a slope for drainage, erosion control and maintenance purposes.

19) Trunk Drainage System: That portion of the drainage system which receives waters from upstream land areas in excess of 20 acres. The drainage system may consist of watercourses or manmade facilities such as pipes, ditches, and culverts.

20) Wetlands: As defined by the Division of State Lands and the US Army Corps of Engineers.

3.8 MATERIALS

a. General

1) Unless otherwise approved by the City Engineer, materials shall conform to the minimum requirements outlined herein and as shown on the Standard Details. This listing is not intended to be complete nor designed to replace the City's Public Works Construction Standards (PWS).

2) In the case of conflicts between the provisions of these design standards and the PWS, the more stringent as determined by the City Engineer and Public Works Superintendent shall apply. Acceptable materials shall be as outlined in these Design Standards.

3) It is not intended that materials listed herein are to be considered acceptable for all applications. The design engineer shall determine the materials suitable for the project to the satisfaction of the City Engineer.

b. **Pipe Type By Cover Depth**: Unless otherwise approved by the City Engineer, storm drain pipe materials shall conform to the table below. Uniform pipe material shall be used on each pipe run between structures. Special requirements for use of jointed HDPE pipe for slopes exceeding 6% for or cover depths greater than 10 feet are listed in the following table.

Copyright 1996
Westech Engineering, Inc

ALLOWABLE STORM DRAINAGE PIPE BASED ON COVER DEPTH	
↓ COVER DEPTH ↓ (from finish grade)	**10" – 18" DIAMETER**
Less than 1½' Cover	Class 52 Ductile iron pipe with bell & spigot joints and rubber gaskets.
1½' to 2½' Cover	Pipe specified for lesser depths **-OR-** Class 3, ASTM C-14 non-reinforced concrete pipe with bell & spigot joints and rubber gaskets. **-OR-** PVC pipe conforming to AWWA C900 DR 18 (6"-12") or AWWA C-905 (14"-18") with bell and spigot joints and rubber gasket.
2½' to 10' Cover	Pipe specified for lesser depths **-OR-** PVC pipe conforming to ASTM D-3034 solid wall PVC SDR 35 (6"-15") or ASTM F-679 PVC solid wall SDR 35 (18") with bell and spigot joints and rubber gasket **-OR-** HDPE (High Density Polyethylene) pipe conforming to AASHTO M-252 (8"-10") or AASHTO M-294 (12"-18"). For slopes less than 6% the pipe shall be ADS N-12 IB ST, Hancor Sure-Lok F477, or approved equal. For slopes greater than 6% the pipe shall be ADS N-12 IB WT, Hancor Blue Seal, or approved equal with watertight pressure testable fittings.
More than 10' Cover	Case by case basis.
↓ COVER DEPTH ↓ (from finish grade)	**21" – 30" DIAMETER**
Less than 1½' Cover	Class 52 Ductile iron pipe with bell & spigot joints and rubber gaskets.
1½' to 2½' Cover	Pipe specified for lesser depths **-OR-** Class IV (minimum), ASTM C-76 reinforced concrete pipe with bell & spigot joints and rubber gaskets **-OR-** PVC pipe conforming to AWWA C900 DR 18 (6"-12") or AWWA C-905 (14"-18") with bell and spigot joints and rubber gasket.
2½' to 10' Cover	Pipe specified for lesser depths **-OR-** ASTM F-679 PVC solid wall SDR 35 pipe with bell and spigot joints and rubber gasket **-OR-** HDPE (High Density Polyethylene) pipe conforming to AASHTO M-294. For slopes less than 6% the pipe shall be ADS N-12 IB ST, Hancor Sure-Lok F477, or approved equal. For slopes greater than 6% the pipe shall be ADS N-12 IB WT, Hancor Blue Seal, or approved equal with watertight pressure testable fittings.
More than 10' Cover	Case by case basis.
GREATER THAN 30" DIAMETER, OTHER PIPE MATERIALS - Case by case basis.	
Residential Driveway Culverts: Pipe type based on cover depth, minimum size 12-inch diameter or adjacent street crossing or storm drain size, whichever is greater. PVC or HDPE pipe not allowed without structural concrete end caps.	

Copyright 1996
Westech Engineering, Inc

c. **Storm Drain Pipe**

1) **Ductile Iron**

a) Ductile iron pipe shall be Class 52 pipe conforming to AWWA C-151, and cement-mortar lined and seal coated in accordance with AWWA C-104.

2) **Non-Reinforced Concrete Pipe (CP)**

a) Non-reinforced concrete pipe and specials shall conform to AASHTO M86 (ASTM C-14), Class 3 minimum.

b) Joints shall be bell and spigot with an O-ring as specified or shown on the drawings and conforming to the following:

(1) Bell and Spigot joints shall be sealed with flexible watertight gaskets meeting or exceeding all requirements of Federal Specifications SS-S-06210 (GSA, FSS Washington, DC) "Sealing Compounds, Preformed Plastic for Pipe Joints," type 1 Ropeform. Such gaskets may be RAMNEK as manufactured by K.T. Snyder Co., Inc., of Houston, Texas; KENTSEAL No. 2 Joint Sealant as manufactured by Hamilton Kent Mfg., Co., of Kent, Ohio, or approved equal.

(2) O-Ring joints shall conform to ASTM C-443. The gaskets shall conform to material requirements of ASTM C-361.

3) **Reinforced Concrete Pipe (RCP)**

a) Reinforced concrete pipe shall meet the requirements of AASHTO M170 (ASTM C-76) Class IV minimum.

b) Joints shall be O-ring type in conformance with non-reinforced concrete pipe joint and gasket specifications above.

4) **PVC Pipe**

a) Pipe and fittings shall conform to ASTM D-3034, SDR 35 or ASTM F 679, SDR 35 as outlined above.

b) Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM classification.

c) The joints shall conform to ASTM D-3212, Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

Copyright 1996
Westech Engineering, Inc

5) **High Density Polyethylene Pipe (HDPE)**

a) Pipe and fittings shall have integrally formed smooth interior pipe surface.

b) Pipe and fittings shall conform to the requirements as listed in the table above.

c) HDPE (High Density Polyethylene) pipe conforming to AASHTO M-252 (8"-10") or AASHTO M-294 (≥12"). For slopes less than 6% the pipe shall be ADS N-12 IB ST, Hancor Sure-Lok F477, or approved equal. For slopes greater than 6% the pipe shall be ADS N-12 IB WT, Hancor Blue Seal, or approved equal with watertight pressure testable fittings.

d. **Joints**

1) Except as otherwise specified, joints for pipe shall be watertight joints using elastomeric ring gaskets. The gaskets shall be securely fixed into place so that they cannot be dislodged during joint assembly.

2) The gaskets shall be of a composition and texture which is resistant to common ingredients of drainage, including oils and groundwater, and which will endure permanently under the conditions of the proposed use.

e. **Pipe Accessories**

1) Fittings shall be of the same material as the pipe, molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations as required.

2) Manufactured fittings shall be used for all connections to existing or new storm drains.

f. **Catch Basins**

1) Catch basin construction and dimensions shall conform to the Standard Details. Side inlet grated catch basins shall be required.

2) Catch basin frame and grate shall conform to standard details, and shall be fabricated of structural steel, ASTM A-7, A-36 or A-273.

3) Solid lids on junction boxes shall be minimum 3/4-inch steel plate, and shall be provided with at least one lifting hole. Junction boxes located in a travel lane shall have a manhole frame and cover.

Copyright 1996
Westech Engineering, Inc

g. **Manholes**

1) Except as modified herein, precast concrete pipe manhole sections, transition sections, eccentric cones, flat slab tops, and adjusting rings shall conform to the requirements outlined under Division 4, Sanitary Sewers and as shown in the standard details.

2) Steps shall not be required for manholes 4 feet or less in depth (rim to invert).

3) Manhole castings for storm manholes shall have 16-hole lids.

4) Pollution/Flow Control Manholes

a) Pollution/flow control manholes shall be provided with a 30-inch diameter casting and lid.

h. **Mainline Storm Cleanouts**

1) Except as modified herein, mainline storm cleanouts (where approved by the City) shall conform to the requirements outlined under Division 4, Sanitary Sewers and as shown in the standard details.

2) A 3,300 psi concrete collar is required for cleanouts located outside of paved areas. The shaft or chimney of the cleanout shall be a minimum of 8-inches in diameter.

i. **Concrete (Cast-in-Place)**

1) All concrete shall conform to the requirements of OSSC (ODOT/APWA) 00440, Commercial Grade Concrete, 3300 psi.

j. **Underground Warning Tape**

1) Underground warning tape shall be detectable or non-detectable acid and alkali resistant safety warning tape. The tape shall consist of a minimum 4.0 mil (0.004") thick, virgin low density polyethylene plastic film formulated for extended use underground. The tape shall be in accordance with the APWA national color code and shall be permanently imprinted in lead free black pigments suitable for direct burial.

2) The tape shall be safety green and shall be provided with the legend "CAUTION BURIED STORM DRAIN LINE BELOW" or approved equivalent printed continuously down the length of the tape.

Copyright 1996
Westech Engineering, Inc

k. **Toning Wire**

1) A continuous insulated 12 gauge solid core copper toning wire shall be supplied with non-metallic pipe. Insulation shall be green in color for storm piping.

2) Wire shall penetrate into manholes and catch basins within 18 inches of the rim elevation.

3.9 Bore Casing & AccessoriesGENERAL DESIGN CONSIDERATIONS

a. **General Requirements**

1) The design of storm drainage systems shall include provisions to adequately control runoff from all public and private streets and the roof, footing, and area drains of residential, multifamily, commercial and industrial developments, and to provide for the future extension of the storm drainage system to serve the entire drainage basin.

2) All storm water runoff shall be conveyed to an approved point of disposal. In the case of private development, the developer shall pay all costs associated with designing and constructing the facilities necessary to meet this requirement.

3) The design storm peak discharge from the subject property may not be increased from conditions existing prior to the proposed development except where it can be satisfactorily demonstrated by the applicant that there is no adverse impact to downstream properties.

4) Public storm drains within easements will be permitted only upon a showing that drainage cannot be provided from within a right-of-way. Minimum easement widths shall be as outlined herein.

5) Gravity Flow: Where possible, all public storm drains shall be designed to flow by gravity to an existing or new storm drain system without lift stations.

Copyright 1996
Westech Engineering, Inc

b. **Approved Point of Disposal**

1) Surface or subsurface drainage, caused or affected by changing of the natural grade of the existing ground or removal of natural ground cover of placement of impervious surfaces, shall not be allowed to flow over adjacent public or private property in a volume or location materially different from that which existed before development occurred, and shall be collected and conveyed in an approved manner to an approved point of disposal.

2) The approved point of disposal for all stormwater may be a storm drain, existing well defined open channel or creek as approved by the City Engineer and the Public Works Superintendent. Acceptance of proposed point of disposal will depend upon the prevailing site conditions, condition and capacity of existing downstream facilities, and feasibility of alternate design.

3) When private property must be crossed in order to reach an approved point of disposal, it shall be the developer's responsibility to acquire a recorded drainage easement from the private property owner meeting the approval of the City Engineer and the Public Works Superintendent. The drainage facility installed must be a closed conduit system. Temporary drainage ditch facilities, when approved, must be engineered to contain the stormwater without causing erosion or other adverse effects to the private property.

c. **Providing for Future Development**

1) As a condition of development, all developments will be required to provide public storm drainage systems to serve adjacent upstream parcels in order to provide for the orderly development of the drainage area, as well as connection (to the new system) of existing storm lines or laterals crossed or intercepted by the new storm lines (including manholes or catch basins which can be served by the new storm lines), at locations as required by the City Engineer and Public Works Superintendent (see also PWDS 1.6.e). This shall include the extension of storm drain lines in easements across the property to adjoining properties and across street frontage*s* of the property to adjoining properties when the storm drain system is located in the street right-of-way. This shall include extension to the far side of streets fronting or adjacent to the development as required to avoid work within or under these streets in the future This shall include storm drains which are oversized to provide capacity for upstream development.

Copyright 1996
Westech Engineering, Inc

d. **Design Factors**

1) The following factors as a minimum shall be addressed in the design of storm drainage systems and determination of design flows.

a) Drainage basin to be served.

b) Topography of the area

c) Depth of excavation

d) Soils conditions

e) Land use within the area to be served.

f) Projected population within the area to be served at build-out.

g) Flows from commercial, industrial or institutional users.

h) Condition and size of existing storm drains

i) Location of approved disposal point

j) Maintenance, including accessibility for cleaning and inspection personnel and equipment.

3.10 DESIGN CALCULATIONS AND CAPACITY

a. **Design Calculations**

1) Design calculations shall be submitted for all drainage facilities. A summary of these drainage calculations, including basin maps, shall be included on the site plan drawings and shall be stamped by a professional engineer licensed in the State of Oregon.

2) Peak design discharges shall be computed using the rational formula, Q=CiA.

3) If use of a Santa Barbara Urban Hydrograph (SBUH) based computer program is proposed for use in sizing storm drain pipes for peak discharge, a 50 year SBUH storm event must be used in lieu of the 10 year or 25 year rational storm frequency to provide equivalent capacity. All CN parameters shall be as or more conservative than the equivalent runoff coefficients listed in these standards. The City Engineer reserves the right to verify all calculations using the rational method, and require larger pipe sizes if the rational calculations result in higher flows than the SBUH methodology.

Copyright 1996
Westech Engineering, Inc

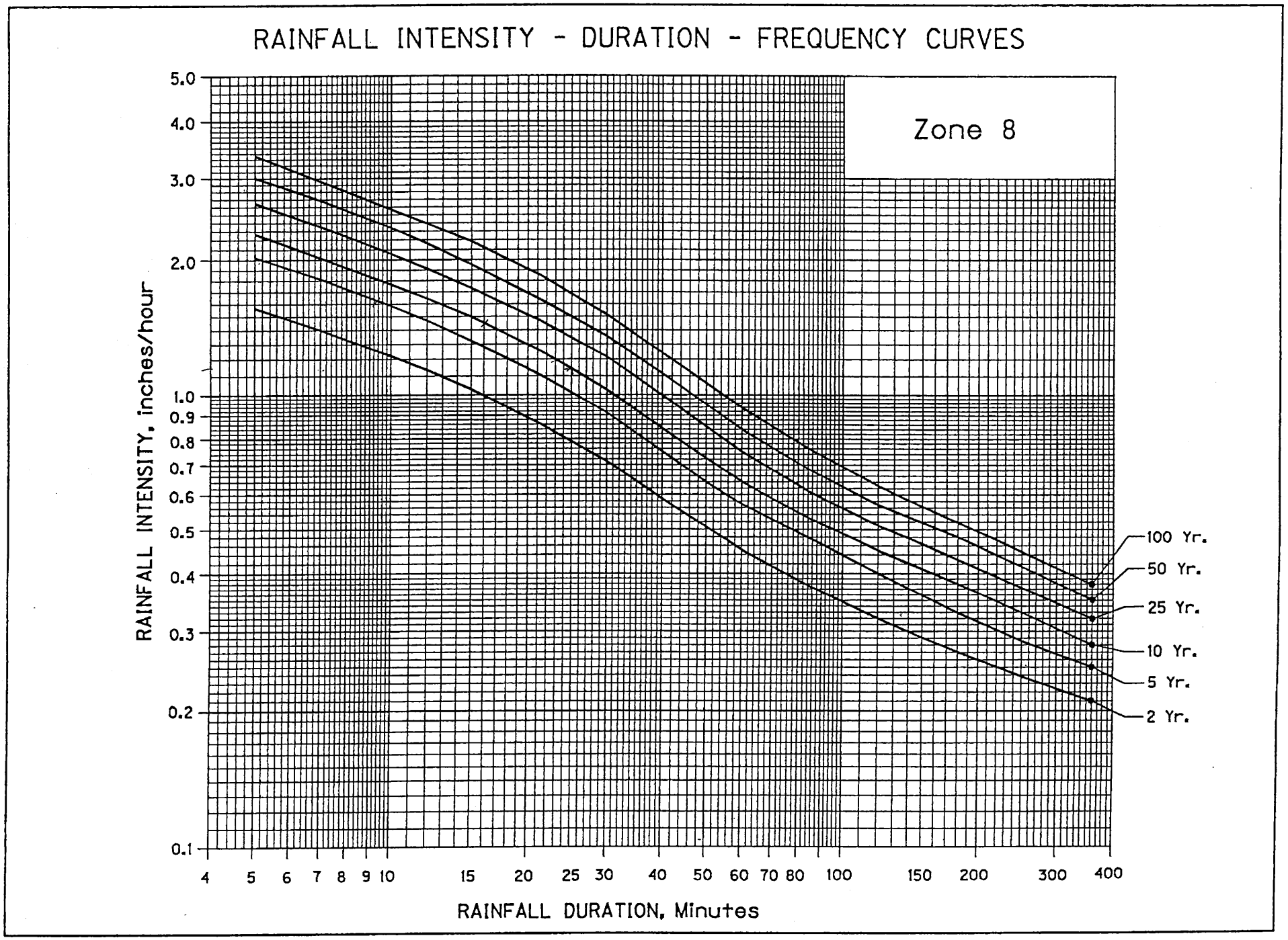
b. **Design Storm**

1) Rainfall Intensity-Duration Curve - The rainfall intensity-duration-frequency (IDF) curve for use in the City of Mt. Angel is the ODOT Zone 8 IDF curve (enclosed herein).

2) Design Frequency - The intensity-duration design frequency is based on the time of concentration for the area and the size of the drainage facility. The adopted criteria are listed in the following table.

DESIGN STORM FREQUENCY	
AREA	**FREQUENCY**
Residential areas	10-year storm
Commercial and high value districts	10-year storm
Trunk lines (18" pipe and larger)	25-year storm
Minor creeks and drainage ways (not shown as a flood plain on the Flood Insurance Rate Map (FIRM))	50-year storm
Major creeks (shown as a flood plain on the FIRM)	100-year storm

Copyright 1996
Westech Engineering, Inc


RAINFALL INTENSITY - DURATION - FREQUENCY CURVES
Zone 8
RAINFALL INTENSITY, inches/hour
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
4
5
6
7
8
9
10
15
20
25
30
40
50
60
70
80
100
150
200
300
400
RAINFALL DURATION, Minutes
100 Yr.
50 Yr.
25 Yr.
10 Yr.
5 Yr.
2 Yr.

ODOT Zone 8 IDF Curve Tabular Data (Mt. Angel)

Rainfall Duration (Min)	Rainfall Intensity, inches/hour				
	5 year Storm	10 year Storm	25 year Storm	50 year Storm	100 year Storm
5	2.01	2.25	2.63	3.00	3.35
6	1.90	2.12	2.50	2.81	3.12
7	1.81	2.01	2.35	2.68	2.95
8	1.71	1.91	2.24	2.55	2.80
9	1.65	1.83	2.14	2.43	2.69
10	1.60	1.78	2.07	2.33	2.58
11	1.51	1.70	1.98	2.25	2.48
12	1.48	1.65	1.90	2.18	2.40
13	1.41	1.60	1.85	2.10	2.31
14	1.38	1.55	1.79	2.01	2.24
15	1.32	1.50	1.72	1.95	2.19
20	1.13	1.30	1.50	1.69	1.90
25	1.00	1.14	1.35	1.50	1.69
30	0.91	1.02	1.21	1.36	1.51
35	0.82	0.92	1.10	1.21	1.38
40	0.75	0.84	0.98	1.11	1.24
45	0.69	0.78	0.92	1.02	1.15
50	0.64	0.73	0.85	0.95	1.08
55	0.60	0.68	0.80	0.89	1.00
60	0.57	0.64	0.75	0.84	0.94
70	0.53	0.59	0.68	0.76	0.85
80	0.49	0.54	0.63	0.70	0.78
90	0.46	0.52	0.59	0.66	0.74
100	0.44	0.49	0.56	0.62	0.69
110	0.42	0.47	0.53	0.60	0.66
120	0.40	0.45	0.51	0.57	0.63
130	0.385	0.44	0.49	0.55	0.60
140	0.37	0.420	0.48	0.53	0.58
150	0.36	0.410	0.46	0.520	0.56
160	0.35	0.400	0.45	0.50	0.540
170	0.340	0.390	0.44	0.49	0.53
180	0.33	0.38	0.43	0.48	0.52

c. **Runoff Coefficients**

1) The coefficients of runoff "C" are listed below. Use of coefficients other than those listed must be based on field investigations which demonstrate conclusively that the proposed coefficients are justified.

RUNOFF COEFFICIENTS			
SOIL COVER	FLAT TERRAIN S<2%	ROLLING TERRAIN 2%<S≤10%	STEEP TERRAIN S>10%
Cultivated Land	0.30	0.35	0.40
Parks & Cemeteries	0.15	0.20	0.30
Woodlands & Forests	0.10	0.15	0.20
Meadows & Pasture Land	0.25	0.30	0.35
1)Single-family residential in urban areas, except corner lots with duplex potential	0.40	0.45	0.50
2)Gravel parking lots	0.50	0.55	0.60
3)Mobile home parks	0.60	0.65	0.70
4)Multi-family residential, zero-lot-line single-family residential and potential duplex lots in single-family residential	0.70	0.75	0.80
Highly impermeable (roofs and paved areas)	0.90	0.90	0.90

d. **Time of Concentration**

1) For land in a pre-development condition, the minimum time of concentration from the most remote point in the basin to the first defined channel (e.g. gutter, ditch or pipe) shall be 10 minutes. Pre-development shall be defined as a site with natural vegetation on native soil.

2) For developed residential and commercial/industrial property, the maximum time of concentration from the most remote point in the development to the closest inlet shall be 10 minutes, unless calculations by an acceptable method show the time to be longer.

3.11 OPEN CHANNELS

a. Within the UGB, creation of new open channels will not generally be allowed. Where allowed by the City, ditches shall be located along or adjacent to lot lines.

Copyright 1996
Westech Engineering, Inc

b. For reasons of maintenance and safety, bank slopes generally shall be 3H:1V or flatter unless otherwise required by the Public Works Superintendent.

c. The maximum allowable design velocity shall be 7 fps.

d. The minimum allowable design velocity shall be 2 fps. The installation of a concrete lined low-flow channel may be required to achieve minimum velocity.

e. Unless otherwise approved by the City Engineer, all piped discharges to open channels (existing or new) shall be mitered to match the channel side slope and include a reinforced concrete collar (6" minimum thickness) to prevent settlement or erosion of the pipe trench at the discharge location, and to protect the end of the pipe. Unless otherwise approve by Public Works and the City Engineer, the concrete collar shall extend from the channel bottom to the top of bank. Grates shall be provided on all inlets or outlets 18" or larger unless otherwise specifically approved by Public Works and the City Engineer, as well as at any locations required by Public Works to accommodate maintenance or mowing requirements.

3.12 ALIGNMENT AND LOCATION

a. General

1) Generally, storm drains shall be laid on a straight alignment between catch basins and between manholes. Lines 15-inch in diameter and smaller may be laid on horizontal curves conforming to the street curvature provided the radius of the horizontal curve is not less than 200 feet.

2) Variance for horizontal curves on larger size pipes shall be reviewed by the City Engineer on a case by case basis.

3) Where storm drains are being designed for installation parallel to other utility pipe or conduit lines, the vertical location shall be in such a manner that will permit future side connections of main or lateral storm drains and avoid conflicts with parallel utilities without abrupt changes in vertical grade of main or lateral storm drains.

b. Location in Relation to Water and Sewer Lines and Other Utilities

1) Public storm drainage lines shall be separated from all other parallel public utilities by a minimum of 5 feet.

2) Installation of private utilities in a common trench with storm drain lines shall be prohibited.

c. Location in Street Right-of-Ways

1) Unless otherwise approved by the City Engineer and the Public Works

Copyright 1996
Westech Engineering, Inc

Superintendent, storm drain lines shall generally be located in the street right-of-way within six (6) feet of the face of curb.

2) Variance for horizontal curves on larger size pipes shall be reviewed on a case by case basis for approval by the City Engineer.

d. **Location in Easements & Easement Widths**

1) Minimum Easement Widths: Unless otherwise specified or authorized by the City, minimum easements widths for storm drains shall be as follows:

MINIMUM STORM DRAIN EASEMENT WIDTHS		
Storm Drain Diameter	Depth to Invert	
	≤ 6 feet	> 6 feet
10 - 15 inches	12 feet	12 feet plus 2 feet for each foot (or fraction thereof) deeper than 6 feet to invert.
18 - 24 inches	16 feet	16 feet plus 2 feet for each foot (or fraction thereof) deeper than 6 feet to invert.
> 24 inches	20 feet	20 feet plus 2 feet for each foot (or fraction thereof) deeper than 6 feet to invert.
Note: Easements shall be a constant width between manholes or other in-line structures. Easement width shall be based on the deepest portion of the line between such structures.		

2) Open channels located outside of public right-of-ways shall be provided with an easement widths as follows:

a) Channel width less than 14 feet at top of banks: Channel width plus 12 feet on one side and 2 feet on the other.

b) Channel width greater than 14 feet at top of banks: Channel width plus 12 feet on both sides.

3) Public storm drains in easements will be allowed only after all reasonable attempts to place the mains in a right-of-way have been exhausted. All easement installations must be approved in writing by the City Engineer and the Public Works Superintendent on a case-by-case basis.

4) When storm drains in easements are approved by the City, the storm line shall be offset a minimum of 6 feet from any property line or easement boundary, or 1/3 the required easement width, whichever is greater.

Copyright 1996
Westech Engineering, Inc

5) The conditions of the easement shall be such that the easement shall not be used for any purpose which would interfere with the unrestricted use for storm drain purposes. Under no circumstances shall a building or structure, tree or fence be placed over a storm drain pipe or easement. This shall include overhanging structures with footings located outside the easement.

6) Easement locations for public storm drain lines serving a PUD, apartment complex or commercial/industrial development shall be in parking lots, private drives or similar open areas which will permit an unobstructed vehicle access for maintenance by City forces.

7) Common placement in the easement of a sanitary sewer and storm drain line may be allowed under certain conditions subject to approval by the City Engineer and the Public Works Superintendent. Easements wider than the minimum may be required.

8) Common easements will be reviewed on a case-by-case basis. Separation of utilities must meet Oregon State Department of Environmental Quality (DEQ) requirements.

9) All easements must be furnished to the City for review and approval prior to recording. All recording costs shall be borne by the Developer.

3.13 MINIMUM PIPE SIZE

a. Public mainline, lateral or connector pipe storm drains shall not be less than 10-inches inside diameter, and shall begin at a structure and terminate at an approved point of disposal.

b. When two parallel pipes are installed in lieu of a box culvert, the minimum separation between the pipes shall be one foot or 1/3 the diameter, whichever is greater. This requirement may be waived if the void between the pipes below the springline is filled by grouting or other approved method.

3.14 MINIMUM COVER

a. All storm drains shall be laid at a depth sufficient to protect against damage by traffic and to drain building footings where practical. Sufficient depth shall mean the minimum cover form the top of the pipe to finish grade at the storm drain alignment.

b. Under normal conditions minimum cover shall be 24-inches above the top of the pipe in paved areas and 30-inches at all other locations.

c. In areas of relatively flat terrain, the design engineer must demonstrate that sufficient depth is provided at the boundary of the development to properly drain the reminder of the upstream basin area tributary to the site.

Copyright 1996
Westech Engineering, Inc

3.15 MINIMUM SLOPE

a. All storm drains shall be laid on a grade which will produce a mean velocity (when flowing full) of at least 2½ feet per second, based upon Manning's pipe friction formula using a roughness coefficient of not less than 0.013 for smooth wall pipe and 0.024 for corrugated wall pipe, or the pipe manufacturer's recommendations, whichever is greater.

b. The minimum acceptable slopes for various pipe sizes and types are listed below:

MINIMUM STORM DRAIN PIPE SLOPES (for 2½ fps velocity)	
Inside Pipe Diameter (inches)	Smooth Wall (n=0.013) % Slope (ft/100 ft)
10	0.39
12	0.30
15	0.23
18	0.18
21	0.14
24	0.12
27 & larger	0.10

c. In general, gradients greater than those shown above are desirable and are particularly recommended on connector pipes and the upper ends of laterals.

d. The minimum grade may be reduced from the above table to produce an absolute minimum velocity of 2.0 fps upon approval of the City Engineer. Cases requiring a flatter grade than permitted above shall also be reviewed on a case by case basis for approval by the City Engineer.

e. Engineers are cautioned not to specify sewers of sizes which are obviously larger than necessary for satisfactory carrying capacity but which are specified in order to meet grade requirements (ie. a 15-inch pipe for an 12-inch pipe to acquire a decrease in slope).

f. Storm drains shall be laid with uniform slope between structures.

g. Grades (slopes) shall be determined to the pipe invert at the edge of the catch basin or manhole and lengths to the center of the catch basin or manhole.

Copyright 1996
Westech Engineering, Inc

h. The difference between the inlet pipe slope (Si) and outlet pipe slope (So) at any catch basin or manhole shall not exceed 25 percent.

i. Storm drains on slopes of 20 percent or more shall be anchored with concrete anchor walls or other restraining methods approved or specified by the City.

j. Where velocities greater than fifteen (15) feet per second are attained, the pipe material shall be ductile iron and special provision shall be made to protect manholes against erosion and displacement by shock. This may be accomplished by installing one additional manhole to decrease the slope or to split a 90° horizontal direction change into two 45° incremental changes.

3.16 UNDERGROUND WARNING TAPE

a. Detectable or non-detectable acid and alkali resistant safety warning tape shall be provided along the full length of all service laterals and all mainlines not located under sidewalks or paved portions of public streets.

b. Underground warning tape shall be placed a minimum of 12-inches and a maximum of 18-inches below the finish ground surface, and shall be continuous the entire length of the service laterals installed from the mainline to the back of the PUE. Where required for mainlines not located under sidewalks or paved portions of public streets, the warning tape shall be continuous between manholes or cleanouts.

3.17 MANHOLES AND CATCH BASINS

a. General

1) All junctions between storm drains shall be made at manholes, catch basins or detention basins.

2) Manholes or junction boxes shall be required at the following locations or as determined by the City Engineer:

   a) All changes in horizontal or vertical alignment. Minor horizontal curvature in pipe less than 15 degrees may be allowed, (without manholes or cleanouts), depending on pipe size, street alignment, degree of curvature and reason. Maximum joint deflection shall be per manufacturer's recommendation.

   b) All connections unless otherwise noted herein.

   c) All changes in pipe size.

   d) At a spacing no greater than five hundred (500) feet.

Copyright 1996
Westech Engineering, Inc

3) For new mainline and lateral construction, catch basin laterals of 10 feet or less in length and 10 inches in diameter or less may connect to the main line with a shop fabricated 90 degree "T", provided the connections is located not more than one hundred (100) feet from a manhole or cleanout on the main line and the main line is a minimum of 14-inches or larger in diameter.

4) In place of manholes or junction boxes, laterals draining private property may be connected directly to the main line, provided the lateral diameter is 8-inches or less and is no more than half the diameter of the main line. Unless otherwise approved by Public Works, the connection to the mainlines shall be with an Inserta-Tee connection so as to provide a strong, leak-proof joint. The lateral shall not project inside the main line.

b. **Catch Basins**

1) General

a) Side inlet grated catch basins shall be used at all locations. Exceptions will be considered on a case by case basis.

b) Catch basins may be used for the junction of pipes 15-inches in diameter or less where the depth from rim to invert is less than 4 feet.

c) Catch basins shall be designed to completely intercept the 5 year design storm gutter flow.

2) Location

a) The maximum length of curb and gutter which may be drained by a catch basin is 500 feet.

b) The maximum impervious area which may be drained by a catch basin is 20,000 square feet.

c) Catch basins shall be installed where the improvement ends on all streets terminating on a descending grade, and piped to an approved point of disposal.

d) Catch basins on corners shall not be located in front of handicap access ramps.

e) Catch basins in the middle of blocks shall be located within 5 feet of the extension of a common property line.

f) Catch basins shall be installed at all low spots, whether on private or public property, and shall be connected to a storm drainage facility.

Copyright 1996
Westech Engineering, Inc

3) Drop Across Catch Basin Structure

a) The vertical drop across flow-through storm drain catch basins shall not be less the 0.1 feet.

c. **Manholes**

1) Manhole Size

a) Manhole size shall conform to the requirements outlined under Division 4, Sanitary Sewers and the standard details.

2) Manhole Location

a) Manholes shall be installed at all pipe junctions where the depth from rim to invert exceeds 4 feet or where the pipe is 18-inches in diameter or greater. Exceptions will be reviewed on a case by case basis.

3) Drop Across Manhole Structure

a) The vertical drop across storm drain manholes shall conform to the requirements outlined under Division 4, Sanitary Sewers.

4) Rim Elevation

a) The rims of all manholes located within paved or other hard surfaced areas shall be set to finished grade.

b) Concrete riser rings shall be used to bring casting to grade. The height from the top of the cone or flattop section to the rim shall not exceed 18 inches.

d. **Mainline Storm Cleanouts**

1) Mainline storm cleanouts will not be approved as substitutes for manholes or terminal catch basins. Cleanouts shall only be allowed at the upper end of main storm lines less than 150 feet long which will be extended on the same grade and alignment during the next construction phase of a multiphase development, and which do not have any laterals.

2) All mainline cleanouts will be considered on a case-by-case basis and approved by the City Engineer and the Public Works Superintendent. In all cases, plan and profile showing the alignment and depth of the anticipated future extension from the proposed cleanout to the next manhole shall be submitted prior to approval of cleanouts.

Copyright 1996
Westech Engineering, Inc

3.18 DETENTION FACILITIES

a. Where Required

1) Peak storm water runoff shall be controlled by detention facilities for the following:

   a) All commercial, industrial and multi-family developments

   b) Parking lots with 10,000 square feet or more of impervious area

   c) All other developments where such control is needed to prevent the capacity of the downstream system from being exceeded.

2) Developers shall be responsible for demonstrating to the satisfaction of the City Engineer that the downstream system has capacity for the proposed flows.

3) Developers proposing to not provide detention or control shall be responsible for demonstrating to the satisfaction of the Engineer that such control is not necessary.

b. Allowable Runoff Rate (Outflow)

1) Peak runoff rate shall be limited to that which would occur in a 5-year frequency storm with pre-development conditions as defined above, or the *remaining available downstream capacity for the site being developed*, whichever is more stringent.

2) Remaining available downstream capacity is defined as the downstream capacity unused during the design storm event. The *remaining available downstream capacity for the site being developed* is that portion of the remaining available downstream capacity equivalent to the ratio of the site being developed to the total undeveloped land in the basin.

c. Detention Facility Siting

1) Unless otherwise approved by the City Engineer and Public Works Superintendent, all detention facilities shall be located on private property and shall be maintained by the property owner, including but not limited to cleaning and maintenance of outlet/flow control structures, irrigation (via a permanent irrigation system), mowing, etc. Maintenance shall be assured through a recorded maintenance agreement acceptable to the City. All detention basins, with the exception of parking lot detention basins, shall be within a public utility and access easement to the City, with grass and the permanent irrigation system to be provided by the developer.

Copyright 1996
Westech Engineering, Inc

d. **Design**

1) General

a) All detention facilities and drainage calculations shall be designed and stamped by a Professional Engineer registered in the State of Oregon. Detention facilities shall be designed to protect public and private property.

b) The maximum water level in the receiving stream must be lower than the bottom of the detention basin.

c) Unless otherwise approved by the City Engineer, all open detention basins shall be designed as off-stream storage basins, sloped to drain completely between design storms.

2) Detention Basin Storage Capacity

a) Detention facilities shall have storage capacities to detain the greater of the following:

(1) The difference between a 5-year frequency storm with pre-development conditions and a 25-year frequency storm under developed conditions.

(2) The difference between the *remaining available downstream capacity for the site being developed* (as defined above) under design storm conditions and a 25 year frequency storm under developed conditions.

3) Orifice

a) The orifice size and the hydraulic head shall be adjusted to produce the allowable outflow based on the following formula:

$$D = 6.166\left(\frac{Q}{H^{1/2}}\right)^{1/2}$$

Where:

D = Orifice diameter in inches.
Q = Discharge in cubic feet per second.
H = Hydraulic head above the orifice in feet.

b) To prevent excessive plugging, the minimum orifice diameter shall be 1½-inches. The orifice shall be located in a pollution control manhole in an accessible location outside of the detention basin.

Copyright 1996
Westech Engineering, Inc

c) The outlets of all detention basins shall be provided with suitable debris barriers designed to protect the outlet from blockage or plugging.

4) Overflow System

a) The detention facility shall have an overflow system with the capacity to pass a 50-year frequency storm. The overflow shall discharge into a public storm drain facility or the natural drainage course for the drainage basin where the development is located, and shall be designed to minimize the impact to downstream systems.

b) The design of detention facilities shall ensure that overflow or system failure will not cause flooding in any habitable building area.

5) Open Basins

a) Depth - At maximum storage, the maximum allowable water depth shall not exceed 5 feet.

b) Freeboard - The maximum water surface elevation shall be a minimum of 1.0 feet below the top of the structure (curb, bank, berm, etc.) designed to contain the water.

c) Side Slopes - The side slopes for detention basins shall be no steeper than 4H:1V. Steeper slopes may be used where approved by the Chief of Public Safety and if access to the detention facility is restricted by chain link or other approved fencing a minimum of six (6) feet high.

d) The bottom of all constructed and graded detention basins shall be sloped a minimum of 1% towards the outlets for drainage.

6) Parking Lot Detention Basins

a) Depth - The maximum water depth for parking lot detention basins shall be 1 foot.

b) Freeboard - The maximum water surface elevation shall be a minimum of 0.25 feet below the top of any and all structures designed to contain the water. Landscape berming is typically not allowed for containing water on parking lot detention basins.

c) The maximum water level (overflow) in parking lot detention basins shall be a minimum of 1 foot below the lowest habitable floor elevation of buildings within the proximity of the basin.

d) No parking lot detention basins shall be located within the primary

Copyright 1996
Westech Engineering, Inc

ingress/egress portions of the site. Parking lot detention basins shall be designed to provide a minimum 11 foot wide unflooded emergency access route at maximum water level conditions (ie. overflow conditions).

7) Piped Detention System

a) Piped detention systems shall be designed as a watertight subsurface pipeline, and shall be sloped a minimum of 0.1% towards the outlet to drain.

b) Access points - A pollution control manhole with an orifice shall be provided at the downstream end of the piped detention system, and a standard manhole shall be provided at the upper end of the upstream end.

c) Pipe type shall be based upon the depth of cover and loading conditions as specified herein.

d) Easement widths shall conform to the minimum requirements outlined herein.

3.19 PRIVATE STORM DRAINAGE COLLECTION SYSTEMS

a. Private storm drainage collection systems shall be designed in conformance with main line standards specified herein when plumbing code grade requirements of Oregon Plumbing Code (OPC) cannot be met. The private storm drainage collection systems shall conform to the detention requirements contained herein as applicable.

b. These provisions of the PWDS do not, nor are they intended to supercede the UPC, but are intended to allow the design engineer flexibility in the design of private storm drainage systems where the UPC minimum slope requirements cannot be satisfied.

3.20 DRYWELLS AND FRENCH DRAINS

a. Drywells and french drains are not allowed as the exclusive method for draining public right-of-ways but may be used for developments on private property for buildings, paved driveways, parking and loading spaces, subject to the all of the following conditions:

1) There are no public storm drain facilities, available within a reasonable distance of the development as determined by the City Engineer. The need to acquire easements across private property to access a public storm drain facility that is within a reasonable distance shall not be grounds for allowing an infiltration system unless all other criteria are met.

2) Soils percolation tests shall be performed by a State certified laboratory to

Copyright 1996
Westech Engineering, Inc

show that there is adequate permeability. Tests shall be conducted between December 1 and April 30 during a period of normal or above normal rainfall to demonstrate that perched water tables are not a concern.

3) The system shall be engineered to ensure that adequate reserve capacity is available. Adequate reserve capacity shall include all runoff assuming the maximum amount of impervious area allowed by City Code based on zoning, and shall include an instrument recorded against the property reserving a area adequate for a replacement infiltration system equal in size to the primary system.

4) Provisions shall be made for grease and fines removal, including recording of a maintenance agreement (acceptable to the City Engineer & City Attorney) against the property.

5) The site shall be graded so that it does not drain onto a public right-of-way without a storm drain system or neighboring property in the event that the drywell or french drain fails. The site and adjacent down gradient areas shall have no history of groundwater surfacing or being within 12-inches of the ground surface during the wet winter months, and shall not have field tile systems which may convey the infiltration water onto neighboring property.

6) The design shall include pretreatment conforming with Oregon DEQ standards for groundwater injection wells, shall be acceptable to the City Engineer, and shall be approved by and registered with DEQ prior to final plan approval by the City.

b. Where drywells, french drains or other infiltration systems are permitted, they shall be registered with the Oregon DEQ as required by OAR 340-044-005 through 340-044-055 prior to final approval by the City and construction (in addition to the standards above). Only DEQ "rule authorized" infiltration systems are acceptable, unless otherwise approved by DEQ and the City Engineer. Under these regulations, stormwater dry wells are "rule authorized" if they meet certain highly restrictive standards (conformance with current DEQ/EPA standards must be confirmed prior to submittal for review by the City). These standards restrict the use of dry wells under the rule authorized provisions to the following.

1) No other method of storm water disposal, including construction or use of surface discharging storm sewers or surface infiltration systems, is appropriate. An appropriate method shall protect groundwater quality and may consider management of surface water quality and watershed health issues.

2) No domestic drinking water wells are present within 500 feet of the injection system.

Copyright 1996
Westech Engineering, Inc

3) The injection system does not exceed a depth of 100 feet and the bottom of the infiltration structure is a minimum of 10 feet above the highest seasonal groundwater level.

c. It should be noted that DEQ standards consider water draining from building roof areas (that has not been mixed with any other stormwater) differently, in that it can be discharged in a dry well without the same level of treatment required for other types of runoff, although it must still comply with the City and DEQ criteria above and receive DEQ approval prior to final City approval or construction.

3.21 STORM DRAIN SERVICE LATERALS

a. As a minimum criterion, construction of the storm service laterals shall be of the same quality and meet the same requirements as the public storm drain with regard to materials, watertightness, and location. In addition, these storm drains shall conform to the State and local plumbing codes and restrictions.

b. Storm drain laterals shall be installed for any residential lots which do not have finish grades that slope 2% minimum to the fronting curb so as to allow both the roof and footing drains to flow to the fronting curb weep holes. In all cases, storm drain lines shall be provided as required to prevent roof and surface drainage from flowing across pedestrian access routes.

c. A cleanout shall be installed at the right-of-way or easement line for all storm drain service laterals. The storm drain service lateral shall extend beyond the cleanout to the back of any private utility easement (PUE) fronting the right-of-way or easement.

d. The minimum inside diameter of a storm drain lateral shall be four (4) inches and shall be equal to or greater than the building drain diameter.

e. Additional storm laterals must be stubbed into the property lines sufficient to serve all residential parcels (including those which can be further partitioned in the future) where such service or future partition would require that new streets be cut to install such services.

Copyright 1996
Westech Engineering, Inc