



**JOINT WORK SESSION MEETING
AGENDA
CITY OF CREVE COEUR
CITY COUNCIL AND
STORM WATER COMMITTEE
300 NORTH NEW BALLAS RD
JULY 24, 2017
6:00 PM**

CALL TO ORDER

ROLL CALL

DISCUSSION ITEMS

1. Revised Stormwater Regulation

Summary: The City's Stormwater Committee and City staff propose revisions to the City's Stormwater Regulations (Chapter 425 of the Municipal Code) that are intended to protect residents from the potential negative effects of stormwater runoff resulting from development on adjacent residential lots. The proposed regulation would apply to large-scale residential developments that disturb less than one acre of land, such as a new home, swimming pool, or garage addition. The proposed revision also adopts the most recent (2006) MSD Regulations by reference. The current Chapter 425 is an adaptation of the 1997 MSD Regulations.

Pursuant to Section 610.022 RSMo., the City Council could, at any time during the meeting, vote to close the public meeting and move to closed session to discuss matters relating to litigation, legal actions and/or communications from the City Attorney as provided under Section 610.021(1) RSMo. and/or personnel matters under Section 610.021(13) RSMo. And/or employee matters under Section 610.021(3) RSMo. and/or real estate matters under Section 610.021(2) or other matters as permitted by Chapter 610.

Posted: _____ posted 07/20/2017
Deborah Ryan, MPCC
City Clerk



City Council
300 North New Ballas Rd
Creve-Coeur, MO 63141

SCHEDULED

Meeting: 07/24/17 06:00 PM
Department: Public Works Department
Category: Report
Prepared By: Matt Wohlberg
Department Head: Jim Heines

STAFF REPORT

Revised Stormwater Regulation

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The proposed revision also adopts the most recent (2006) MSD Regulations by reference. The current Chapter 425 is an adaptation of the 1997 MSD Regulations.



DEPARTMENT OF PUBLIC WORKS STAFF MEMORANDUM

DATE: July 20, 2017

TO: Mark Perkins, City Administrator

CC: Jim Heines, Director of Public Works

FROM: Matt Wohlberg, P.E., City Engineer

SUBJECT: Recommended Revisions to Chapter 425 Stormwater Regulations

The City's Stormwater Committee and City staff propose subtle yet substantial revisions to the City's Stormwater Regulations (Chapter 425 of the Municipal Code) in an effort to simplify the regulation and protect the residents of Creve Coeur from the effects of stormwater runoff.

Background

The City of Creve Coeur, dozens of other municipalities in the St. Louis area, and the Metropolitan St. Louis Sewer District (MSD) together hold a permit for stormwater discharge under the federal Clean Water Act. As "co-permittees," the City and MSD work together to meet the requirements of this permit.

MSD developed a set of stormwater management standards for development that its co-permittees (including Creve Coeur) have agreed to adopt and enforce. These MSD regulations were adopted by the City and make up the substantial majority of Chapter 425 of the Municipal Code. These regulations apply to projects and development that disturbs one acre or more of land, which would include most commercial and residential subdivision development. Development of a single residential lot would generally be considered too small for the MSD regulations to apply.

Because Creve Coeur is predominately a built-out residential community, development of a single residential lots is more common in Creve Coeur than is large-scale subdivision development. Such "infill development" is too small to require stormwater detention according to the MSD/City regulations. Unfortunately, such development is often large enough and disruptive enough to generate and/or redirect additional stormwater runoff onto adjacent properties. This runoff can cause erosion, ponding, or even basement flooding for the affected neighbors.

Calls for Action

Attempts to address the impact of residential development began about ten years ago. At that time, the Stormwater Committee recommended a regulation to apply detention and water quality standards to residential developments. This approach mirrored what the City of Frontenac had recently enacted, but it was found to be too restrictive and its feasibility was questioned. The proposed regulation ultimately failed in 2010.

The impacts of infill residential development on neighboring properties did not go away. The rebounding housing market brought additional development, and this fueled renewed calls for a

means to mitigate the impacts that one's development can be anticipated to have on others. Those calls to action are found in key planning documents that have been recently adopted by the City, including the Comprehensive Plan Creve Coeur 2030 and the Strategic Plan FY2018-2020.

- *Comprehensive Plan.* The comprehensive plan identifies the adoption of stormwater regulations for lots measuring less than one acre as one of the "early action items" for the implementation of the Plan.
- *Strategic Plan.* The strategic plan lists the development, adoption, and implementation of regulations for better management of stormwater from residential development as a one of its near-term goals for sustainability.

Excerpts of each plan are attached for reference.

Proposed Stormwater Regulation Changes

The City's Stormwater Committee and City staff propose to protect neighboring properties from residential development through a revision to Chapter 425 of the Municipal Code. The proposed revisions include the requirement that large-scale residential development be completed responsibly with regard to stormwater runoff. In particular, new developments would need to be designed and constructed such that it provides no new stormwater impacts to neighboring properties. In other words, residential developments need to find a way to mitigate the additional stormwater runoff that they will create.

Applicable Projects. This requirement is proposed for larger residential development that would not otherwise trigger review and mitigation requirements through MSD regulations. Examples of development to which the proposed changes would affect include:

- New homes
- Tear-down/rebuild homes
- Land disturbance permits
- New swimming pools
- Garage additions

These types of projects have been found by staff to be large enough to potentially impact the stormwater runoff to neighboring properties. These projects are also large enough to typically need engineered drawings for their design, permit, and construction. The proposed revisions to Chapter 425 require that the mitigation of the added or re-directed runoff become a part of the project's design. Staff finds it unlikely that the proposed requirements would add the need to design a project that otherwise would not have needed plans.

Staff found that the proposed regulation would have applied to 37 projects in 2016. Of these were 14 new homes or teardown/rebuild projects, 14 pools, and 3 garage additions. The remaining 6 projects were land disturbance permits involving less than one acre of disturbance.

Mitigation Costs. The cost to manage the additional stormwater from a project will vary greatly depending upon factors such as the scope of the project, the amount of additional stormwater, and the approach taken to manage the stormwater. In general, the cost to manage the additional stormwater should increase along with the amount of new impervious surface involved with the project.

Assuming that the mitigation is added to a project that increases the impervious cover by 1,000 square feet, staff estimates the following costs associated with these mitigation techniques:

Rain barrels (est. 8 required).....	\$ 1,200
Rain garden	\$ 2,000 – \$ 5,000
Replace 1,000 SF concrete with pervious pavers	\$ 17,000

Please note that these are rough estimates and not based upon specific quotes.

Staffing. The proposed changes have been drafted with consideration for the City's existing practices and permits. The revisions will require some additional review time for the applicable project applications and may add a feature to inspect during construction, but no new permits or processes are required to implement the new requirements.

Staff estimates that the time required to review and inspect any stormwater mitigation features will be partially balanced by the time saved in consulting with neighbors of recent development to determine how to handle the new stormwater runoff that they are receiving.

Additional Aspects of the Revisions

While the substantive revision to Chapter 425 is the addition of requirements to create no new stormwater impacts for neighboring properties, the most notable change to the chapter may be its length. The current Chapter 425 is an adaptation of the MSD regulations from 1997 and restates much of these regulations verbatim. Consequently, the existing Chapter 425 is relatively long, can be difficult to navigate, and contains some provisions that are no longer applicable. The proposed revision to Chapter 425 adopts the current (2006) MSD regulations by reference, both clarifying and shortening the City's requirements.

The proposed revision to Chapter 425 also includes some reorganization of the order of its provisions. The sections pertaining to applicability and defining no adverse effect have been moved to the beginning of the chapter. The intent is to provide clear direction to the reader as quickly as possible.

Reviews and Recommendations

Staff has offered the proposed regulation to several of the City's boards and commissions for their review and comment.

Stormwater Committee Recommendation. The Stormwater Committee has considered the conceptual regulation change for over a year and has shaped the proposed revisions to Chapter 425 for several months. The Committee voted its unanimous recommendation for these revisions at the Committee's meeting on May 10, 2017. The draft meeting summary from this meeting is attached for reference.

Planning and Zoning Commission Recommendation. Members of the Stormwater Committee and staff presented the proposed revisions to Chapter 425 to the Planning and Zoning Commission at its meetings on June 19, 2017, and July 17, 2017. At their meeting on July 17, the Planning and Zoning Commission voted unanimously to recommend that the City Council approve the proposed revisions as drafted.

Energy and Environment Committee. The proposed revisions to Chapter 425 have been offered to the Energy and Environment Committee for their information, but the Committee has not been able to hold a meeting recently and has therefore not yet considered the proposal.

Home Builders Association (HBA). Staff sent a copy of the proposal to the HBA for review and comment in June, and staff has discussed portions of it with the HBA in the meantime, but the HBA has not yet offered any comments regarding the proposal.

Schedule for Public Review and Adoption

The proposed revisions will be required to be posted for public review for at least ninety (90) days due to the change from a direct statement of the stormwater requirements to a reference of the MSD regulations. Upon a favorable outcome at the City Council work session, staff would post the necessary documents for review.

The revised regulations would need to be adopted through an ordinance of the City Council. The ninety-day public comment period would mean that the earliest approval of these revisions would be either in late October or early November 2017.

Recommendation

With the support of the Stormwater Committee and the concurrence from the Planning and Zoning Commission, staff has developed the proposed revisions to the City's stormwater regulations with the goals of simplifying the regulations and of providing protection for neighboring properties in a way that is fair to the developer. The City encourages property improvements, but these improvements should be responsible so that they do not create a stormwater-related issue for neighbors. At the same time, the proposed regulation calls for the mitigation of only the *change* to the runoff that is created by a project.

Attachments: Excerpts from Comprehensive Plan Creve Coeur 2030 (with highlights added for emphasis)
 Excerpts from Creve Coeur Strategic Plan FY2018-2020 (with highlights added for emphasis)
 Draft meeting summary from the May 10, 2017, Stormwater Committee meeting (with the Committee recommendation for the revised Chapter 425 highlighted for emphasis)
 Proposed revision to Chapter 425 Stormwater Regulation ("clean copy")
 List of key comments from the Stormwater Committee and staff regarding the proposed revisions, and their corresponding responses
 Proposed revision to Chapter 425 Stormwater Regulation ("redline copy")
 Current Chapter 425 Stormwater Regulation

Creve Coeur



The Heart of Community & Commerce



COMPREHENSIVE PLAN UPDATE
for the City of Creve Coeur, Missouri

March 2017

05

IMPLEMENTATION PLAN

Early Action Items

Identification and successful completion of several early action items will be key to setting the stage for on-going implementation. First, it will establish essential regulatory frameworks for continued, ongoing implementation efforts. Second, it will initiate several key catalytic projects to leverage future investment. Lastly, it will build critical momentum and excitement about the City's future.

In order to successfully begin implementation of the Creve Coeur 2030 Plan, the following eight (8) early action items should be completed by the City of Creve Coeur:

1. **Establish an ongoing outcome reporting and management system to track progress:** While the ongoing evaluation process specified in the 2002 Comprehensive Plan was too prescriptive and intensive to be successful, tracking progress of the Comprehensive Plan is an important part of successful implementation. In order to achieve this, Creve Coeur should develop and establish an Outcome Measurement Reporting system to track implementation progress. The City should also consider developing a web-based, Community Dashboard to publish outcome measurement reports. This system should also include a five (5) year assessment interval, with the potential to update tracking measures, targets, and/or benchmarks to reflect current implementation status.

2. **Develop and adopt a Stormwater Ordinance for lots less than one (1) acre in area:** Currently, stormwater runoff resulting from land disturbance one (1) acre and greater in size is regulated by Metropolitan Sewer District (MSD) under the U.S. Environmental Protection Agency's (EPA's) MS4 (Small Municipality Stormwater) regulations. These

regulations require that any net increase in stormwater runoff resulting from development or redevelopment be detained and recharged on site. These regulations do not apply to land disturbance of less than one (1) acre. In Creve Coeur, disturbances of less than one acre has resulted in similar stormwater runoff issues that MS4 is designed to mitigate.

In order to address this issue, the City's Planning and Community Development and Public Works Departments have been working with the City's Stormwater Committee to develop a local stormwater ordinance. Completion and adoption of this ordinance will have a positive effect on land use, development, and environmental protection in Creve Coeur. The Creve Coeur 2030 Plan recommends that this ordinance be finalized and adopted as soon as possible.

3. **Develop and adopt updates to the City's Zoning Ordinance for residential districts:** Creve Coeur has faced numerous issues with teardowns and redevelopment of infill lots in existing residential neighborhoods. As presented herein, this is due primarily to the current zoning regulations for residential zoning districts in the City's Zoning Ordinance.

As detailed on page 71 in recommendations for residential neighborhoods, a variety of development standards for residential neighborhoods should be adopted. These standards should be written as updates to the current City Zoning Ordinance for residential districts and subsequently adopted by the Planning and Zoning Commission and City Council.



STRATEGIC PLAN

FY2018-2020



GOAL 4

PRACTICE AND PROMOTE SUSTAINABILITY

4a. Update and implement bicycle and pedestrian plans.

	Implementation Lead	Schedule
As opportunities arise, participate in regional bicycle/pedestrian planning including (but not limited to) efforts by Great Rivers Greenway and St. Louis County.	Community Development	TBD, Priority 1
Install bike racks at all City properties that do not currently have them. \$	Public Works Director	FY18, Priority 1
Review comprehensive plan and existing bikeways plan to determine priorities for bicycle and pedestrian infrastructure.	Community Development Director, Public Works Director	FY18, Priority 1
Explore a bike/pedestrian trail between Mason and Bellerive School through Creekside at Mason. Create a concept plan for the trail, recommended implementation steps and funding required. Request funds. \$	Public Works Director, City Council	FY19, Priority 1
Identify funding for new bicycle/pedestrian paths. \$	Public Works Director, Recreation Director, City Council	FY19, Priority 1
Identify a test project to connect parks through trails and seek public comment.	Public Works Director	FY19, Priority 3

4b. Integrate sustainability into municipal operations.

	Implementation Lead	Schedule
Incorporate energy efficiency into all building renovations at public facilities, to the extent practical.	Public Works Director	Ongoing, Priority 1
Pursue emissions reductions in government buildings as established by Phase 2 of the Climate Action Plan.	Public Works Director	Ongoing, Priority 1
Evaluate electric and other alternative fuels for new City vehicles. Make recommendation to City Administrator and share findings with Energy and Environment Committee.	Public Works Director, Energy and Environment Committee	FY18, Priority 1
Evaluate use of car chargers at government facilities. Make recommendation to City Administrator and share findings with Energy and Environment Committee.	Public Works Director	FY20, Priority 3

4c. Serve as a community leader in sustainability.

	Implementation Lead	Schedule
Encourage restaurants to join Green Dining Alliance.	Energy and Environment Committee	FY18, Priority 1 (& ongoing)
Draft, adopt and implement a stormwater ordinance. Use permit process and permit guidelines to implement a better tear-down solution for residential redevelopment.	Community Development Director	FY18, Priority 1 (draft) FY19, Priority 1 (adopt)
Continue to promote the Climate Action Plan and recognize community success.	Energy and Environment Committee, Public Information Officer	Ongoing, Priority 2
Compile a master list of City's environmental commitments; track progress. As needed, identify priorities for implementation and ways departments can work together.	Administration	FY18, Priority 2



**Stormwater Committee
Committee Meeting Minutes
May 10, 2017
5:30 PM
City Council Chamber**

I. Call Meeting to Order

II. Roll Call

Martin Jaffe	Chairman	
Laura Catalano	Board Member	
Tom D'Alfonso	Board Member	(Absent)
George Orton	Board Member	
Richard Koch	Vice Chairman	
Judith Campbell	Board Member	
James Myers	Board Member	
Barry Glantz	Mayor	
Alexis Travers	Councilwoman	
James Faron	Councilman/Liaison	
Jim Heines	Public Works Director	
Matt Wohlberg	City Engineer	

III. Approval of Agenda

The agenda was approved unanimously without change.

IV. Approval of Minutes

1. Approval of April 12, 2017 Stormwater Committee Meeting Minutes

RESULT:	ACCEPTED [UNANIMOUS]
AYES:	Jaffe, Catalano, Orton, Koch, Campbell, Myers
ABSENT:	D'Alfonso

V. Comments from General Public

There are no speakers scheduled for this meeting.

A. 12 Wedgewood Lane

Andrew Mayer, the resident at 12 Wedgewood Lane, made a presentation to the Stormwater Committee to describe the stormwater concerns he has for his back yard. These concerns stem from residential development around him over the past ten years.

The Stormwater Committee requested that staff meet with Mr. Mayer to review the situation and that the Committee visit his yard as part of a field trip meeting.

B. Mosley Acres Dam and Pond

Laura Bantele, an attorney with Armstrong Teasdale who represents Martin and Marci Boyer at 13 Mosley Acres Drive, discussed the Boyers' situation with the Committee. Ms. Bantele explained that her clients want to pursue a solution to the failing dam, but they have a minority stake in the issue and this standing has made it difficult for them to make any progress. Ms. Bantele sought advice from the Committee on how to proceed and any contacts for who could help with the project.



**Stormwater Committee
Committee Meeting Minutes
May 10, 2017
5:30 PM
City Council Chamber**

The Committee recommended that staff provide a list of contacts, particularly those who responded to the recent dam rehabilitation project at the Creve Coeur Golf Course.

VI. New Business

A. Residential Stormwater Concerns

i. Falaise Hillside

Staff briefly reviewed a hillside failure along Falaise Drive on the Country Forest Subdivision's common ground. This hillside was repaired in the fall of 2016, but it has failed again.

Staff stated that the subdivision has gotten a permit to remove much of the hillside and to temporarily deposit it on another section of their common ground while they have a solution to the hillside designed. The subdivision expects that the hillside would be finished in the fall of 2017.

ii. Back yard at 273 Princetowne Drive

Staff informed the Committee that the back yard at 273 Princetowne Drive slid several feet the evening of May 3, prompting the resident to request input from staff. The resident has contacted an engineering firm to design a solution.

iii. Drainage at 74 Morwood Drive

Staff informed the Committee that Andy Zimmerman, the son of the resident at 74 Morwood Lane, recently asked staff to review the stormwater runoff situation in his mother's yard. He claims that this runoff got worse when the homes uphill from this yard were built about 10 years ago. Staff stated that they would schedule a time to review the situation and would report back to the Committee.

B. Ladue Road Shoulder

Staff informed the Committee that they were monitoring a failure of the shoulder along Ladue Road near the lake southeast of the intersection of Ladue Road with New Ballas Road. This hillside began to show failure following a series of rain events, as was the case with several other hillsides in Creve Coeur. Staff stated that stormwater was a contributing factor, but the apparent cause of the hillside failure was the combination of its steep slope and the soil saturation.

VII. Unfinished Business

A. Residential Stormwater Regulation

Staff presented the revised Stormwater Regulation (Chapter 425), including the proposed regulation, a redline copy of the current regulation, and the responses to the questions and comments from the Committee and from staff. Members of the subcommittee formed to review the revisions discussed how they met on April 25 to incorporate the most recent comments from staff.

Members of the Committee pointed out some spelling and grammatical errors in the regulation, and staff stated that these would be corrected for the final draft.



**Stormwater Committee
Committee Meeting Minutes
May 10, 2017
5:30 PM
City Council Chamber**

The Committee voted unanimously to recommend approval of the revisions to Chapter 425 Stormwater Regulations.

Staff stated that the next step for the revised regulation would be to present it to the Planning and Zoning Commission in June. Staff stated that they would inform the Stormwater Committee when that meeting would take place and encouraged members of the Stormwater Committee to attend that meeting.

B. Stormwater Projects Update

i. Alden Lane Culvert

Staff briefly updated the Committee regarding the Alden Culvert Repair Project, stating that work had been postponed until the rainy weather slowed down. Staff estimated that the project would be complete by the end of June.

ii. Dam Stabilization

Staff stated that the dam appears to have made it through the spring without any leaks and that staff is currently working on proposals to include an aeration unit in the pond, as was recommended for the health of the pond.

iii. Parks Bridge Replacements

Staff anticipates receiving preliminary plans for this project in June or July.

C. Phase II Permit Update

Staff provided a very brief update regarding City's new goals and requirements in the proposed 5-year stormwater management plan through the Phase II permit.

This discussion was postponed to the next meeting due to the length of time spent on other items.

VIII. Business from Committee Members

A. Field Trip

Mrs. Campbell stated that the Donald Danforth Plant Science Center would be willing to provide a tour for the Stormwater Committee and offered to schedule the tour. The Committee agreed.

The Committee decided to meet for a field trip at 5:00 p.m. on Wednesday, June 14. The Committee also decided to include a review of Mr. Mayer's back yard as part of the field trip after the tour.

B. Guest Speakers

This discussion was postponed to the next meeting due to the length of time spent on other items.

IX. Business from Staff Liaison

A. Meeting Schedule

The Committee will meet at 5:00 p.m. on Wednesday, June 14, for a field trip.



**Stormwater Committee
Committee Meeting Minutes
May 10, 2017
5:30 PM
City Council Chamber**

The next meeting of the Stormwater Committee scheduled for 5:30 p.m. on Wednesday, August 9.

X. Adjournment

The meeting adjourned at approximately 8:15 p.m.

CHAPTER 425 – STORMWATER REGULATIONS

SECTION 425.010: PURPOSE AND INTENT

- A. This Chapter seeks to provide those standards, criteria, procedures, and controls necessary to avoid adverse effects and minimize the harmful physical and economic effects of flooding from stormwater within the City of Creve Coeur. This goal is to be accomplished through the requirements of special measures set forth in Stormwater Management Plans to mitigate by means of detention and controlled discharge of the differential runoff from a property (unless excepted from regulation hereunder) whereon any grading, excavation, filling, or other disturbance of the natural vegetation or any construction, erection, or alteration of a building or structure is to be undertaken. Erosion control requirements are specified in Chapter 420 Land Disturbance Code.
- B. Design Standard. This Chapter adopts the Rules and Regulations and Engineering Design Requirements for Sanitary Sewer and Stormwater Drainage Facilities, dated February 2006, of the Metropolitan St. Louis Sewer District (MSD) as the City's sanitary and stormwater design standard. This document and its regulations shall be referenced herein as "MSD Regulations." This Chapter may need to be revised in the event that MSD changes their ordinance. (R.O. 2008 §24-30.1; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.020: APPLICABILITY

- A. The provisions of this Chapter shall apply to all Land Disturbance Permits (as defined in Section 420.020) and Residential Development Permits issued by the City of Creve Coeur.
- B. Exceptions. The following activities and situations shall be exempt from the requirements of this Chapter:
 - 1. Building permits for entirely interior work.
 - 2. Room additions and other building permits that disturb less than 2,000 square feet.
 - 3. Permitted development of any undeveloped lot of record of less than one-quarter ($\frac{1}{4}$) acre existing as of January 1, 2017.
 - 4. The planting, trimming, pruning or removal of trees, shrubs, grass, weeds, vegetation, ground cover or other plant material when such actions are incidental to and part of the normal maintenance of land and property in the City of Creve Coeur.
- C. In considering the applicability of the exceptions listed above, the effective acreage for a project, development, or subdivision is not limited to a fractional part of the total concept. Rather, if a project is developed in phases or small plats, the total acreage of the project, development, or subdivision will be considered

- D. The Director of Public Works has the discretion to require that, for any building permit, the applicant provide a grading plan, a siltation control plan, and/or a stormwater management plan. (R.O. 2008 §24-30.5; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.030: NO ADVERSE EFFECT

- A. Definition. No adverse effect shall mean that the proposed changes to a property will not increase the volume, direction, velocity, or intensity of stormwater runoff for adjoining properties for the design storm.
- B. Design Storm. For the purposes of determining “no adverse effect,” the design storm shall be 15-year rainfall intensity for a duration of 20 minutes (15-year, 20-minute storm).
1. Table 4-2 of the MSD Regulations lists specific stormwater runoff rates for the design storm.
 2. The determination of the change to the site’s stormwater runoff rate will be based upon comparing the stormwater runoff rates in MSD’s Table 4-2 for the existing and proposed conditions of the site.
- C. Site Grading. Sites shall be designed such that the proposed conditions will not increase the volume or speed of stormwater runoff onto any adjacent property.
1. For subdivisions with stormwater detention or retention facilities that are demonstrated by the applicant to have the capacity to accommodate the site’s differential stormwater runoff, the site’s differential stormwater runoff will be allowed to flow directly into these facilities or directly into an enclosed system which flows into such a facility, provided that no other properties are crossed in order to do so.
 2. For subdivisions without stormwater detention or retention facilities, the differential stormwater runoff for a development will need to be contained on site.

SECTION 425.040: SUBMISSION, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS

- A. Stormwater Management Plan Required. Except as otherwise provided in Section 425.020, no permit shall be issued to construct, erect, or alter any building or structure or to clear, grade, excavate, fill, remove topsoil from, or otherwise change the contour of any property within the City until a stormwater management plan has been submitted, approved, and recorded in accordance with the provisions of this Chapter.
1. A stormwater management plan shall be those documents, plans, calculations, and any other information necessary to demonstrate, to the satisfaction of the Director of Public Works, that the proposed work creates no adverse effect, as defined in Section 425.030.
 2. The amount of detail provided in the stormwater management plan will depend on the extent and nature of the project. At a minimum, the stormwater management plan will include contoured site plans, details, and calculations that show the proposed improvements, the pre-construction and post-construction runoff calculations for the

site, specifications and details regarding the proposed mitigation method(s), and the location(s) of the stormwater mitigation on the site.

- B. Review Process. Designs, plans, and specifications of all drainage facilities, as defined in Section 425.120, that are proposed to be constructed, connected to, altered, or reconstructed by any person or corporation, private or public, within the City boundaries shall be submitted to the City and MSD for review, comment, and revision, leading to approval, approval with comments, or rejection. The design engineer shall meet with the Director of Public Works before starting stormwater facilities design to review the Stormwater Management Plan. The stormwater management plan must be reviewed with the Director of Public Works before submittal to MSD. Such designs, plans and specifications (excluding house connections, curb cuts, or similar work as determined by the Director of Public Works) shall be prepared and sealed by a professional engineer registered in the State of Missouri and shall meet the minimum standards of the City, MSD, and the Missouri Department of Natural Resources before approval is granted.
- C. Procedure.
 1. Preliminary conferences. At any time prior to formal submission of project plans, the owner's engineer may arrange for a preliminary conference with the Director of Public Works to obtain informal guidance in project plan preparation with the City. Preliminary conferences are recommended for all permit applications, especially in unique or unusual circumstances, but preliminary conferences are required for land disturbance activities. The preliminary conference is intended to expedite the subsequent formal review and approval process. This includes review of the downstream areas jointly by the City and the developer's engineer with photographs, online content, geographic information system (GIS), and other pertinent information as determined by the Director of Public Works.
 2. Application. When required, a stormwater management plan shall be included with the permit application for the proposed project to the Director of Public Works by the owner of the land prior to the time any work subject to this Chapter is begun on the land. Said plans must accompany any such application, parts of which may also be on forms prepared by the City.
 3. Approval process. Upon receipt of any application and plan, the Director of Public Works shall consider the plan in light of the provisions of this Chapter and shall approve the plan, disapprove the plan or approve the plan with modifications, noting thereon any changes that will be required.
 4. Notification. The City shall promptly notify the applicant of the City's decision on a plan. Such notification shall be within forty-five (45) calendar days after the plan has been properly filed. Any approved plan shall be issued, dated, and bear the manual signature of the Director of Public Works or his designee.
 5. Site development plan approval. A stormwater management plan may, as required, be included in and made part of an application for site development plan approval in accordance with Section 405.1080 or of an application for approval of improvement plans for a subdivision in accordance with Chapter 410 of the Creve Coeur subdivision regulations.

6. Upon approval, the owner shall provide proof that the stormwater management plan has been recorded with the St. Louis County Recorder of Deeds.
- D. Downstream Conveyance System. For land disturbance activities, the developer is required to evaluate the downstream conveyance system where the connection is receiving the proposed development's runoff in order to determine if it has the capacity to receive the proposed development's runoff. The evaluation has to continue until the proposed development's runoff is less than ten percent (10%) of the downstream conveyance system. The Director of Public Works can request additional studies further downstream if a stormwater problem is anticipated.
- E. Corrective Action. If a development during or after construction adversely affects downstream property, corrective action will be required by the developer and/or landowner as determined by the Director of Public Works. The development shall make the required study and repairs during construction or after completion of the proposed development according to the Stormwater Management Plan, as directed by the Director of Public Works, if the stormwater-related problems downstream of the development can be demonstrated to be caused by the development.
- F. Time of Validity.
 1. An approved stormwater management plan shall become invalid if the authorized work is not commenced within six (6) months after issuance of the permit, if the authorized work is suspended or abandoned for six (6) months, or if the project is not completed within one (1) year after the issuance of the land disturbance or residential development permit.
 2. An updated plan shall be subject to the provisions of this Chapter in effect at the time of resubmission. (R.O. 2008 §24-30.2; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.050: REQUIRED SUBMITTALS BY THE DESIGN ENGINEER

Refer to the MSD Regulations for full details regarding information to be submitted to MSD for applicable land disturbance permits. Plan review may be delayed if all required information is not provided by the applicant.

To facilitate the review of plans before approval for construction, the design engineer shall submit with the plans a stormwater management plan containing all necessary data, maps, computations, and checklists as defined in the MSD Regulations in support of the designs and plans.

SECTION 425.060: GENERAL

The developer will need to confirm with MSD whether MSD will accept for dedication any sewers and pump stations within easements dedicated to MSD that have been constructed to MSD standards and for which the requirements stated herein have been met.

The maintenance of these facilities will remain the responsibility of the project Owner and their successors in interest until such time that they have been accepted for dedication by MSD. (R.O. 2008 §24-30.8; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.070: ABANDONMENT OF WORK

Upon receipt of a written statement from the Owner that further work on the project has been abandoned, or upon Owner's failure to promptly complete work after notice of apparent abandonment, the City and MSD shall determine whether or not the uncompleted work is required to ensure the public health, safety and welfare. Should it be determined that completion of the work is necessary, the Owner shall complete such work immediately. Otherwise, the City may utilize the monies deposited in the construction escrow for the project to complete this work or seek other applicable remedies. (R.O. 2008 §24-30.9; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.080: FEES REQUIRED BEFORE PLAN APPROVAL

- A. The City will require that certain fees be paid prior to the acceptance of the plans for review or the subsequent approval of the project plans. Failure to submit the fees in a timely manner could delay the review and approval of the plans. No plans will be approved until all required fees have been paid.
- B. Because the amount of these fees are subject to change, no amount for these fees is given herein. Please contact the City and MSD for a current list of fees. See Appendix B to Title IV--Community Development and Public Works Fee Schedule for fees required by the City for plan submittal and approval.
- C. MSD may apply its own fees to the project proposal.
- D. Recording fees. The owner will be responsible for paying the recording fees for all documents to be recorded with the Recorder of Deeds for St. Louis County. (R.O. 2008 §24-30.10; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.090: BONDS

A corporate surety bond or cash escrow, conditioned upon carrying out all and every part of approved plans for at least the sum estimated to be the full costs of carrying out such plans, shall be furnished to the City whenever such costs are estimated to exceed five hundred dollars (\$500.00). The bond or escrow shall be released upon proper completion of all of the requirements of such approved plans. (R.O. 2008 §24-30.12; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.100 CONSTRUCTION AND MAINTENANCE OF STORMWATER FACILITIES

- A. Detention/retention facilities, when mandatory, are to be built in conjunction with the storm sewer installation and/or grading. Since these facilities are intended to control increased runoff, they must be partially or fully operational soon after the clearing of the vegetation.
- B. Silt and debris connected both with early construction and with general erosion from the site and elsewhere in the watershed after construction shall be removed periodically from the detention area and/or control structure in order to maintain the facility close to its full storage capacity.
- C. The responsibility of maintenance of the detention/retention facilities in subdivision projects shall remain with the developer until such time as applicable escrows are released. Upon release of

escrows the maintenance responsibility for facilities on common ground shall be vested jointly and severally in the trustees of the subdivision by virtue of the trust indenture and the owners of the subdivision lots and their successors in interest. The indenture of the trust should clearly indicate resident responsibility for maintenance in cases of projects without common ground, but the absence of such a provision shall not eliminate such responsibility.

- D. The responsibility of maintenance of the detention/retention facilities in single owner development projects shall remain with the general contractor until final inspection of the development is performed and approved and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention/retention facilities shall be vested with the owner of the lot and their successors. (R.O. 2008 §24-30.11; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.110: ENFORCEMENT, VIOLATIONS, AND PENALTIES

- A. Enforcement. This Chapter shall be enforced by the Director of Public Works. The construction, reconstruction and/or alteration of buildings shall not be undertaken and the development of land shall not be commenced except in accordance with the provisions of this Chapter, as applicable. No permit or application for the construction or alteration of buildings and/or land shall be approved if the project would be in violation of this Chapter.

The Director of Public Works is authorized to institute any appropriate actions or proceedings to prevent, halt, or correct construction or maintenance that is found to be in violation of this Chapter.

- B. Notice of Violation and Sanctions. If the Director of Public Works finds that any of the provisions of this Chapter are being violated in the completion and/or maintenance of a stormwater management plan, he/she shall notify in writing the person(s) responsible for such violation, indicating the nature of the violation and ordering the action necessary to correct it. The Director of Public Works shall take any other action authorized by law to ensure compliance with or to prevent violation of the provisions of this Chapter. (R.O. 2008 §26-121; Ord. No. 1903 §1, 11-24-1997; Ord. No. 5165 §1, 12-13-2010)
- C. Violations. Violations of this Chapter shall include, but are not limited to, the following:
 1. The alteration or construction of buildings and/or land not in accordance with the provisions of this Chapter.
 2. Failure to obtain the necessary approvals as required by this Chapter.
 3. Failure to maintain the approved and recorded stormwater management plan for the property.
- D. Persons Liable for Violation. Those chargeable, singly or jointly, with violations of this Chapter shall include, but shall not be limited to, the following:
 1. Those who commit, assist in, or otherwise participate in a violation.
 2. The owner or other persons who maintain the building, premises, property, or other place where the violation has been committed exists.

3. The owner's agent or person in charge of the building, premises, property or other place where the violation has been committed or exists.
4. The developer, engineer, architect, contractor, subcontractor, or any other person who performs work or enters into a contract for work in violation of this Chapter.

E. Violations and Penalties.

1. In case any building, structure, or land is erected, constructed, reconstructed, altered, converted, maintained, or used in violation of this Chapter, or of any ordinance or other regulation made under authority conferred by Sections 89.010 to 89.140, RSMo., the proper local authorities of the City, in addition to other remedies, may institute any appropriate action or proceedings to prevent such unlawful erection, construction, reconstruction, alteration, conversion, maintenance, or use, to restrain, correct, or abate such violation, to prevent the occupancy of such building, structure, or land, or to prevent any illegal act, conduct, business, or use in or about such premises. Such regulations shall be enforced by an officer empowered to cause any building, structure, place or premises to be inspected and examined and to order in writing the remedying of any condition found to exist therein or thereat in violation of any provision of the regulations made under authority of Sections 89.010 to 89.140, RSMo.
2. The owner or general agent of a building or premises where a violation of any provision of said regulations has been committed or shall exist, or other persons or parties liable for said violation, as indicated in Section 425.110(D) shall be guilty of an ordinance violation punishable by a fine of not less than ten dollars (\$10.00) and not more than five hundred dollars (\$500.00) for each and every day that such violation continues, or by both such fine and imprisonment in the discretion of the court. Notwithstanding the provisions of Section 82.300, RSMo., however, for the second (2nd) and subsequent offenses involving the same violation at the same building or premises, the punishment shall be a fine of not less than two hundred fifty dollars (\$250.00) or more than one thousand dollars (\$1,000.00) for each and every day that such violation shall continue or by imprisonment for ten (10) days for each and every day such violation shall continue, or by both such fine and imprisonment in the discretion of the court.
3. Any such person who having been served with an order to remove any such violation shall fail to comply with such order within ten (10) days after such service or shall continue to violate any provision of the regulations made under authority of Sections 89.010 to 89.140, RSMo., in the respect named in such order shall also be subject to a civil penalty of two hundred fifty dollars (\$250.00). (RSMo. §89.120; R.O. 2008 §26-122; Ord. No. 1903 §1, 11-24-1997; Ord. No. 5165 §1, 12-13-2010)

SECTION 425.120: DEFINITIONS

In addition to words and terms that may be defined elsewhere in this Chapter, the following words and terms shall have the meanings defined below:

CHANNELS: A natural or artificial watercourse.

CITY: The City of Creve Coeur.

DEVELOPED RUNOFF RATE: The peak flow corresponding to a selected rainfall event as a result of developed site conditions.

DIFFERENTIAL RUNOFF RATE: The difference between the pre-developed runoff rate and the developed runoff rate.

DIFFERENTIAL VOLUME OF STORMWATER: The amount of differential stormwater volume between the pre-developed and developed runoff rates which the detention basin must detain (hold).

DIRECTOR OR DIRECTOR OF PUBLIC WORKS: The Director of Public Works for the City of Creve Coeur or his/her designee.

DRAINAGE FACILITY: Any system of artificially constructed drains, including open channels and sewers, used to convey stormwater, surface or ground water, either continuously or intermittently, to natural watercourses.

ENGINEER: A registered professional engineer currently certified by law in the State of Missouri.

IMPERVIOUS SURFACE: Materials through which no stormwater or only an incidental amount of stormwater is able to pass. Examples of impervious surfaces include, but are not limited to, building roofs, asphalt pavement, and concrete pavement.

LAND DISTURBANCE: Clearing, grading, removal of improvements, or any other work that temporarily or permanently exposes the ground surface or subsurface to erosion. Section 420.020 includes additional discussion and definitions related to land disturbance.

MDNR: The Missouri Department of Natural Resources.

MSD: The Metropolitan St. Louis Sewer District

OUTFALL: The point location or structure where wastewater or drainage discharges.

PERSON: Any individual, firm, proprietorship, partnership, company, municipality, association, society, corporation, group or other entity.

PRE-DEVELOPED RUNOFF RATE: The amount of flow from an existing site prior to new development or improvements as computed by the Rational Formula.

PRIVATE FACILITIES: Any device, structure, or feature that has not been expressly adopted for maintenance by the City of Creve Coeur, the Metropolitan St. Louis Sewer District, or other municipal, county, state, or federal entity.

RATIONAL METHOD: A means to calculate flow quantities, by which:

$$Q = A * P * I$$

where:

Q = runoff, in cubic feet per second

A = tributary area, in acres

P = runoff factor based upon runoff from pervious and impervious surfaces

I = average intensity of rainfall, in inches per hour, for a given period and a given frequency
 The definition of these factors, including the tables used to select the appropriate values, are outlined in Section 4.030 Stormwater Design Criteria of the MSD Regulations.

RESOLUTION: A resolution duly adopted by the City Council of the City of Creve Coeur.

RETENTION: A stormwater runoff facility designed to retain (hold) stormwater both permanently and temporarily (above normal pool elevation) during and immediately after a runoff event.

RESIDENTIAL DEVELOPMENT PERMIT. A permit from the City of Creve Coeur that is required for any new home (including “tear-down/rebuild” homes), home addition, garage, or swimming pool on residential property. This permit combines the applicable building permit(s) according to Section 500.040 and land disturbance permits according to Section 420.070. Fees for a Residential Development Permit are described in Appendix B to Title IV – Community Development and Public Works Fee Schedule.

STORMWATER DETENTION: A stormwater runoff facility designed to detain (hold) stormwater temporarily during and immediately after a runoff event.

STORMWATER MANAGEMENT PLAN: Study and design for a stormwater conveyance system, a downstream evaluation system, detention requirements, floodplain/floodway, sink hole and regulating permitting requirements.

STORMWATER SEWER: A sewer which carries surface runoff and subsurface waters.

SWALE: A broad, shallow watercourse.

TIME OF CONCENTRATION: Consists of inlet time plus the travel time in the sewer or channel from the most remote point in the watershed to the point under consideration.

TRAVEL TIME: The time it takes for the runoff to flow through the drainage system from one point of reference to the next point of reference.

U.S.G.S.: United States Geological Survey

WATERCOURSE: A stream of water or a natural channel through which water may flow.

REVISIONS TO CHAPTER 425 STORMWATER REGULATIONS

June 6, 2017

Please note that all comments reference the original section number, as much as possible.

FORMAT

[Commenter] Stormwater Committee and Staff Comments Prior to May 2017.

Corresponding Revisions to Regulation

GENERAL

[Carl Lumley] There is inconsistency between references to “MSD Rules and Regulations” and “MSD Regulations” – since this is used as shorthand for specific adopted regs, needs to be consistent – suggest a search and limit to just “MSD Regulations”, as rules and regulations are synonymous.

Revision incorporated as suggested.

[George Seifried] The reference throughout the ordinance for the Director of Public Works and/or City staff. Would it avoid confusion if the term “City staff” is used everywhere and eliminate the term “Director of Public Works,” or [use] “the Director of Public Works” and eliminate “City Staff?”

“City staff” has been replaced with “Director of Public Works,” and the definition of “Director of Public Works” has been updated to be the Director of Public Works or his/her designee.

SECTION 425.010: PURPOSE AND INTENT

425.010.A

[Carl Lumley] Revise "...the requirements of special measures through a development agreement to mitigate through detention..." to read "...the requirements of special measures set forth in Stormwater Management Plans to mitigate by means of detention..."

Revision incorporated as suggested.

[Jim Myers] Insert words in bold to first sentence as follows: *This chapter seeks to provide those standards, criteria, procedures, and controls necessary to **avoid adverse effects and** minimize...*

Revision incorporated as suggested.

[Jason Jaggi] The term "development agreement" doesn't seem to be the correct term. "Development standards" would seem better.

The revisions proposed by Carl Lumley above remove this text from the regulation. The intent is similar: "development agreement" is replaced by "stormwater management plan."

[Jason Jaggi] Cite specific ordinance for Erosion Control (Chapter 420 Land Disturbance Code).

Chapter 420 (Land Disturbance Code) is now cited for erosion control standards.

425.010.B DESIGN STANDARD

[Carl Lumley] Text edit – replace "...by [MSD]..." with "...of [MSD]..."

Revision incorporated as suggested.

[Carl Lumley] Section 67.280 RSMO will require that a copy of the MSD rules be posted in the clerk's office for 90 days prior to adoption, with a notice of proposed adoption on the message board and probably elsewhere - and after adoption must be available to public - the adoption ordinance must state penalties for violations.

The period of notice is noted.

SECTION 425.020: APPLICABILITY

425.020.A

[Jim Myers]

How does this relate to the criteria listed on the PowerPoint slide for when permits are required?

A review of the stormwater impacts that a change to a site is expected to make will be triggered through the existing permitting process.

[Jason Jaggi]

This is an important section which I believe needs more clarity. There needs to be a distinction between permits and the various site plans referenced. The distinction is that a site plan, in and of itself, does not authorize construction. A site plan authorizes the filing of a building permit or site improvement permit application based upon specifications within the set of construction drawings. I think this section needs to say that a stormwater management plan needs to be submitted in conjunction with these applications for review. I also think there needs to be a specific trigger for when a stormwater management plan is required. In practice, I believe using zoning or building permits when they are required as the sole basis for looking at stormwater will create confusion for applicants and substantially increase the workload for staff. A clearer approach would be to set a min. standard (such as 500 square feet or more of additional impervious surface) requires a stormwater management plan.

Other than simplifying the regulation, the applicability of this chapter is the most significant clarification/revision that is proposed.

This discussion led to calls for specific areas of increased impervious surface as triggers (as suggested here) for the sake of simplicity and clarity. Unfortunately, what that area should be was debatable, as the City does not have a study that has determined this.

Staff initially suggested to require a stormwater management plan for any permit application (other than what was exempted) filed with the City. The Stormwater Committee's subcommittee for the regulation found that this would be burdensome on smaller projects and softened this approach by giving the Director of Public Works discretion to determine when stormwater management plans would be required.

Further staff review found this to be too ambiguous and stressed clarity for homeowners and designers. This led to the current recommendation that the regulation apply to those projects that would fall under the Residential Development Permit (e.g. new home, major additions, and swimming pools). Room additions were added to the "exceptions" to focus the regulation on larger projects.

425.020.B EXCEPTIONS

[Carl Lumley] Replace B.2 with the following:

Any undeveloped lot of record of less than one-quarter (1/4) acre existing as of January 1, 2017.

We have not had a recent subdivision so should be ok date.

Revision incorporated as suggested.

[Jim Myers] Use of the word “undeveloped” [in paragraph B.2]. Should this word be eliminated? Is the City’s intent to regulate lots less than ¼ acre?

The text was not changed. It is not the City’s intention that the owner of an undeveloped lot measuring ¼ acre or less should need to address the differential runoff for a new home on that lot, because that situation appears to require the most detention on the smallest lots.

[Carl Lumley] 425.020(B)(3) – What is the exempted activity? Any development?

The provision was revised to begin with “Permitted development of any...” to clarify the intent.

[Judy Campbell] Removal of trees, scrubs, plants for site development can result in an increase in stormwater runoff. If most of them are removed or not planted that could affect sw management. There should be a process to be met or criteria before vegetation is removed or not planted.

Changes to vegetation on a site, particularly the impacts to stormwater runoff, would be considered as part of the stormwater management plan.

[Jason Jaggi] This section could be re-worked if a min. threshold is established per comments [in 425.020.A] above.

A specific area threshold is not recommended.

Room additions and building permits that would not require a site improvement permit (i.e. that disturb less than 2,000 square feet) were added as exceptions.

425.020.C

[Carl Lumley] How would you know since no permit application required?

See comment response below.

[Richard Koch] last sentence – I don't understand how either the property owner or the PWD would know when or if "in the judgement of the Public Works Director, conditions in the receiving system are inadequate or harmful effects can be anticipated".

This paragraph has been revised to eliminate the apparently contradictory statement that refers to staff judgment for a project where no permit would be required.

[Jason Jaggi] See comment above. [This section could be re-worked if a min. threshold is established per comments [in 425.020.A] above.]

This comment was noted, but no changes appeared necessary.

SECTION 425.030: NO ADVERSE EFFECT

425.030.A DEFINITION

[Judy Campbell] Further definition of NAI [no adverse impact]: to not divert additional stormwater onto other properties; to not divert an increase of water velocities onto other properties.

Velocity was added to the definition of no adverse effect.

[Richard Koch] after the word "volume" add ", direction".

Direction was added to the definition of no adverse effect.

425.030.B DESIGN STORM

[Judy Campbell] Be aware that MSD Table 4-2 (2006) is outdated and that it only uses stationary climate data for its precipitation frequency (pf) estimates. It is no longer considered accurate due to climate change not being factored in which was common occurrence for that time period. Often design storms (see table with 15 year and 20 year rainfall frequency) are formulated through NOAA. NOAA most recent estimates are from Atlas 14 (2013-14) also has used stationary climate data. The old 15 year storm could be the new 5-10 year storm. They are updating their statistical models. MSD is also updating their information.

Of more concern is extreme pf estimates as the rainfall amounts are vastly underestimated if using stationary climate data which could drastically affects stormwater infrastructures. Climatologists (MO) and the National Weather Service are now researching recent past data to develop a new model and thus new design storms. (Yes, I have the links and recent emails.) Future dam repairs at the golf course and any new large development contractors (BJC West County Hospital expansion) should be questioned as to which type of data (stationary vs non-stationary) climate data they are using for design storms which would determine their stormwater management plan. The BJC West County Hospital and medical office building expansion will be using the city's Millennium Park's detention pond which is the city responsibility for maintaining per previous agreement. Also, the downstream conveyance system for that expansion would be the surrounding area of the detention pond and Fernridge creek. Again, this is only for extreme precipitation frequency estimates but those are becoming more frequent and very costly.

Section 425.010(B) states that this regulation may need to be revised in the event that MSD's regulations change. Staff recommends following the current standard and considering the changes to that standard as they are made.

425.030.C SITE GRADING

[Jason Jaggi] Should through the use of stormwater BMP's be inserted at the end? It seems as though some guidance would be helpful in terms of acceptable mitigation (rain gardens, cisterns, rain barrels, bio-swales, etc.). Also, how are these on-site private stormwater facilities going to be maintained?

There is no mention of a specific BMP listed here, because that might suggest that one type of BMP is preferred or recommended over another. The Stormwater Committee recommends providing references to MSD's design guide and offering instructional materials for those who apply for permits that would require stormwater mitigation.

On-site stormwater facilities would need to be maintained by the property owners.

SECTION 425.040: SUBMISSION, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS

425.040.A STORMWATER MANAGEMENT PLAN REQUIRED

[Carl Lumley] Text edit – "...submitted and approved..." to be replaced with "...submitted, approved, and recorded..."

Revision was made as suggested.

[Jason Jaggi] A specific list of the required contents of the stormwater management plan should be provided. Sec. A.2 leaves it too open and unpredictable for an applicant.

The minimum requirements for a stormwater management plan are included.

[Jim Myers] 425.040.A.2 Insert words in bold as follows: ...*depend on the **extent and nature of the project***.

Revision was made as suggested.

[Richard Koch] In 2007 I had a 12' x 18' (216 SF) gazebo kit fabricated in my back yard that required a Creve Coeur permit for its foundation only. Do we really want to require a Stormwater management plan by the owner as well as a City staff review on such a small project?

The revisions to the Section 425.020 (Applicability) should clarify the City's intent. A stormwater management plan would be necessary only for large-scale projects.

425.040.B REVIEW PROCESS

[Carl Lumley] Replace “development agreement” with “Stormwater Management Plan.”

Revision was made as suggested.

[Jason Jaggi] Not sure what the intent is behind the term “development agreement”.

The revision suggested by Carl Lumley (above) should answer this question.

[Carl Lumley] Etc not a workable concept in an ordinance, so need to complete list or say similar work as determined by the Director of Public Works.

“Etc.” has been replaced with “or similar work as determined by the Director of Public Works.”

[Richard Koch] the term “drainage works” probably needs to be defined. Also, will MSD do this review for the City if it defines when it is required? If staff reviews all plans first it [may] require additional staff.

“Drainage works” has been replaced with “drainage facilities,” which is defined in Section 425.080.

MSD automatically reviews any improvements to or changes to the drainage system.

425.040.C PROCEDURE

425.040.C.1 Preliminary Conferences

[Matt Wohlberg] Review whether this section should be duplicated or expanded to clarify when submissions to MSD and the City are necessary.

The reference to MSD standards should be sufficient. It may become problematic in the future to continue to state and maintain MSD's process and requirements in our regulation.

[Carl Lumley] Revise to read "...a preliminary conference with City staff to obtain..."

Revision was made as suggested.

[Carl Lumley] Replace "etc." with "and other pertinent information as determined by City staff."

Revision was made as suggested.

[Jason Jaggi] Is a preliminary conference a necessary requirement for all submittals? The first sentence suggests that it is required. Second sentence states that it is recommended.

A preliminary conference is recommended, but not required. The first sentence has been revised to change "shall" to "may."

[Jason Jaggi] Application requirement states that a separate and distinct application submittal is required. This suggests that the stormwater management regulations needs to stand on its own as noted in the applicability section comments.

A separate application for the stormwater management plan was not the intent. The text has been revised to state that the stormwater management plan would be submitted with the permit application for the project.

425.040.C.4 Notification

- [Carl Lumley] Why have automatic approval?
- [Matt Wohlberg] Review 75-day review provision.
- [Jim Myers] Discuss the 75 day notification requirement
- [Judy Campbell] No approval by default if the city has not responded within 75 days. Notification must be made by accepted legal communication. Days to approve should be discussed in subcommittee with past performance history provided by Dir of Community Development and his recommendations.
- [Richard Koch] "seventy-five (75) days is too long for small projects, depends upon how small a project requires a "permit".

The subcommittee recommended 45 calendar days. Staff standards would provide review and comments much earlier, but this time frame would allow for extenuating circumstances.

Section 420.040(B) states that land disturbance permits will be reviewed "promptly." The suggested revision references this section and removes the provision for automatic approval.

- [Carl Lumley] 425.040(C)(4) – Not sure why we need to refer to [Section] 420.040.

The reference was not necessary, but defining what is a reasonable amount of time to "promptly notify" the applicant about the City's review of the plan was problematic. Referencing Section 420.040 was meant to be more consistent and clear by using a defined standard rather than by coming up with a new one.

425.040.C.5 Site Development Plan Approval

- [Jason Jaggi] Site Development Plan Submittal: as noted earlier a stormwater management plan can be submitted in conjunction but a separate permit to authorize construction under this Chapter will be needed.

The Applicability section was changed to reference permit applications only – it no longer references site plan submittals. This paragraph appears to give the City the option to require a stormwater management plan for the approval of a site development plan, if the City feels that this is necessary.

425.040.C.6 Recorded Plan [new]

[Carl Lumley] Add 425.040.C.6 Upon approval, the owner shall provide proof that the stormwater management plan has been recorded with the St. Louis County Recorder of Deeds.

Revision was made as suggested.

425.040.D DOWNSTREAM CONVEYANCE SYSTEM

[Judy Campbell] Should be further defined. All developers should provide detailed plans.

The calculations involved with a stormwater management plan should show whether the runoff cause a substantial increase to the downstream conveyance system. This provision may only rarely apply to single-lot residential development. It seems excessive to require a detailed study of the downstream stormwater system capacity for every project.

425.040.E CORRECTIVE ACTION

[Carl Lumley] Replace “development agreement” with “Stormwater Management Plan.”

Revision was made as suggested.

[Richard Koch] last sentence, delete the words “according to the development agreement”.

This text was changed to be “stormwater management plan” (see above).

[Jim Myers] What is the criteria for applicability for a “land disturbance activity” in current regulations?

Land disturbance activity involves 2,000 square feet or more of disturbance.

[Judy Campbell] All corrective action plans should be highly detailed and include time limits for when action needs to originate to prevent further damage for residential, commercial, or municipal property.

The corrective action will be based upon the issue, and any details, such as the restoration required or the time to remedy the problem, will be stated by staff in the violation notice.

425.040.F TIME OF VALIDITY

[Carl Lumley] Revise 425.040.F.1 to read:

Any approved stormwater management plan, unless construction has started and is continuing, shall become null and void one hundred eighty (180) days after the date of approval and no further work subject to this Chapter shall be allowed unless and until additional or updated plans have been submitted and approved in accordance with the provisions of this Chapter. If work is suspended after such 180 day period for more than 90 days, the plan shall likewise become null and void.

The suggested changes were initially accepted as stated, but “consecutive” was added to revise the statement to be “90 consecutive days” by the recommendation of the Subcommittee.

See the comment below for further revisions.

[George Seifried] I noticed that the [stormwater management plan] is only good for 6 months, but a Site Improvement Permit is good for a year. Would it not make sense to have both expire at the same time since they will likely be issued together?

This section has been revised to match the times stated on the Site Improvement Permit and Residential Development Permit forms, which are the ones to which the stormwater regulations would apply.

[Carl Lumley] Revise 425.040.F.2 to read:

An updated plan shall be approved in accordance with the provisions of this Chapter in effect at the time of resubmission. (R.O. 2008 §24-30.2; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

The suggested changes were accepted as stated.

[Jim Myers] Insert words in bold as follows: *development agreement **or building permit** the stormwater...*

The revisions to the references to a development agreement seem to have addressed this suggestion.

SECTION 425.050: REQUIRED SUBMITTALS BY THE DESIGN ENGINEER

[Jason Jaggi] No list of required submittal information is provided.

[Carl Lumley] Delete statement referencing “the following list of information.”

[Jim Myers] second paragraph. Remove the word “following” since the list does not follow

The reference to the “following list” has been deleted. Reference is made to MSD’s Rules and Regulations for MSD permit submittals instead of listing each requirement in the City’s regulation..

SECTION 425.060: PERMIT FEES

[Carl Lumley] Shouldn't this be consolidated with subsequent section on fees?

This section has been incorporated into the other section for fees near the end of the regulation, as suggested. The new section number is 425.080.

[Jason Jaggi] There should be additional fees established as part of this permitting requirement.

Any recommended changes to the fee schedule should be part of the recommendation to the City Council for approval of the regulation.

This section was revised to remove several references to MSD and its fees and forms.

[Carl Lumley] Won't all City fees be in Appendix B? Delete items 1 and 2.

Provisions 425.080(C)(1) and 425.080(C)(2) have been deleted.
Provision 425.080(C)(3) has been revised to be 425.080(D).

SECTION 425.070: PRIVATE FACILITIES

[Judy Campbell] Provide further definition of what constitutes a private facility.

[Jim Myers] Need to define "Private Facilities" in the Definitions

425.070.A ADDITIONAL DESIGN CRITERIA

[Judy Campbell] Detention basin fencing. Should be provided by developer with a sign attached to fence. The CDC reports the number one cause of death for children between the ages of 1-14 is unintentional injuries including drowning.

[Richard Koch] Consider deleting fencing requirement all together. Or, at least specify a minimum total depth at which fencing would be required. Perhaps say 4.0' depth or so.

[Judy Campbell] Detention basin elevation...should utilize the latest design storms using non-stationary climate data.

425.070.B PRIVATELY OWNED PONDS

[Carl Lumley] This should all be deleted and replaced with direct assignment of responsibility

[Richard Koch] 425.070 B, 1, a – at the end of the sentence add "or property owner".

[Jim Myers] 425.070.B.1.d. What is the meaning of "downstream facility"?

[Jim Myers] 425.070.B.1.d. Reference should be to (1)(a), not (4)(a).

[Richard Koch] 425.070, B, 1, d – this sentence refers "(4)(a) above", which I don't see the 425.

[Judy Campbell] Obtain information from the PW dept regarding how many subdivisions have asked for assistance the last 3-5 years? What is the average amount of financial assistance that was provided? Is this a common feature in other municipal stormwater management committees?

[Judy Campbell] The city should determine if there was a specific cause that resulted in the non-functioning retention/detention basin. The city should determine if MSD or other entities or at all responsible or have contributed to the problem.

[Judy Campbell] The city should continue to partially fund privately owned dry and wet ponds/lake retention/detention basin repairs.

This entire section was deleted. The subcommittee recommended against future funding for private facilities.

SECTION 425.070: DEFINITIONS

[Carl Lumley] Do we need any of these definitions anymore?

Most definitions were removed, but some relevant ones were left.

[Jim Myers] The definitions should be moved to the end of the regulation and only include terms used in the regulation. Assume the other definitions are already included in the MSD rules.

This section has been moved to the end of the regulation as suggested.

[Jim Myers] Include definition of the following: “impervious surface”, “land disturbance”, and “private facilities”.

These definitions have been added. A definition for “Residential Development Permit” was also added.

[Carl Lumley] There is a typo in the Land Disturbance definition.

This has been corrected.

[Carl Lumley] What is the rational formula referenced in the pre-developed runoff rate definition?

The Rational Formula is a standard means of calculating stormwater runoff volume.

[Carl Lumley] Add Code cross references for the Residential Development Permit definition.

The definition now references Section 500.040, Section 420.070, and Appendix B to Title IV.

SECTION 425.080: GENERAL

[Carl Lumley] Revise to include “and their successors in interest...”

The suggested changes were accepted as stated.

[Jim Myers] Need to bold the section title.

The suggested changes were accepted as stated.

[Carl Lumley] The facilities will not be public until accepted. Delete both references to “public.”

The references were deleted as suggested.

SECTION 425.090: ABANDONMENT OF WORK

[Carl Lumley] Revise to read [new text in italics for emphasis]:

Upon receipt of a written statement from the Owner that further work on the project has been abandoned, *or upon Owner's failure to promptly complete work after notice of apparent abandonment*, the City and MSD shall determine whether or not the uncompleted work is required to ensure the public health, safety and welfare. Should it be determined that completion of the work is necessary, the *Owner shall complete such work immediately. Otherwise*, the City *may* utilize the monies deposited in the construction escrow for the project to complete this work *or seek other applicable remedies*. (R.O. 2008 §24-30.9; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

The suggested changes were accepted as stated.

[Richard Koch] Should escrow requirements be defined here?

Escrow is mentioned in the section "Enforcement, Violations, and Penalties" at the end of the Chapter.

SECTION 425.120: CONSTRUCTION AND MAINTENANCE OF STORMWATER FACILITIES

[Carl Lumley] Paragraph C. Revise to read [italics for emphasis on new text]:

Upon release of escrows the maintenance responsibility shall be vested *jointly and severally* in the trustees of the subdivision by virtue of the trust indenture *and the owners of the subdivision lots*.

The suggested changes were accepted as stated.

[Carl Lumley] [Paragraph C] Either delete the sentence about indentures or change "shall" to "should" and indicate that failure to do this does not excuse from liability.

The revision approach was used.

[Carl Lumley] Paragraph D. Revise to read [italics for emphasis on revised text]:

After legal occupancy of the project, the maintenance of detention/retention facilities shall be vested with the owner of the *lot and their successors* ~~[project]~~.

The suggested changes were accepted as stated.

SECTION 425.130: ENFORCEMENT, VIOLATIONS, AND PENALTIES

[Carl Lumley] Paragraph A. Need to specifically state all penalties. If we don't list violations here, we will have to list in the adoption ordinance.

Section 425.110 now includes revised versions of Section 405.1140 and Section 405.1150.

[Carl Lumley] Paragraph B. The reference to the additional penalty seems out of place.

This sentence has been deleted.

[Carl Lumley] Paragraph B. The bond/escrow provision should not be under enforcement/violations. Perhaps a section located in sequence by fee provisions.

The discussion about bonds and escrow has been moved to a new section (425.090), as suggested.

CHAPTER 425 – STORMWATER REGULATIONS

SECTION 425.010: PURPOSE AND INTENT

- A. This ~~Chapter~~Section seeks to provide those standards, criteria, procedures, and controls necessary to avoid adverse effects and minimize the harmful physical and economic effects of flooding from stormwater within the City of Creve Coeur ~~(City)~~. This goal is to be accomplished through the requirements of special measures set forth in through a development agreement Stormwater Management Plans to mitigate by means of through detention and controlled discharge of the differential runoff from any property (unless excepted from regulation hereunder) whereon any grading, excavation, filling, or other disturbance of the natural vegetation or any construction, erection, or alteration of a building or structure is to be undertaken. Erosion control requirements are specified in Chapter 420 Land Disturbance Code. will be handled by separate ordinance.
- B. Design Standard. This Chapter adopts the is adapted from the MSD ordinance dated February, 1997, Rules and Regulations and Engineering Design Requirements for Sanitary Sewerage and Stormwater Drainage Facilities, dated February 2006, of by the Metropolitan St. Louis Sewer District (MSD) as the City's sanitary and stormwater design standard. This document and its regulations shall be referenced herein as "MSD Regulations." ~~Non-applicable Sections have been deleted and minor modifications have been made to comply with the City of Creve Coeur's policies and requirements.~~ This Chapter may need to be revised in the event that MSD may changes their ordinance. (R.O. 2008 §24-30.1; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.020: APPLICABILITY

- A. The provisions of this Chapter shall apply to all Land Disturbance Permits (as defined in Section 420.020) and Residential Development Permits issued by the City of Creve Coeur.
- B. Exceptions. The following activities and situations shall be exempt from the requirements of this Chapter:
1. Building permits for entirely interior work.
 2. Room additions and other building permits that disturb less than 2,000 square feet.
 3. Permitted development of any existing undeveloped lot of record property of less than one-quarter (¼) acre existing as of January 1, 2017, not to include newly subdivided lots zoned in an "A", "B", "C" or "D" or "RA" single family residential district.
 4. The planting, trimming, pruning or removal of trees, shrubs, grass, weeds, vegetation, ground cover or other plant material when such actions are incidental to and part of the normal maintenance of land and property in the City of Creve Coeur.

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Commented [CL1]: Section 67.280 RSMO will require that a copy of the MSD rules be posted in the clerk's office for 90 days prior to adoption, with a notice of proposed adoption on the message board and probably elsewhere - and after adoption must be available to public - the adoption ordinance must state penalties for violations

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Commented [CL2]: We have not had a recent subdivision so should be ok date

C. In considering the applicability of the exceptions listed above, the effective acreage for a project, development, or subdivision is not limited to a fractional part of the total concept. Rather, if a project is developed in phases or small plats, the total acreage of the project, development, or subdivision will be considered.

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D. The Director of Public Works has the discretion to require that, for any building permit, the applicant provide a grading plan, a siltation control plan, and/or a stormwater management plan. (R.O. 2008 §24-30.5; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.030: NO ADVERSE EFFECT

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A. Definition. No adverse effect shall mean that the proposed changes to a property will not increase the volume, direction, velocity, or intensity of stormwater runoff for adjoining properties for the design storm.

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B. Design Storm. For the purposes of determining "no adverse effect," the design storm shall be 15-year rainfall intensity for a duration of 20 minutes (15-year, 20-minute storm).

1. Table 4-2 of the MSD Regulations lists specific stormwater runoff rates for the design storm.

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2. The determination of the change to the site's stormwater runoff rate will be based upon comparing the stormwater runoff rates in MSD's Table 4-2 for the existing and proposed conditions of the site.

C. Site Grading. Sites shall be designed such that the proposed conditions will not increase the volume or speed of stormwater runoff onto any adjacent property.

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1. For subdivisions with stormwater detention or retention facilities that are demonstrated by the applicant to have the capacity to accommodate the site's differential stormwater runoff, the site's differential stormwater runoff will be allowed to flow directly into these facilities or directly into an enclosed system which flows into such a facility, provided that no other properties are crossed in order to do so.

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2. For subdivisions without stormwater detention or retention facilities, the differential stormwater runoff for a development will need to be contained on site.

SECTION 425.040: SUBMISSION, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS

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A. ~~Requirements For Building Or Grading Permit~~ Stormwater Management Plan Required. Except as otherwise provided in Section 425.020, No permit shall be issued to construct, erect, or alter any building or structure or to clear, grade, excavate, fill, remove topsoil from, or otherwise change the contour of any property within the City until a stormwater management plan has been submitted, and approved, and recorded in accordance with the provisions of this Chapter, except as provided in Section 425.050 Exceptions, below.

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1. A stormwater management plan shall be those documents, plans, calculations, and any other information necessary to demonstrate, to the satisfaction of the Director of Public Works, that the proposed work creates no adverse effect, as defined in Section 425.030.

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2. The amount of detail provided in the stormwater management plan will depend on the extent and nature of the project. At a minimum, the stormwater management plan will include contoured site plans, details, and calculations that show the proposed improvements, the pre-construction and post-construction runoff calculations for the site, specifications and details regarding the proposed mitigation method(s), and the location(s) of the stormwater mitigation on the site.

- B. Review Process. Designs, plans, and specifications of all drainage ~~works facilities, as defined in~~ Section 425.120, that are proposed to be constructed, connected to, altered, or reconstructed by any person or corporation, private or public, within the City boundaries shall be submitted to the City and MSD for review, comment, and revision, leading to ~~approval~~, approval with comments, or rejection. The design engineer shall meet with ~~City staff~~ the Director of Public Works before starting stormwater facilities design to review the Stormwater Management Plan development agreement. ~~Then~~ the stormwater management plan must be reviewed with ~~City staff~~ the Director of Public Works before submittal to MSD. Such designs, plans and specifications (excluding house connections, curb cuts, ~~etc. or similar work as determined by the Director of Public Works~~) shall be prepared and sealed by a professional engineer registered in the State of Missouri and shall meet the minimum standards of the City, ~~the St. Louis Metropolitan Sewer District (MSD),~~ and the Missouri Department of Natural Resources before approval is granted.

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Commented [CL4]: Etc not a workable concept in an ordinance, so need to complete list or say similar work as determined by the Director of Public Works

C. Procedure.

1. Preliminary conferences. At any time prior to formal submission of project plans, the owner's engineer ~~shall may~~ arrange for a preliminary conference with City staff the Director of Public Works to obtain informal guidance in project plan preparation with the City. Preliminary conferences are recommended for all permit applications, especially in unique or unusual circumstances, but preliminary conferences are required for land disturbance activities. The preliminary conference is intended ~~, especially in unique or unusual situations,~~ to expedite the subsequent formal review and approval process. This includes review of the downstream areas jointly by the City and the developer's engineer with photographs, online content, geographic information system (GIS), and other pertinent information as determined by City staff the Director of Public Works. etc.
2. Application. When required, a stormwater management plan ~~Application for an approved stormwater management plan, as required,~~ shall be included with the permit application for the proposed project ~~submitted~~ to the Director of Public Works by the owner of the land prior to the time any work subject to this Chapter is begun on the land. Said plans must accompany any such application, parts of which may also be on forms prepared by the City.
3. Approval process. Upon receipt of any application and plan, the Director of Public Works shall consider the plan in light of the provisions of this Chapter and shall approve the plan, disapprove the plan or approve the plan with modifications, noting thereon any changes that will be required.
4. Notification. ~~The~~ The City shall promptly notify the applicant of the City's decision on a plan. Such notification shall be within forty-five (45) calendar days ~~Failure of the Director of Public~~

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~~Works to act on any plan within seventy five (75) days after it the plan~~ has been properly filed ~~should be deemed to constitute approval of the plan.~~ Any approved plan shall be issued, dated, and bear the manual signature of the Director of Public Works or his designee.

Commented [CL5]: Why have automatic approval?

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5. Site development plan approval. A stormwater management plan may, as required, be included in and made part of an application for site development plan approval in accordance with Section 405.1080 or of an application for approval of improvement plans for a subdivision in accordance with Chapter 410 of the Creve Coeur subdivision regulations.

6. Upon approval, the owner shall provide proof that the stormwater management plan has been recorded with the St. Louis County Recorder of Deeds.

~~D. Submission Requirements. In order to facilitate review of plans, all projects shall be submitted with a letter of transmittal which shall include the name of the project, name and address of owner or developer; name, address, telephone number and seal of the professional engineer licensed in the State of Missouri; and clarification as to the purpose of submittal.~~

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DE. Downstream Conveyance System. For land disturbance activities, the developer is required to evaluate the ~~The~~ downstream conveyance system where the connection is receiving the proposed development's runoff in order is required to be evaluated to determine if it has the capacity acceptable to receive the proposed development's runoff. The evaluation has to continue until the proposed development's runoff is less than ten percent (10%) of the downstream conveyance system. The Director of Public Works can request additional studies further downstream if a stormwater problem is anticipated.

EF. Corrective Action. If a development during or after construction adversely affects downstream property, corrective action will be required by the developer and/or landowner as determined by the Director of Public Works. The development shall make the required study and repairs during construction or after completion of the proposed development according to the Stormwater Management Plan, as directed by the Director of Public Works, development agreement if the stormwater-related problems downstream of the development can be demonstrated to be caused by the development.

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~~G. Stormwater Fund Contributions. Any developer which is not required to provide detention by MSD may be required to contribute to the City's stormwater fund for detention or downstream improvements, at the discretion of the Director of Public Works, in lieu of being required to make the on site or downstream improvements if the proposed development is a contributor to the downstream conveyance system. The detention will need to be designed for the total watershed. The developer may be required to participate on the percentage of his/her development with the applicable watershed or subwatershed. This will be part of a City-wide stormwater district established by the City.~~

Commented [WM6]: How can this be enforced? Recommend removal.

FH. Time ~~Of~~ Validity.

1. An approved stormwater management plan shall become invalid if the authorized work is not commenced within six (6) months after issuance of the permit, if the authorized work is suspended or abandoned for six (6) months, or if the project is not completed within one (1)

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year after the issuance of the land disturbance or residential development permit. Any approved stormwater management plan, unless construction has started and/or is continuing, shall become null and void one hundred eighty (180) days after the date of approval and no further work subject to this Chapter shall be allowed unless and until additional or updated plans have been submitted and approved in accordance with the provisions of this Chapter. If work is suspended after such 180 day period for more than 90 days, the plan shall likewise become null and void, or unless all requirements of the approved control plans have been completed in less than one hundred eighty (180) days in accordance with said plans and verified by an on-site inspection by the Director of Public Works.

2. When no change in conditions has occurred since the date of approval for the one hundred eighty (180) days, an updated plan shall be approved in accordance with subject to the provisions of this Chapter with the requirements in effect at the time of resubmission. (R.O. 2008 §24-30.2; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.039050: REQUIRED SUBMITTALS BY THE DESIGN ENGINEER

A. Refer to MSD's information sheet, the MSD's Regulations stormwater submittal form for full details of regarding information to be submitted to MSD for applicable land disturbance permits. Plan review may be delayed if all required information is not provided by the applicant.

—To facilitate the review of plans before approval for construction, the design engineer shall submit with the plans a stormwater management plan containing all necessary data, maps, computations, and checklists as defined in the MSD Regulations below in support of the designs and plans. The following list of requested information is a minimum and may be supplemented by any additional information which the design engineer considers to be helpful in the review process.

1. General. The submittal of all project information for all stormwater drainage projects shall be verified by the checklists provided herein. It shall be the responsibility of the submitting design engineer to see that all applicable information listed on the checklists is provided to the City. This includes the design information as well as information on the plans and specifications. Two (2) copies of the stormwater management plan with the checklist shall be submitted with the design information, plans, specifications.

a. Storm drainage projects. All storm drainage project submittals should include Checklist No. 2 and Checklist No. 3.

—For any checklist item not pertinent to the specific project being submitted for review, the submitting (design) engineer shall insert the letters "N.A" for not applicable.

b. Project review information form. This form is required on all project submittals.

c. Storm sewers design data, maps and computations.

See Checklist No. 2.

d. Storm sewer contract drawings.

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See Checklist No. 3.

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e. Components of the stormwater management plan.

(1) Downstream system evaluation results and recommendations;

(2) Project's on-site storm drainage system's design;

(3) Stormwater detention requirements and supporting calculations and design properties;

(4) Floodplain and floodway analysis and report;

(5) Sinkhole analysis and report;

(6) Regulatory permitting requirements and methods to address these issues. Permits pertaining to stormwater may include, but are not limited to:

(a) (National Flood Insurance Program.) The National Flood Insurance Program (NFIP) 44 CFR Parts 50-77;

(b) (Wetlands and Waters Information.) Sections 401 and 404 of the Clean Water Act (CWA) as pertaining to wetlands and waters of the United States;

(c) (NPDES Information.) Section 402 of the Clean Water Act (CWA) for Phase I and II of the National Pollutant Discharge Elimination System (NPDES) when they take effect;

(d) (Dam Construction Rules, Regulations.) Rules and regulations of the Missouri Dam and Reservoir Safety Council for dam construction;

(e) Maintenance requirements. The following list of requested information is a minimum and may be supplemented by any additional information which the design engineer considers to be helpful in the review process.

2. The following information shall be provided, as applicable:

a. Engineer's name, mailing address, telephone number, fax number, e-mail address and contact name.

b. Owner and/or developer's name, mailing address, telephone number, fax number, e-mail address and contact name.

c. Accurate location of property relative to an intersection.

d. "Wunnenberg's" page and grid number for the project, the MSD base map number, the St. Louis County locator number for the property and the property address.

~~e. Narrative of the project's scope, existing and proposed features and a description of intent to address the major components of the stormwater management plan.~~

~~f. Total acreage of property and impervious acres if other than residential. Drainage area upstream of the project and downstream to a point where the projects contribution is less than ten percent (10%) of the total watersheds area.~~

~~g. Existing and proposed land uses of the project and the upstream drainage area, i.e., commercial, residential, etc.~~

~~h. The MSD "P" number shall be used in all subsequent correspondence concerning the project and shall be utilized as soon as possible after issued.~~

~~i. If the submittal is a revision or addendum to a previous project, the previous project shall be properly identified and the particulars of the revision or addendum shall be described.~~

~~3. Number of copies of plans and supporting data to be submitted. Plans shall be complete and a minimum of three (3) sets of plans and two (2) sets of the stormwater hydraulic calculations will be required.~~

~~Floodplain. Submit three (3) additional sets of plans and a total of three (3) sets of the floodplain report.~~

~~Detention. Submit one (1) additional set of plans and a total of three (3) sets of the detention calculations.~~

~~Pump Station. Submit three (3) additional sets of plans and a total of four (4) copies of the pump station report and specifications.~~

Commented [WM8]: MSD Section 1.040-02

~~4. Submit electronic file compatible with City's system and one (1) mylar copy of as built's sealed by a professional engineer registered in the State of Missouri.~~

~~5. The owner shall be responsible for notifying the City for the final release one (1) year later and provide all items required to obtain final approval and release of final escrows. This includes a final as built of the detention basin to verify the actual capacity of the detention basin.~~

~~B. Subdivisions. For projects within a proposed subdivision, a subdivision plat shall be provided substantially ready for filing, adequately dimensioned and located from well established points and lines to permit accurate platting on record maps. The design engineer shall provide a statement concerning the established zoning requirements of the City together with any other pertinent information.~~

~~C. Projects Normally Requiring A Sewer Connection Permit Only. Plans for connections to existing storm sewers for commercial, industrial, public or private non-residential projects, for parking areas and for multiple dwelling projects with paved areas shall show thereon:~~

1. Location, type, size and elevations of the existing storm sewer to which connection for the project is to be made.

2. The location, size and elevations of proposed storm drainage facilities.

3. Existing and proposed grade elevations with limits and direction of stormwater flows tributary to drainage facilities within the property.

4. Private storm sewers requiring permits from the City will require project approval by the City prior to submittal of permit application to MSD.

5. Identify the public and private pipe reaches.

D. Return Of Plans Without Review. Plans lacking the required information or those that are difficult to read or interpret due to poor drafting, poor arrangement or poor writing will be returned without review for correction, additional information or redrafting as may be required.

E. Return Of Plans For Revision. On completion of the review, one (1) set of plans or a letter with comments with requested revisions and notations will be returned to the design engineer for revision to the original submission. The assigned MSD "P" number and base map number shall be shown in or near the title block upon resubmittal of the plans. Additional sets of plans for further review or final approval will then be submitted to the City.

F. Failure To Revise Or Correct Plans Promptly. Plans returned to the owner's engineer for revision, correction or additional information shall be modified and returned to the City within ninety (90) days for final approval or the project will be considered abandoned. Further review will be continued only upon resubmittal as a new project, complete with all necessary data, submittal fee, review fee, etc.

G. Fees For Review And Permitting. See Appendix B to Title IV Community Development and Public Works Fee Schedule for fees required for plan submittal and approval. (R.O. 2008 §24-30.3; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.040: CONSTRUCTION DRAWING PLAN REQUIREMENTS

A. Drawing Sizes. Plan sizes shall be uniform for each set. Where practical, plan and profile sheets twenty-four (24) inches by thirty-six (36) inches are preferred. When the sheet size is considerably smaller than twenty-four (24) inches by thirty-six (36) inches, a size eleven (11) inches by seventeen (17) inches is preferred for filing convenience. White line prints on blue background will not be approved. Good drafting practice, either manual or automated, at a suitable scale to facilitate the plan review and field construction shall be followed. The scale for a residential subdivision shall be a minimum of fifty (50) feet to the inch.

B. Plans submitted shall include:

1. Location of the project with respect to arterial roads, local streets or subdivisions.

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Commented [CL10]: Shouldn't this be consolidated with subsequent section on fees?

Commented [WM11]: This section was consolidated as suggested.

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~~2. Key map of the entire project to scale showing easements, sewer lines and facilities, both existing and proposed to be constructed.~~

~~3. Recorder of Deeds book and page from St. Louis County for existing recorded easements when not part of a recorded subdivision plat.~~

~~4. Plans and profiles of each sewer line, channel or retaining wall showing location, size, flowline elevations, design flows for all segments, construction gradients, hydraulic grade lines, materials, proposed and original ground lines, boring information and rock elevations along the proposed sewer line, location, depths and sizes of adjacent or crossing sewer lines and utilities and special construction requirements such as a concrete cradle or encasement, type of backfill, strength class of pipe, etc.~~

~~5. All elevations shall be based upon U.S.G.S. or FEMA or (FIRM) datum with location of the bench mark indicated on the plans. Acceptable bench marks include those established by the MSD, St. Louis County Department of Highways and Traffic, Missouri Department of Transportation or City of Creve Coeur. The elevations shall also include the centerline of the road adjacent to the proposed development at the property lines and at the center of the lot/development. All two (2) foot contours within one hundred fifty (150) feet of the proposed development property lines shall also be required.~~

~~6. Profiles and typical cross sections of existing and proposed swales, ditches or channels.~~

~~7. Details of special structures, channel improvements, culverts, transitions, headwalls, aprons and junction chambers, all adequately detailed and dimensioned including placement of steel in reinforced concrete structures. Unless otherwise indicated, standard MSD structures are assumed to be utilized.~~

~~8. A drainage area map (refer to Section 425.060(A)(1) showing original and proposed topography with drainage areas identified.~~

~~9. A subdivision plat, dimensioned and substantially complete and ready for filing.~~

~~10. The location of all utilities anticipated to be encountered during construction shall be shown. Plans must be submitted to all utility companies for verification of conflicts. Storm and sanitary sewers shall be located to comply with State laws and regulations governing such placement.~~

~~11. Drawing of all existing and proposed easements and rights-of-way. (R.O. 2008 §24-30.4; Ord. No. 2207 §1, 1 27 03; Ord. No. 5043 §2, 7 14 08)~~

~~SECTION 425.050: EXCEPTIONS~~

The provisions of this Section shall not apply to:

~~1. Any reconstruction, repair or alteration of any existing building or structure when no land, trees, shrubs, grass or other vegetation is to be disturbed, destroyed or removed.~~

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2. Any existing undeveloped property of less than one quarter (¼) acre not to include newly subdivided lots zoned in an "A", "B", "C" or "D" or "RA" single-family residential district.

3. The clearing, grading, excavation, filling, removing topsoil from or changing the contour of less than twenty five hundred (2,500) square feet of land and less than three (3) feet of elevation.

4. The planting, trimming, pruning or removal of trees, shrubs, grass, weeds, vegetation, ground cover or other plant material in accordance with the concept landscape plan of approved site development plan in accordance with Section 405.1080 or when such actions are incidental to and part of the normal maintenance of land and property in the City of Creve Coeur.

5. In considering the applicability of these exceptions, the effective acreage for a project, development or subdivision is not limited to a fractional part of the total concept. Rather, if a project is developed in phases or small plats, the total acreage of the project, development or subdivision will be considered. Furthermore, projects of less acreage than provided for in this Chapter shall also provide detention/retention if in the judgment of the Public Works Director conditions in the receiving system are inadequate or harmful effects can be anticipated if detention/retention is not implemented. Also the Public Works Director has the discretion to require for any building permit, a grading, a siltation control plan and/or a stormwater management plan. (R.O. 2008-524 30.5; Ord. No. 2207-51, 1-27-03; Ord. No. 5043-52, 7-14-08)

SECTION 425.060: DESIGN STANDARDS FOR STORMWATER PROJECTS

A. Storm Drainage Design Data, Maps And Computations.

1. General criteria. The project drainage area map or maps shall accurately show the watershed boundary lines and areas tributary to each inlet, sewer and channel section. The established elevations, gradients and contours of the finished graded surfaces and streets shall be shown in support of the inlet drainage area lines and indicated directions of flow. The information shown shall be the same as given on a development plat usually required by financing agencies, which shows the project, the dwellings, streets, walks, finish grades at corners of the buildings, finish contours, street elevations and gradients, inlet, sewer and utility locations. Sufficient information showing locations, elevations, cross sections of downstream watercourses, channels, sewers, culverts, structures and adjoining land shall be provided to determine the effects of the stormwater discharge and the possible needs for special easement requirements and/or downstream drainage modifications or protection.

2. Basic design data to include:

a. Rainfall frequency.

b. Tributary area in acres with percentage of imperviousness.

c. Runoff factor(s) used.

B. Design Requirements For Storm Drainage Facilities.

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1. General. Stormwater sewers or channels provide the facility for removing and transporting surface runoff produced from rainfall.

This Section gives the minimum technical design requirements of the City storm drainage facilities. In general, the formulae presented herein for hydraulic design represent "acceptable" procedures not necessarily to the exclusion of other sound and technically supportive formulae. Any departure from these design requirements should be discussed before submission of plans for approval and should be justified. All construction details pertaining to storm sewer improvements shall be prepared in accordance with the MSD Standard Construction Specifications unless otherwise noted.

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2. General requirements of storm sewer construction. All storm sewers shall meet the following general requirements:

a. Size and shape. The minimum diameter of pipes for stormwater sewers shall be twelve (12) inches. Sewers shall not decrease in size in the direction of the flow unless approved by the Director of Public Works. Circular pipe sewers are preferred for stormwater sewers, although rectangular or elliptical conduits may be used with special permission.

b. Materials. All materials shall conform to MSD standard construction specifications. Reinforced concrete pipe joints shall be Type "A" or better, as required.

c. Bedding.

(1) The project plans and specifications shall indicate the specific type or types of bedding, cradling or encasement required in the various parts of the storm sewer construction if different than current MSD standard construction specifications.

(2) Special provisions shall be made for pipes laid within fills or embankments and/or in shallow or partial trenches, either by specifying extra strength pipe for the additional loads due to differential settlement or by special construction methods including ninety percent (90%) modified Proctor compaction (ASTM D 1557) of fill to prevent or to minimize such additional loads.

(3) Compacted granular backfill or controlled low strength material (CLSM) as approved by the Director of Public Works shall be required in all trench excavation within public (or private) streets rights of way or areas where street rights of way are anticipated to be dedicated for public use. Under areas to be paved, the compacted granular backfill shall be placed to the subgrade of the pavement. Under unpaved areas, the compacted granular backfill shall be placed to within two (2) feet of the finished surface.

(4) Pipes having a cover of less than three (3) feet shall be encased in concrete, unless otherwise directed by the City and the District.

(5) If the storm and sanitary sewers are parallel and in the same trench, the upper pipe shall be placed on a shelf and the lower pipe shall be bedded in compacted granular fill to the flow line of the upper pipe.

d. Concrete pipe or conduit strengths.

(1) Reinforced concrete pipe shall be Class II, minimum.

(2) Any concrete pipe, conduit or culvert beneath a street right-of-way or with reasonable probability of being so located shall be a minimum of Class III, but also shall account for all vertical loads including the live load required by the highway authority having jurisdiction. In no case shall the design provide for less than HS 20 loading of the AASHTO.

e. Monolithic structures. Monolithic reinforced concrete structures shall be designed structurally as continuous rigid units.

f. Alignment. Sewer alignments are normally limited by the available easements which in turn should reflect proper alignment requirements. Since changes in alignment affect certain hydraulic losses, care in selecting possible alignments can minimize such losses and use available head to the best advantage. Sewers shall be aligned:

(1) To be in a straight line between structures, such as manholes, inlets, inlet manholes and junction chambers, for all pipe sewers thirty (30) inches in diameter and smaller.

(2) To be parallel with or perpendicular to the centerlines of straight streets unless otherwise unavoidable. Deviations may be made only with approval of the City and the District.

(3) To avoid meandering, off setting and unnecessary angular changes.

(4) To make angular changes in alignment for sewers thirty (30) inches in diameter or smaller in a manhole located at the angle point and for sewers thirty three (33) inches in diameter or larger, by a uniform curve between two (2) tangents. Curves shall have a minimum radius of ten (10) times the pipe diameter.

(5) To avoid angular changes in direction greater than necessary and any exceeding ninety degrees (90°).

g. Location. Storm sewer locations are determined primarily by the requirements of service and purpose. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses and effects of easements on private property. Storm sewers shall be located:

(1) To serve all property conveniently and to best advantage.

(2) In public streets, roads, alleys, rights of way or in sewer easements dedicated to MSD.

(3) On private property along property lines or immediately adjacent to public streets, avoiding diagonal crossings through the central areas of the property.

(4) At a sufficient distance from existing and proposed buildings (including footings) and underground utilities or other sewers to avoid encroachments and reduce construction hazards.

(5) To avoid interference between other stormwater sewers and house connections to foulwater or sanitary sewers.

(6) In unpaved or unimproved areas whenever possible.

(7) To avoid, whenever possible, any locations known to be or probably to be beneath curbs, paving or other improvements particularly when laid parallel to centerlines.

(8) To avoid sinkhole areas if possible. However, if sinkhole areas cannot be avoided, see Subparagraph (h) for requirements.

(9) Crossing perpendicular to street, unless otherwise unavoidable.

h. Sinkhole areas.

(1) Sinkhole report. Where improvements are proposed in any areas identified as sinkhole areas, a sinkhole report will be required. This report is to be prepared by a professional engineer, registered in the State of Missouri, with demonstrated expertise in geotechnical engineering and shall bear his/her seal and signature.

The sinkhole report shall verify the adaptability of grading and improvements with the soil and geologic conditions available in the sinkhole areas. Sinkhole(s) shall be inspected to determine its functional capabilities with regard to handling drainage.

The report shall contain provisions for the sinkholes to be utilized as follows:

(a) All sinkhole crevices shall be located on the plan. Functioning sinkholes may be utilized as a point of drainage discharge by a standard drainage structure with a properly sized outfall pipe provided to an adequate natural discharge point, such as a ditch, creek, river, etc.

(b) Non functioning sinkholes and sinkholes under a proposed building may be capped.

(c) If development affects sinkholes, they may be left in their natural state, however, they will still require a properly sized outfall pipe to an adequate natural discharge point.

(d) An overland flow path shall be required for all sinkholes assuming the outfall pipe and sinkhole become blocked.

(e) Where the topography will not allow for an overland flow path:

(i) The storm sewer shall be designed for the 100-year, 20-minute storm; and

(ii) If this storm pipe is smaller than thirty six (36) inches in diameter, a designated ponding area shall be identified, assuming the pipe is blocked; and

(iii) The ponding area shall be based on the 100-year, 24-hour storm; and

(iv) The low sill of all structures adjacent to the ponding area shall be above the 100 year high water elevation.

(v) Special siltation measures shall be installed during the excavation of sinkholes and during the grading operations to prevent siltation of the sinkhole crevice.

(2) Procedure for utilization of sinkholes.

(a) Excavation. Prior to filling operations in the vicinity of a sinkhole, the earth in the bottom of the depression will be excavated to expose the fissure(s) in the bedrock. The length of fissure exposed will vary, but must include all unfilled voids or fissure widths greater than one-half (1/2) inch maximum dimensions which are not filled with plastic clay.

(b) Closing fissures. The fissure or void will be exposed until bedrock in its natural attitude is encountered. The rock will be cleaned of loose material and the fissures will be hand-packed with quarry run rock of sufficient size to prevent entry of this rock into the fissures and all the voids between this hand-packed quarry run rock filled with smaller rock so as to prevent the overlying material's entry into the fissures. For a large opening, a structural (concrete) dome will be constructed with vents to permit the flow of ground water.

(c) Placing filter material. Material of various gradations, as approved, will be placed on top of the hand-packed rock with careful attention paid to the minimum thicknesses. The filter material must permit either upward or downward flow without loss of the overlying material.

The fill placed over the granular filter may include granular material consisting of clean (no screenings) crushed limestone with ten (10) inch maximum size and one (1) inch minimum size or an earth fill compacted to a minimum density of ninety percent (90%) modified Proctor as determined by ASTM D 1557.

(d) Supervision. Periodic supervision of the cleaning of the rock fissures must be furnished by the engineer who prepared the soil report. Closing of the rock fissures will not begin until the cleaning has been inspected and approved by that engineer.

During the placement and compaction of earth fill over the filter, supervision by the engineer shall be continuous. Earth fill densities will be determined during the placement and compaction of the fill in sufficient number to ensure compliance with the specification. The engineer is responsible for the quality of the work and to verify that the specifications are met.

i. Flowline. The flowline of storm sewers shall meet the following requirements:

(1) The flowline shall be straight or without gradient change between the inner walls of connected structures; that is, from manhole to manhole, manhole to junction chamber, inlet to manhole or inlet to inlet.

(2) Gradient changes in successive reaches normally shall be consistent and regular. Gradient designations less than the nearest one one thousandth (0.001) foot per foot, except under special circumstances and for larger sewers, shall be avoided.

(3) Sewer depths shall be determined primarily by the requirements of pipe or conduit size, utility obstructions, required connections, future extensions and adequate cover.

(4) Stormwater pipes discharging into lakes shall have the discharge flowline a minimum of three (3) feet above the lake bottom at the discharge point or no higher than the normal water line.

(5) A concrete cradle is required when the grade of a sewer is twenty percent (20%) or greater. A special design and specification is required for grades exceeding fifty percent (50%).

(6) For sewers with a design grade less than one percent (1%), field verification of the sewer grade will be required for each installed reach of sewer, prior to any surface restoration or installation of any surface improvements.

(7) The District may require the submittal of revised hydraulic calculations for any sewer reach having an as-built grade flatter than the design grade by more than one tenth percent (0.1%). Based on a review of this hydraulic information, the District may require the removal and replacement of any portion of the sewer required to ensure sufficient hydraulic capacity of the system.

j. Manholes. Manholes provide access to sewers for purposes of inspection, maintenance and repair. They also serve as junction structures for lines and as entry points for flow. Requirements of sewer maintenance determine the main characteristics of manholes.

(1) For sewers thirty (30) inches in diameter or smaller, manholes shall be located at changes in direction; changes in size of pipe; changes in flowline gradient of pipes and at junction points with sewers and inlet lines.

For sewers thirty three (33) inches in diameter and larger, manholes shall be located on special structures at junction points with other sewers and at changes of size, alignment

change and gradient. A manhole shall be located at one (1) end of a short curve and at each end of a long curve.

(2) Spacing of manholes shall not exceed four hundred (400) feet for pipe sewers thirty six (36) inches in diameter and smaller; five hundred (500) feet for pipe sewers forty two (42) inches in diameter and larger, except under special approved conditions. Spacing shall be approximately equal, whenever possible.

(3) When large volumes of stormwater are permitted to drop into a manhole from lines twenty one (21) inches or larger, the manhole bottom and walls below the top of such lines shall be of reinforced concrete.

(4) Manholes shall be avoided in driveways or sidewalks.

(5) Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.

(6) When a project requires a manhole to be adjusted to grade a maximum of twelve (12) inches of rise is allowed if not previously adjusted. When adjustments to raise or lower a manhole is required, the method of adjustment must be stated on the project plans and approved by the District.

k. Overflow/design system. The "design" components of the drainage system include the inlets, pipe, storm sewers and improved and unimproved channels that function during typical rainfall events. The "overflow" system comprises the major overflow routes such as swales, streets, floodplains, detention basins and natural overflow and ponding areas.

The purpose of the overflow system is to provide a drainage path to safely pass flows which cannot be accommodated by the design system without causing flooding of adjacent structures.

The criteria for the design of the overflow and design systems shall be as follows:

(1) The "design" system shall be designed in accordance with Subsection (3) below.

(2) The "overflow" system shall be designed for the 100-year, 20-minute event, assuming the "design" system is blocked. The capacity of the "overflow" system shall be verified with hydraulic calculations at critical cross sections. The "overflow" system shall be directed to the detention facility or as approved by the District.

(3) The low floor of all structures adjacent to the "overflow" system swales shall be one (1) foot above the 100-year high water elevation.

(4) Where the topography will not allow for an overland flow path:

(a) The storm sewer shall be designed for the 100-year, 20-minute storm; and

(b) If this storm pipe is smaller than thirty-six (36) inches in diameter, a designated ponding area shall be identified, assuming the pipe is blocked; and

(c) The ponding area shall be based on the 100-year, 24-hour storm; and

(d) The low-sill of all structures adjacent to the ponding area shall be above the 100-year high-water elevation;

(5) The "overflow" system shall be designated on the drainage area map and on the grading plan;

(6) All overflow systems will be considered on a site-specific basis;

(7) The stormwater design for projects within such designated future stormwater districts in the City of Creve Coeur may involve additional requirements;

3. Stormwater design criteria;

a. Flow quantities. Flow quantities are to be calculated by the "Rational Method" in which:

$$Q = AI$$

where:

$$Q = \text{Runoff in cubic feet per second}$$

$$A = \text{Tributary area in acres}$$

I = Average intensity of rainfall (inches per hour) for a given period and a given frequency

P = Runoff factor based on runoff from pervious and impervious surfaces

P (Runoff Factors) for various impervious conditions are shown in Table 4-1.

$P.I.$ values for various impervious conditions are shown in Tables 4-2 to 4-4.

(1) Rainfall frequency. In the design of local storm sewer systems, a twenty (20) minute time of concentration shall be used. Figure 4-1 gives rainfall curves for 2-, 5-, 10-, 15-, 20-, 25- and 100-year frequencies.

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(2) Impervious percentages and land use. Minimum impervious percentages to be used are as follows or the actual percentage of coverage:

(a) For manufacturing and industrial areas, one hundred percent (100%)*.

(b) For business and commercial areas, one hundred percent (100%)*.

(c) For residential areas including all areas for roofs of dwellings and garages; for driveways, streets and paved areas; for public and private sidewalks; with adequate allowance in area for expected or contingent increases in imperviousness:

In apartment, condominium and multiple dwelling areas: seventy-five percent (75%)*.

In single family areas:

¼ acre or less 50%

¼ acre to ½ acre 40%

½ acre to 1 acre 35%

1 acre or larger 30%

Playgrounds (non paved) 20% - 35%*

(d) For small, non-perpetual charter cemeteries, for parks and large perpetual charter cemeteries: five percent (5%):

* NOTE: Drainage areas may be broken into component areas, with the appropriate runoff factor applied to each component, i.e., a proposed development may show one hundred percent (100%) impervious for paved areas and five percent (5%) impervious for grassed areas.

The design engineer shall provide adequate detailed computations for any proposed, expected or contingent increases in imperviousness and shall make adequate allowances for changes in zoning use. If consideration is to be given to any other value than the above for such development, the request must be made at the beginning of the project, must be reasonable, fully supported and adequately presented and must be approved in writing before its use is permitted.

Runoff design for undeveloped areas shall be designed in accordance with the current land use plan.

Although areas generally will be developed in accordance with current zoning requirements, recognition must be given to the fact that zoning ordinances can be amended to change the currently proposed types of development and any existing use. Under these circumstances the possibility and the probability of residential areas having lot sizes changed or rezoned to business, commercial or light manufacturing uses should be given careful consideration.

(e) Average 20-minute values of P.I. (cfs per acre) to be used are as follows:

Percent Imperviousness	20 Minute Duration				
	15-year	20-year	25-year	50-year	100-year
5	1.7	1.8	2.0	2.2	2.4
10	1.8	1.9	2.1	2.3	2.5
20	2.0	2.1	2.4	2.6	2.8
30	2.2	2.3	2.6	2.8	3.0
40	2.4	2.5	2.8	3.1	3.3
50	2.6	2.7	3.0	3.3	3.6
90	3.4	3.5	3.9	4.3	4.7
100	3.5	3.7	4.2	4.5	4.9

* Roofs 4.2

* For direct connection to storm sewer

(3) Reduction in P.I. with time and area. Reduction in P.I. values for the total time of concentration exceeding twenty (20) minutes and for tributary areas exceeding three hundred (300) acres will be allowed only in trunk sewers and main channels. The reduced average P.I. value for the tributary area shall not be less than the value determined as follows on the basis of:

(a) Time. As the time of concentration increases beyond twenty (20) minutes, select the appropriate P.I. value from Table 4-1. The travel time through a drainage channel should be based on an improved concrete section. These reduced values shall be used unless a further reduction is allowed for the area.

(b) Area. As the total tributary area at any given location in a channel increases in excess of three hundred (300) acres, the P.I. value may be further reduced by multiplying it by an area coefficient "Ka". (The area coefficient is obtained from data in a special study of a major storm

in the St. Louis area by the U.S. Army Corps of Engineers. The average rainfall rate, for a given storm, for a given period for the tributary area, is less than the corresponding point value as determined from recording rainfall gauges. The curve data is as follows:

P.I. Coefficients Ka Area (Abscissas) "Ka" (Ordinates)

300-449 acres 1.00

450-549 acres .99

550-749 acres .98

750-999 acres .97

1,000-1,280 acres .961, 281-1,600 acres .95

1,601-1,920 acres .92

1,921-2,240 acres .91

4. Hydraulic grade line for closed conduits.

a. Computation methods. The hydraulic grade line is a line coinciding with (a) the level of flowing water at any given point along an open channel, or (b) the level to which water would rise in a vertical tube connected to any point along a pipe or closed conduit flowing under pressure.

The hydraulic grade line shall be computed to show its elevation at all structures and junction points of flow in pipes, conduits and open channels and shall provide for the losses and the differences in elevations as required below. Since it is based on design flow in a given size of pipe or conduit or channel, it is of importance in determining minimum sizes of pipes within narrow limits. Sizes larger than the required minimum generally provide extra capacity, however consideration still must be given to the respective pipe system losses.

There are several methods of calculating "losses" in storm sewer design. The following procedures are presented for the design engineer's information and consideration.

It is expected that the design will recognize the reality of such "losses" occurring and make such allowances as good engineering judgment requires.

(1) Friction loss. The hydraulic grade line is affected by friction loss and by velocity head transformations and losses. Friction loss is the head required to maintain the necessary flow in a straight alignment against frictional resistance because of pipe or channel roughness. It is determined by the equation.

$$hf = L \times Sh$$

Where:

h_f = difference in water surface elevation or head in feet in length L

L = length in feet of pipe or channel

S_h = hydraulic slope required for a pipe of given diameter or channel of

given cross section and for a given roughness " n ", expressed as feet

of slope per foot of length

From Manning's formula: $S_h = C^2 (V n / (1.486 R^{0.667}))^2$

Where:

R = hydraulic radius of pipe, conduit or channel (feet)(ratio of flow

area/wetted perimeter)

V = velocity of flow in feet per second (fps)

n = Manning's value for coefficient of roughness

Use:

n = .013 for pipes of concrete, vitrified clay and PVC pipe

n = .012 for formed monolithic concrete, i.e., vertical wall channels, box

culverts and for R.C.P. over forty eight (48) inches in diameter

n = .015 for concrete lining in ditch or channel inverts and trapezoidal

channels

n = .020 for grouted riprap lining on ditch or channel side slopes

n = .033 for gabion walled channels

Note:

" n " will have a weighted value for composite lined channels.

"n" values for unlined channels to be determined on an individual basis.

(2) **Curve loss.** Curve loss in pipe flow is the additional head required to maintain the required flow because of curved alignment and is in addition to the friction loss of an equal length of straight alignment. It should be determined from Figure 4-2 which includes an example.

(3) **Entrance loss at terminal inlets.** Entrance loss is the additional head required to maintain the required flow because of resistance at the entrance. The entrance loss at a terminal inlet is calculated by the formula:

$$H_{ti} = (V^2/2g)$$

Where:

V = Velocity in flow of outgoing pipe

g = Acceleration of gravity (32.2ft/sec/sec)

(4) **Turn loss.** Head losses in structures due to change in direction of flow (turns) in a structure will be determined in accordance with the following:

Change in Direction of Flow (A) Multiplier of Velocity Head of Water Being Turned (K)

90° 0.7

60° 0.55

45° 0.47

30° 0.35

15° 0.18

0° 0.0

Other angles By interpolation

Diagram 1

$$\text{Formula: } H_1 = K(V_1)^2/2g$$

Where:

H₁ = Feet of head lost in manhole due to change in lateral flow

V_1 = Velocity of flow in lateral in ft/sec

g = Acceleration of gravity (32.2 ft/sec/sec)

K = Multiplier of velocity head of water being turned

(5) Junction chamber loss. A sewer junction occurs for large pipes or conduits too large to be brought together in the usual forty two (42) inch diameter manhole or inlet where one (1) or more branch sewers enter a main sewer. Allowances should be made for head loss due to curvature of the paths and due to impact at the converging streams.

Losses in a junction chamber for combining large flows shall be minimized by setting flowline elevations so that pipe centerlines (springlines) will be approximately in the same planes.

At junction points for combining large storm flows, a manhole with a slotted cover shall be provided.

A computation method for determining junction chamber losses is presented below:

$$H_j = \epsilon_y + V_{h1} - V_{h2}$$

Where:

H_j = junction chamber loss (ft.)

V_{h1} = upstream velocity head

V_{h2} = downstream velocity head

ϵ_y = change in hydraulic grade line through the junction in feet

Where:

$$\epsilon_y = \left[\frac{(Q_2 V_2)^2 - (Q_1 V_1)^2 + ((Q_3 V_3 \cos E_3) + (Q_n V_n \cos E_n))}{0.5(A_1 + A_2)g} \right]$$

Where:

Q_2 = Discharge in cubic feet per second (cfs) at the exiting conduit

V_2 = Velocity in feet per second (fps) at the exiting conduit

A_2 = Cross-sectional area of flow in square feet for the exiting conduit

Q_1 = Discharge in cfs for the incoming pipe (main flow)

V_1 = Velocity in fps for the incoming pipe (main flow)

A_1 = Cross-sectional area of flow in square feet for the incoming pipe (main flow)

Q_3, Q_n = Discharge(s) in cfs for the branch lateral(s)

V_3, V_n = Velocity(ies) in fps for the branch lateral(s)

E_3, E_n = The angle between the axes of the exiting pipe and the branch laterals(s)

g = Acceleration of gravity (32.2 ft/sec/sec)

Where:

E = is the angle between the axes of the outfall and the incoming laterals

(6) Losses at junctions of several flows in manholes and/or inlets. The computation of losses in a manhole, inlet or inlet manhole with several flows entering the structure should utilize the principle of the conservation of energy. This involves both the elevation of water surface and momentum (mass times the velocity head). Thus, at a structure (manhole, inlet or inlet manhole) with laterals, the sum of the energy content for inflows is equal to the sum of the energy content of the outflows plus the additional energy required by the turbulence of the flows passing through the structure.

Diagram 2

The upstream hydraulic grade line may be calculated as follows:

$$H_u = (V_D^2/2g) - \{((Q_U/Q_D)(1-K)(V_U^2/2g)) + ((Q_L/Q_D)(1-K)$$

$$(V_L^2/2g)) + ((Q_{LN}/Q_D)(1-K)(V_{LN}^2/2g))\} + H_D$$

Where:

H_u = Upstream hydraulic grade line in feet

QU = Upstream main line discharge in cubic feet per second

QD = Downstream main line discharge in cubic feet per second

$QLI - Q_n$ = Lateral discharges in cubic feet per second

VU = Upstream main line velocity in feet per second

VD = Downstream main line velocity in feet per second

$VLI - V_{LN}$ = Lateral velocities in feet per second

HD = Downstream hydraulic grade line in feet

K = Multiplier of velocity of water being turned

g = Acceleration of gravity, 32.2 ft/sec/sec

The above equation does not apply when two (2) almost equal and opposing flows, each perpendicular to the downstream pipe, meet and no other flows exist in the structure. In this case the head loss is considered as the total velocity head of the downstream discharge.

(7) Transition loss. The relative importance of the transition loss is dependent on the velocity head of the flow. If the velocity and velocity head of the flow are quite low, the transition losses cannot be very great. However, even small losses may be significant in flat terrain. The sewer design shall provide for the consideration of the necessary transitions and resulting energy losses. The possibility of objectionable deposits is to be considered in the design of transitions.

For design purposes it shall be assumed that the energy loss and changes in depth, velocity and invert elevation, if any, occur at the center of the transition. These changes shall be distributed throughout the length of the transition in actual detailing. The designer shall carry the energy head, piezometric head (depth in an open channel) and invert as elevations and work from the energy grade line. Because of inherent differences in the flow, transitions for closed conduits will be considered separately from those for open channels.

(a) Closed conduits. Transitions in small sewers may be confined within a manhole. Special structures may be required for larger sewers. If a sewer is flowing surcharged, the form and friction losses are independent of the invert slope, therefore, the transition may vary at the slopes of the adjacent conduits. The energy loss in a transition shall be expressed as a coefficient multiplied by the change in velocity head ($LV^2/2g$) in which V is the change in velocity before and after the transition. The coefficient may vary from zero (0) to one (1), depending on the design of the transition.

If the areas before and after a transition are known, it is often convenient to express the transition loss in terms of the area ratios and either the velocity upstream or downstream.

For an expansion:

$$H_1 = K(V_1 - V_2)^2 / 2g \times [K(V_1)^2 / 2g] [1 - (A_1/A_2)]^2$$

in which H_1 is the energy loss; K is a coefficient equal to 1.0 for a sudden expansion and approximately two tenths (0.2) for a well designed transition and the subscripts 1 and 2 denote the upstream and downstream sections, respectively, i.e., A_1 = Area Before Transition and A_2 = Area After Transition.

For a contraction:

$$H_1 = [K(V_2)^2 / 2g] \{ [(1/C_c - 1)^2 K(V_2)^2 / 2g] [1 - (A_2/A_1)]^2$$

in which K is a coefficient equal to five tenths (0.5) for a well designed transition, C_c is a coefficient of contraction and the other terms and subscripts are similar to the previous equation. Losses in closed conduits of constant area are expressed in terms of $(V_2/2g)$.

The above equations may be applied to approximate the energy loss through a manhole for a circular pipe flowing full. If the invert is fully developed, that is, semi-circular on the bottom and vertical on the sides from one half (1/2) depth up to the top of the pipe, for the expansion $(A_1/A_2)=0.88$ and for the contraction $(A_2/A_1)=0.88$. The expansion is sudden, therefore, $K=1$. The contraction may be rounded if the downstream pipe has a bell or socket. In this case, K may be assumed to be two tenths (0.2).

The expansion energy loss is fourteen thousandths (0.014) $\{(V_1)^2/2g\}$ and the contraction energy loss is one hundredth (0.010) $\{(V_2)^2/2g\}$. If the invert is fully developed, the manhole loss is small, but if the invert is only developed for one half (1/2) of the depth or not at all, the losses will be of considerable magnitude.

(b) Open channel transitions. The hydraulics of open channel transitions are further complicated by possible changes in depth. As a first approximation to the energy loss, unless a jump occurs, the equations given above may be used with a trial and error solution for the unknown area and velocity. The K value for a well designed expansion should probably be increased to three tenths (0.3) or four tenths (0.4). Whether the properties of the upstream or downstream section will be known will depend on the characteristics of the flow and the channel, but can be determined by a profile analysis. In transitions for supercritical flow, additional factors shall be considered. Standing waves of considerable magnitude will be produced in transitions. The height of these waves must be estimated to provide a proper channel depth. In addition, in long transitions, air entrainment will cause bulking of the flow with resultant greater depths of the air-water mixture.

(8) Hydraulic grade line limits. The hydraulic grade line shall not rise above the following limits as determined by flow quantities calculated per Section 425.060(B)(3)(a).

(a) The hydraulic grade line at any inlet or storm manhole shall not be higher than two (2) feet below the inlet sill or top of manhole.

(b) Storm sewers shall not flow with greater than three (3) feet of head.

(c) The hydraulic grade line for combined sewers shall not rise above the pipe intrados.

(d) The beginning point for the hydraulic grade line computations shall be the higher elevation as determined below:

(i) For connection to existing pipe system:

i) Top of pipe intrados of one (1) reach downstream of the connection point of the existing system; or

ii) The hydraulic grade line computed for the existing system.

(ii) For connection to channels or ditches:

i) Top of pipe intrados of the proposed pipe; or

ii) The hydraulic grade line computed for the channel or ditch as approved by the District.

(9) Inlets. Inlets function entirely as entry points for stormwater flow. They also may be constructed to serve as a manhole on separate stormwater sewers and are then termed inlet manholes. Steep gradients may give such low inlet capacities that additional inlets should be located at more favorable grade locations or special inlets designed for steep gradients must be used. Provision must be made to control by-pass flow and to provide additional capacity in the inlet and line affected by such increased flow. Six (6) inch, open throat inlets should be used at all times.

Grated inlets without an open throat or other provision for overflow shall be avoided except under exceptional conditions and are prohibited in grade pockets. Any exceptions shall be used only with District approval.

Curb inlets shall be placed at street intersections or driveways such that no part of the inlet structure or sump is within the curb rounding.

(a) Inlets are shown in the standard details of sewer construction. The minimum depth of a terminal inlet is four (4) feet from the top of the inlet to the flowline of the outlet pipe. Greater depth shall be used for intermediate inlets if necessary for the required depth of the hydraulic grade line. Trapped inlets shall have the depth shown in the Standard Details of Sewer Construction.

(b) Inlet capacity should not be less than the quantity flow tributary to the inlet and by-pass flow shall be avoided whenever possible.

Inlets at low points or grade pockets should have extra capacity to compensate for possible flow by-pass of upstream inlets.

Figure 4-3 shows inlet capacity/maximum gutter capacity with a given gutter line grade and flow.

(c) Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.

Commented [WM16]: MSD Section 4.030.04

(10) Open channels.

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* NOTE: This Section contains some excerpts relating to design and are attributed to Open Channel Hydraulics by Ven Te Chow, a McGraw-Hill work published in 1959.

All open channels shall meet the following requirements:

(a) Size and shape. Open channels shall not decrease in size in the direction of flow. Open channels shall be vertical walled except in special cases where other approved materials are being considered.

(b) Materials. Channels may be constructed with reinforced concrete or other approved material. However, the District shall have the right to approve or disapprove any channel material and shall select the appropriate channel material if a proposed material is rejected. Swales shall be sodded unless velocities are excessive (greater than five (5) fps) or where velocities are less than two (2) fps causing deposition of soil particles, then concrete swales may be used.

(c) Bedding. Special provisions shall be made for channels or paved swales laid over fill on non-supportive soils to support the channel on paved swales. Pipes extended to the channel in a fill area shall have compacted crushed limestone bedding for support.

(d) Structural considerations. Provision must be made for all loads on the channel.

(e) Alignment. Open channel alignments may be limited by available easements, physical topography, existing utilities, buildings, residential development, maintenance access and roadways.

(f) Locations. Storm channel locations are determined primarily by natural drainage conditions. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses and evaluating effects of easements on private property. Storm channels shall be located:

(i) To serve all adjacent property conveniently and to best advantage.

(ii) In easements or rights of way dedicated to the District.

(iii) In easements on common ground when feasible.

(iv) On private property along property lines or immediately adjacent to public streets, avoiding crossings through the property.

(v) At a sufficient distance from existing and proposed buildings (including footings) and underground utilities or sewers to avoid future problems of flooding or erosion.

(vi) To avoid interference between stormwater sewers and house connections to foul water or sanitary sewers.

(vii) In unpaved or unimproved areas whenever possible.

(viii) Crossing perpendicular to streets, unless unavoidable.

(g) Flowline. The flowline of open channels shall meet the following requirements:

(i) Gradient changes shall be kept to a minimum and be consistent and regular.

(ii) Gradient designations less than the nearest one one-thousandths (0.001) foot per foot shall be avoided.

(iii) Channel and swale depths shall be determined primarily by the requirements of the channel size, utility obstructions and any required connections.

(h) Other open channel considerations and requirements:

(i) Natural channels and ditches. All natural channels and ditches shall be improved unless otherwise authorized by the District.

(ii) Drainage control. Drainage within private property should be controlled to prevent damage to the property crossed. Swales or broad shallow grass-lined ditches with non-erosive slopes are generally located at or near rear lots and along common property lines. If a paved gutter is utilized, then appropriate erosion protection shall be used at both ends.

(iii) Subdivisions. Drainage channels and watercourses draining through a subdivision shall be enclosed if the required pipe size does not exceed sixty (60) inches. When it is undesirable or impractical to enclose a channel with a pipe across a road or street, a suitable bridge or culvert shall be required.

(iv) Inlets inlet manholes. For flows greater than four (4) cfs, area inlets or inlet manholes are required to intercept the gutter or swale flow.

(v) Improved concrete channels. All improved concrete channels shall have a forty-eight (48) inch chain link fence on each side of the channel or other protective measures as directed by the District.

(vi) Large areas. Channels and watercourses draining large areas shall be located in rights of way or easements previously approved by the District as a part of an adequate overall plan for drainage.

Commented [WM17]: MSD 4.030.05

(vii) Riparian corridor protection. In certain conditions and upon the approval of the Director of Public Works and MSD, twenty five (25) feet minimum buffer adjacent to existing natural channels shall remain natural or be designed with bioengineering. The intent of riparian corridor protections shall be:

i) Improve surface and ground water quality by reducing the amount of nutrients, sediment organic matter, pesticides and other harmful substances that reach watercourses, wetlands and subsurface and surface water bodies by using scientifically proven processes including filtration, deposition, absorption, adsorption, plant uptake and denitrification and by improving infiltration, encouraging sheet flow and stabilizing concentrated flows;

ii) Preserve and protect areas that intercept stormwater and surface water runoff, wastewater, subsurface flow and/or deep ground water flows from upland sources and reduce, to the maximum extent practicable, the effects of the entry of associated nutrients, sediment organic matter, pesticides or other pollutants into surface waters, as well as provide wildlife habitat, moderate water temperature in surface waters, attenuate flood flow and, where appropriate and feasible, provide opportunities for recreational activities;

iii) Assist in the implementation of pertinent Federal, State and local laws concerning clean water, pollutant discharges, storm and surface water management, erosion and sediment control and flood control;

iv) Conserve natural features important to land or water resources, such as headwater areas, ground water recharge zones, floodway, floodplain, springs, streams, wetlands, woodlands, prime wildlife habitats and other features within the riparian corridor;

v) Recognize that natural features contribute to the welfare and quality of life of the City's residents;

vi) Conserve natural, scenic and recreation areas within and adjacent to stream corridors for the community's benefit; and

vii) Create added value to lands adjacent to stream corridors.

viii) Recognition that a certain amount of erosion is a natural occurrence, causing streams to meander within their floodway and therefore keeping

improvements from unnecessary risk of erosion damage or later otherwise unnecessary structural constraints to the channel.

Commented [WM18]: Stream Buffer Ordinance

(i) Design limitations.

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(i) The flow quantity shall be calculated by the method presented in Section 425.060(B)(3)(a), Flow Quantities, of this Chapter.

(ii) If the channel is within an area designated in a community's Flood Insurance Study, then the channel shall also meet all District and the community's floodplain requirements.

(iii) Other agencies of jurisdiction may have requirements which must be met. A U.S. Army Corps of Engineers permit may be required for any construction affecting a watercourse.

(j) Hydraulic grade line.

(i) Computation methods. In open channels, the water surface is identical with the hydraulic grade line. The hydraulic grade line shall be computed throughout the channel reach to show its elevation at junctions with incoming pipes or channels and at the ends of the channel reach under consideration. It shall also provide for the losses and differences in elevations as required below. Since it is based on design flow in a given channel, it is of importance in determining minimum sizes within narrow limits. The depth at which the actual flows will occur is controlled by the two (2) end conditions of the reach considered and by the relationship between the energy available and by the energy required to overcome the losses that are encountered along the channel.

There are several methods of calculating "losses" in channel design. The following procedures are presented for the engineer's information and consideration.

It is required that the design recognize the reality of such "losses" occurring and make such allowances as good engineering judgment indicates.

i) Control sections. The engineer should locate all possible control sections for the reach in question. A control section refers to any section at which the depth of flow is known or can be controlled to a required stage. At the control section, flow must pass through a control depth which may be the critical depth, the normal depth or any other known depth. Three (3) types of control sections include (a) upstream control section; (b) Downstream control section; (c) artificial control section, which occurs at a control structure, such as a weir, dam, sluice gate, roadway embankment, culvert, bridge or at the confluence with a major river or stream.

ii) Friction loss. The friction loss may be calculated by the same procedure as is presented in Section 425.060(B)(4)(a)(1) of this Chapter.

iii) Flow in curved channels. The centrifugal force caused by flow around a curve produces a rise in the water surface on the outside wall and a lowering of the inner wall. This phenomenon is called superelevation. The flows tend to behave differently according to the state of flow.

In subcritical flow, friction effects are of importance, whereby in supercritical flow, the formation of cross-waves is of major concern.

a) Curve losses. Curve losses may be estimated from Figure 4-2 by replacing D , diameter, with b , width of channel.

b) Super elevations. In addition to curve losses, an evaluation of superelevations should be considered and, if required, an allowance made in the top elevation of the outside wall. Equations are presented below which may be used to determine the superelevation at channel bends.

1) Trapezoidal channels.

Subcritical flow:

$$\epsilon H_w = \frac{1.15(V^2/2g\epsilon c)[b+D(ZL+ZR)]}{\epsilon c}$$

Supercritical flow:

$$\epsilon H_w = 2.6(V^2/2g\epsilon c)[b+D(ZL+ZR)]$$

2) Rectangular channels.

Subcritical flow:

$$\epsilon H_w = (V^2 b / 2g\epsilon c)$$

Supercritical flow:

$$\epsilon H_w = (V^2 b / g\epsilon c)$$

Where:

ϵH_w = Change in water height above the centerline water surface elevation.

V = Average velocity of design flow in fps.

g = Acceleration of gravity (32.2 ft/sec/sec).

r_c = Radius
of curve on horizontal alignment in feet.

b = Base
width of channel in feet.

D = Depth
of flow in straight channel.

Z_L = Left
side slope (ft/ft).

Z_R = Right
side slope (ft/ft).

iv) Transitions. Transitions should be designed to accomplish the required change in cross section with as little flow disturbance as possible.

The following features are to be considered in design of transition structures:

a) Proportioning. For a well designed transition, the following rules should be used:

1) The optimum maximum angle between the channel axis and a line connecting the channel sides between the entrance and exit sections is twelve and one half degrees (12.5°).

2) Sharp angles in the structure should be avoided.

b) Losses. The energy loss in a transition consists of the friction loss and the conversion loss. The friction loss may be estimated by the Manning Formula. The conversion loss is generally expressed in terms of the change in velocity head between the entrance and exit sections of the structure.

$$H_t = K_t \epsilon V H$$

Where:

H_t = Conversion loss

K_t = Coefficient of head loss in transition

$\epsilon V H$ = Absolute change in velocity head

Average design values for K are presented in the table below:

Type of Transition	Contracting Section	Expanding Section
Warped	0.10	0.20
Wedge	0.20	0.50
Cylinder quadrant	0.15	0.25
Straight Line	0.30	0.50
Square End	0.40	0.75

See Figure 4-4 for sketches of each type of transition.

c) Freeboard. A transition shall have a minimum of one (1) foot of freeboard above the hydraulic grade line.

d) Hydraulic jump. The existence of a hydraulic jump in a transition may become objectionable and the design of the transition should be checked for such.

e) Sudden enlargement and contraction. A sudden enlargement results when an intense shearing action occurs between incoming high-velocity jet and the surrounding water. As a result, much of the kinetic energy of the jet is dissipated by eddy action. The head loss at a sudden enlargement, H_{Le} , is:

$$H_{Le} = K_e(\epsilon V^2/2g)$$

Where:

K_e = Coefficient of head loss for enlargements = 1

ϵV = Change in velocities between incoming and outgoing sections

g = Acceleration of gravity (32.2 ft/sec/sec)

The flow in a sudden contraction is first contracted and then expanded resulting in high losses as compared to a sudden enlargement. Thus the head loss at a sudden contraction, H_{Lc} , is:

$$H_{Le} = K_c \left(\frac{V^3}{2g} \right)$$

Where:

$$K_c = \text{Coefficient of head loss for contractions} = 0.5$$

$$\Delta V = \text{Change in velocities between incoming and outgoing sections}$$

$$g = \text{Acceleration of gravity, ft/sec/sec}$$

v) **Constrictions.** A constriction results in a sudden reduction in channel cross section. The effect of the constriction on the flow depends mainly on the boundary geometry, the discharge and the state of flow. When the flow is subcritical, the constriction will induce a backwater effect that extends a long distance upstream. If the flow is supercritical, the disturbance is usually local and will only affect the water adjacent to the upstream side of the constriction. A control section may or may not exist at a constriction. The control section, when it exists, may be at either side of the constriction (upstream or downstream), depending on whether the slope of the constricted channel is steep or mild. The entrance and outlet of the constriction then acts as a contraction and an expansion, respectively.

vi) **Obstructions.** An obstruction in open channel flow creates at least two (2) paths of flow in the channel. Typical obstructions include bridge piers, pile trestles and trash racks. The flow through an obstruction may be subcritical or supercritical.

(iii) **Hydraulic grade line limits.**

i) The hydraulic grade line at any point along a channel shall not be higher than one (1) foot below the top of the channel wall.

ii) The hydraulic grade line at any point along a channel shall not cause the hydraulic grade limits of the storm sewer system to be exceeded as stated in Section 425.060(B)(4)(8)(a) of this Chapter.

(k) **Hydraulic jump.** When flow changes from the supercritical to subcritical state, a hydraulic jump may occur. A study should be made on the height and location of the jump and for discharges less than the design discharge to ensure adequate wall heights extend over the full ranges of discharge.

(l) **Open channel junctions.**

(i) **General.**

i) Consideration shall be given in the design of open-channel junctions to the geometry of the confluence of flows in order to minimize undesirable hydraulic effects due to supercritical velocities.

(ii) Confluence design criteria:

i) The momentum equation can be applied to the confluence design if the below stated criteria is used.

ii) The design water surface elevations in the two (2) joining channels should be approximately equal at the upstream end of the confluence.

iii) The angle of the junction intersection can vary from zero to twelve degrees (0 – 12°).

iv) The width of the main channel shall be expanded below the junction to maintain approximate flow depths throughout the junction.

v) Flow depths should not exceed ninety percent (90%) of the critical depth.

(m) Erosion protection. Grouted rock blankets, minimum one (1) foot thick, shall be required at each end of the improved channel. The minimum length of the grouted rock blanket shall be twenty five (25) feet. A grouted rock toe wall, minimum two (2) feet deep, shall be constructed at the free end of each blanket.

(n) Sanitary sewer crossings. The characteristics of any sanitary sewer crossing shall be given consideration in the design of the channel floor.

5. Culverts. The design of culverts shall include consideration of many factors relating to requirements of hydrology, hydraulics, physical environment, imposed exterior loads, construction and maintenance.

With the design discharge and general layout requirements determined, the design requires detailed consideration of such hydraulic factors as shape and slope of approach and exit channels, allowable head at entrance (and ponding capacity, if appreciable), tailwater levels, hydraulic and energy gradelines and erosion potential.

a. Hydraulic design. The hydraulic design of a culvert for a specified design discharge involves (1) selection of a type and size, (2) determination of the position of hydraulic control, and (3) hydraulic computations to determine whether acceptable headwater depths and outfall conditions will result. Hydraulic computations will be carried out by standard methods based on pressure, energy, momentum and loss considerations.

b. Entrances and headwalls outlets and endwalls. Where an existing culvert is to be extended, the possibility for maintaining or improving existing capacity should be investigated. Marked

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~~improvement may be obtained by proper entrance design. All culverts shall be designed for possible extension unless there are extenuating circumstances.~~

Commented [WM20]: MSD 4.030.06

~~6. Bridges. Bridges shall be designed to meet the current criteria of the governing agencies.~~

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~~a. Waterway capacity and backwater effects. Sufficient capacity will be provided to pass the runoff from the design storm determined in accordance with principles given elsewhere in this Chapter.~~

~~b. Clearance. The lowest point of the bridge superstructure shall have a (freeboard) clearance of two (2) feet above design water surface elevation for the 15 year frequency in St. Louis County and one (1) foot for the 100 year frequency.~~

~~c. Waterway alignment. The bridged waterway will be aligned to result in the least obstruction to stream flow, except that for natural streams, consideration will be given to future realignment and improvement of the channel.~~

~~d. Erosion protection. To preclude failure by scouring, abutment and pier footings usually will be placed either to a depth of not less than five (5) feet below the anticipated depth of scour or on firm rock if such is encountered at a higher elevation. Large multi-span structures crossing alluvial streams may require extensive pile foundations. To protect the channel, revetment on channel sides and/or bottom consisting of concrete or grouted rock blanket should be placed as required. The governing authority should be contacted regarding their design requirements.~~

Commented [WM21]: MSD Section 4.040

~~7. Outlet erosion protection. If outlet velocities exceed five (5) fps, an appropriate erosion protection must be provided. Erosion protection may be required at outlets where velocities are less than five (5) fps if soil conditions warrant.~~

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~~For paved channels, a cutoff wall will be required at the termini with appropriate protection. The cutoff wall shall extend a minimum depth of two (2) feet into the existing ground line.~~

Commented [WM22]: MSD Section 4.050

~~8. Limitations on areas draining across sidewalks or driveways. Up to three thousand (3,000) square feet of parking area may discharge via a driveway to a public or private street. An additional three thousand (3,000) square feet may discharge into a public alley. Areas larger than this must have any excess area discharge into interceptor basins as set forth in the City.~~

~~Area inlets shall be required to intercept overland flows greater than one (1) cfs to prevent that flow from crossing sidewalks or curbs.~~

Commented [WM23]: Stricken from MSD

~~9. Impervious areas. Any area which is to be paved, repaved, expanded or otherwise improved, that is over three thousand (3,000) square feet in area, whether presently paved or not, shall at such time as it is to be paved, repaved, expanded or be otherwise improved, be provided with stormwater drainage facilities constructed in accordance with plans and specifications submitted to and approved by the District.~~

Commented [MW24]: Generally Section 4 of the MSD Design Guide

Commented [MW25]: Stricken from MSD

~~10. Stormwater detention.~~~~a. When required.~~

~~(1) The requirement of stormwater detention shall be evaluated for all projects submitted to MSD for review and approval and may be required, if deemed necessary. Detention facilities shall be provided and designed in accordance with the requirements of this Section.~~

~~(2) Projects which have a differential runoff for the 25-year, 20-minute event in the City shall have the following detention requirements:~~

Creek	100-year, 24-hour Storm Release Rate	2-year, 24-hour Storm Release Rate	Critical Time Period of Watershed
Creve Coeur	1.2 cfs/acre	0.13 cfs/acre	Hour 12.0 17.2
Deer	differential	differential	N/A
Fee	1.3 cfs/acre	0.15 cfs/acre	Hour 12.0 14.1

~~(a) The Public Works Director has the discretion to waive this requirement.~~

~~(3) When existing detention facilities are going to be used to accommodate additional runoff from building or parking lot expansions or subdivision additions, the facilities shall be retrofitted to meet the current detention requirements for the drainage area which is tributary to the facility. Projects which cannot meet this requirement due to physical constraints will be evaluated on a case-by-case basis.~~

~~(4) The stormwater design project will be based on the City's stormwater master plan.~~

~~(5) Shared detention facilities can be evaluated on both existing and proposed detention facilities. The plan can be proposed by the City or the applicant and needs to be discussed with the City before preparing preliminary plans.~~

~~b. Design considerations.~~

~~(1) The 2-year and 100-year, 24-hour inflow hydrographs shall be determined by using Technical Release 55 (TR 55) "Urban Hydrology for Small Watersheds" from the Natural Resources Conservation Service, formerly Soil Conservation Service (SCS). The inflow hydrograph shall be developed based on the actual flow and timing characteristics upstream of the detention facility. The rainfall distribution shall be Type II.~~

Commented [WM26]: Why is the City involved in determining stormwater detention volumes? This is MSD's purview.

Commented [CL27]: This is to be deleted right?

Commented [WM28]: MSD Table 4-5

Commented [WM29]: Deleted from current MSD regulations.

~~(2) Stormwater shall be detained on site or off site as approved and released at a rate not to exceed the allowable release rates for the 2-year and 100-year, 24-hour events as determined by the District for the watershed in question. The allowable release rates have been determined by watershed modeling, which may be obtained from MSD. The design engineer has the option to calculate a site-specific release rate based on procedures provided by MSD. Note that stormwater pipes, downstream from the control structure, shall be sized to carry the runoff from the 25-year, 20-minute design storm for the total tributary upstream watershed. No reduction in outfall pipe size shall be permitted because of detention.~~

~~(3) The volume of detention may be provided through permanent detention facilities such as dry basins or ponds, permanent ponds or lakes, underground storage facilities or in parking lots. The design engineer shall make every effort to locate the detention facility at or near the lowest point of the project such that all of the on-site runoff will be directed into the detention facility.~~

~~Flows from off-site upstream areas should be by-passed around the detention facility to ensure that the proposed detention facility will function as designed and will provide effective control of downstream flows with development in place. If off-site flows are directed into a detention facility, the allowable release rates shall not be modified without MSD approval. Modifying the release rate to accommodate off-site flows may reduce or eliminate the effectiveness of the detention facility, because it will no longer control the increased volume of runoff during the critical time period of the watershed.~~

~~As stated in item 2 above, the design engineer has the option to calculate a site-specific release rate based on procedures provided by MSD. The design engineer shall provide detailed modeling to prove that the increase in runoff volume has been limited to existing conditions during the critical time period of the watershed.~~

~~(4) Detention basin volume will be based on routing the post-developed 2-year and 100-year, 24-hour inflow hydrographs through the detention facility while satisfying the appropriate allowable release rate. The routing computations shall be based on an application of the continuity principle (i.e., level pool routing).~~

~~(5) Design of underground basins.~~

~~(a) Adequate access for basin maintenance and inspection shall be provided. A means of visual inspection from the ground surface of the low flow device, overflow weir and outlet structure is necessary. Access also shall be provided to allow for cleaning of the low flow device from the ground surface.~~

~~(b) The basin should have sufficient volume and spillway capacity to pass/contain the 100-year, 24-hour event with the low flow outlet blocked.~~

~~(6) The design engineer must submit the following for review of a detention facility:~~

- (a) Elevation vs. discharge tables or curves for all frequencies.
 - (b) Elevation vs. storage tables or curves for all frequencies.
 - (c) Inflow calculations and data for all frequencies.
 - (d) Hydraulic gradeline computations for pipes entering and leaving the basin for all frequencies.
 - (e) If the embankment contains fill material, a geotechnical report may be required.
 - (f) Site plan showing appropriate design information.
 - (g) Structural calculations for the outlet control structures (if required).
 - (h) Cross sections defining the size, shape and depth of the detention basin shall be required. At a minimum, three (3) sections, one (1) at each end and one (1) in the middle of the basin, will be required.
 - (i) Upon close-out of a development in which a detention pond was constructed prior to the completion of the primary development and accepted runoff from the project area during construction, the basin shall be physically surveyed to determine the extent that sediment may have reduced the depth from that of the approved design and that the sediment shall be removed to restore the design depth. These sections will be used to compute the as-built volume of the basin and thus must be tied to a known physical structure or baseline.
- (7) All ends of pipes discharging into a dry basin or pond shall be connected with the low flow pipe or control structure by means of a paved swale. The paved swale shall be non-reinforced concrete, six (6) inches thick, with a minimum two percent (2%) slope to the center and a minimum two tenths percent (0.2%) longitudinal slope. Paved swales shall be a minimum of six (6) inches deep and four (4) feet wide or one and three tenths (1.3) times the diameter of the pipe entering the basin, whichever is greater, and be keyed to structure or channel. The bottom of the basin shall be sloped a minimum of two percent (2%) towards the concrete swale.
- (8) Railroad tie walls and galvanized gabion walls cannot be used where water will be in contact with the railroad tie wall or the galvanized gabion wall.
- (9) Permanent detention ponds or lakes are to be designed to minimize fluctuating lake levels. Maximum fluctuation from the permanent pool elevation to the maximum ponding elevation shall be three (3) feet.
- (10) The maximum side slopes for dry basins or ponds and the fluctuating area of permanent ponds or lakes shall be 3:1 (three (3) feet horizontal, one (1) foot vertical) without fencing.

(11) Dry basins or ponds and the fluctuating areas of permanent ponds or lakes are to be sodded and kept mowed.

(12) Control structures and overflow structures are to be reinforced concrete.

(13) The outflow pipe shall be sized for the developed flow rate.

(14) In basins with concrete walls or rock blanket covered slopes, the bottoms should be paved or provisions made for moving equipment to reach the bottom (ramps, etc.).

c. Maximum depths.

(1) The maximum depth of water in a dry detention basin or pond shall not exceed eight (8) feet. Projects which need a deeper basin to attain the required detention volume due to physical constraints may be evaluated on a case-by-case basis. The design and construction of dams greater than eight (8) feet or as directed by the Public Works Director must be sealed and certified by a professional engineer registered in the State of Missouri with demonstrated expertise in geotechnical engineering.

(2) Parking lots used for automobiles shall have a maximum depth of eight (8) inches of water.

(3) Parking lots used for trucks or truck trailers shall have a maximum depth of water of twelve (12) inches.

Commented [WM30]: MSD Section 4.080.04

d. Limits of maximum ponding.

(1) The maximum ponding elevation shall be calculated based on a routing of the design storm (100 year, 24 hour event) assuming the low flow outlet is blocked with water ponded to the overflow structure's sill.

(2) The limits of maximum ponding in dry basins or ponds and permanent lakes or ponds shall not be closer than thirty (30) feet horizontally to any building and not less than two (2) feet vertically below the lowest sill elevation of any building.

(3) The limits of maximum ponding in parking lots shall not be closer than ten (10) feet horizontally from any building and not less than one (1) foot vertically below the lowest sill elevation of any building.

(4) A minimum of one (1) foot of freeboard shall be provided from the top of the basin to the maximum ponding elevation.

Commented [WM31]: MSD Section 4.080.03

e. Easement required. In subdivisions, the detention basin, access roads or paths, control structures and outfall pipes are to be located in easements dedicated to the subdivision trustees.

Commented [WM32]: MSD Section 4.080.07

f. Maintenance agreement. The owner(s) of the project shall execute an MSD maintenance agreement for the detention basin or pond to ensure the detention area will be kept in working order prior to plan approval. MSD will not be responsible for maintenance of detention basins.

Commented [WM33]: MSD Section 4.080.08

g. Detention basin fencing. A four (4) foot (minimum height) approved fence shall be provided around the perimeter of any basin where the side slopes exceed 3:1 (three (3) feet horizontal, one (1) foot vertical).

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h. Detention basin elevation. The low elevation of the detention basin shall be above the 15-year, 20-minute hydraulic elevation of the receiving channel or pipe system or as directed by the Director of Public Works.

i. Privately owned ponds. The Stormwater Committee's policy and guidelines regarding the City's financial commitment to these privately owned residential ponds which are retention or detention facilities.

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DRY POND

1. If the storage capacity (based on the original design criteria) has been reduced by fifty percent (50%) of its original volume, the City could participate up to twenty-five percent (25%) of the cost of the project not to exceed ten thousand dollars (\$10,000.00). The rest of the project cost will be borne by the residents of that subdivision.

2. If certain improvements need to be made to the spillway, low water carrying pipe or the paved ditch, the City could contribute up to twenty-five percent (25%) of the cost of this project not to exceed two thousand five hundred dollars (\$2,500.00) to repair and refurbish the related items.

3. The normal maintenance such as mowing of the area or pruning of the trees/shrubs will be the total responsibility of the trustees/property owners.

4. The downstream facility from the overflow structure if repairs are needed receive cost sharing under the similar guidelines as described in time (4)(a) above.

WET POND/LAKE

1. The cost of repairs to the dam and/or the downstream structures including improved channels or enclosed systems could be shared by the City up to twenty-five percent (25%) of the cost of the project not to exceed twenty thousand dollars (\$20,000.00). The rest of the project cost will be borne by the residents of that subdivision.

2. The dredging of a lake or wet pond for aesthetic purposes will be the total responsibility of the trustees and/or property owners.

3. The normal maintenance of mowing grass, pruning of trees and shrubs and controlling algae, etc., will be the total responsibility of the trustees and/or homeowners.

~~11. Dam permit requirements. Dams with a height of thirty five (35) feet or greater will require approval from the Missouri Department of Natural Resources. (R.O. 2008 524-30.6; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)~~

Commented [WM35]: MSD Section 4.090

~~SECTION 425.070: DEFINITIONS~~

Commented [CL36]: Do we need any of these definitions any more?

~~In addition to words and terms that may be defined elsewhere in this Chapter, the following words and terms shall have the meanings defined below:~~

~~AASHTO: American Association of State Highway and Transportation Officials.~~

~~ALLOWABLE RELEASE RATE: The pre-development or existing condition peak flow corresponding to a selected rainfall frequency event.~~

~~BACKFILL: The material used to fill an excavation.~~

~~BASE FLOOD: The flood having a one percent (1%) chance of being equaled or exceeded in any given year. (The base flood, adopted by the Federal Emergency Management Agency (FEMA), is the 100-year flood.)~~

~~BEDDING: The material on which the pipe or conduit is supported and protected.~~

~~BOARD: The Board of Trustees of the Metropolitan St. Louis Sewer District.~~

~~BUILDING STRUCTURE: Walled or roofed building that is principally above ground, as well as a manufactured home, and a gas or liquid storage tank that is principally above ground.~~

~~CHANNELS: A natural or artificial watercourse.~~

~~CITY: The City of Creve Coeur.~~

~~COMBINED FLOW: A combination of stormwater and wastewater.~~

~~COMBINED SEWER: A sewer receiving both surface runoff and wastewater.~~

~~CULVERT: A closed conduit for the free passage of surface drainage water under a highway, railroad or other embankment.~~

~~CURVE, LONG: A curve having a centerline length of curve equal to or greater than one hundred fifty (150) feet.~~

~~CURVE, SHORT: A curve having a centerline length of curve of less than one hundred fifty (150) feet.~~

~~DEDICATION: The process by which the owner gives approved sanitary, combined and/or storm sewers and facilities to the District for public use and maintenance.~~

~~DETENTION: See "STORMWATER DETENTION".~~

~~DEVELOPED RUNOFF RATE: The peak flow corresponding to a selected rainfall event as a result of developed site conditions.~~

~~DIFFERENTIAL RUNOFF RATE: The difference between the pre-developed runoff rate and the developed runoff rate.~~

~~DIFFERENTIAL VOLUME OF STORMWATER: The amount of differential stormwater volume between the pre-developed and developed runoff rates which the detention basin must detain (hold).~~

~~DIRECTOR: The Executive Director of the Metropolitan St. Louis Sewer District or his/her properly authorized agents.~~

~~DISTRICT: The Metropolitan St. Louis Sewer District.~~

~~DRAINAGE FACILITY: Any system of artificially constructed drains, including open channels and sewers, used to convey stormwater, surface or ground water, either continuously or intermittently, to natural watercourses.~~

~~DROP: A structural configuration where flow falls into a structure from an incoming pipe.~~

~~ENGINEER: A registered professional engineer currently certified by law in the State of Missouri.~~

~~FEMA: Federal Emergency Management Agency.~~

~~FLOOD INSURANCE FLOODWAY MAPS: Current maps from the Federal Emergency Management Agency Flood Insurance Study.~~

~~FLOOD INSURANCE STUDY: The official report provided by the Federal Emergency Management Agency containing flood profiles; flood boundaries; floodway maps and the water surface elevation of the base flood.~~

~~FLOODPLAIN: A geographic area susceptible to periodic inundation from the overflow of natural waterways during the base (100-year) flood.~~

~~FLOODPLAIN STUDY: An engineering analysis to determine the hydraulic effect, if any, of the proposed development to the existing floodplain.~~

~~FLOODWAY: The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one (1) foot and so delineated in the Flood Insurance Study.~~

~~FORCE MAIN: A pressurized sewer carrying wastewater.~~

~~FREEBOARD: The difference in elevation (expressed in feet) between the hydraulic grade line elevation and:~~

- ~~1. The inlet sill elevation; or~~

2. The top of structure elevation; or

3. The top of channel bank elevation; or

4. The top of wall elevation.

HOUSE LATERAL: Private sewer from building drain to the public sewer. This shall include the connection to the sewer.

HS-20: The live truck wheel loads as designated by the AASHTO specifications.

HYDRAULIC GRADE LINE: A line coinciding with the level of flowing water at any given point along an open channel; or the level to which water would rise in a vertical tube connected to any point along a pipe or closed conduit flowing under pressure.

INLET TIME: The overland flow time for runoff to reach the inlet.

INTRADOS: The inside top of the sewer pipe.

LATERAL SEWER: A sewer that discharges into a branch or other sewer and has no other common sewer tributary to it.

LOW SILL: The lowest elevation of any opening in a building.

MAIN SEWER: The principal sewer to which branch sewers and submains are tributary; also called trunk sewers.

MDNR: The Missouri Department of Natural Resources.

MSD: The Metropolitan St. Louis Sewer District

"n" VALUE: A dimensionless coefficient used in the Manning's Equation to account for frictional losses in steady uniform flow.

OUTFALL: The point location or structure where wastewater or drainage discharges.

PERSON: Any individual, firm, proprietorship, partnership, company, municipality, association, society, corporation, group or other entity.

PRE-DEVELOPED RUNOFF RATE: The amount of flow from an existing site prior to new development or improvements as computed by the Rational Formula.

PRISMATIC CHANNEL: A channel characterized by uniform cross sections and constant bottom slope.

PRIVATE SEWER: A sewer not accepted for public maintenance as determined by the reviewing agencies.

PUBLIC SEWER: A sewer which has been accepted for public maintenance as determined by the reviewing agencies.

REACH: A distance, in pipe or channel, between two (2) identified points.

RESOLUTION: Any resolution duly adopted by the City.

RETENTION: A stormwater runoff facility designed to retain (hold) stormwater both permanently and temporarily (above normal pool elevation) during and immediately after a runoff event.

REVIEWING AGENCIES: The reviewing agency can be either MSD or the City of Creve Coeur.

RIPARIAN: Those areas associated with streams, lakes and wetlands where vegetation communities are predominately influenced by their association with water.

SANITARY SEWER: A sewer which carries wastewater.

SEMI-PUBLIC: A governmental, institutional, educational or municipal building or structure.

SEPARATE SEWER: A sewer intended to receive only wastewater or stormwater runoff.

SEWER: A pipe or closed conduit carrying wastewater, stormwater or a combination thereof.

SINKHOLE: A topographic depression with no natural surface drainage outlet.

SPRINGLINE: The line or plane in which an arch rises from its impose. In circular conduits, the horizontal plane through the midpoint of the section.

STANDARD DETAILS OF SEWER CONSTRUCTION: Plans of structures or devices or construction details commonly used on District work and referred to on the plans or in the specifications.

STEADY FLOW: The quantity of water passing a cross section is constant, i.e., has patterns and magnitudes which do not vary with time.

STORMWATER DETENTION: A stormwater runoff facility designed to detain (hold) stormwater temporarily during and immediately after a runoff event.

STORMWATER MANAGEMENT PLAN: Study and design for a stormwater conveyance system, a downstream evaluation system, detention requirements, floodplain/floodway, sink hole and regulating permitting requirements.

STORMWATER SEWER: A sewer which carries surface runoff and subsurface waters.

SWALE: A broad, shallow watercourse.

TIME OF CONCENTRATION: Consists of inlet time plus the travel time in the sewer or channel from the most remote point in the watershed to the point under consideration.

TRAVEL TIME: The time it takes for the runoff to flow through the drainage system from one point of reference to the next point of reference.

~~TRUNK SEWER: The principal sewer to which branch sewers and subtrunks are tributary; also called main sewers.~~

~~UNIFORM FLOW: The flow in a channel, conduit or pipe having a uniform cross section and velocity at every location within a given reach.~~

~~U.S.G.S.: United States Geological Survey~~

~~UTILITIES: Public service facilities for supplying gas, electricity, potable water or irrigation systems, sanitary sewers, power, steam, cable T.V., telephone, fiber optics and telegraph communication, railway transportation and the like.~~

~~WASTEWATER: The spent water of a community.~~

~~WATERCOURSE: A stream of water or a natural channel through which water may flow.~~

~~WUNNENBERG'S: A commercial street guide published by St. Louis Area Maps, Inc. for the St. Louis metropolitan area. (R.O. 2008 §24-30.7; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)~~

SECTION 425.089060: GENERAL

The developer will need to confirm with MSD whether MSD will accept for dedication any all public sewers and pump stations within easements dedicated to MSD that have been constructed to MSD standards and for which the requirements stated herein have been met.

The maintenance of these public facilities will remain the responsibility of the project Owner and their successors in interest until such time that they have been accepted for dedication by MSD. (R.O. 2008 §24-30.8; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

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SECTION 425.070090: ABANDONMENT OF WORK

Upon receipt of a written statement from the Owner that further work on the project has been abandoned, or upon Owner's failure to promptly complete work after notice of apparent abandonment, the City and ~~the District~~ MSD shall determine whether or not the uncompleted work is required to ensure the public health, safety and welfare. Should it be determined that completion of the work is necessary, the Owner shall complete such work immediately. Otherwise, the City may~~shall~~ utilize the monies deposited in the construction escrow for the project to complete this work or seek other applicable remedies. (R.O. 2008 §24-30.9; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.100080: FEES REQUIRED BEFORE PLAN APPROVAL

~~A. A.~~ The City ~~and MSD~~ will require that certain fees be paid prior to the acceptance of the plans for review or the subsequent approval of ~~these the project~~ plans. Failure to submit the fees in a timely manner could delay the review and approval of the plans. No plans will be approved until all required fees have been paid.

~~B. B.~~ ~~Since Because~~ the amount of these fees are subject to change, no amount for these fees is given herein. Please contact the City and MSD for a current list of fees. See Appendix B to Title IV--Community Development and Public Works Fee Schedule for fees required by the City for plan submittal and approval.

~~C. MSD may apply its own fees to the project proposal.~~

~~1. Submittal fee. A submittal fee in the amount indicated on MSD Engineering Form E.2 must be submitted along with the plans and Form E.2. Failure to submit this fee, Form E.2 or the appropriate number of plans will result in the rejection of the plans for review.~~

~~2. Review fee. The City and the District will charge a fee to review the project based on the acreage of the development. This fee will be determined by the District and refer to Appendix B to Title IV, Community Development and Public Works Fee Schedule for the City and the Owner will be notified of the amount as part of the review process.~~

~~D. 3.~~ Recording fees. The owner will be responsible for paying the recording fees for all documents to be recorded with the Recorder of Deeds for St. Louis County. (R.O. 2008 §24-30.10; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425.090: BONDS

A corporate surety bond or cash escrow, conditioned upon carrying out all and every part of approved plans for at least the sum estimated to be the full costs of carrying out such plans, shall be furnished to the City whenever such costs are estimated to exceed five hundred dollars (\$500.00). The bond or escrow shall be released upon proper completion of all of the requirements of such approved plans. (R.O. 2008 §24-30.12; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

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SECTION 425. ~~110~~100: CONSTRUCTION AND MAINTENANCE OF STORMWATER FACILITIES

- A. Detention/retention facilities, when mandatory, are to be built in conjunction with the storm sewer installation and/or grading. Since these facilities are intended to control increased runoff, they must be partially or fully operational soon after the clearing of the vegetation.
- B. Silt and debris connected both with early construction and with general erosion from the site and elsewhere in the watershed after construction shall be removed periodically from the detention area ~~and~~ and/or control structure in order to maintain the facility close to its full storage capacity.
- C. The responsibility of maintenance of the detention/retention facilities in subdivision projects shall remain with the developer until such time as applicable escrows are released. Upon release of escrows the maintenance responsibility for facilities on common ground shall be vested jointly and severally in the trustees of the subdivision by virtue of the trust indenture and the owners of the subdivision lots and their successors in interest. The indenture of the trust ~~shall~~ should clearly indicate resident responsibility for maintenance in cases of projects without common ground, but the absence of such a provision shall not eliminate such responsibility.
- D. The responsibility of maintenance of the detention/retention facilities in single owner development projects shall remain with the general contractor until final inspection of the development is performed and approved and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention/retention facilities shall be vested with the owner of the lot and their successors-project. (R.O. 2008 §24-30.11; Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08)

SECTION 425. ~~120~~110: ENFORCEMENT, VIOLATIONS, AND PENALTIES

- A. Enforcement. This Chapter shall be enforced by the Director of Public Works. The construction, reconstruction and/or alteration of buildings shall not be undertaken and the development of land shall not be commenced except in accordance with the provisions of this Chapter, as applicable. No permit or application for the construction or alteration of buildings and/or land shall be approved if the project would be in violation of this Chapter.

The Director of Public Works is authorized to institute any appropriate actions or proceedings to prevent, halt, or correct construction or maintenance that is found to be in violation of this Chapter.

- B. Notice of Violation and Sanctions. If the Director of Public Works finds that any of the provisions of this Chapter are being violated in the A-completion and/or maintenance of a stormwater management plan, he/she shall notify in writing the person(s) responsible for such violation, indicating the nature of the violation and ordering the action necessary to correct it. The Director of Public Works shall take any other action authorized by law to ensure compliance with or to prevent violation of the provisions of this Chapter. (R.O. 2008 §26-121; Ord. No. 1903 §1, 11-24-1997; Ord. No. 5165 §1, 12-13-2010)

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C. Violations. Violations of this Chapter shall include, but are not limited to, the following:

1. The alteration or construction of buildings and/or land not in accordance with the provisions of this Chapter.
2. Failure to obtain the necessary approvals as required by this Chapter.
3. Failure to maintain the approved and recorded stormwater management plan for the property.

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D. Persons Liable for Violation. Those chargeable, singly or jointly, with violations of this Chapter shall include, but shall not be limited to, the following:

1. Those who commit, assist in, or otherwise participate in a violation.
2. The owner or other persons who maintain the building, premises, property, or other place where the violation has been committed exists.
3. The owner's agent or person in charge of the building, premises, property or other place where the violation has been committed or exists.
4. The developer, engineer, architect, contractor, subcontractor, or any other person who performs work or enters into a contract for work in violation of this Chapter.

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E. Violations and Penalties.

1. In case any building, structure, or land is erected, constructed, reconstructed, altered, converted, maintained, or used in violation of this Chapter, or of any ordinance or other regulation made under authority conferred by Sections 89.010 to 89.140, RSMo., the proper local authorities of the City, in addition to other remedies, may institute any appropriate action or proceedings to prevent such unlawful erection, construction, reconstruction, alteration, conversion, maintenance, or use, to restrain, correct, or abate such violation, to prevent the occupancy of such building, structure, or land, or to prevent any illegal act, conduct, business, or use in or about such premises. Such regulations shall be enforced by an officer empowered to cause any building, structure, place or premises to be inspected and examined and to order in writing the remedying of any condition found to exist therein or thereat in violation of any provision of the regulations made under authority of Sections 89.010 to 89.140, RSMo.
2. The owner or general agent of a building or premises where a violation of any provision of said regulations has been committed or shall exist, or other persons or parties liable for said violation, as indicated in Section 425.110(D) shall be guilty of an ordinance violation punishable by a fine of not less than ten dollars (\$10.00) and not more than five hundred dollars (\$500.00) for each and every day that such violation continues, or by both such fine and imprisonment in the discretion of the court. Notwithstanding the provisions of Section 82.300, RSMo., however, for the second (2nd) and subsequent offenses involving the same violation at the same building or premises, the punishment shall be a fine of not less than two hundred fifty dollars (\$250.00) or more than one thousand dollars (\$1,000.00) for each and every day that such violation shall continue or by imprisonment for ten (10) days for each and

every day such violation shall continue, or by both such fine and imprisonment in the discretion of the court.

3. Any such person who having been served with an order to remove any such violation shall fail to comply with such order within ten (10) days after such service or shall continue to violate any provision of the regulations made under authority of Sections 89.010 to 89.140, RSMo., in the respect named in such order shall also be subject to a civil penalty of two hundred fifty dollars (\$250.00). ~~shall be subject to all provisions of Article IX of Chapter 405 relating to Enforcement, Violations and Penalties. In addition, a corporate surety bond, conditioned upon carrying out all and every part of approved plans for at least the sum estimated to be the full costs of carrying out such plans, or a cash escrow, upon the same conditions and in the same amount, shall be furnished the City whenever such costs exceed five hundred dollars (\$500.00). An additional penalty of five hundred dollars (\$500.00) a day can be assessed. The bond or escrow shall be released upon proper completion of all of the requirements of such approved plans. (RSMo. §89.120; R.O. 2008 §2426-30.12122; Ord. No. 1903 §1, 11-24-1997; Ord. No. 5165 §1, 12-13-2010).~~

Ord. No. 2207 §1, 1-27-03; Ord. No. 5043 §2, 7-14-08) **SECTION 425.120: DEFINITIONS**

In addition to words and terms that may be defined elsewhere in this Chapter, the following words and terms shall have the meanings defined below:

CHANNELS: A natural or artificial watercourse.

CITY: The City of Creve Coeur.

DEVELOPED RUNOFF RATE: The peak flow corresponding to a selected rainfall event as a result of developed site conditions.

DIFFERENTIAL RUNOFF RATE: The difference between the pre-developed runoff rate and the developed runoff rate.

DIFFERENTIAL VOLUME OF STORMWATER: The amount of differential stormwater volume between the pre-developed and developed runoff rates which the detention basin must detain (hold).

DIRECTOR OR DIRECTOR OF PUBLIC WORKS: The Director of Public Works for the City of Creve Coeur or his/her designee.

DRAINAGE FACILITY: Any system of artificially constructed drains, including open channels and sewers, used to convey stormwater, surface or ground water, either continuously or intermittently, to natural watercourses.

ENGINEER: A registered professional engineer currently certified by law in the State of Missouri.

IMPERVIOUS SURFACE: Materials through which no stormwater or only an incidental amount of stormwater is able to pass. Examples of impervious surfaces include, but are not limited to, building roofs, asphalt pavement, and concrete pavement.

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LAND DISTURBANCE: Clearing, grading, removal of improvements, or any other work that temporarily or permanently exposes the ground surface or subsurface to erosion. Section 420.020 includes additional discussion and definitions related to land disturbance.

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MDNR: The Missouri Department of Natural Resources.

MSD: The Metropolitan St. Louis Sewer District

OUTFALL: The point location or structure where wastewater or drainage discharges.

PERSON: Any individual, firm, proprietorship, partnership, company, municipality, association, society, corporation, group or other entity.

PRE-DEVELOPED RUNOFF RATE: The amount of flow from an existing site prior to new development or improvements as computed by the Rational Formula.

PRIVATE FACILITIES: Any device, structure, or feature that has not been expressly adopted for maintenance by the City of Creve Coeur, the Metropolitan St. Louis Sewer District, or other municipal, county, state, or federal entity.

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RATIONAL METHOD: A means to calculate flow quantities, by which:

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$$Q = A * P * I$$

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where:

Q = runoff, in cubic feet per second

A = tributary area, in acres

P = runoff factor based upon runoff from pervious and impervious surfaces

I = average intensity of rainfall, in inches per hour, for a given period and a given frequency

The definition of these factors, including the tables used to select the appropriate values, are outlined in Section 4.030 Stormwater Design Criteria of the MSD Regulations.

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RESOLUTION: A resolution duly adopted by the City Council of the City of Creve Coeur.

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RETENTION: A stormwater runoff facility designed to retain (hold) stormwater both permanently and temporarily (above normal pool elevation) during and immediately after a runoff event.

RESIDENTIAL DEVELOPMENT PERMIT: A permit from the City of Creve Coeur that is required for any new home (including "tear-down/rebuild" homes), home addition, garage, or swimming pool on residential property. This permit combines the applicable building permit(s) according to Section 500.040 and land disturbance permits according to Section 420.070. Fees for a Residential Development Permit are described in Appendix B to Title IV – Community Development and Public Works Fee Schedule.

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STORMWATER DETENTION: A stormwater runoff facility designed to detain (hold) stormwater temporarily during and immediately after a runoff event.

STORMWATER MANAGEMENT PLAN: Study and design for a stormwater conveyance system, a downstream evaluation system, detention requirements, floodplain/floodway, sink hole and regulating permitting requirements.

STORMWATER SEWER: A sewer which carries surface runoff and subsurface waters.

SWALE: A broad, shallow watercourse.

TIME OF CONCENTRATION: Consists of inlet time plus the travel time in the sewer or channel from the most remote point in the watershed to the point under consideration.

TRAVEL TIME: The time it takes for the runoff to flow through the drainage system from one point of reference to the next point of reference.

U.S.G.S.: United States Geological Survey

WATERCOURSE: A stream of water or a natural channel through which water may flow.

City of Creve Coeur, MO
Monday, June 5, 2017

Chapter 425. Stormwater Regulations

Section 425.010. Purpose and Intent.

[R.O. 2008 §24-30.1; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

- A. This Section seeks to provide those standards, criteria, procedures and controls necessary to minimize the harmful physical and economic effects of flooding from stormwater within the City of Creve Coeur (City). This is to be accomplished through the requirements of special measures through a development agreement to mitigate through detention and controlled discharge of the differential runoff from any property whereon any grading, excavation, filling or other disturbance of the natural vegetation or any construction, erection or alteration of a building or structure is to be undertaken. Erosion control will be handled by separate ordinance.
- B. This Chapter is adapted from the MSD ordinance dated February, 1997, Rules and Regulations and Engineering Design Requirements for Sanitary Sewage and Stormwater Drainage Facilities. Non-applicable Sections have been deleted and minor modifications have been made to comply with the City of Creve Coeur's policies and requirements. This Chapter may need to be revised in the event that MSD may change their ordinance.

Section 425.020. Submission, Review and Approval of Plans and Specifications.

[R.O. 2008 §24-30.2; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

- A. *Requirements For Building Or Grading Permit.* No permit shall be issued to construct, erect or alter any building or structure or to clear, grade, excavate, fill, remove topsoil from or change the contour of any property within the City until a stormwater management plan has been submitted and approved in accordance with the provisions of this Chapter, except as provided in Section **425.050** Exceptions, below.
- B. *Review Process.* Designs, plans and specifications of all drainage works proposed to be constructed, connected to, altered or reconstructed by any person or corporation, private or public, within the City boundaries shall be submitted to the City and MSD for review, revision, approval or rejection. The design engineer shall meet with City staff before starting stormwater facilities design to review the development agreement. Then the stormwater management plan must be reviewed with City staff before submittal to MSD. Such designs, plans and specifications (excluding house connections, curb cuts, etc.) shall be prepared and sealed by a professional engineer registered in the State of Missouri and shall meet the minimum standards of the City, the St. Louis Metropolitan Sewer District (MSD) and the Missouri Department of Natural Resources before approval is granted.
- C. *Procedure.*
 - 1. *Preliminary conferences.* At any time prior to formal submission of project plans, the owner's engineer shall arrange for a preliminary conference to obtain informal guidance in project plan preparation with the City. Preliminary conferences are required, especially in unique or unusual situations, to expedite the subsequent formal review and approval process. This includes review of the downstream areas jointly by the City and the developer's engineer with photographs.
 - 2. *Application.* Application for an approved stormwater management plan, as required, shall be submitted to the Director of Public Works by the owner of the land prior to the time any work subject to this Chapter

- is begun on the land. Said plans must accompany any such application, parts of which may also be on forms prepared by the City.
3. *Approval process.* Upon receipt of any application and plan, the Director of Public Works shall consider the plan in light of the provisions of this Chapter and shall approve the plan, disapprove the plan or approve the plan with modifications, noting thereon any changes that will be required.
 4. *Notification.* The City shall promptly notify the applicant of the City's decision on a plan. Failure of the Director of Public Works to act on any plan within seventy-five (75) days after it has been properly filed should be deemed to constitute approval of the plan. Any approved plan shall be issued, dated and bear the manual signature of the Director of Public Works.
 5. *Site development plan approval.* A stormwater management plan may, as required, be included in and made part of an application for site development plan approval in accordance with Section **405.1080** or of an application for approval of improvement plans for a subdivision in accordance with Chapter **410** of the Creve Coeur subdivision regulations.
- D. *Submission Requirements.* In order to facilitate review of plans, all projects shall be submitted with a letter of transmittal which shall include the name of the project, name and address of owner or developer; name, address, telephone number and seal of the professional engineer licensed in the State of Missouri; and clarification as to the purpose of submittal.
- E. *Downstream Conveyance System.* The downstream conveyance system where the connection is receiving the proposed development's runoff is required to be evaluated to determine if acceptable to receive the proposed development's runoff. The evaluation has to continue until the proposed development's runoff is less than ten percent (10%) of the downstream conveyance system. The Director of Public Works can request additional studies further downstream if a stormwater problem is anticipated.
- F. *Corrective Action.* If a development during or after construction adversely affects downstream property, corrective action will be required by the developer and/or landowner as determined by the Director of Public Works. The development shall make the required study and repairs during construction or after completion of the proposed development according to the development agreement if the stormwater-related problems downstream of the development can be demonstrated to be caused by the development.
- G. *Stormwater Fund Contributions.* Any developer which is not required to provide detention by MSD may be required to contribute to the City's stormwater fund for detention or downstream improvements, at the discretion of the Director of Public Works, in lieu of being required to make the on-site or downstream improvements if the proposed development is a contributor to the downstream conveyance system. The detention will need to be designed for the total watershed. The developer may be required to participate on the percentage of his/her development with the applicable watershed or subwatershed. This will be part of a City-wide stormwater district established by the City.
- H. *Time Of Validity.*
1. Any approved stormwater management plan, unless construction has started or is continuing, shall become null and void one hundred eighty (180) days after the date of approval and no further work subject to this Chapter shall be allowed unless and until additional or updated plans have been submitted and approved in accordance with the provisions of this Chapter or unless all requirements of the approved control plans have been completed in less than one hundred eighty (180) days in accordance with said plans and verified by an on-site inspection by the Director of Public Works.
 2. When no change in conditions has occurred since the date of approval for the one hundred eighty (180) days, an updated plan shall be approved in accordance with the provisions of this Chapter with the requirements in effect at the time of resubmission.

Section 425.030. Required Submittals By The Design Engineer.

[R.O. 2008 §24-30.3; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

- A. Refer to MSD's information sheet, MSD's stormwater submittal form for full details of information to be submitted. Plan review may be delayed if all required information is not provided by the applicant. To facilitate the review of plans before approval for construction, the design engineer shall submit with the plans a stormwater management plan containing all necessary data, maps, computations and checklists as defined below in support of the designs and plans. The following list of requested information is a minimum and may be supplemented by any additional information which the design engineer considers to be helpful in the review process.

1. *General.* The submittal of all project information for all stormwater drainage projects shall be verified by the checklists provided herein. It shall be the responsibility of the submitting design engineer to see that all applicable information listed on the checklists is provided to the City. This includes the design information as well as information on the plans and specifications. Two (2) copies of the stormwater management plan with the checklist shall be submitted with the design information, plans, specifications.
 - a. *Storm drainage projects.* All storm drainage project submittals should include Checklist No. 2 and Checklist No. 3.
For any checklist item not pertinent to the specific project being submitted for review, the submitting (design) engineer shall insert the letters "N.A" for not applicable.
 - b. *Project review information form.* This form is required on all project submittals.
 - c. *Storm sewers design data, maps and computations.*
See Checklist No. 2.
 - d. *Storm sewer contract drawings.*
See Checklist No. 3.
 - e. *Components of the stormwater management plan.*
 - (1) Downstream system evaluation results and recommendations;
 - (2) Project's on-site storm drainage system's design;
 - (3) Stormwater detention requirements and supporting calculations and design properties;
 - (4) Floodplain and floodway analysis and report;
 - (5) Sinkhole analysis and report;
 - (6) Regulatory permitting requirements and methods to address these issues. Permits pertaining to stormwater may include, but are not limited to:
 - (a) (National Flood Insurance Program.) The National Flood Insurance Program (NFIP) 44 CFR Parts 50 — 77;
 - (b) (Wetlands and Waters Information.) Sections 401 and 404 of the Clean Water Act (CWA) as pertaining to wetlands and waters of the United States;
 - (c) (NPDES Information.) Section 402 of the Clean Water Act (CWA) for Phase I and II of the National Pollutant Discharge Elimination System (NPDES) when they take effect;
 - (d) (Dam Construction Rules, Regulations.) Rules and regulations of the Missouri Dam and Reservoir Safety Council for dam construction;
 - (e) *Maintenance requirements.* The following list of requested information is a minimum and may be supplemented by any additional information which the design engineer considers to be helpful in the review process.
2. The following information shall be provided, as applicable:
 - a. Engineer's name, mailing address, telephone number, fax number, e-mail address and contact name.

- b. Owner and/or developer's name, mailing address, telephone number, fax number, e-mail address and contact name.
 - c. Accurate location of property relative to an intersection.
 - d. "Wunnenberg's" page and grid number for the project, the MSD base map number, the St. Louis County locator number for the property and the property address.
 - e. Narrative of the project's scope, existing and proposed features and a description of intent to address the major components of the stormwater management plan.
 - f. Total acreage of property and impervious acres if other than residential. Drainage area upstream of the project and downstream to a point where the projects contribution is less than ten percent (10%) of the total watersheds area.
 - g. Existing and proposed land uses of the project and the upstream drainage area, i.e., commercial, residential, etc.
 - h. The MSD "P" number shall be used in all subsequent correspondence concerning the project and shall be utilized as soon as possible after issued.
 - i. If the submittal is a revision or addendum to a previous project, the previous project shall be properly identified and the particulars of the revision or addendum shall be described.
3. *Number of copies of plans and supporting data to be submitted.* Plans shall be complete and a minimum of three (3) sets of plans and two (2) sets of the stormwater hydraulic calculations will be required.
Floodplain. Submit three (3) additional sets of plans and a total of three (3) sets of the floodplain report.
Detention. Submit one (1) additional set of plans and a total of three (3) sets of the detention calculations.
Pump Station. Submit three (3) additional sets of plans and a total of four (4) copies of the pump station report and specifications.
4. Submit electronic file compatible with City's system and one (1) mylar copy of as-builts sealed by a professional engineer registered in the State of Missouri.
5. The owner shall be responsible for notifying the City for the final release one (1) year later and provide all items required to obtain final approval and release of final escrows. This includes a final as-built of the detention basin to verify the actual capacity of the detention basin.
- B. *Subdivisions.* For projects within a proposed subdivision, a subdivision plat shall be provided substantially ready for filing, adequately dimensioned and located from well-established points and lines to permit accurate platting on record maps. The design engineer shall provide a statement concerning the established zoning requirements of the City together with any other pertinent information.
- C. *Projects Normally Requiring A Sewer Connection — Permit Only.* Plans for connections to existing storm sewers for commercial, industrial, public or private non-residential projects, for parking areas and for multiple-dwelling projects with paved areas shall show thereon:
- 1. Location, type, size and elevations of the existing storm sewer to which connection for the project is to be made.
 - 2. The location, size and elevations of proposed storm drainage facilities.
 - 3. Existing and proposed grade elevations with limits and direction of stormwater flows tributary to drainage facilities within the property.
 - 4. Private storm sewers requiring permits from the City will require project approval by the City prior to submittal of permit application to MSD.
 - 5. Identify the public and private pipe reaches.
- D. *Return Of Plans Without Review.* Plans lacking the required information or those that are difficult to read or interpret due to poor drafting, poor arrangement or poor writing will be returned without review for

correction, additional information or redrafting as may be required.

- E. *Return Of Plans For Revision.* On completion of the review, one (1) set of plans or a letter with comments with requested revisions and notations will be returned to the design engineer for revision to the original submission. The assigned MSD "P" number and base map number shall be shown in or near the title block upon resubmittal of the plans. Additional sets of plans for further review or final approval will then be submitted to the City.
- F. *Failure To Revise Or Correct Plans Promptly.* Plans returned to the owner's engineer for revision, correction or additional information shall be modified and returned to the City within ninety (90) days for final approval or the project will be considered abandoned. Further review will be continued only upon resubmittal as a new project, complete with all necessary data, submittal fee, review fee, etc.
- G. *Fees For Review And Permitting.* See Appendix B to Title IV — Community Development and Public Works Fee Schedule for fees required for plan submittal and approval.

Section 425.040. Construction Drawing Plan Requirements.

[R.O. 2008 §24-30.4; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

- A. *Drawing Sizes.* Plan sizes shall be uniform for each set. Where practical, plan and profile sheets twenty-four (24) inches by thirty-six (36) inches are preferred. When the sheet size is considerably smaller than twenty-four (24) inches by thirty-six (36) inches, a size eleven (11) inches by seventeen (17) inches is preferred for filing convenience. White line prints on blue background will not be approved. Good drafting practice, either manual or automated, at a suitable scale to facilitate the plan review and field construction shall be followed. The scale for a residential subdivision shall be a minimum of fifty (50) feet to the inch.
- B. Plans submitted shall include:
 1. Location of the project with respect to arterial roads, local streets or subdivisions.
 2. Key map of the entire project to scale showing easements, sewer lines and facilities, both existing and proposed to be constructed.
 3. Recorder of Deeds book and page from St. Louis County for existing recorded easements when not part of a recorded subdivision plat.
 4. Plans and profiles of each sewer line, channel or retaining wall showing location, size, flowline elevations, design flows for all segments, construction gradients, hydraulic grade lines, materials, proposed and original ground lines, boring information and rock elevations along the proposed sewer line, location, depths and sizes of adjacent or crossing sewer lines and utilities and special construction requirements such as a concrete cradle or encasement, type of backfill, strength class of pipe, etc.
 5. All elevations shall be based upon U.S.G.S. or FEMA or (FIRM) datum with location of the bench mark indicated on the plans. Acceptable bench marks include those established by the MSD, St. Louis County Department of Highways and Traffic, Missouri Department of Transportation or City of Creve Coeur. The elevations shall also include the centerline of the road adjacent to the proposed development at the property lines and at the center of the lot/development. All two (2) foot contours within one hundred fifty (150) feet of the proposed development property lines shall also be required.
 6. Profiles and typical cross sections of existing and proposed swales, ditches or channels.
 7. Details of special structures, channel improvements, culverts, transitions, headwalls, aprons and junction chambers, all adequately detailed and dimensioned including placement of steel in reinforced concrete structures. Unless otherwise indicated, standard MSD structures are assumed to be utilized.
 8. A drainage area map (refer to Section **425.060(A)(1)**) showing original and proposed topography with drainage areas identified.
 9. A subdivision plat, dimensioned and substantially complete and ready for filing.

10. The location of all utilities anticipated to be encountered during construction shall be shown. Plans must be submitted to all utility companies for verification of conflicts. Storm and sanitary sewers shall be located to comply with State laws and regulations governing such placement.
11. Drawing of all existing and proposed easements and rights-of-way.

Section 425.050. Exceptions.

[R.O. 2008 §24-30.5; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

A. The provisions of this Section shall not apply to:

1. Any reconstruction, repair or alteration of any existing building or structure when no land, trees, shrubs, grass or other vegetation is to be disturbed, destroyed or removed.
2. Any existing undeveloped property of less than one-quarter ($\frac{1}{4}$) acre not to include newly subdivided lots zoned in an "A", "B", "C" or "D" or "RA" single-family residential district.
3. The clearing, grading, excavation, filling, removing topsoil from or changing the contour of less than twenty-five hundred (2,500) square feet of land and less than three (3) feet of elevation.
4. The planting, trimming, pruning or removal of trees, shrubs, grass, weeds, vegetation, ground cover or other plant material in accordance with the concept landscape plan of approved site development plan in accordance with Section **405.1080** or when such actions are incidental to and part of the normal maintenance of land and property in the City of Creve Coeur.
5. In considering the applicability of these exceptions, the effective acreage for a project, development or subdivision is not limited to a fractional part of the total concept. Rather, if a project is developed in phases or small plats, the total acreage of the project, development or subdivision will be considered. Furthermore, projects of less acreage than provided for in this Chapter shall also provide detention/retention if in the judgment of the Public Works Director conditions in the receiving system are inadequate or harmful effects can be anticipated if detention/retention is not implemented. Also the Public Works Director has the discretion to require for any building permit, a grading, a siltation control plan and/or a stormwater management plan.

Section 425.060. Design Standards For Stormwater Projects.

[R.O. 2008 §24-30.6; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

A. *Storm Drainage Design Data, Maps And Computations.*

1. *General criteria.* The project drainage area map or maps shall accurately show the watershed boundary lines and areas tributary to each inlet, sewer and channel section. The established elevations, gradients and contours of the finished graded surfaces and streets shall be shown in support of the inlet drainage area lines and indicated directions of flow. The information shown shall be the same as given on a development plat usually required by financing agencies, which shows the project, the dwellings, streets, walks, finish grades at corners of the buildings, finish contours, street elevations and gradients, inlet, sewer and utility locations. Sufficient information showing locations, elevations, cross sections of downstream watercourses, channels, sewers, culverts, structures and adjoining land shall be provided to determine the effects of the stormwater discharge and the possible needs for special easement requirements and/or downstream drainage modifications or protection.
2. *Basic design data to include:*
 - a. Rainfall frequency.
 - b. Tributary area in acres with percentage of imperviousness.
 - c. Runoff factor(s) used.

B. *Design Requirements For Storm Drainage Facilities.*

1. *General.* Stormwater sewers or channels provide the facility for removing and transporting surface runoff produced from rainfall.
This Section gives the minimum technical design requirements of the City storm drainage facilities. In general, the formulae presented herein for hydraulic design represent "acceptable" procedures not necessarily to the exclusion of other sound and technically supportive formulae. Any departure from these design requirements should be discussed before submission of plans for approval and should be justified. All construction details pertaining to storm sewer improvements shall be prepared in accordance with the MSD Standard Construction Specifications unless otherwise noted.
2. *General requirements of storm sewer construction.* All storm sewers shall meet the following general requirements:
 - a. *Size and shape.* The minimum diameter of pipes for stormwater sewers shall be twelve (12) inches. Sewers shall not decrease in size in the direction of the flow unless approved by the Director of Public Works. Circular pipe sewers are preferred for stormwater sewers, although rectangular or elliptical conduits may be used with special permission.
 - b. *Materials.* All materials shall conform to MSD standard construction specifications. Reinforced concrete pipe joints shall be Type "A" or better, as required.
 - c. *Bedding.*
 - (1) The project plans and specifications shall indicate the specific type or types of bedding, cradling or encasement required in the various parts of the storm sewer construction if different than current MSD standard construction specifications.
 - (2) Special provisions shall be made for pipes laid within fills or embankments and/or in shallow or partial trenches, either by specifying extra-strength pipe for the additional loads due to differential settlement or by special construction methods including ninety percent (90%) modified Proctor compaction (ASTM D-1557) of fill to prevent or to minimize such additional loads.
 - (3) Compacted granular backfill or controlled low strength material (CLSM) as approved by the Director of Public Works shall be required in all trench excavation within public (or private) streets rights-of-way or areas where street rights-of-way are anticipated to be dedicated for public use. Under areas to be paved, the compacted granular backfill shall be placed to the subgrade of the pavement. Under unpaved areas, the compacted granular backfill shall be placed to within two (2) feet of the finished surface.
 - (4) Pipes having a cover of less than three (3) feet shall be encased in concrete, unless otherwise directed by the City and the District.
 - (5) If the storm and sanitary sewers are parallel and in the same trench, the upper pipe shall be placed on a shelf and the lower pipe shall be bedded in compacted granular fill to the flow line of the upper pipe.
 - d. *Concrete pipe or conduit strengths.*
 - (1) Reinforced concrete pipe shall be Class II, minimum.
 - (2) Any concrete pipe, conduit or culvert beneath a street right-of-way or with reasonable probability of being so located shall be a minimum of Class III, but also shall account for all vertical loads including the live load required by the highway authority having jurisdiction. In no case shall the design provide for less than HS-20 loading of the AASHTO.
 - e. *Monolithic structures.* Monolithic reinforced concrete structures shall be designed structurally as continuous rigid units.

- f. *Alignment.* Sewer alignments are normally limited by the available easements which in turn should reflect proper alignment requirements. Since changes in alignment affect certain hydraulic losses, care in selecting possible alignments can minimize such losses and use available head to the best advantage. Sewers shall be aligned:
- (1) To be in a straight line between structures, such as manholes, inlets, inlet manholes and junction chambers, for all pipe sewers thirty (30) inches in diameter and smaller.
 - (2) To be parallel with or perpendicular to the centerlines of straight streets unless otherwise unavoidable. Deviations may be made only with approval of the City and the District.
 - (3) To avoid meandering, off-setting and unnecessary angular changes.
 - (4) To make angular changes in alignment for sewers thirty (30) inches in diameter or smaller in a manhole located at the angle point and for sewers thirty-three (33) inches in diameter or larger, by a uniform curve between two (2) tangents. Curves shall have a minimum radius of ten (10) times the pipe diameter.
 - (5) To avoid angular changes in direction greater than necessary and any exceeding ninety degrees (90°).
- g. *Location.* Storm sewer locations are determined primarily by the requirements of service and purpose. It is also necessary to consider accessibility for construction and maintenance, site availability and competing uses and effects of easements on private property. Storm sewers shall be located:
- (1) To serve all property conveniently and to best advantage.
 - (2) In public streets, roads, alleys, rights-of-way or in sewer easements dedicated to MSD.
 - (3) On private property along property lines or immediately adjacent to public streets, avoiding diagonal crossings through the central areas of the property.
 - (4) At a sufficient distance from existing and proposed buildings (including footings) and underground utilities or other sewers to avoid encroachments and reduce construction hazards.
 - (5) To avoid interference between other stormwater sewers and house connections to foulwater or sanitary sewers.
 - (6) In unpaved or unimproved areas whenever possible.
 - (7) To avoid, whenever possible, any locations known to be or probably to be beneath curbs, paving or other improvements particularly when laid parallel to centerlines.
 - (8) To avoid sinkhole areas if possible. However, if sinkhole areas cannot be avoided, see Subparagraph (h) for requirements.
 - (9) Crossing perpendicular to street, unless otherwise unavoidable.
- h. *Sinkhole areas.*
- (1) *Sinkhole report.* Where improvements are proposed in any areas identified as sinkhole areas, a sinkhole report will be required. This report is to be prepared by a professional engineer, registered in the State of Missouri, with demonstrated expertise in geotechnical engineering and shall bear his/her seal and signature.
The sinkhole report shall verify the adaptability of grading and improvements with the soil and geologic conditions available in the sinkhole areas. Sinkhole(s) shall be inspected to determine its functional capabilities with regard to handling drainage.
The report shall contain provisions for the sinkholes to be utilized as follows:

- (a) All sinkhole crevices shall be located on the plan. Functioning sinkholes may be utilized as a point of drainage discharge by a standard drainage structure with a properly sized outfall pipe provided to an adequate natural discharge point, such as a ditch, creek, river, etc.
- (b) Non-functioning sinkholes and sinkholes under a proposed building may be capped.
- (c) If development affects sinkholes, they may be left in their natural state, however, they will still require a properly sized outfall pipe to an adequate natural discharge point.
- (d) An overland flow path shall be required for all sinkholes assuming the outfall pipe and sinkhole become blocked.
- (e) Where the topography will not allow for an overland flow path:
 - (i) The storm sewer shall be designed for the 100-year, 20-minute storm; and
 - (ii) If this storm pipe is smaller than thirty-six (36) inches in diameter, a designated ponding area shall be identified, assuming the pipe is blocked; and
 - (iii) The ponding area shall be based on the 100-year, 24-hour storm; and
 - (iv) The low sill of all structures adjacent to the ponding area shall be above the 100-year high water elevation.
 - (v) Special siltation measures shall be installed during the excavation of sinkholes and during the grading operations to prevent siltation of the sinkhole crevice.

(2) *Procedure for utilization of sinkholes.*

- (a) *Excavation.* Prior to filling operations in the vicinity of a sinkhole, the earth in the bottom of the depression will be excavated to expose the fissure(s) in the bedrock. The length of fissure exposed will vary, but must include all unfilled voids or fissure widths greater than one-half ($\frac{1}{2}$) inch maximum dimensions which are not filled with plastic clay.
- (b) *Closing fissures.* The fissure or void will be exposed until bedrock in its natural attitude is encountered. The rock will be cleaned of loose material and the fissures will be hand packed with quarry-run rock of sufficient size to prevent entry of this rock into the fissures and all the voids between this hand-packed quarry-run rock filled with smaller rock so as to prevent the overlying material's entry into the fissures. For a large opening, a structural (concrete) dome will be constructed with vents to permit the flow of ground water.
- (c) *Placing filter material.* Material of various gradations, as approved, will be placed on top of the hand-packed rock with careful attention paid to the minimum thicknesses. The filter material must permit either upward or downward flow without loss of the overlying material.
The fill placed over the granular filter may include granular material consisting of clean (no screenings) crushed limestone with ten (10) inch maximum size and one (1) inch minimum size or an earth fill compacted to a minimum density of ninety percent (90%) modified Proctor as determined by ASTM D-1557.
- (d) *Supervision.* Periodic supervision of the cleaning of the rock fissures must be furnished by the engineer who prepared the soil report. Closing of the rock fissures will not begin until the cleaning has been inspected and approved by that engineer.
During the placement and compaction of earth fill over the filter, supervision by the engineer shall be continuous. Earth fill densities will be determined during the placement and compaction of the fill in sufficient number to ensure compliance with the specification. The engineer is responsible for the quality of the work and to verify that the specifications are met.

- i. *Flowline.* The flowline of storm sewers shall meet the following requirements:

- (1) The flowline shall be straight or without gradient change between the inner walls of connected structures; that is, from manhole to manhole, manhole to junction chamber, inlet to manhole or inlet to inlet.
 - (2) Gradient changes in successive reaches normally shall be consistent and regular. Gradient designations less than the nearest one one-thousandth (0.001) foot per foot, except under special circumstances and for larger sewers, shall be avoided.
 - (3) Sewer depths shall be determined primarily by the requirements of pipe or conduit size, utility obstructions, required connections, future extensions and adequate cover.
 - (4) Stormwater pipes discharging into lakes shall have the discharge flowline a minimum of three (3) feet above the lake bottom at the discharge point or no higher than the normal water line.
 - (5) A concrete cradle is required when the grade of a sewer is twenty percent (20%) or greater. A special design and specification is required for grades exceeding fifty percent (50%).
 - (6) For sewers with a design grade less than one percent (1%), field verification of the sewer grade will be required for each installed reach of sewer, prior to any surface restoration or installation of any surface improvements.
 - (7) The District may require the submittal of revised hydraulic calculations for any sewer reach having an as-built grade flatter than the design grade by more than one-tenth percent (0.1%). Based on a review of this hydraulic information, the District may require the removal and replacement of any portion of the sewer required to ensure sufficient hydraulic capacity of the system.
- j. *Manholes.* Manholes provide access to sewers for purposes of inspection, maintenance and repair. They also serve as junction structures for lines and as entry points for flow. Requirements of sewer maintenance determine the main characteristics of manholes.
- (1) For sewers thirty (30) inches in diameter or smaller, manholes shall be located at changes in direction; changes in size of pipe; changes in flowline gradient of pipes and at junction points with sewers and inlet lines.
For sewers thirty-three (33) inches in diameter and larger, manholes shall be located on special structures at junction points with other sewers and at changes of size, alignment change and gradient. A manhole shall be located at one (1) end of a short curve and at each end of a long curve.
 - (2) Spacing of manholes shall not exceed four hundred (400) feet for pipe sewers thirty-six (36) inches in diameter and smaller; five hundred (500) feet for pipe sewers forty-two (42) inches in diameter and larger, except under special approved conditions. Spacing shall be approximately equal, whenever possible.
 - (3) When large volumes of stormwater are permitted to drop into a manhole from lines twenty-one (21) inches or larger, the manhole bottom and walls below the top of such lines shall be of reinforced concrete.
 - (4) Manholes shall be avoided in driveways or sidewalks.
 - (5) Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.
 - (6) When a project requires a manhole to be adjusted to grade a maximum of twelve (12) inches of rise is allowed if not previously adjusted. When adjustments to raise or lower a manhole is required, the method of adjustment must be stated on the project plans and approved by the District.
- k. *Overflow/design system.* The "design" components of the drainage system include the inlets, pipe, storm sewers and improved and unimproved channels that function during typical rainfall events.

The "overflow" system comprises the major overflow routes such as swales, streets, floodplains, detention basins and natural overflow and ponding areas.

The purpose of the overflow system is to provide a drainage path to safely pass flows which cannot be accommodated by the design system without causing flooding of adjacent structures.

The criteria for the design of the overflow and design systems shall be as follows:

- (1) The "design" system shall be designed in accordance with Subsection (3) below.
- (2) The "overflow" system shall be designed for the 100-year, 20-minute event, assuming the "design" system is blocked. The capacity of the "overflow" system shall be verified with hydraulic calculations at critical cross sections. The "overflow" system shall be directed to the detention facility or as approved by the District.
- (3) The low floor of all structures adjacent to the "overflow" system swales shall be one (1) foot above the 100-year high-water elevation.
- (4) Where the topography will not allow for an overland flow path:
 - (a) The storm sewer shall be designed for the 100-year, 20-minute storm; and
 - (b) If this storm pipe is smaller than thirty-six (36) inches in diameter, a designated ponding area shall be identified, assuming the pipe is blocked; and
 - (c) The ponding area shall be based on the 100-year, 24-hour storm; and
 - (d) The low sill of all structures adjacent to the ponding area shall be above the 100-year high-water elevation.
- (5) The "overflow" system shall be designated on the drainage area map and on the grading plan.
- (6) All overflow systems will be considered on a site-specific basis.
- (7) The stormwater design for projects within such designated future stormwater districts in the City of Creve Coeur may involve additional requirements.

3. *Stormwater design criteria.*

- a. *Flow quantities.* Flow quantities are to be calculated by the "Rational Method" in which:

$$Q = API$$

where:

$$Q = \text{Runoff in cubic feet per second}$$

$$A = \text{Tributary area in acres}$$

$$I = \text{Average intensity of rainfall (inches per hour) for a given period and a given frequency}$$

$$P = \text{Runoff factor based on runoff from pervious and impervious surfaces}$$

P (Runoff Factors) for various impervious conditions are shown in Table 4-1.

P.I. values for various impervious conditions are shown in Tables 4-2 to 4-4.

- (1) *Rainfall frequency.* In the design of local storm sewer systems, a twenty (20) minute time of concentration shall be used. Figure 4-1 gives rainfall curves for 2-, 5-, 10-, 15-, 20-, 25- and 100-year frequencies.
- (2) *Impervious percentages and land use.* Minimum impervious percentages to be used are as follows or the actual percentage of coverage:
 - (a) For manufacturing and industrial areas, one hundred percent (100%)*.

- (b) For business and commercial areas, one hundred percent (100%)*.
- (c) For residential areas including all areas for roofs of dwellings and garages; for driveways, streets and paved areas; for public and private sidewalks; with adequate allowance in area for expected or contingent increases in imperviousness:
In apartment, condominium and multiple dwelling areas: seventy-five percent (75%)*.
In single-family areas:

¼ acre or less	50%
¼ acre to ½ acre	40%
½ acre to 1 acre	35%
1 acre or larger	30%
Playgrounds (non-paved)	20% — 35%*

- (d) For small, non-perpetual charter cemeteries, for parks and large perpetual charter cemeteries: five percent (5%).

* NOTE: Drainage areas may be broken into component areas, with the appropriate runoff factor applied to each component, i.e., a proposed development may show one hundred percent (100%) impervious for paved areas and five percent (5%) impervious for grassed areas.

The design engineer shall provide adequate detailed computations for any proposed, expected or contingent increases in imperviousness and shall make adequate allowances for changes in zoning use. If consideration is to be given to any other value than the above for such development, the request must be made at the beginning of the project, must be reasonable, fully supported and adequately presented and must be approved in writing before its use is permitted.

Runoff design for undeveloped areas shall be designed in accordance with the current land use plan.

Although areas generally will be developed in accordance with current zoning requirements, recognition must be given to the fact that zoning ordinances can be amended to change the currently proposed types of development and any existing use. Under these circumstances the possibility and the probability of residential areas having lot sizes changed or rezoned to business, commercial or light manufacturing uses should be given careful consideration.

- (e) Average 20-minute values of P.I. (cfs per acre) to be used are as follows:

Percent Imperviousness	20-Minute Duration				
	15-year	20-year	25-year	50-year	100-year
5	1.7	1.8	2.0	2.2	2.4
10	1.8	1.9	2.1	2.3	2.5
20	2.0	2.1	2.4	2.6	2.8
30	2.2	2.3	2.6	2.8	3.0
40	2.4	2.5	2.8	3.1	3.3
50	2.6	2.7	3.0	3.3	3.6
90	3.4	3.5	3.9	4.3	4.7
100	3.5	3.7	4.2	4.5	4.9

* Roofs 4.2

* For direct connection to storm sewer

- (3) *Reduction in P.I. with time and area.* Reduction in P.I. values for the total time of concentration exceeding twenty (20) minutes and for tributary areas exceeding three hundred (300) acres will be allowed only in trunk sewers and main channels. The reduced average P.I. value for the tributary area shall not be less than the value determined as follows on the basis of:

- (a) *Time.* As the time of concentration increases beyond twenty (20) minutes, select the appropriate P.I. value from Table 4-1. The travel time through a drainage channel should be based on an improved concrete section. These reduced values shall be used unless a further reduction is allowed for the area.
- (b) *Area.* As the total tributary area at any given location in a channel increases in excess of three hundred (300) acres, the P.I. value may be further reduced by multiplying it by an area coefficient "Ka". (The area coefficient is obtained from data in a special study of a major storm in the St. Louis area by the U.S. Army Corps of Engineers. The average rainfall rate, for a given storm, for a given period for the tributary area, is less than the corresponding point value as determined from recording rainfall gauges. The curve data is as follows:

P.I. Coefficients Ka Area (Abscissas)	"Ka" (Ordinates)
300 — 449 acres	1.00
450 — 549 acres	.99
550 — 749 acres	.98
750 — 999 acres	.97
1,000 — 1,280 acres	.96
1,281 — 1,600 acres	.95
1,601 — 1,920 acres	.92
1,921 — 2,240 acres	.91

4. *Hydraulic grade line for closed conduits.*

- a. *Computation methods.* The hydraulic grade line is a line coinciding with (a) the level of flowing water at any given point along an open channel, or (b) the level to which water would rise in a vertical tube connected to any point along a pipe or closed conduit flowing under pressure. The hydraulic grade line shall be computed to show its elevation at all structures and junction points of flow in pipes, conduits and open channels and shall provide for the losses and the differences in elevations as required below. Since it is based on design flow in a given size of pipe or conduit or channel, it is of importance in determining minimum sizes of pipes within narrow limits. Sizes larger than the required minimum generally provide extra capacity, however consideration still must be given to the respective pipe system losses. There are several methods of calculating "losses" in storm sewer design. The following procedures are presented for the design engineer's information and consideration. It is expected that the design will recognize the reality of such "losses" occurring and make such allowances as good engineering judgment requires.

- (1) *Friction loss.* The hydraulic grade line is affected by friction loss and by velocity head transformations and losses. Friction loss is the head required to maintain the necessary flow in a straight alignment against frictional resistance because of pipe or channel roughness. It is determined by the equation.

$$h_f = L \times S_h$$

Where:

$$h_f = \text{difference in water surface elevation or head in feet in length } L$$

$$L = \text{length in feet of pipe or channel}$$

$$S_h = \text{hydraulic slope required for a pipe of given diameter or channel of given cross section and for a given roughness "n", expressed as feet of slope per foot of length}$$

From Manning's formula: $S_h = C (V n / (1.486 R^{0.667}))^2$

Where:

$$R = \text{hydraulic radius of pipe, conduit or channel (feet) (ratio of flow area/wetted perimeter)}$$

V = velocity of flow in feet per second (fps)
 n = Manning's value for coefficient of roughness

Use:

n = .013 for pipes of concrete, vitrified clay and PVC pipe
 n = .012 for formed monolithic concrete, i.e., vertical wall channels, box culverts and for R.C.P. over forty-eight (48) inches in diameter
 n = .015 for concrete lining in ditch or channel inverts and trapezoidal channels
 n = .020 for grouted riprap lining on ditch or channel side slopes
 n = .033 for gabion walled channels

Note:

"n" will have a weighted value for composite lined channels.

"n" values for unlined channels to be determined on an individual basis.

- (2) *Curve loss.* Curve loss in pipe flow is the additional head required to maintain the required flow because of curved alignment and is in addition to the friction loss of an equal length of straight alignment. It should be determined from Figure 4-2 which includes an example.
- (3) *Entrance loss at terminal inlets.* Entrance loss is the additional head required to maintain the required flow because of resistance at the entrance. The entrance loss at a terminal inlet is calculated by the formula:

$$H_{ti} = (V^2/2g)$$

Where:

V = Velocity in flow of outgoing pipe
 g = Acceleration of gravity (32.2ft/sec/sec)

- (4) *Turn loss.* Head losses in structures due to change in direction of flow (turns) in a structure will be determined in accordance with the following:

Change in Direction of Flow (A)	Multiplier of Velocity Head of Water Being Turned (K)
90°	0.7
60°	0.55
45°	0.47
30°	0.35
15°	0.18
0°	0.0
Other angles	By interpolation

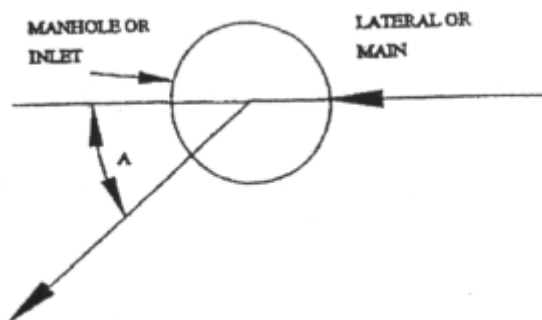


Diagram 1

$$\text{Formula: } H_t = K(V_1)^2/2g$$

Where:

H_1	=	Feet of head lost in manhole due to change in lateral flow
V_1	=	Velocity of flow in lateral in ft/sec
g	=	Acceleration of gravity (32.2 ft/sec/sec)
K	=	Multiplier of velocity head of water being turned

- (5) *Junction chamber loss.* A sewer junction occurs for large pipes or conduits too large to be brought together in the usual forty-two (42) inch diameter manhole or inlet where one (1) or more branch sewers enter a main sewer. Allowances should be made for head loss due to curvature of the paths and due to impact at the converging streams.

Losses in a junction chamber for combining large flows shall be minimized by setting flowline elevations so that pipe centerlines (springlines) will be approximately in the same planes.

At junction points for combining large storm flows, a manhole with a slotted cover shall be provided.

A computation method for determining junction chamber losses is presented below:

$$H_j = \Delta y + V_{h1} - V_{h2}$$

Where:

H_j = **junction chamber loss (ft.)**

V_{h1} = **upstream velocity head**

V_{h2} = **downstream velocity head**

Δy = change in hydraulic grade line through the junction in feet

Where:

$$\Delta y = \frac{[(Q_2 V_2) - (Q_1 V_1) + \{(Q_3 V_3 \cos E_3) + (Q_n V_n \cos E_n)\}]}{0.5(A_1 + A_2)g}$$

Where:

Q_2 = Discharge in cubic feet per second (cfs) at the exiting conduit

V_2 = Velocity in feet per second (fps) at the exiting conduit

A_2 = Cross-sectional area of flow in square feet for the exiting conduit

Q_1 = Discharge in cfs for the incoming pipe (main flow)

V_1 = Velocity in fps for the incoming pipe (main flow)

A_1 = Cross-sectional area of flow in square feet for the incoming pipe (main flow)

Q_3, Q_n = Discharge(s) in cfs for the branch lateral(s)

V_3, V_n = Velocity(ies) in fps for the branch lateral(s)

E_3, E_n = The angle between the axes of the exiting pipe and the branch laterals(s)

g = Acceleration of gravity (32.2 ft/sec/sec)

Where:

E = is the angle between the axes of the outfall and the incoming laterals

- (6) *Losses at junctions of several flows in manholes and/or inlets.* The computation of losses in a manhole, inlet or inlet manhole with several flows entering the structure should utilize the principle of the conservation of energy. This involves both the elevation of water surface and momentum (mass times the velocity head). Thus, at a structure (manhole, inlet or inlet manhole) with laterals, the sum of the energy content for inflows is equal to the sum of the

energy content of the outflows plus the additional energy required by the turbulence of the flows passing through the structure.

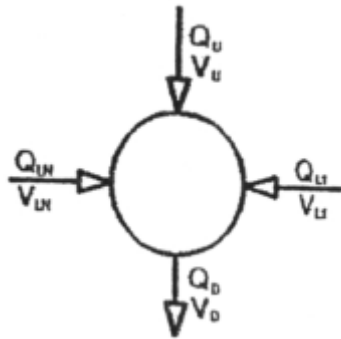


Diagram 2

The upstream hydraulic grade line may be calculated as follows:

$$H_u = (V_D^2/2g) - [((Q_U/Q_D)(1 - K)(V_U^2/2g)) + ((Q_{LH}/Q_D)(1 - K)(V_{LH}^2/2g)) + ((Q_{LD}/Q_D)(1 - K)(V_{LD}^2/2g))] + H_D$$

Where:

H_u = Upstream hydraulic grade line in feet

Q_U = Upstream main line discharge in cubic feet per second

Q_D = Downstream main line discharge in cubic feet per second

$Q_{LH} - Q_n$ = Lateral discharges in cubic feet per second

V_U = Upstream main line velocity in feet per second

V_D = Downstream main line velocity in feet per second

$V_{LH} - V_{LD}$ = Lateral velocities in feet per second

H_D = Downstream hydraulic grade line in feet

K = Multiplier of velocity of water being turned

g = Acceleration of gravity, 32.2 ft/sec/sec

The above equation does not apply when two (2) almost equal and opposing flows, each perpendicular to the downstream pipe, meet and no other flows exist in the structure. In this case the head loss is considered as the total velocity head of the downstream discharge.

- (7) *Transition loss.* The relative importance of the transition loss is dependent on the velocity head of the flow. If the velocity and velocity head of the flow are quite low, the transition losses cannot be very great. However, even small losses may be significant in flat terrain. The sewer design shall provide for the consideration of the necessary transitions and resulting energy losses. The possibility of objectionable deposits is to be considered in the design of transitions. For design purposes it shall be assumed that the energy loss and changes in depth, velocity and invert elevation, if any, occur at the center of the transition. These changes shall be distributed throughout the length of the transition in actual detailing. The designer shall carry the energy head, piezometric head (depth in an open channel) and invert as elevations and work from the energy grade line. Because of inherent differences in the flow, transitions for closed conduits will be considered separately from those for open channels.
- (a) *Closed conduits.* Transitions in small sewers may be confined within a manhole. Special structures may be required for larger sewers. If a sewer is flowing surcharged, the form and friction losses are independent of the invert slope, therefore, the transition may vary at the slopes of the adjacent conduits. The energy loss in a transition shall be expressed as a coefficient multiplied by the change in velocity head ($LV^2/2g$) in which V is the change in velocity before and after the transition. The coefficient may vary from zero (0) to one (1), depending on the design of the transition.

If the areas before and after a transition are known, it is often convenient to express the transition loss in terms of the area ratios and either the velocity upstream or downstream.

For an expansion:

$$H_1 = K(V_1 - V_2)^2/2g \times [K(V_1/2g)] [1 - (A_1/A_2)]^2$$

in which H_1 is the energy loss; K is a coefficient equal to 1.0 for a sudden expansion and approximately two-tenths (0.2) for a well-designed transition and the subscripts 1 and 2 denote the upstream and downstream sections, respectively, i.e., A_1 = Area Before Transition and A_2 = Area After Transition.

For a contraction:

$$H_1 = [K(V_2)^2/2g] [(1/C_c - 1)^2 [K(V_2)^2/2g] [1 - (A_2/A_1)]^2$$

in which K is a coefficient equal to five-tenths (0.5) for a well-designed transition, C_c is a coefficient of contraction and the other terms and subscripts are similar to the previous equation. Losses in closed conduits of constant area are expressed in terms of $(V_2/2g)$.

The above equations may be applied to approximate the energy loss through a manhole for a circular pipe flowing full. If the invert is fully developed, that is, semi-circular on the bottom and vertical on the sides from one-half ($1/2$) depth up to the top of the pipe, for the expansion $(A_1/A_2)=0.88$ and for the contraction $(A_2/A_1)=0.88$. The expansion is sudden, therefore, $K=1$. The contraction may be rounded if the downstream pipe has a bell or socket. In this case, K may be assumed to be two-tenths (0.2).

The expansion energy loss is fourteen thousandths (0.014) $[(V_1)^2/2g]$ and the contraction energy loss is one-hundredth (0.010) $[(V_2)^2/2g]$. If the invert is fully developed, the manhole loss is small, but if the invert is only developed for one-half ($1/2$) of the depth or not at all, the losses will be of considerable magnitude.

- (b) *Open channel transitions.* The hydraulics of open channel transitions are further complicated by possible changes in depth. As a first approximation to the energy loss, unless a jump occurs, the equations given above may be used with a trial-and-error solution for the unknown area and velocity. The K value for a well-designed expansion should probably be increased to three-tenths (0.3) or four-tenths (0.4). Whether the properties of the upstream or downstream section will be known will depend on the characteristics of the flow and the channel, but can be determined by a profile analysis. In transitions for supercritical flow, additional factors shall be considered. Standing waves of considerable magnitude will be produced in transitions. The height of these waves must be estimated to provide a proper channel depth. In addition, in long transitions, air entrainment will cause bulking of the flow with resultant greater depths of the air-water mixture.
- (8) *Hydraulic grade line limits.* The hydraulic grade line shall not rise above the following limits as determined by flow quantities calculated per Section **425.060(B)(3)(a)**.
 - (a) The hydraulic grade line at any inlet or storm manhole shall not be higher than two (2) feet below the inlet sill or top of manhole.
 - (b) Storm sewers shall not flow with greater than three (3) feet of head.
 - (c) The hydraulic grade line for combined sewers shall not rise above the pipe intrados.
 - (d) The beginning point for the hydraulic grade line computations shall be the higher elevation as determined below:
 - (i) For connection to existing pipe system:
 - i) Top of pipe intrados of one (1) reach downstream of the connection point of the existing system; or
 - ii) The hydraulic grade line computed for the existing system.
 - (ii) For connection to channels or ditches:
 - i) Top of pipe intrados of the proposed pipe; or

- ii) The hydraulic grade line computed for the channel or ditch as approved by the District.

- (9) *Inlets.* Inlets function entirely as entry points for stormwater flow. They also may be constructed to serve as a manhole on separate stormwater sewers and are then termed inlet manholes. Steep gradients may give such low inlet capacities that additional inlets should be located at more favorable grade locations or special inlets designed for steep gradients must be used. Provision must be made to control by-pass flow and to provide additional capacity in the inlet and line affected by such increased flow. Six (6) inch, open-throat inlets should be used at all times.

Grated inlets without an open throat or other provision for overflow shall be avoided except under exceptional conditions and are prohibited in grade pockets. Any exceptions shall be used only with District approval.

Curb inlets shall be placed at street intersections or driveways such that no part of the inlet structure or sump is within the curb rounding.

- (a) Inlets are shown in the standard details of sewer construction. The minimum depth of a terminal inlet is four (4) feet from the top of the inlet to the flowline of the outlet pipe. Greater depth shall be used for intermediate inlets if necessary for the required depth of the hydraulic grade line. Trapped inlets shall have the depth shown in the Standard Details of Sewer Construction.

- (b) Inlet capacity should not be less than the quantity flow tributary to the inlet and by-pass flow shall be avoided whenever possible.

Inlets at low points or grade pockets should have extra capacity to compensate for possible flow by-pass of upstream inlets.

Figure 4-3 shows inlet capacity/maximum gutter capacity with a given gutter line grade and flow.

- (c) Connections to existing structures may require rehabilitation or reconstruction of the structure being utilized. This work will be considered part of the project being proposed.

- (10) *Open channels.*

* NOTE: This Section contains some excerpts relating to design and are attributed to Open Channel Hydraulics by Ven Te Chow, a McGraw-Hill work published in 1959.

All open channels shall meet the following requirements:

- (a) *Size and shape.* Open channels shall not decrease in size in the direction of flow. Open channels shall be vertical walled except in special cases where other approved materials are being considered.

- (b) *Materials.* Channels may be constructed with reinforced concrete or other approved material. However, the District shall have the right to approve or disapprove any channel material and shall select the appropriate channel material if a proposed material is rejected. Swales shall be sodded unless velocities are excessive (greater than five (5) fps) or where velocities are less than two (2) fps causing deposition of soil particles, then concrete swales may be used.

- (c) *Bedding.* Special provisions shall be made for channels or paved swales laid over fill on non-supportive soils to support the channel on paved swales. Pipes extended to the channel in a fill area shall have compacted crushed limestone bedding for support.

- (d) *Structural considerations.* Provision must be made for all loads on the channel.

- (e) *Alignment.* Open channel alignments may be limited by available easements, physical topography, existing utilities, buildings, residential development, maintenance access and roadways.

- (f) *Locations.* Storm channel locations are determined primarily by natural drainage conditions. It is also necessary to consider accessibility for construction and maintenance,

site availability and competing uses and evaluating effects of easements on private property. Storm channels shall be located:

- (i) To serve all adjacent property conveniently and to best advantage.
 - (ii) In easements or rights-of-way dedicated to the District.
 - (iii) In easements on common ground when feasible.
 - (iv) On private property along property lines or immediately adjacent to public streets, avoiding crossings through the property.
 - (v) At a sufficient distance from existing and proposed buildings (including footings) and underground utilities or sewers to avoid future problems of flooding or erosion.
 - (vi) To avoid interference between stormwater sewers and house connections to foul water or sanitary sewers.
 - (vii) In unpaved or unimproved areas whenever possible.
 - (viii) Crossing perpendicular to streets, unless unavoidable.
- (g) *Flowline*. The flowline of open channels shall meet the following requirements:
- (i) Gradient changes shall be kept to a minimum and be consistent and regular.
 - (ii) Gradient designations less than the nearest one one-thousandths (0.001) foot per foot shall be avoided.
 - (iii) Channel and swale depths shall be determined primarily by the requirements of the channel size, utility obstructions and any required connections.
- (h) *Other open channel considerations and requirements*.
- (i) *Natural channels and ditches*. All natural channels and ditches shall be improved unless otherwise authorized by the District.
 - (ii) *Drainage control*. Drainage within private property should be controlled to prevent damage to the property crossed. Swales or broad shallow grass-lined ditches with non-erosive slopes are generally located at or near rear lots and along common property lines. If a paved gutter is utilized, then appropriate erosion protection shall be used at both ends.
 - (iii) *Subdivisions*. Drainage channels and watercourses draining through a subdivision shall be enclosed if the required pipe size does not exceed sixty (60) inches. When it is undesirable or impractical to enclose a channel with a pipe across a road or street, a suitable bridge or culvert shall be required.
 - (iv) *Inlets — inlet manholes*. For flows greater than four (4) cfs, area inlets or inlet manholes are required to intercept the gutter or swale flow.
 - (v) *Improved concrete channels*. All improved concrete channels shall have a forty-eight (48) inch chain link fence on each side of the channel or other protective measures as directed by the District.
 - (vi) *Large areas*. Channels and watercourses draining large areas shall be located in rights-of-way or easements previously approved by the District as a part of an adequate overall plan for drainage.
 - (vii) *Riparian corridor protection*. In certain conditions and upon the approval of the Director of Public Works and MSD, twenty-five (25) feet minimum buffer adjacent to existing natural channels shall remain natural or be designed with bioengineering. The intent of riparian corridor protections shall be:

- i) Improve surface and ground water quality by reducing the amount of nutrients, sediment organic matter, pesticides and other harmful substances that reach watercourses, wetlands and subsurface and surface water bodies by using scientifically proven processes including filtration, deposition, absorption, adsorption, plant uptake and denitrification and by improving infiltration, encouraging sheet flow and stabilizing concentrated flows;
 - ii) Preserve and protect areas that intercept stormwater and surface water runoff, wastewater, subsurface flow and/or deep ground water flows from upland sources and reduce, to the maximum extent practicable, the effects of the entry of associated nutrients, sediment organic matter, pesticides or other pollutants into surface waters, as well as provide wildlife habitat, moderate water temperature in surface waters, attenuate flood flow and, where appropriate and feasible, provide opportunities for recreational activities;
 - iii) Assist in the implementation of pertinent Federal, State and local laws concerning clean water, pollutant discharges, storm and surface water management, erosion and sediment control and flood control;
 - iv) Conserve natural features important to land or water resources, such as headwater areas, ground water recharge zones, floodway, floodplain, springs, streams, wetlands, woodlands, prime wildlife habitats and other features within the riparian corridor;
 - v) Recognize that natural features contribute to the welfare and quality of life of the City's residents;
 - vi) Conserve natural, scenic and recreation areas within and adjacent to stream corridors for the community's benefit; and
 - vii) Create added value to lands adjacent to stream corridors.
 - viii) Recognition that a certain amount of erosion is a natural occurrence, causing streams to meander within their floodway and therefore keeping improvements from unnecessary risk of erosion damage or later otherwise unnecessary structural constraints to the channel.
- (i) *Design limitations.*
- (i) The flow quantity shall be calculated by the method presented in Section **425.060(B)(3)(a)**, Flow Quantities, of this Chapter.
 - (ii) If the channel is within an area designated in a community's Flood Insurance Study, then the channel shall also meet all District and the community's floodplain requirements.
 - (iii) Other agencies of jurisdiction may have requirements which must be met. A U.S. Army Corps of Engineers permit may be required for any construction affecting a watercourse.
- (j) *Hydraulic grade line.*
- (i) *Computation methods.* In open channels, the water surface is identical with the hydraulic grade line. The hydraulic grade line shall be computed throughout the channel reach to show its elevation at junctions with incoming pipes or channels and at the ends of the channel reach under consideration. It shall also provide for the losses and differences in elevations as required below. Since it is based on design flow in a given channel, it is of importance in determining minimum sizes within narrow limits. The depth at which the actual flows will occur is controlled by the two (2) end conditions of the reach considered and by the relationship between the energy

available and by the energy required to overcome the losses that are encountered along the channel.

There are several methods of calculating "losses" in channel design. The following procedures are presented for the engineer's information and consideration.

It is required that the design recognize the reality of such "losses" occurring and make such allowances as good engineering judgment indicates.

- i) *Control sections.* The engineer should locate all possible control sections for the reach in question. A control section refers to any section at which the depth of flow is known or can be controlled to a required stage. At the control section, flow must pass through a control depth which may be the critical depth, the normal depth or any other known depth. Three (3) types of control sections include (a) upstream control section; (b) Downstream control section; (c) artificial control section, which occurs at a control structure, such as a weir, dam, sluice gate, roadway embankment, culvert, bridge or at the confluence with a major river or stream.
- ii) *Friction loss.* The friction loss may be calculated by the same procedure as is presented in Section **425.060(B)(4)(a)(1)** of this Chapter.
- iii) *Flow in curved channels.* The centrifugal force caused by flow around a curve produces a rise in the water surface on the outside wall and a lowering of the inner wall. This phenomenon is called superelevation. The flows tend to behave differently according to the state of flow.
In subcritical flow, friction effects are of importance, whereby in supercritical flow, the formation of cross-waves is of major concern.

- a) *Curve losses.* Curve losses may be estimated from Figure 4-2 by replacing D, diameter, with b, width of channel.

Super elevations. In addition to curve losses, an evaluation of superelevations should be considered and, if required, an allowance

- b) made in the top elevation of the outside wall. Equations are presented below which may be used to determine the superelevation at channel bends.

- 1) *Trapezoidal channels.*

Subcritical flow:

$$\Delta H_w = 1.15(V^2/2gr_c)[b+D(ZL+ZR)]$$

Supercritical flow:

$$\Delta H_w = 2.6(V^2/2gr_c)[b+D(ZL+ZR)]$$

- 2) *Rectangular channels.*

Subcritical flow:

$$\Delta H_w = (V^2b/2gr_c)$$

Supercritical flow:

$$\Delta H_w = (V^22b/gr_c)$$

Where:

ΔH_w	=	Change in water height above the centerline water surface elevation.
V	=	Average velocity of design flow in fps.
g	=	Acceleration of gravity (32.2 ft/sec/sec).
r_c	=	Radius of curve on horizontal alignment in feet.
b	=	Base width of channel in feet.

D = Depth of flow in straight channel.

ZL = Left side slope (ft/ft).

ZR = Right side slope (ft/ft).

- iv) *Transitions.* Transitions should be designed to accomplish the required change in cross section with as little flow disturbance as possible.

The following features are to be considered in design of transition structures.

- a) *Proportioning.* For a well-designed transition, the following rules should be used:

- 1) The optimum maximum angle between the channel axis and a line connecting the channel sides between the entrance and exit sections is twelve and one-half degrees (12.5°).
- 2) Sharp angles in the structure should be avoided.

Losses. The energy loss in a transition consists of the friction loss and the conversion loss. The friction loss may be estimated by the Manning

- b) *Formula.* The conversion loss is generally expressed in terms of the change in velocity head between the entrance and exit sections of the structure.

$$H_t = K_t \Delta V_H$$

Where:

H_t = Conversion loss

K_t = Coefficient of head loss in transition

ΔV_H = Absolute change in velocity head

Average design values for K are presented in the table below:

Type of Transition	Contracting Section	Expanding Section
Warped	0.10	0.20
Wedge	0.20	0.50
Cylinder-quadrant	0.15	0.25
Straight Line	0.30	0.50
Square End	0.40	0.75

See Figure 4-4 for sketches of each type of transition.

- c) *Freeboard.* A transition shall have a minimum of one (1) foot of freeboard above the hydraulic grade line.

- d) *Hydraulic jump.* The existence of a hydraulic jump in a transition may become objectionable and the design of the transition should be checked for such.

- e) *Sudden enlargement and contraction.* A sudden enlargement results when an intense shearing action occurs between incoming high-velocity jet and the surrounding water. As a result, much of the kinetic energy of the jet is dissipated by eddy action. The head loss at a sudden enlargement, H_{Le} , is:

$$H_{Le} = K_e \Delta V^2 / 2g$$

Where:

K_e = K_e = Coefficient of head loss for enlargements
= 1

ΔV = Change in velocities between incoming and outgoing sections

g = Acceleration of gravity (32.2 ft/sec/sec)

The flow in a sudden contraction is first contracted and then

expanded resulting in high losses as compared to a sudden enlargement. Thus the head loss at a sudden contraction, H_{Lc} , is:

$$H_{Lc} = K_c(\Delta V^2/2g)$$

Where:

K_e	=	Coefficient of head loss for enlargements — 0.5
ΔV	=	Change in velocities between incoming and outgoing sections
g	=	Acceleration of gravity, ft/sec/sec

- v) *Constrictions.* A constriction results in a sudden reduction in channel cross section. The effect of the constriction on the flow depends mainly on the boundary geometry, the discharge and the state of flow. When the flow is subcritical, the constriction will induce a backwater effect that extends a long distance upstream. If the flow is supercritical, the disturbance is usually local and will only affect the water adjacent to the upstream side of the constriction. A control section may or may not exist at a constriction. The control section, when it exists, may be at either side of the constriction (upstream or downstream), depending on whether the slope of the constricted channel is steep or mild. The entrance and outlet of the constriction then acts as a contraction and an expansion, respectfully.
- vi) *Obstructions.* An obstruction in open-channel flow creates at least two (2) paths of flow in the channel. Typical obstructions include bridge piers, pile trestles and trash racks. The flow through an obstruction may be subcritical or supercritical.
- (ii) *Hydraulic grade line limits.*
 - i) The hydraulic grade line at any point along a channel shall not be higher than one (1) foot below the top of the channel wall.
 - ii) The hydraulic grade line at any point along a channel shall not cause the hydraulic grade limits of the storm sewer system to be exceeded as stated in Section 425.060(B)(4)(8)(a) of this Chapter.
- (k) *Hydraulic jump.* When flow changes from the supercritical to subcritical state, a hydraulic jump may occur. A study should be made on the height and location of the jump and for discharges less than the design discharge to ensure adequate wall heights extend over the full ranges of discharge.
- (l) *Open channel junctions.*
 - (i) *General.*
 - i) Consideration shall be given in the design of open-channel junctions to the geometry of the confluence of flows in order to minimize undesirable hydraulic effects due to supercritical velocities.
 - (ii) *Confluence design criteria.*
 - i) The momentum equation can be applied to the confluence design if the below stated criteria is used.
 - ii) The design water surface elevations in the two (2) joining channels should be approximately equal at the upstream end of the confluence.
 - iii) The angle of the junction intersection can vary from zero to twelve degrees (0 — 12°).

- iv) The width of the main channel shall be expanded below the junction to maintain approximate flow depths throughout the junction.
 - v) Flow depths should not exceed ninety percent (90%) of the critical depth.
 - (m) *Erosion protection.* Grouted rock blankets, minimum one (1) foot thick, shall be required at each end of the improved channel. The minimum length of the grouted rock blanket shall be twenty-five (25) feet. A grouted rock toe wall, minimum two (2) feet deep, shall be constructed at the free end of each blanket.
 - (n) *Sanitary sewer crossings.* The characteristics of any sanitary sewer crossing shall be given consideration in the design of the channel floor.
5. *Culverts.* The design of culverts shall include consideration of many factors relating to requirements of hydrology, hydraulics, physical environment, imposed exterior loads, construction and maintenance. With the design discharge and general layout requirements determined, the design requires detailed consideration of such hydraulic factors as shape and slope of approach and exit channels, allowable head at entrance (and ponding capacity, if appreciable), tailwater levels, hydraulic and energy gradelines and erosion potential.
- a. *Hydraulic design.* The hydraulic design of a culvert for a specified design discharge involves (1) selection of a type and size, (2) determination of the position of hydraulic control, and (3) hydraulic computations to determine whether acceptable headwater depths and outfall conditions will result. Hydraulic computations will be carried out by standard methods based on pressure, energy, momentum and loss considerations.
 - b. *Entrances and headwalls — outlets and endwalls.* Where an existing culvert is to be extended, the possibility for maintaining or improving existing capacity should be investigated. Marked improvement may be obtained by proper entrance design. All culverts shall be designed for possible extension unless there are extenuating circumstances.
6. *Bridges.* Bridges shall be designed to meet the current criteria of the governing agencies.
- a. *Waterway capacity and backwater effects.* Sufficient capacity will be provided to pass the runoff from the design storm determined in accordance with principles given elsewhere in this Chapter.
 - b. *Clearance.* The lowest point of the bridge superstructure shall have a (freeboard) clearance of two (2) feet above design water surface elevation for the 15-year frequency in St. Louis County and one (1) foot for the 100-year frequency.
 - c. *Waterway alignment.* The bridged waterway will be aligned to result in the least obstruction to stream flow, except that for natural streams, consideration will be given to future realignment and improvement of the channel.
 - d. *Erosion protection.* To preclude failure by scouring, abutment and pier footings usually will be placed either to a depth of not less than five (5) feet below the anticipated depth of scour or on firm rock if such is encountered at a higher elevation. Large multi-span structures crossing alluvial streams may require extensive pile foundations. To protect the channel, revetment on channel sides and/or bottom consisting of concrete or grouted rock blanket should be placed as required. The governing authority should be contacted regarding their design requirements.
7. *Outlet erosion protection.* If outlet velocities exceed five (5) fps, an appropriate erosion protection must be provided. Erosion protection may be required at outlets where velocities are less than five (5) fps if soil conditions warrant.
For paved channels, a cutoff wall will be required at the termini with appropriate protection. The cutoff wall shall extend a minimum depth of two (2) feet into the existing ground line.
8. *Limitations on areas draining across sidewalks or driveways.* Up to three thousand (3,000) square feet of parking area may discharge via a driveway to a public or private street. An additional three thousand (3,000) square feet may discharge into a public alley. Areas larger than this must have any excess area discharge into interceptor basins as set forth in the City.

Area inlets shall be required to intercept overland flows greater than one (1) cfs to prevent that flow from crossing sidewalks or curbs.

9. *Impervious areas.* Any area which is to be paved, repaved, expanded or otherwise improved, that is over three thousand (3,000) square feet in area, whether presently paved or not, shall at such time as it is to be paved, repaved, expanded or be otherwise improved, be provided with stormwater drainage facilities constructed in accordance with plans and specifications submitted to and approved by the District.

10. *Stormwater detention.*

a. *When required.*

- (1) The requirement of stormwater detention shall be evaluated for all projects submitted to MSD for review and approval and may be required, if deemed necessary. Detention facilities shall be provided and designed in accordance with the requirements of this Section.
- (2) Projects which have a differential runoff for the 25-year, 20-minute event in the City shall have the following detention requirements:

Creek	100-year, 24-hour Storm Release Rate	2-year, 24-hour Storm Release Rate	Critical Time Period of Watershed
Creve Coeur	1.2 cfs/acre	0.13 cfs/acre	Hour 12.0 — 17.2
Deer	differential	differential	N/A
Fee	1.3 cfs/acre	0.15 cfs/acre	Hour 12.0 — 14.1

- (a) The Public Works Director has the discretion to waive this requirement.
- (3) When existing detention facilities are going to be used to accommodate additional runoff from building or parking lot expansions or subdivision additions, the facilities shall be retrofitted to meet the current detention requirements for the drainage area which is tributary to the facility. Projects which cannot meet this requirement due to physical constraints will be evaluated on a case-by-case basis.
- (4) The stormwater design project will be based on the City's stormwater master plan.
- (5) Shared detention facilities can be evaluated on both existing and proposed detention facilities. The plan can be proposed by the City or the applicant and needs to be discussed with the City before preparing preliminary plans.

b. *Design considerations.*

- (1) The 2-year and 100-year, 24-hour inflow hydrographs shall be determined by using Technical Release 55 (TR-55) "Urban Hydrology for Small Watersheds" from the Natural Resources Conservation Service, formerly Soil Conservation Service (SCS). The inflow hydrograph shall be developed based on the actual flow and timing characteristics upstream of the detention facility. The rainfall distribution shall be Type II.
- (2) Stormwater shall be detained on site or off site as approved and released at a rate not to exceed the allowable release rates for the 2-year and 100-year, 24-hour events as determined by the District for the watershed in question. The allowable release rates have been determined by watershed modeling, which may be obtained from MSD. The design engineer has the option to calculate a site-specific release rate based on procedures provided by MSD. Note that stormwater pipes, downstream from the control structure, shall be sized to carry the runoff from the 25-year, 20-minute design storm for the total tributary upstream watershed. No reduction in outfall pipe size shall be permitted because of detention.
- (3) The volume of detention may be provided through permanent detention facilities such as dry basins or ponds, permanent ponds or lakes, underground storage facilities or in parking lots. The design engineer shall make every effort to locate the detention facility at or near the lowest point of the project such that all of the on-site runoff will be directed into the detention facility.

Flows from off-site upstream areas should be by-passed around the detention facility to ensure that the proposed detention facility will function as designed and will provide effective control of downstream flows with development in place. If off-site flows are directed into a detention facility, the allowable release rates shall not be modified without MSD approval. Modifying the release rate to accommodate off-site flows may reduce or eliminate the effectiveness of the detention facility, because it will no longer control the increased volume of runoff during the critical time period of the watershed.

As stated in item 2 above, the design engineer has the option to calculate a site-specific release rate based on procedures provided by MSD. The design engineer shall provide detailed modeling to prove that the increase in runoff volume has been limited to existing conditions during the critical time period of the watershed.

- (4) Detention basin volume will be based on routing the post-developed 2-year and 100-year, 24-hour inflow hydrographs through the detention facility while satisfying the appropriate allowable release rate. The routing computations shall be based on an application of the continuity principle (i.e., level pool routing).
- (5) *Design of underground basins.*
 - (a) Adequate access for basin maintenance and inspection shall be provided. A means of visual inspection from the ground surface of the low flow device, overflow weir and outlet structure is necessary. Access also shall be provided to allow for cleaning of the low-flow device from the ground surface.
 - (b) The basin should have sufficient volume and spillway capacity to pass/contain the 100-year, 24-hour event with the low flow outlet blocked.
- (6) The design engineer must submit the following for review of a detention facility:
 - (a) Elevation vs. discharge tables or curves for all frequencies.
 - (b) Elevation vs. storage tables or curves for all frequencies.
 - (c) Inflow calculations and data for all frequencies.
 - (d) Hydraulic gradeline computations for pipes entering and leaving the basin for all frequencies.
 - (e) If the embankment contains fill material, a geotechnical report may be required.
 - (f) Site plan showing appropriate design information.
 - (g) Structural calculations for the outlet control structures (if required).
 - (h) Cross sections defining the size, shape and depth of the detention basin shall be required. At a minimum, three (3) sections, one (1) at each end and one (1) in the middle of the basin, will be required.
 - (i) Upon close-out of a development in which a detention pond was constructed prior to the completion of the primary development and accepted runoff from the project area during construction, the basin shall be physically surveyed to determine the extent that sediment may have reduced the depth from that of the approved design and that the sediment shall be removed to restore the design depth. These sections will be used to compute the as-built volume of the basin and thus must be tied to a known physical structure or baseline.
- (7) All ends of pipes discharging into a dry basin or pond shall be connected with the low-flow pipe or control structure by means of a paved swale. The paved swale shall be non-reinforced concrete, six (6) inches thick, with a minimum two percent (2%) slope to the center and a minimum two-tenths percent (0.2%) longitudinal slope. Paved swales shall be a minimum of six (6) inches deep and four (4) feet wide or one and three-tenths (1.3) times the diameter of the

pipe entering the basin, whichever is greater, and be keyed to structure or channel. The bottom of the basin shall be sloped a minimum of two percent (2%) towards the concrete swale.

- (8) Railroad tie walls and galvanized gabion walls cannot be used where water will be in contact with the railroad tie wall or the galvanized gabion wall.
- (9) Permanent detention ponds or lakes are to be designed to minimize fluctuating lake levels. Maximum fluctuation from the permanent pool elevation to the maximum ponding elevation shall be three (3) feet.
- (10) The maximum side slopes for dry basins or ponds and the fluctuating area of permanent ponds or lakes shall be 3:1 (three (3) feet horizontal, one (1) foot vertical) without fencing.
- (11) Dry basins or ponds and the fluctuating areas of permanent ponds or lakes are to be sodded and kept mowed.
- (12) Control structures and overflow structures are to be reinforced concrete.
- (13) The outflow pipe shall be sized for the developed flow rate.
- (14) In basins with concrete walls or rock blanket covered slopes, the bottoms should be paved or provisions made for moving equipment to reach the bottom (ramps, etc.).

c. *Maximum depths.*

- (1) The maximum depth of water in a dry detention basin or pond shall not exceed eight (8) feet. Projects which need a deeper basin to attain the required detention volume due to physical constraints may be evaluated on a case-by-case basis. The design and construction of dams greater than eight (8) feet or as directed by the Public Works Director must be sealed and certified by a professional engineer registered in the State of Missouri with demonstrated expertise in geotechnical engineering.
- (2) Parking lots used for automobiles shall have a maximum depth of eight (8) inches of water.
- (3) Parking lots used for trucks or truck trailers shall have a maximum depth of water of twelve (12) inches.

d. *Limits of maximum ponding.*

- (1) The maximum ponding elevation shall be calculated based on a routing of the design storm (100-year, 24-hour event) assuming the low-flow outlet is blocked with water ponded to the overflow structure's sill.
- (2) The limits of maximum ponding in dry basins or ponds and permanent lakes or ponds shall not be closer than thirty (30) feet horizontally to any building and not less than two (2) feet vertically below the lowest sill elevation of any building.
- (3) The limits of maximum ponding in parking lots shall not be closer than ten (10) feet horizontally from any building and not less than one (1) foot vertically below the lowest sill elevation of any building.
- (4) A minimum of one (1) foot of freeboard shall be provided from the top of the basin to the maximum ponding elevation.

e. *Easement required.* In subdivisions, the detention basin, access roads or paths, control structures and outfall pipes are to be located in easements dedicated to the subdivision trustees.

f. *Maintenance agreement.* The owner(s) of the project shall execute an MSD maintenance agreement for the detention basin or pond to ensure the detention area will be kept in working order prior to plan approval. MSD will not be responsible for maintenance of detention basins.

g. *Detention basin fencing.* A four (4) foot (minimum height) approved fence shall be provided around the perimeter of any basin where the side slopes exceed 3:1 (three (3) feet horizontal, one (1) foot

vertical).

- h. *Detention basin elevation.* The low elevation of the detention basin shall be above the 15-year, 20-minute hydraulic elevation of the receiving channel or pipe system or as directed by the Director of Public Works.
- i. *Privately owned ponds.* The Stormwater Committee's policy and guidelines regarding the City's financial commitment to these privately owned residential ponds which are retention or detention facilities:

DRY POND

1. If the storage capacity (based on the original design criteria) has been reduced by fifty percent (50%) of its original volume, the City could participate up to twenty-five percent (25%) of the cost of the project not to exceed ten thousand dollars (\$10,000.00). The rest of the project cost will be borne by the residents of that subdivision.
2. If certain improvements need to be made to the spillway, low water carrying pipe or the paved ditch, the City could contribute up to twenty-five percent (25%) of the cost of this project not to exceed two thousand five hundred dollars (\$2,500.00) to repair and refurbish the related items.
3. The normal maintenance such as mowing of the area or pruning of the trees/shrubs will be the total responsibility of the trustees/property owners.
4. The downstream facility from the overflow structure if repairs are needed receive cost sharing under the similar guidelines as described in time (4)(a) above.

WET POND/LAKE

1. The cost of repairs to the dam and/or the downstream structures including improved channels or enclosed systems could be shared by the City up to twenty-five percent (25%) of the cost of the project not to exceed twenty thousand dollars (\$20,000.00). The rest of the project cost will be borne by the residents of that subdivision.
2. The dredging of a lake or wet pond for aesthetic purposes will be the total responsibility of the trustees and/or property owners.
3. The normal maintenance of mowing grass, pruning of trees and shrubs and controlling algae, etc., will be the total responsibility of the trustees and/or homeowners.

11. *Dam permit requirements.* Dams with a height of thirty-five (35) feet or greater will require approval from the Missouri Department of Natural Resources.

Section 425.070. Definitions.

[R.O. 2008 §24-30.7; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

In addition to words and terms that may be defined elsewhere in this Chapter, the following words and terms shall have the meanings defined below:

AASHTO

American Association of State Highway and Transportation Officials.

ALLOWABLE RELEASE RATE

The pre-development or existing condition peak flow corresponding to a selected rainfall frequency event.

BACKFILL

The material used to fill an excavation.

BASE FLOOD

The flood having a one percent (1%) chance of being equaled or exceeded in any given year. (The base flood, adopted by the Federal Emergency Management Agency (FEMA), is the 100-year flood.)

BEDDING

The material on which the pipe or conduit is supported and protected.

BOARD

The Board of Trustees of the Metropolitan St. Louis Sewer District.

BUILDING STRUCTURE

Walled or roofed building that is principally above ground, as well as a manufactured home, and a gas or liquid storage tank that is principally above ground.

CHANNELS

A natural or artificial watercourse.

CITY

The City of Creve Coeur.

COMBINED FLOW

A combination of stormwater and wastewater.

COMBINED SEWER

A sewer receiving both surface runoff and wastewater.

CULVERT

A closed conduit for the free passage of surface drainage water under a highway, railroad or other embankment.

CURVE, LONG

A curve having a centerline length of curve equal to or greater than one hundred fifty (150) feet.

CURVE, SHORT

A curve having a centerline length of curve of less than one hundred fifty (150) feet.

DEDICATION

The process by which the owner gives approved sanitary, combined and/or storm sewers and facilities to the District for public use and maintenance.

DETENTION

See "STORMWATER DETENTION".

DEVELOPED RUNOFF RATE

The peak flow corresponding to a selected rainfall event as a result of developed site conditions.

DIFFERENTIAL RUNOFF RATE

The difference between the pre-developed runoff rate and the developed runoff rate.

DIFFERENTIAL VOLUME OF STORMWATER

The amount of differential stormwater volume between the pre-developed and developed runoff rates which the detention basin must detain (hold).

DIRECTOR

The Executive Director of the Metropolitan St. Louis Sewer District or his/her properly authorized agents.

DISTRICT

The Metropolitan St. Louis Sewer District.

DRAINAGE FACILITY

Any system of artificially constructed drains, including open channels and sewers, used to convey stormwater, surface or ground water, either continuously or intermittently, to natural watercourses.

DROP

A structural configuration where flow falls into a structure from an incoming pipe.

ENGINEER

A registered professional engineer currently certified by law in the State of Missouri.

FEMA

Federal Emergency Management Agency.

FLOOD INSURANCE FLOODWAY MAPS

Current maps from the Federal Emergency Management Agency Flood Insurance Study.

FLOOD INSURANCE STUDY

The official report provided by the Federal Emergency Management Agency containing flood profiles; flood boundaries; floodway maps and the water surface elevation of the base flood.

FLOODPLAIN

A geographic area susceptible to periodic inundation from the overflow of natural waterways during the base (100-year) flood.

FLOODPLAIN STUDY

An engineering analysis to determine the hydraulic effect, if any, of the proposed development to the existing floodplain.

FLOODWAY

The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one (1) foot and so delineated in the Flood Insurance Study.

FORCE MAIN

A pressurized sewer carrying wastewater.

FREEBOARD

The difference in elevation (expressed in feet) between the hydraulic grade line elevation and:

1. The inlet sill elevation; or
2. The top of structure elevation; or
3. The top of channel bank elevation; or
4. The top of wall elevation.

HOUSE LATERAL

Private sewer from building drain to the public sewer. This shall include the connection to the sewer.

HS-20

The live truck wheel loads as designated by the AASHTO specifications.

HYDRAULIC GRADE LINE

A line coinciding with the level of flowing water at any given point along an open channel; or the level to which water would rise in a vertical tube connected to any point along a pipe or closed conduit flowing under pressure.

INLET TIME

The overland flow time for runoff to reach the inlet.

INTRADOS

The inside top of the sewer pipe.

LATERAL SEWER

A sewer that discharges into a branch or other sewer and has no other common sewer tributary to it.

LOW SILL

The lowest elevation of any opening in a building.

MAIN SEWER

The principal sewer to which branch sewers and submains are tributary; also called trunk sewers.

MDNR

The Missouri Department of Natural Resources.

MSD

The Metropolitan St. Louis Sewer District

"n" VALUE

A dimensionless coefficient used in the Manning's Equation to account for frictional losses in steady uniform flow.

OUTFALL

The point location or structure where wastewater or drainage discharges.

PERSON

Any individual, firm, proprietorship, partnership, company, municipality, association, society, corporation, group or other entity.

PRE-DEVELOPED RUNOFF RATE

The amount of flow from an existing site prior to new development or improvements as computed by the Rational Formula.

PRISMATIC CHANNEL

A channel characterized by uniform cross sections and constant bottom slope.

PRIVATE SEWER

A sewer not accepted for public maintenance as determined by the reviewing agencies.

PUBLIC SEWER

A sewer which has been accepted for public maintenance as determined by the reviewing agencies.

REACH

A distance, in pipe or channel, between two (2) identified points.

RESOLUTION

Any resolution duly adopted by the City.

RETENTION

A stormwater runoff facility designed to retain (hold) stormwater both permanently and temporarily (above normal pool elevation) during and immediately after a runoff event.

REVIEWING AGENCIES

The reviewing agency can be either MSD or the City of Creve Coeur.

RIPARIAN

Those areas associated with streams, lakes and wetlands where vegetation communities are predominately influenced by their association with water.

SANITARY SEWER

A sewer which carries wastewater.

SEMI-PUBLIC

A governmental, institutional, educational or municipal building or structure.

SEPARATE SEWER

A sewer intended to receive only wastewater or stormwater runoff.

SEWER

A pipe or closed conduit carrying wastewater, stormwater or a combination thereof.

SINKHOLE

A topographic depression with no natural surface drainage outlet.

SPRINGLINE

The line or plane in which an arch rises from its impost. In circular conduits, the horizontal plane through the midpoint of the section.

STANDARD DETAILS OF SEWER CONSTRUCTION

Plans of structures or devices or construction details commonly used on District work and referred to on the plans or in the specifications.

STEADY FLOW

The quantity of water passing a cross section is constant, i.e., has patterns and magnitudes which do not vary with time.

STORMWATER DETENTION

A stormwater runoff facility designed to detain (hold) stormwater temporarily during and immediately after a runoff event.

STORMWATER MANAGEMENT PLAN

Study and design for a stormwater conveyance system, a downstream evaluation system, detention requirements, floodplain/floodway, sink hole and regulating permitting requirements.

STORMWATER SEWER

A sewer which carries surface runoff and subsurface waters.

SWALE

A broad, shallow watercourse.

TIME OF CONCENTRATION

Consists of inlet time plus the travel time in the sewer or channel from the most remote point in the watershed to the point under consideration.

TRAVEL TIME

The time it takes for the runoff to flow through the drainage system from one point of reference to the next point of reference.

TRUNK SEWER

The principal sewer to which branch sewers and subtrunks are tributary; also called main sewers.

UNIFORM FLOW

The flow in a channel, conduit or pipe having a uniform cross section and velocity at every location within a given reach.

U.S.G.S.: United States Geological Survey

UTILITIES

Public service facilities for supplying gas, electricity, potable water or irrigation systems, sanitary sewers, power, steam, cable T.V., telephone, fiber optics and telegraph communication, railway transportation and the like.

WASTEWATER

The spent water of a community.

WATERCOURSE

A stream of water or a natural channel through which water may flow.

WUNNENBERG'S

A commercial street guide published by St. Louis Area Maps, Inc. for the St. Louis metropolitan area.

Section 425.080. General.

[R.O. 2008 §24-30.8; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

MSD will accept for dedication all public sewers and pump stations within easements dedicated to MSD that have been constructed to MSD standards and for which the requirements stated herein have been met.

The maintenance of these public facilities will remain the responsibility of the project Owner until such time that they have been accepted for dedication by MSD.

Section 425.090. Abandonment of Work.

[R.O. 2008 §24-30.9; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

Upon receipt of a written statement from the Owner that further work on the project has been abandoned, the City and the District shall determine whether or not the uncompleted work is required to ensure the public health, safety and welfare. Should it be determined that completion of the work is necessary, the City shall utilize the monies deposited in the construction escrow for the project to complete this work.

Section 425.100. Fees Required Before Plan Approval.

[R.O. 2008 §24-30.10; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

- A. The City and MSD will require that certain fees be paid prior to the acceptance of the plans for review or the subsequent approval of these plans. Failure to submit the fees in a timely manner could delay the review and approval of the plans. No plans will be approved until all required fees have been paid.
- B. Since the amount of these fees are subject to change, no amount for these fees is given herein. Please contact the City and MSD for a current list of fees.
 1. *Submittal fee.* A submittal fee in the amount indicated on MSD Engineering Form E.2 must be submitted along with the plans and Form E.2. Failure to submit this fee, Form E.2 or the appropriate number of plans will result in the rejection of the plans for review.
 2. *Review fee.* The City and the District will charge a fee to review the project based on the acreage of the development. This fee will be determined by the District and refer to Appendix B to Title IV, Community Development and Public Works Fee Schedule for the City and the Owner will be notified of the amount as part of the review process.
 3. *Recording fees.* The owner will be responsible for paying the recording fees for all documents to be recorded with the Recorder of Deeds for St. Louis County.

Section 425.110. Construction and Maintenance of Stormwater Facilities.

[R.O. 2008 §24-30.11; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

- A. Detention/retention facilities, when mandatory, are to be built in conjunction with the storm sewer installation and/or grading. Since these facilities are intended to control increased runoff, they must be partially or fully operational soon after the clearing of the vegetation.

- B. Silt and debris connected both with early construction and with general erosion from the site and elsewhere in the watershed after construction shall be removed periodically from the detention area and control structure in order to maintain close to full storage capacity.
- C. The responsibility of maintenance of the detention/retention facilities in subdivision projects shall remain with the developer until such time as applicable escrows are released. Upon release of escrows the maintenance responsibility shall be vested in the trustees of the subdivision by virtue of the trust indenture. The indenture of the trust shall clearly indicate resident responsibility for maintenance in cases of projects without common ground.
- D. The responsibility of maintenance of the detention/retention facilities in single owner development projects shall remain with the general contractor until final inspection of the development is performed and approved and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention/retention facilities shall be vested with the owner of the project.

Section 425.120. Enforcement, Violations and Penalties.

[R.O. 2008 §24-30.12; Ord. No. 2207 §1, 1-27-2003; Ord. No. 5043 §2, 7-14-2008]

A stormwater management plan shall be subject to all provisions of Article **IX** of Chapter **405** relating to Enforcement, Violations and Penalties. In addition, a corporate surety bond, conditioned upon carrying out all and every part of approved plans for at least the sum estimated to be the full costs of carrying out such plans, or a cash escrow, upon the same conditions and in the same amount, shall be furnished the City whenever such costs exceed five hundred dollars (\$500.00). An additional penalty of five hundred dollars (\$500.00) a day can be assessed. The bond or escrow shall be released upon proper completion of all of the requirements of such approved plans.