CHAPTER

1

OVERVIEW OF INTEGRATED SITE DESIGN

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1.1 Purpose and Scope of the Technical Guidance Manual

The Stormwater Manual for the City of Wichita and Sedgwick County consists of three volumes:

- Volume 1 – Policy Manual
- Volume 2 – Technical Guidance Manual
- Volume 3 – Plan Preparation Guidance Manual

Volume 1 is an overview of the general stormwater policies that form much of the basis for the stormwater and floodplain ordinances, and the criteria and guidelines presented in Volume 2 and Volume 3. Volume 3 is intended to assist the developer and the developer's designers in the plan preparation, review and approval process. The purpose of this Manual (Volume 2 - Technical Guidance Manual) is to provide guidelines and certain criteria to be used in the design and maintenance of stormwater management facilities constructed for new developments or redevelopments. The guidance presented in this volume is intended to be consistent with the stormwater policies adopted by the City of Wichita and Sedgwick County (and presented in Volume 1), and the stormwater management and floodplain regulations for each jurisdiction. Where inconsistencies occur between the Manual and the regulation(s), the latter shall apply.

1.2 How to Use this Manual

A graphical stormwater manual navigation aide is provided on the next pages to assist the user in the application of this Manual to the specific local development process. These aides depict the general steps for land development in the City of Wichita and Sedgwick County. The appropriate corresponding chapters/sections/appendices for each development process step are also shown.

1.3 Integrated Site Design

This section provides guidance on the Integrated Site Design (ISD) methodology whereby the need to control both the water quality and water quantity impacts of new development are incorporated into a comprehensive, coordinated plan for the development site. Included are specific structural and non-structural controls or practices that may be used to accomplish those requirements. In addition, basic guidelines and criteria for the design of stormwater management infrastructure are included. The rationale behind the use of an integrated site design approach is presented in Volume 1 and therefore is not repeated here.

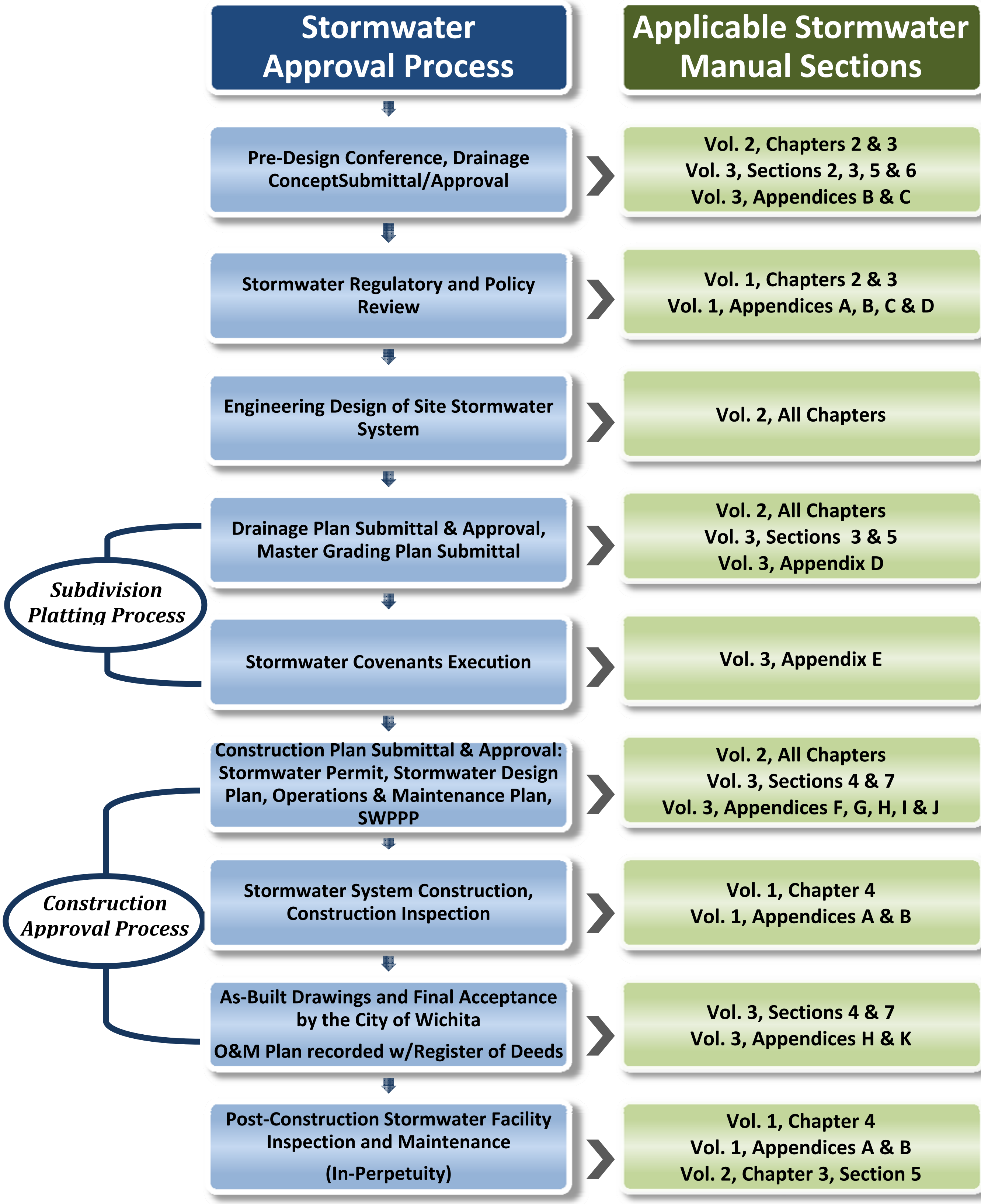

Figure 1-1 Manual Navigational Aide for the City/County Land Development Process

1.3.1 Goals

The basic goals of integrated site design for stormwater management facilities for new development or redevelopment, as defined in the relevant ordinances, are:

- To the maximum extent practicable, remove pollutants from the stormwater runoff from the development to protect water quality;
- Prevent increases in long-term downstream bank and channel erosion due to the development;
- Safely convey stormwater runoff through the project stormwater control system;
- Safely pass stormwater runoff through the downstream project boundary and control facilities without increasing peak flow rates at the project boundary; and,
- Prevent increases in flooding downstream of the development boundary.

The ISD approach is a coordinated set of design standards used to design stormwater controls to address these goals. Each of the ISD design steps may be used in conjunction with the other steps in the process to address the overall stormwater impacts from a developed site. When used as a set, the ISD approach addresses a wide range of hydrologic events, from the smallest runoff-producing rainfalls up to the 100-year, 24-hour rain event.

The requirements for achieving the ISD goals are presented in Table 1-1 as steps in the ISD process. Please note that there are some limited exceptions to these requirements. Those exceptions are presented in the ordinances and/or in the detailed discussions of the requirements.

Table 1-1 Steps for Integrated Site Design

Steps	Approach
Step 1: Water Quality Protection	The Water Quality Protection Volume (WQ_v) is the volume of runoff from the development as a result of the 85th percentile rain event. In the Wichita and Sedgwick County area, this is the 1.2 inch rain event. Water quality protection must be achieved by treating the WQ_v to remove 80% of the total suspended solids from the development site runoff.
Step 2: Channel Protection	The Channel Protection Volume (CP_v) is the volume of temporary detention required to detain the development site runoff for the 1-year, 24-hour rain event (of 2.8”) for a minimum of 24 hours (centroid-to-centroid) to prevent increased long-term downstream channel erosion. Alternatively, the difference in pre- and post-development runoff for the 1-year, 24-hour rain event may be retained on-site and released through evapotranspiration and/or infiltration, or reused.
Step 3: On-Site Stormwater Conveyance	On-site conveyances must be designed to convey their applicable design rain events (see criteria in Chapter 5) through the project while providing adequate protection from flooding for structures and other critical areas in the development for the 100-year rain event.

Steps	Approach
Step 4: Flood Protection	Principal and emergency stormwater controls must be designed to ensure that the post-development peak discharges for the 2-year through 100-year, 24-hour rain events do not exceed pre-development values at the project boundary, and can be discharged safely from the project.
Step 5: Downstream Assessment	In conjunction with Step 4, principal and emergency stormwater controls must be designed to ensure that the post-development peak discharges for the 2-year through 100-year, 24-hour rain events do not exceed pre-development values downstream of the project boundary.

Figure 1-22 conceptually illustrates the relative volume requirements of each of the integrated site design steps and demonstrates that the requirements typically overlay one another. If the assessments for flood control indicate on-site detention is needed to limit the discharge from a development, the volume requirement to achieve the flood protection requirement could also contain the volume needed to provide for channel protection and water conveyance. The appropriate type of detention facility could be designed with outlet controls to address each of the steps of the design approach. Obviously, detention may not be required in all situations; consideration of site design practices and stormwater controls that work together to meet all the requirements is what is important. The following sections describe the integrated site design approach in more detail.

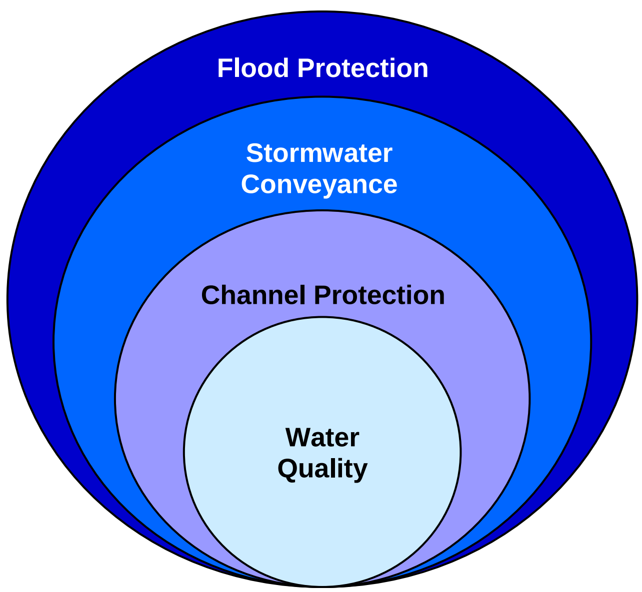

Figure 1-2 Representation of the Integrated Site Design Approach

1.3.2 Water Quality Protection Volume and 80% TSS Removal

Hydrologic studies show smaller, frequently occurring rain events account for the majority of rain events. Consequently, the runoff from the many smaller events also accounts for a major portion of the annual pollutant loadings. By treating these frequently-occurring, smaller rain events and the initial portion of the stormwater runoff from larger events, it is possible to effectively mitigate the water quality impacts from a developed area.

Studies have shown the 85th percentile rain event (i.e., the storm event that is equal or greater than 85% of the events that occur) is a reasonable target for addressing the majority of smaller, pollutant-laden runoff events. Based on a rainfall analysis, 1.2 inches of rainfall has been identified as the depth corresponding to the 85th percentile storm for the City of Wichita and Sedgwick County (using a 6-hour minimum dry interval to separate "events"). The runoff from these 1.2 inches of rainfall is referred to as the water quality protection volume, henceforth abbreviated as WQ_v.

In accordance with the stormwater policies presented in Volume 1, Chapter 3 of this Manual, the WQ_v must be treated to a standard of 80% removal of total suspected solids (TSS). TSS is the parameter chosen as the representative stormwater pollutant for measuring treatment effectiveness for several reasons:

- The standard of using TSS as an "indicator" pollutant is well established;
- suspended sediment and turbidity are directly associated with TSS and are a major source of water quality impairment due to urban development; and,
- a fraction of many other pollutants of concern are removed either along with TSS, or at rates proportional to the TSS removal.

Thus, a stormwater management system designed to meet the requirements for treating the WQ_v will treat the first 1.2 inches of runoff (or less for smaller storms) to the 80% TSS removal standard. Detailed guidance on the calculation of WQ_v and % TSS Removal is presented in Volume 2, Chapter 4, Sections 4.13 and 4.14 respectively.

1.3.3 Channel Protection Volume

The increase in the frequency and duration of bankfull flow conditions in stream channels (typically the 1 to 2-year storm events) due to development is a primary cause of accelerated channel erosion and the widening and down-cutting of stream channels. Therefore, the channel protection requirements apply to all development sites for which there is an increase in flow from the 1 to 2-year rainfall events (either volume or rate) to downstream channels, ditches and streams. (This type of channel protection is not to be confused with localized protection against erosion and scour. This type of protection is intended to address long-term channel-forming flows associated with stream geomorphological changes. Localized erosion and scour protection are discussed in Chapter 5, Section 5.7.

Channel protection is achieved by providing 24 hours of extended detention on-site for the post-developed runoff generated by the 1-year, 24-hour rainfall event. The reduction in the frequency and duration of bankfull flows through the controlled release provided by extended detention of the Channel Protection Volume (CP_v) will reduce the bank scour rate and severity. An alternative to extended detention of the CP_v is to retain the difference between the 1-year, 24-hour pre-development and post-development runoff volume on-site, and release the volume through evapotranspiration, reuse, and/or infiltration. Detailed guidance on the calculation of CP_v is presented in Volume 2, Chapter 4, Section 4.15.

1.3.4 On-Site Conveyance

The on-site stormwater system must be designed to convey the design storm events to provide protection for structures, streets, sidewalks, and other critical areas in the development. On-site conveyance is typically accomplished with a combination of conveyance systems including street and roadway gutters, inlets and drains, storm sewers, culverts, swales and ditches. The presence of other stormwater management facilities may affect the design of these systems. The design storm event criteria associated with the various features, and guidance on stormwater analysis and design, are presented in Volume 2, Chapter 5.

After the initial set of on-site controls are selected for the design storms, the full development build-out 100-year, 24-hour storm (or appropriate duration for intensity-based runoff estimates) shall be applied to the on-site conveyance system and stormwater controls to determine the overall flow paths, velocities and depths for the larger storm. Even though the conveyance systems may be appropriately designed for smaller design storm events per the criteria discussed in Volume 2, Chapter 5, overall the site must be designed to safely pass or temporarily store the resulting flows from the full build-out 100-year storm event without flooding structures or other critical features. Guidance on calculation methods to compute peak flows for use in the on-site conveyance design is presented in detail in Volume 2, Chapter 4.

1.3.5 Flood Control

Principal and emergency stormwater controls must be designed to ensure that the post-development peak discharges for the 2-year through 100-year, 24-hour rainfall events do not exceed pre-development values at the project boundary, and can be discharged safely from the project. This is typically accomplished by constructing a stormwater detention pond at or near the downstream project boundary that is designed to control peak flows, and is constructed in such a manner that will permit the flood discharges to pass through and beyond the facility without causing damage to the facility or receiving stream.

The physical characteristics required for detention ponds are reviewed in Volume 2, Chapter 3. The hydrologic procedures for computing flood inflow to detention ponds, and routing those flows through the ponds, are presented in Volume 2, Chapter 4. Note that when multiple flood control facilities are located within the site (not just at the project boundaries), a hydrologic model reflecting the pond network must be used. A discussion of hydraulic analysis and design for energy dissipators/erosion protection, spillways, channels, etc. is presented in Volume 2, Chapter 5.

1.3.5.1 Downstream Assessment

In conjunction with the basic flood control requirements (above), principal and emergency stormwater controls must be designed to ensure that the post-development peak discharges for the 2-year through 100-year, 24-hour rainfall events do not exceed pre-development values downstream of the project boundary. If pre-development peak discharges are exceeded, then the site design must be modified to eliminate the peak discharge increases. The local jurisdiction's stormwater management regulation in Volume 1, appendices includes a list of limited exceptions to this requirement.

1.3.6 Summary of Integrated Site Design Requirements

In summary, the following are required (unless accepted in limited cases under the provisions of the local jurisdiction's stormwater management regulation):

- The runoff from the entire development area (except as adjusted for WQ_v reductions) must be treated to remove at least 80% of TSS for the 85th percentile rainfall of 1.2 inches. (Water Quality)
- The runoff from the entire site (including WQ_v reduction areas) for the 1-year, 24-hour storm event must either be detained for at least 24-hours, or the difference in pre- and post-development runoff volume for that event must be retained on-site. (Channel Protection)
- On-site stormwater conveyances must be designed to convey the peak flows associated with their applicable design rainfall criteria, and must also be capable of conveying the 100-year event without flooding structures or other critical features. (On-Site Conveyance)
- If the project results in an increase in flood peaks at the project boundaries, detention controls must be provided to ensure that post-development flows do not exceed pre-development peak flows at the project boundaries, and that the flows may be safely passed through the detention facilities. (Flood Control)
- Flow conditions in the receiving stream downstream of the project must be evaluated to ensure that the development does not increase peak flows or velocities. (Downstream Assessment)

1.4 Preferred Site Design and WQ_v Reductions

The ISD requirements discussed in the previous section are driven by the hydrology of the development site. In the most basic sense, the more runoff generated by a site, the greater the amount of WQ_v that must be treated, the larger the amount of CP_v that must be managed, and the larger the peak flows that must be attenuated for flood control. Therefore, there is a built-in incentive for a development to be designed in a manner that would result in less runoff volume and lower peak flows than would a conventional design that does not consider those effects. This approach is called "Preferred Site Design" (PSD). These "non-structural" practices are not required, but are recommended where practicable and economically viable.

PSD practices are discussed in detail in Volume 2, Chapter 2. In general, these practices consist of site designs that minimize impervious areas, minimize disturbance of site soils, preserve natural areas, and promote infiltration (where permissible). The obvious effect is reduced hydrologic response of the development and a reduction in the amount of pollutants and thus required treatment.

Some of the PSD practices are sufficiently effective at reducing or eliminating pollutants in runoff that they are designated as WQ_v reductions. Runoff from those areas is not required to be treated for water quality protection and thus may be subtracted from the WQ_v. Reductions are discussed in detail in Volume 2, Chapter 2.

1.5 Structural Stormwater Controls

In some cases, the use of non-structural PSD practices may eliminate the need for constructing any stormwater management facilities (stormwater controls) on a site other than for routine conveyance needs. However, in most cases structural stormwater controls must be used to completely accomplish all of the requirements of integrated site design.

Volume 2, Chapter 3 provides a detailed presentation of the various types of stormwater management facilities permitted for use. In general, the controls consist of detention, filtration, or infiltration facilities that remove TSS from the runoff, and/or detain runoff for quantity control (CP_v and floods). Examples include detention and retention ponds, constructed wetlands, bioretention areas, infiltration trenches, and engineered swales. For each type of control, a design value for the TSS removal rate is provided for use in computing overall TSS removal for the project site. In addition, specific criteria for the facilities are provided to ensure that the controls will achieve the design objectives.