Ensuring Hydrologic Balance

Goal 2	**To ensure balance between inflow, outflow and the storage of water and encourage a productive landscape**
Objectives	2.1 To protect, preserve and use natural surface and groundwater storage and retention systems. 2.2 To promote Groundwater recharge. 2.3 To gather and disseminate weather data and climatic information, and provide meteorological expertise in support of Watershed District land and resource management decisions and weather related management activities.

Introduction

Hydrologic balance involves accounting for the inflow to, outflow from, and storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir; the relationship between evaporation, precipitation, runoff, and the change in water storage.

General water balance is represented by the equation:

$$\mathbf{P = ET + R + \Delta SMS + \Delta GMS + \Delta DS + GWF}$$

Where,

Variable	**Definition**
P	Total precipitation input
ET	Total evapotranspiration loss
R	Total stream flow
ΔSMS	Change in soil moisture storage
ΔGMS	Change in groundwater storage
ΔDS	Change in depression storage
GWF	Groundwater flux (groundwater flow into or out of the drainage basin).

Water balance is used to help manage water supply and predict where there may be water shortages or flooding. It is also used in:

- Irrigation
- Runoff assessment (e.g. Through the runoff models),
- Flood control
- Pollution control
- Design of drainage systems.

Within the Coon Creek Watershed emphasis has been placed on the components and characteristics of stream flow. This is because sources, quantity and distribution of stream flow and any changes that may result from future development have direct impacts on the water quality and quantity downstream.

Current Situation

Nine key indicators influence the balance between the inflow, outflow and storage of water within the watershed:

1. Drainage area
2. Disposition of land uses
3. Total precipitation
4. Total loss to evaporation
5. Total stream flow
6. Changes in soil moisture storage
7. Changes in groundwater storage
8. Changes in depression storage
9. Groundwater flux.

Drainage Area

Over the past ten years the drainage area of Coon Creek has increased 13~~4~~ square miles to a total size of 107~~6~~ square miles. With the addition of lands once part of the Six Cities Watershed Management Organization, Coon Creek has inherited many more subwatersheds and minor subwatersheds draining directly to the Mississippi river and more water on average to manage.

Disposition of Land Uses

At present the watershed contains more intensive land uses in the southwestern and downstream portions of the watershed and less intensive land uses in the northeastern portion of the watershed.

Within the less intensive land use areas, land use is expected to become more diverse with intensive land uses existing upstream from less intensive, drainage sensitive land uses like agriculture.

Hydrologic balance within these areas involves an awareness of the effects of the rapid runoff from more intense land uses on agricultural land, and more so the cumulative effect of multiple intensive land uses discharging into a drainage ditch that also provides agricultural drainage. If not analyzed and regulated carefully, the cumulative peak discharges will occur at an elevation and for a duration that will slow or prevent the drainage of crop land. It can also occur at a volume that will trigger or facilitate soil erosion and stream bank failure.

Total Precipitation

Ensuring hydrologic balance depends on knowing the critical duration and frequency of various precipitation events that can create “imbalance” in the system and result in either flooding, non-performance of stormwater infrastructure or erosion.

During the period of 2000 to 2010, annual precipitation has generally decreased from an annual average of 30 inches to approximately 27 inches per year causing drought conditions.

While annual precipitation has generally been below the normal, annual fluctuation and the droughty conditions are among the driest on record, however, the occurrence of below normal precipitation has not altered the frequency, duration and intensity of precipitation for this area of the state. In fact, shorter duration, higher intensity storms appear to be occurring with increased frequency.

Loss to Evapotranspiration

Ensuring hydrologic balance involves recognizing that 80% of all precipitation falling on the watershed is lost to evapotranspiration.

Month	Average Precip. (in)	(PET) Potential Evapotranspiration (in.)	Avg. Precip. minus PET (in)
January	1.13	0.00	1.13
February	0.81	0.00	0.81
March	1.73	0.00	1.73
April	2.62	1.34	1.28
May	3.57	3.55	0.02
June	4.29	4.89	-0.60
July	3.99	5.70	-1.71
August	4.04	4.94	-0.90
September	3.04	3.07	-0.03
October	2.38	1.48	0.90
November	1.92	0.00	1.92
December	1.06	0.00	1.06
Total	**30.58**	24.98 (80%)	5.61

Stream Flow

Ensuring hydrologic balance in drainage sensitive and flood prone area means ensuring stream flow. In other areas, excessive stream flow can result in illegal drainage of wetlands or contribute to flooding downstream.

Lower portions of the watershed (Drainage area below U.S. 10) have become increasingly flashy over the past 20 years. This condition is a result of:

<u>The Age of the Neighborhoods</u>: The subwatersheds that contribute directly to lower coon creek were fully developed and have been long before any of the current stormwater or water quality management programs. Most of the development in this portion of the watershed was built in the 1950's, 60's and early 70's when the stormwater paradigm

was to prevent flooding by getting water off the land. Consequently the stormwater infrastructure focuses on collection and conveyance

Coon Creek Flood Control Strategy: The flood control strategy for Coon Creek in Coon Rapids has relied upon Coon Rapids below Main Street to discharge first. This strategy was designed to accommodate increased volumes of water arriving in Coon Rapids from the then agricultural lands upstream. This strategy is well entrenched in the infrastructure and policies developed within the Coon Creek Watershed and remains a successful and prudent strategy to this day.

Higher intensity, shorter duration rain falls: If we apply the changes discussed in the discussion on precipitation to the lower Coon Creek Watershed we see higher quicker peak discharges for these areas and greater chance of flash flooding.

Changes in Soil Moisture Storage

Ensuring hydrologic balance through maintenance of soil moisture involves keeping organic soils saturated to prevent them from becoming hydrophobic or compensating for the fact that large areas may have been converted to a "well drained" condition, transferring water at a rate and volume which may involve mitigation through stormwater practices.

Changes in Groundwater Storage & Flux

As surficial groundwater declines there is more groundwater storage available. Given the soils over most of the watershed, infiltration will be very difficult to prevent (i.e. groundwater recharge should be easy to accomplish). If surficial groundwater levels continue to fall between 2013 and 2023, the watershed will experience a decline in surficial water features, such as

a. Lakes (decline of 50% surface area)
b. Wetlands (8,375 acres)

Changes in Depression Storage

Depression storage plays a key role in maintaining hydrologic balance. On average, over the last 10 years, there has been a 3.5 day increase in time it takes for the system to return to base flow after a two inch rainfall across the watershed. The increased duration is likely from the ponding constructed during development over the past ten years. The exception is the headwaters of Coon Creek, where little development has occurred.

Peak flows have decreased an estimated 44% across the system. The greatest decrease has occurred on Sand Creek at Central Avenue where peak flows have decrease 80% to 35 cfs. Ditch 58 has seen a 20 cfs increase in peak flows.

Strategies to Achieve the Goal	The Coon Creek Watershed District will pursue five strategies and related actions to pursue hydrologic balance: 1. Development Regulation: Regulation of land disturbing activities and enforcement of the district rules 2. Operations and Maintenance 3. Planning, Programming and Budgeting 4. Public and Governmental Relations 5. Research and Monitoring
Development Regulation	Coon Creek will encourage the utilization of all appropriate best management practices for erosion and sediment control and storm water management. To ensure compliance with permit requirements and the goals, objectives and rules of the District. To prevent unacceptable damage to the water and related natural resources of the watershed. To exercise control over proposed developments or activities, only to the extent necessary, to insure the hydrologic balance, the public health, safety and enjoyment; the preservation and enhancement of wildlife; and the conveyance and disposal of stormwater runoff. To monitor, evaluate and permit plans and programs affecting the water and related land resources of the District. To regulate land-disturbing activities affecting the quality, course, current or cross section of ditches and watercourses.
Operations and Maintenance	Conduct an annual inspection of 20% of the drainage system. Maintain ditch and conveyance systems.
Planning, Programming and Budgeting	Use meteorological data in resource management decisions. Establish formal weather program leadership and management at the sub-watershed level. Ensure that the location of weather stations meets multiple-use management and/or research needs of the Watershed District.
Public & Governmental	Provide materials to educate and opportunities to involve citizenry in improving water quality.

Relations	Keep citizenry and local units of governments informed of high water tables that may result in potential flood conditions. Provide any materials requested or needed to aid in an informed citizenry. Outlet informational materials through local media and governments. Cooperate to the extent feasible with local state and federal agencies to secure water measurement data. Execute an Interagency Agreement specifying actions and other terms of agreement, when water measurement data is furnished to another agency on a regular schedule.
Research and Monitoring	Install, operate, and maintain Watershed District weather stations in accordance with standards issued in this chapter and related directives unless those standards would conflict with the primary objective of a station operated for research purposes. Locate year-round Watershed District weather stations to optimize the multidisciplinary needs for real-time weather and climatological data when consistent with the primary objective of the station. Coordinate weather data collection activities within the Watershed District and with cooperators. Maintain a Watershed District Weather Database. Design, coordinate, and maintain a weather information management system that will meet land and resource management needs of the Watershed District. Monitor water quality and condition of lakes within the watershed. Monitor water quality at the outlet to the watershed for signs of potential impairment. Model the hydrology of surface water flows within the watershed. Assess the overall hydrology of the Watershed every 5 years. To monitor the actual rate of infiltration on various sites within the watershed.

Monitor lake levels.

Monitor water quality and condition of lakes within the watershed.

Monitor water quality at the outlet to the watershed for signs of potential impairment.

Collect continuous precipitation data.

Monitor stream levels.

Monitor wetland hydrology on the edge of known wetlands.

Secure basic information necessary for modeling and forecasting runoff.

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