COMBINED SEWER SYSTEM FLOODING MASTER PLAN

Clean Water Nashville

EXECUTIVE SUMMARY | JANUARY 2024

The Combined Sewer System Flooding Master Plan is a high-level roadmap intended to assist Metro Water Services (MWS) as they address flooding and prepare for growth within Nashville's combined sewer system (CSS). The improvements presented in this Master Plan are large in scope and represent a new phase of investment in Nashville's infrastructure.

Why prepare a CSS Flooding Master Plan?

Metro's CSS provides drainage for both storm and sanitary flows in Nashville's core urban area (**Figure 1**). The CSS covers approximately 12.6 square miles of drainage area, which constitutes 2 percent of Davidson County's land area. Though the CSS represents a small portion of Metro's drainage area, its sanitary flow, which is the flow generated by residents, businesses, and industries, is considerable. Based on population and employee data from the Greater Nashville Regional Council, that flow is anticipated to grow by 9 percent by 2045.

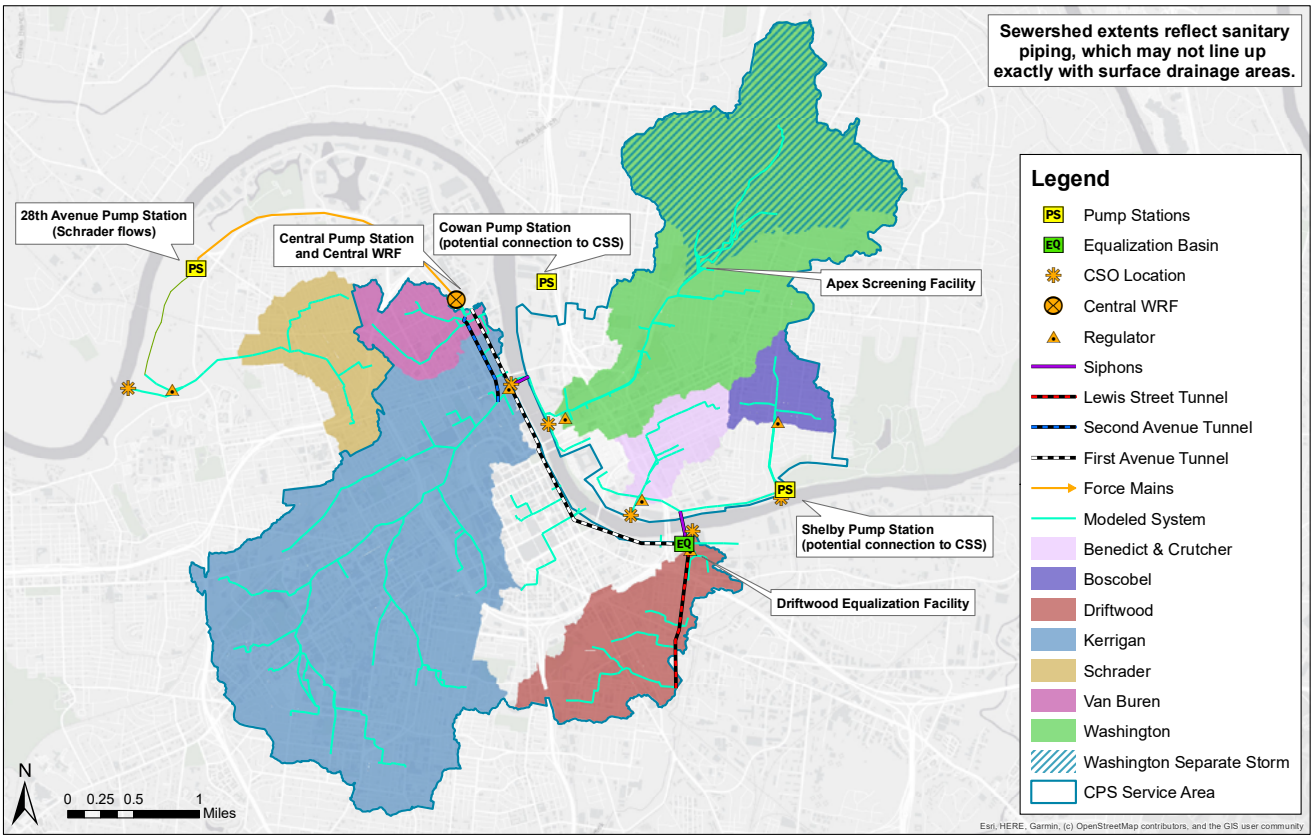

Figure 1. The CSS and its key infrastructure

Redevelopment and growth may also bring changes to storm runoff. Though much of the CSS is highly urbanized and has high levels of impervious surfaces such as parking lots and structures, some areas may see significant increases in runoff over time. Regulations are in place to require appropriate stormwater management for commercial and other large developments, but some residential development (such as smaller infill development or construction of outbuildings) may result in increased runoff for large storm events, such as the 100-year design storm.

These increases to dry- and wet-weather flow in the CSS were considered as the Master Plan was developed.

While previous infrastructure investments within the CSS have focused primarily on water quality–related impacts from combined sewer overflows (CSOs), the improvements included in the Master Plan are intended to address persistent, large-scale flooding issues. MWS evaluates flooding issues and generally prioritizes the potential solutions based on the following, in order of importance: life and safety, property damage, and nuisance flooding.

A hydraulic and hydrologic (H&H) model was used to simulate the infrastructure of the CSS. In addition to the sub-surface pipes and structures of the CSS, the model includes surface features such as streets and ditches that can be used to assess flooding and validate locations with observed inundation. Building footprints, roadways, and elevation data were used to evaluate modeled flooding and assess the risk to life, safety, and properties.

1

Life and Safety

Protecting human life and safety is of the utmost importance in flood mitigation.

2

Property Damage

Evaluating the potential damage to properties caused by flooding is crucial.

3

Nuisance Flooding

Nuisance flooding, which does not threaten life or safety and does not cause property damage, is also important, though to a lesser extent.

Where does it flood?

The identification and confirmation of flood-prone areas was key to the success of this Master Plan. A heat map of stormwater service requests, news reports of flooding, and anecdotal flooding locations were compiled and presented to MWS staff. Twenty-five flooding locations were identified in the CSS. Many of these locations refer to general areas rather than single structures or road crossings. **Figure 2** shows these locations overlain with the flood extents predicted by the H&H model for the 100-year design storm. The H&H model validated 23 of the 25 flooding locations.

Areas that have observed flooding but were not predicted by the H&H model include two locations near 21st and 23rd Avenues North in Midtown. These may be due to capacity limitations in the minor system (inlets and small conveyance), which is beyond the model's resolution. The model assumes that drainage is not constrained by issues in the local collector pipes such as damage or blockages and considers surface flooding to begin when the major system (interceptors and other large conveyance) is at capacity. Flooding locations driven by the minor system warrant additional review.

Areas predicted to flood by the model that were not included as a flood-prone area included City Cemetery and Morgan Park, both of which may experience flooding but are not considered threats to life and safety or property. Flooding caused by high levels in Browns Creek and the Cumberland River were not considered as part of this Master Plan.

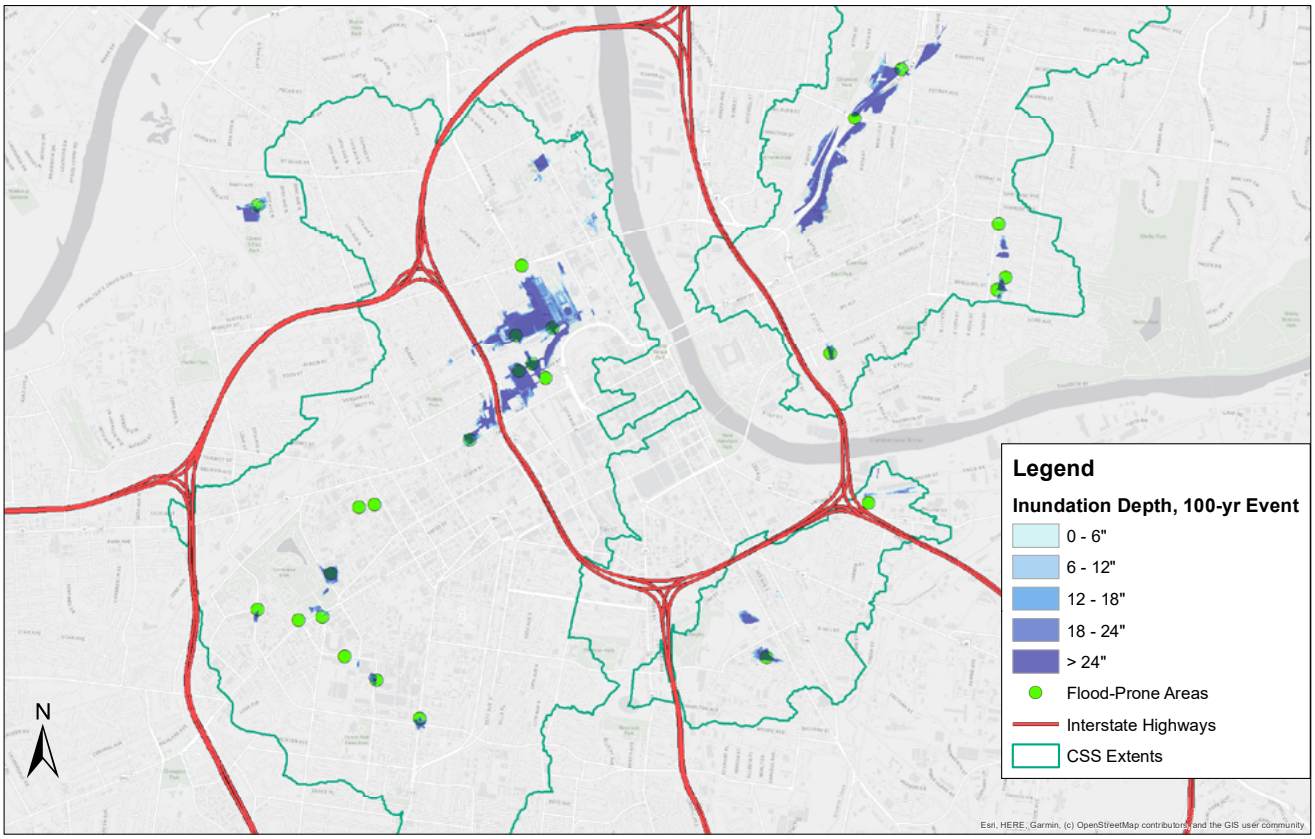

Figure 2. Flood-prone areas and model-predicted flooding in a 100-year storm

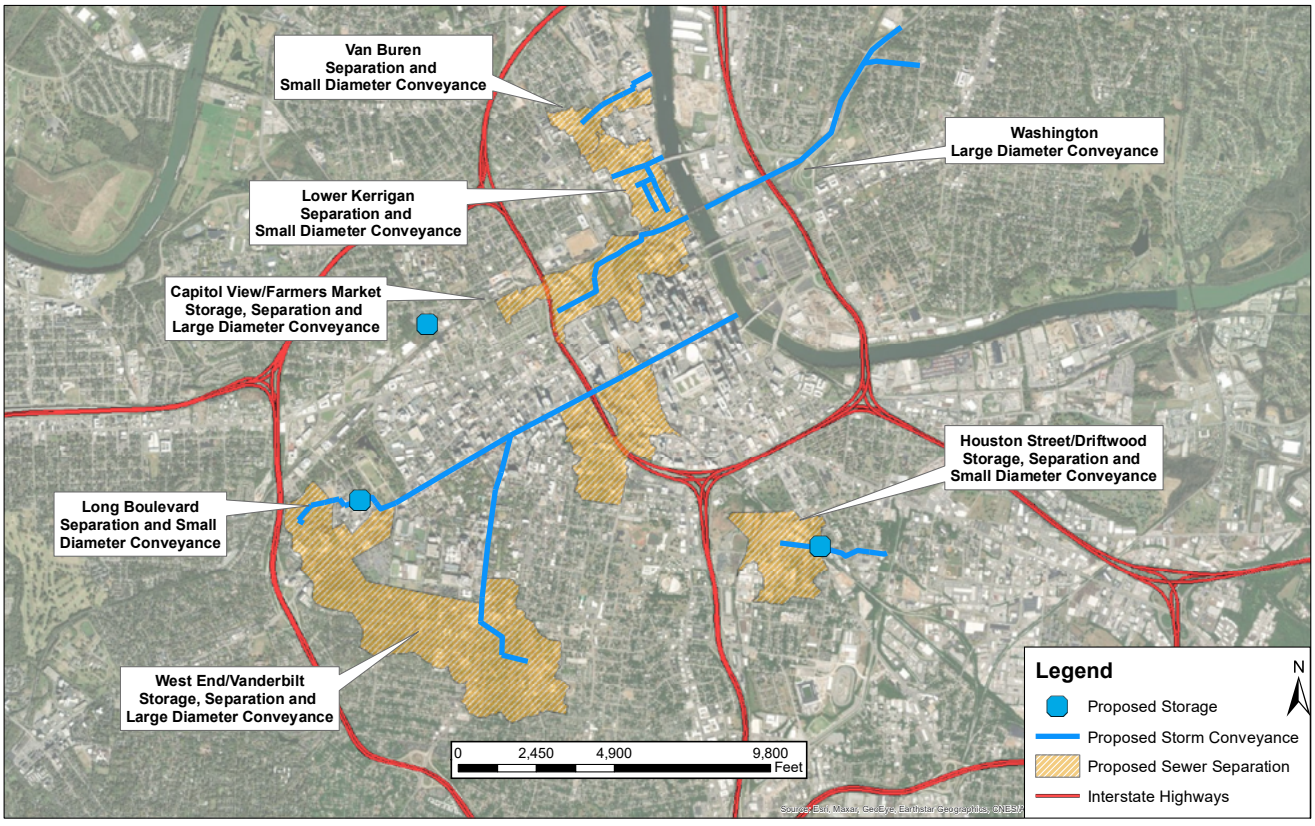

Figure 3. Map of improvements identified in the Master Plan

How do we improve flooding?

The H&H model representing 2045 conditions was used to assess the effectiveness of improvements within the CSS. Potential improvements include piping and pump station conveyance improvements, detention/storage facilities to temporarily capture peak stormwater runoff, and sewer separation which replaces the combined sewer network with separate pipes for stormwater and sanitary sewer flows. Additionally, green infrastructure and low impact development features were also considered but were found to have negligible benefits for large, high-intensity storm events evaluated in this study. The following improvements were identified through the Master Plan process (also shown in **Figure 3**), although detailed siting and routing of improvements will be further evaluated as design progresses:

Washington

- A 13-foot-diameter conveyance tunnel routing storm flow from the Apex screening facility southwest, generally following Ellington Parkway and the railroad right-of-way, collecting additional runoff from Cleveland Street, and terminating at the Cumberland River adjacent to the existing Washington Facility.
- A 54-inch pipe collecting excess runoff from the Cleveland Street corridor and delivering it to the 13-foot-diameter tunnel.

Houston Street/Driftwood

- Separation and conveyance of stormwater flows along Houston Street, continuing east under 4th Avenue South to Browns Creek.
- A 2.25-acre-foot (730,000-gallon) stormwater storage unit/facility near Dudley Park.

Van Buren

- Separation and conveyance of stormwater flows along Van Buren Street beginning at 6th Avenue North and terminating at the existing 72-inch outfall east of Adams Street / 1st Avenue North.

Lower Kerrigan

- Separation and conveyance of stormwater flows to the Cumberland River from the area generally between 1st Avenue North, Harrison Street, 4th Avenue North, and Jefferson Street.

Capitol/Farmers Market

- Separation and conveyance of stormwater flows from the Capitol View area and the north side of the Capitol, with the conveyance terminating at the Cumberland River near Gay Street and 1st Avenue North.
- A 7.75-acre-foot (2.5-million-gallon) stormwater storage unit/facility in the Herman Street corridor.

West End/Vanderbilt

- A 16-foot-diameter conveyance tunnel originating at West End and 25th Avenue North, routed under West End and Broadway, collecting flow at intermediate points near the Gulch, and terminating at the Cumberland River.
- Separation and conveyance of stormwater flows upstream of the Vanderbilt campus and designated areas along the 16-foot-diameter tunnel corridor, as well as an 8-foot-diameter tunnel along 21st Avenue North to capture separated stormwater from upstream of Vanderbilt's campus.
- *Alternative Routing* – All of the above except routing the proposed tunnel along Elliston Place / Church Street and terminating at the Cumberland River near Church Street and 1st Avenue North.

Long Boulevard

- Separation and conveyance of stormwater flow in the Long Boulevard and 31st Avenue North area, which is routed east near Centennial Park, eventually terminating at the proposed 16-foot-diameter stormwater tunnel on West End (West End/Vanderbilt project).
- *Alternative* – All of the above except a 5-acre-foot (1.6-million-gallon) stormwater storage unit/facility near Centennial Park to detain flows from the Long Boulevard project area in lieu of a connection to the West End/ Vanderbilt project.

The planned sewer separation in the Benedict & Crutcher, Boscobel, and Schrader areas is anticipated to resolve flooding issues in those neighborhoods. Areas recommended for separation in the Master Plan may see a reduction in flooding in the minor system due to the installation of new stormwater infrastructure, including inlets and small diameter piping.

What will it cost?

Planning-level project development and construction costs were generated for each improvement. These costs can be used to generate a capital program associated with flood mitigation in the CSS. Project costs are in 2023 dollars and reflect conceptual-level planning efforts.

Due to the anticipated long duration for program implementation, significant escalation of costs is expected, and costs should be further reviewed as anticipated construction timeframes for individual projects are determined.

Summary of Flood Improvement Project Costs

Project	Estimated Project Cost in 2023 Dollars
Washington	$ 144,000,000
Houston/Driftwood	$ 89,000,000
Van Buren	$ 40,000,000
Lower Kerrigan	$ 66,000,000
Capitol/Farmers Market	$ 138,000,000
West End/Vanderbilt Area	$ 451,000,000
West End/Vanderbilt Area (alternate route)[1]	*$ 480,000,000*
Long Boulevard	$ 43,000,000
Long Boulevard (storage alternative)[1]	*$ 55,000,000*
Totals	**$ 971,000,000**

[1] Alternatives for West End/Vanderbilt and Long Boulevard are excluded from the total costs presented. These options, if selected, would replace the base project shown.

Will these projects address all flooding in the CSS?

With all Master Plan projects in place, exposure to flood risk is reduced at all identified problem areas, but flooding is not fully eliminated at four of the identified flood-prone areas. The remaining flooding is shown in **Figure 4**. Three of these areas are related to the Farmers Market and one is related to Washington.

With improvements in place, areas near the Farmers Market continue to exhibit limited flooding in the 10-year event and more significant flooding in the 100-year storm. This area of the system currently experiences extended flooding because of its large drainage area, the reliance on the Kerrigan CSO regulator, and available capacity downstream.

In the 100-year event, Sharpe Avenue in the Washington basin has properties that remain exposed to the risk of inundation after the improvements at Washington. This is driven by projected increases in imperviousness in the Washington basin and by the limited capacity of the box culvert that passes under Ellington Parkway, which was not assumed to be upgraded at part of the improvements.

Further separation and conveyance of stormwater in the Kerrigan and Washington basins would continue to mitigate observed flooding, though the cost of mitigating less frequent flooding may outweigh the benefit. Approaches that are "non-engineered" may supplement the alternatives provided in the Master Plan, particularly in areas that still see flooding in high-intensity rain events despite the proposed improvements. These solutions also may be implemented as near-term improvements to better mitigate flood risks before construction of other improvements. Examples include home and business buyouts, early warning systems, and signage in flood-prone locations.

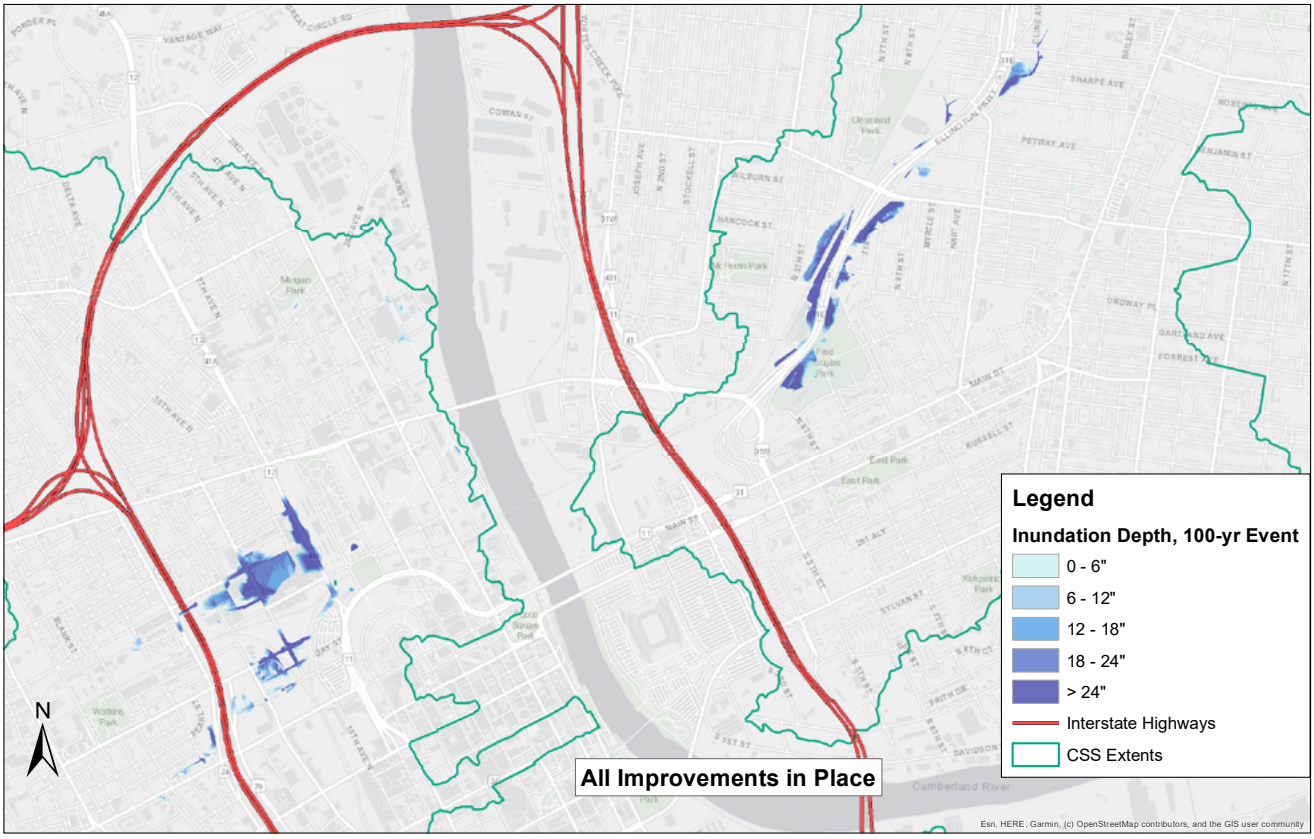

Figure 4. Remaining model-predicted flooding in a 100-year storm with improvements in place

How will these projects affect CSOs?

When all projects are considered together, considerable reductions in CSO activations and volume are predicted. Typical year activations, a metric intended to approximate yearly CSO statistics, are reduced from 15 to 8 at Kerrigan, and CSO volume is reduced by 74 percent. Activations at Washington are reduced from 19 to 12, and the CSO volume is reduced by 69 percent. Additionally, sewer separation projects underway in the Boscobel, Benedict & Crutcher, and Schrader areas are anticipated to eliminate those CSOs. These projects will further improve water quality in the Cumberland River.

Prepared by

CDM Smith®