Harpeth River-Spencer Creek Watershed Based Plan

Lead Organization: Cumberland River Compact
January 2021

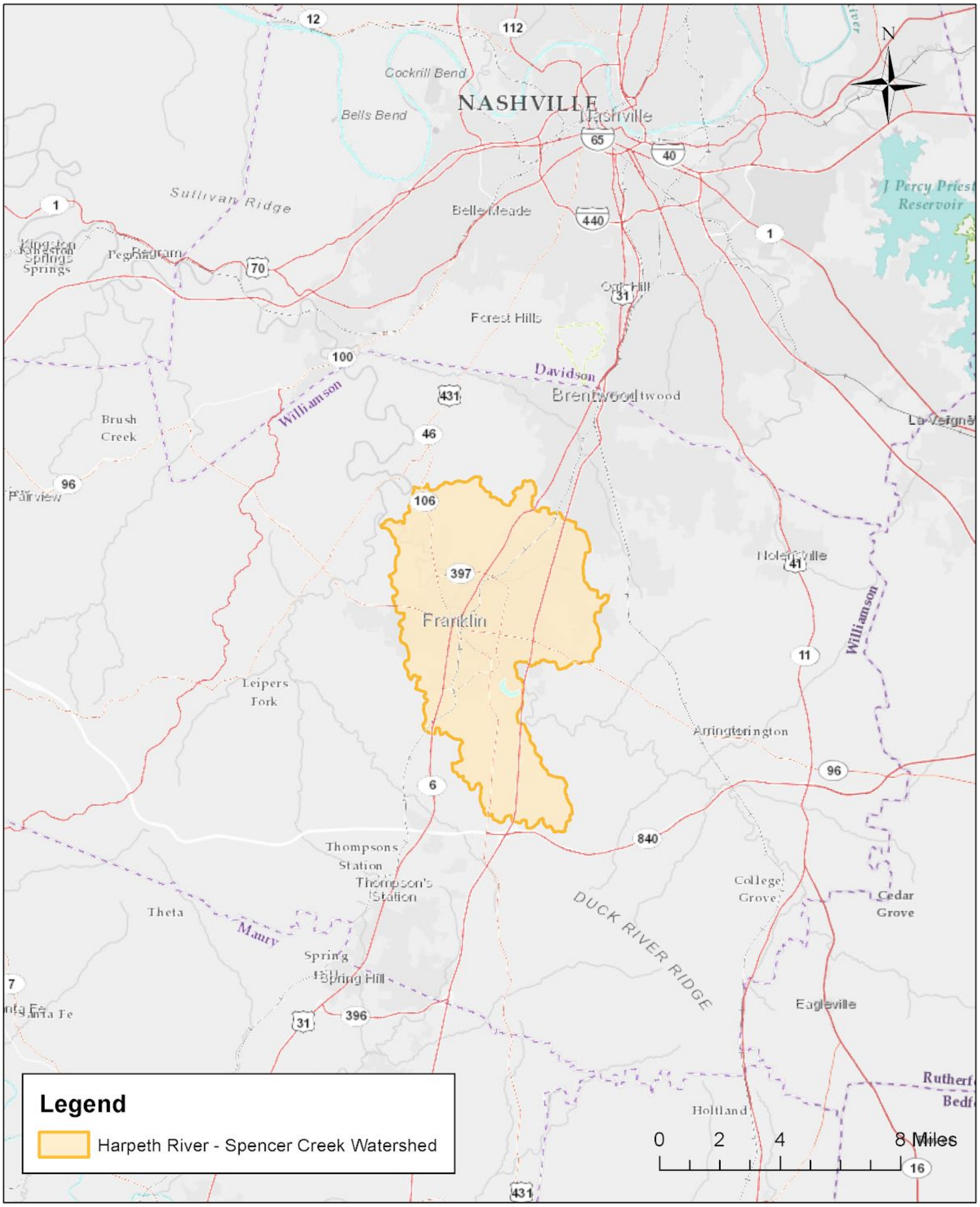
CUMBERLAND RIVER COMPACT

Watershed Identification (name, location, 12-digit HUC, etc.):

The project area is the watershed of Harpeth River - Spencer Creek (HUC_12051302040105), located in the heart of Williamson County in Tennessee (see Figure 1). Spanning approximately 33,000 acres (51.6 mi2), the Harpeth River - Spencer Creek watershed (HRSCW) contains approximately 82 miles of streams listed on the national hydrography dataset. The HRSCW drains a mixture of urban, suburban, agricultural, and forested land uses and encompasses most of the City of Franklin, TN. The 2016 National Land Cover Database (NLCD) categorizes most of the watershed as urban (53%), with additional area being pastureland (19%), forest (24%), and cropland (2%), and the remaining 2% being miscellaneous land uses. Of the developed land, 75% (25.6 mi2) is considered developed, open space or low intensity development, being primarily comprised of single family homes with large lawns.The remaining 25% (6.7 mi2) of the developed land is classified as medium or high development, which is characteristic of land that contains high density single family housing, multifamily housing complexes, and commercial development.

Using U.S. 2010 census data, an estimate of the watershed's population is approximately 62,250 – a population density of 1200/mi^2. However, the area's population has grown rapidly since 2010 and, in 2018, the U.S. Census Bureau estimated that the City of Franklin's population had grown from 62,800 to 80,900 (1900/mi^2). Because the HRSCW drains roughly 77% of the City of Franklin proper, we can safely project that today's population density is also higher.

Figure 1: Location of Harpeth River - Spencer Creek Watershed



Causes and Sources of Nonpoint Source Pollution in the Watershed

According to the current approved 303(d) list for 2020, a total of 76.95 miles of streams within the HRSCW are considered impaired by the Tennessee Department of Environment and Conservation. The remaining 4.84 miles of stream within the watershed are unassessed. Impaired waters make up 76.95 miles of the 81.79 total waterway miles in the watershed, or 94%.

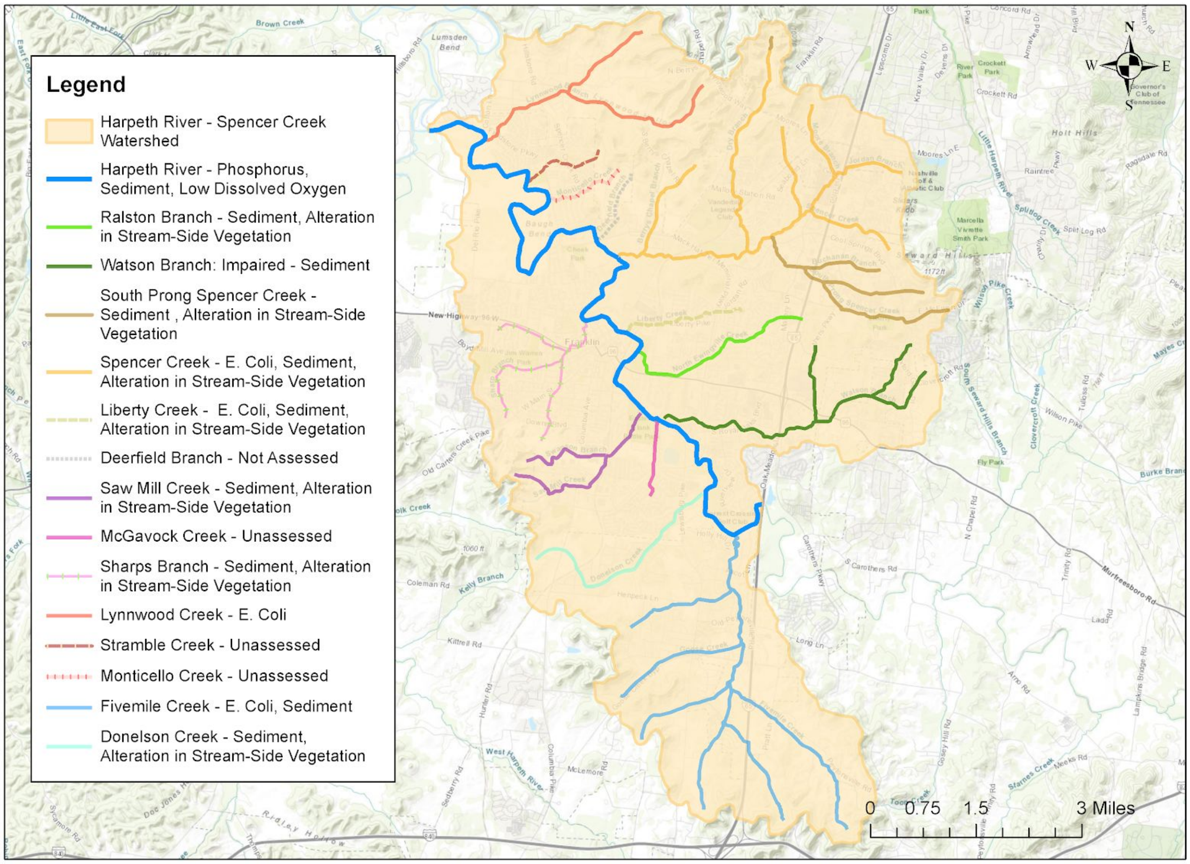
Table 1 identifies stream segments in the HRSCW that are listed on the Tennessee 303(d) list:

Table 1:Impaired Streams in the Harpeth River - Spencer Creek Watershed

Waterbody ID	Impacted Waterbody	Impairment(s)	Miles Impaired
TN05130204016_0100	Lynnwood Creek	*E. coli*	5.4
TN05130204016_0200	Spencer Creek	*E. coli*, Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	13.98
TN05130204016_0210	South Prong Spencer Creek	Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	5.76
TN05130204016_0300	Liberty Creek	*E. coli*, Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	0.54
TN05130204016_0350	Liberty Creek	*E. coli*, Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	1.31
TN05130204016_0400	Unnamed Trib to Harpeth River	Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	2.94
TN05130204016_0500	Watson Branch	Sedimentation/Siltation	6.8
TN05130204016_1000	Harpeth River	Phosphorous, Low Dissolved Oxygen, Sedimentation/Siltation	6.8
TN05130204016_1300	Fivemile Creek	*E. coli*, Sedimentation/Siltation	5.75
TN05130204016_1350	Fivemile Creek	*E. coli*, Sedimentation/Siltation	8.56
TN05130204016_1400	Donelson Creek	Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	3.4
TN05130204016_1500	Unnamed Trib to Harpeth River	Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	4

TN05130204016_160 0	Sharps Branch	Sedimentation/Siltation, Alteration in Stream-Side or Littoral Vegetative Covers	4.9
TN05130204016_200 0	Harpeth River	Phosphorous, Low Dissolved Oxygen, Sedimentation/Siltation	3.9
TN05130204016_300 0	Harpeth River	Low Dissolved Oxygen, Sedimentation/Siltation	9

Figure 2: Map of Impaired Streams



See Figure 2 for a map of impaired streams and their respective impairments.

This watershed plan intends to address stream-side/littoral vegetative alterations, sedimentation, pathogens, low dissolved oxygen, and phosphorous impairments within the HRSCW. Full implementation of the plan will remove all impaired segments from the 303(d) list of impaired streams. In the absence of full implementation, partial implementation of this plan can still greatly improve water quality in the HRSCW.

Total Maximum Daily Loads (TMDL) for the Harpeth River Watershed (HUC_805130204), which encompasses the HRSCW , exist for *E. coli* (2006), low dissolved oxygen and organic enrichment (2004), siltation and habitat alteration (2002), and metals (2002). Since the HRSCW does not contain segments with metal impairments,the 2002 metals TMDL is not referenced in this plan. The other three TMDLs are utilized for guidance on pollutant reduction goals.

However, due to the age of these plans, the EPA's Spreadsheet Tool for Estimating Pollutant Loads (STEPL v4.4) has been used to estimate pollutant loads, allowing this plan to accommodate for land use changes. Though STEPL allows us to estimate current loads within the watershed for Nitrogen, Potassium, and Sediment, version 4.4 does not provide estimates on pathogen loading or pathogen load reductions from best management practices (BMPs).Current bacterial loads were estimated using sampling data from the Tennessee Department of Environment and Conservation, which was accessed through the Environmental Protection Agency's "How's My Waterway" online tool. Needed reductions will be estimated using the TMDL established for *E. coli* in the Harpeth River Watershed.

According to the 303(d) list, the most common sources of impairments within the watershed are non-point sources. High density urbanization is the most common source , and site clearance/land development is another major source of sediment loads. Urbanization and new development create flashy conditions that carry pathogens and nutrients into the storm sewers and streams, and the high flows contribute to bank erosion, introducing excess sediment and additional nutrients from phosphorus rich soils into waterways. A focus on reducing nonpoint sources is extremely important in this watershed and restoration should be centered around four primary activities – runoff containment, infiltration, and mitigation; bank repair/protection; riparian and tree canopy restoration; and public education about pathogen sources and pathogen mitigation practices.

Visual Stream Assessments (VSAs) conducted and provided by the City of Franklin are used in tandem with the 303(d) list to identify potential sources of pollutants and appropriate BMP's to implement. These assessments are done in a phased approach in the City of Franklin and entail in person identification of impairments in local streams. A phased approach is developed in this plan, which dovetails with the City of Franklin's VSA phases to continually monitor the watershed.

E. coli

Table 2: Escherichia Coli (*E. coli*) Sampling In the Harpeth River - Spencer Creek Watershed

Waterbody ID	Impacted Waterbody	Sample Range (MPN/100ml)	Geometric Mean (MPN/100ml)	Sampling Year
TN05130204016_0100	Lynnwood Creek	88 - 1414	NA	2017
TN05130204016_0200	Spencer Creek	153 - 1046	290.46	2016
TN05130204016_0300	Liberty Creek	308 - 2420	880.49	2017
TN05130204016_0350	Liberty Creek	NA	NA	NA
TN05130204016_1300	Fivemile Creek	186 - 1046	535.03	2016
TN05130204016_1350	Fivemile Creek	613 -1986	1045.68	2016

Of the 81.79 stream miles within the watershed, 35.54 miles are impaired for *E. coli*, or 43.5%. Non-point sources of *E. coli* for all segments (with the exception of TN05130204016_1350) are due to high density urbanization in the 303(d) list. *E. coli* in segment TN05130204016_1350 is listed as resulting from grazing in riparian areas. The Tennessee Department of Environment and Conservation's (TDEC) Total Maximum Daily Load (TMDL) for *E. coli* also lists "stormwater runoff, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals" (TDEC, 2006, p. 19) as potential non - point sources of *E. coli*. The most recent available data from TDEC for pathogen loading was accessed through the Environmental Protection Agency's "How's My Waterway" online tool.

This plan's loading reduction goals are based on the 2006 TMDL for *E. coli* in the Harpeth River Watershed. This TMDL states that "The geometric mean standard for the *E. coli* group of 126 colony forming units per 100 ml (CFU/100 ml) and the sample maximum of 941 CFU/100 ml have been selected as the appropriate numerical targets for TMDL development" (TDEC, 2006, p. 7). Sample ranges and their geometric means for all *E. coli* impaired streams in the HRSCW can be found in Table 2.

In the case of TDEC's sampling listed above, all streams with available sampling data have exceeded the single sample maximums, and all streams with available geometric means have exceeded their geometric mean standard. Sampling dates for Lynnwood Creek were too sparse to use for the 30 day geometric mean criteria established in the TMDL. The only sampling location on Liberty Creek existed on segment TN05130204016_0300, downstream of segment TN05130204016_0350; considering both segments of Liberty Creek are listed as impaired for *E. coli*, it is assumed that required reductions to meet the TMDL criteria for the downstream segment TN05130204016_0300 are also applicable to the upstream segment TN05130204016_0350.

Sedimentation/Siltation

Table 3: Potential Sources of Sedimentation/Siltation Impairments		
Waterbody ID	**Impacted Waterbody**	**Potential Source**
TN05130204016_0200	Spencer Creek	Municipal (urbanized high density area)
TN05130204016_0210	South Prong Spencer Creek	Site clearance (land development or redevelopment)
TN05130204016_0300	Liberty Creek	Municipal (urbanized high density area)
TN05130204016_0350	Liberty Creek	Municipal (urbanized high density area)
TN05130204016_0400	Unnamed Trib to Harpeth River	Municipal (urbanized high density area)
TN05130204016_0500	Watson Branch	Site clearance (land development or redevelopment)
TN05130204016_1000	Harpeth River	Municipal (urbanized high density area)
TN05130204016_1300	Fivemile Creek	Site clearance (land development or redevelopment)

TN05130204016_1350	Fivemile Creek	Site clearance (land development or redevelopment)
TN05130204016_1400	Donelson Creek	Municipal (urbanized high density area)
TN05130204016_1500	Unnamed Trib to Harpeth River	Site clearance (land development or redevelopment)
TN05130204016_1600	Sharps Branch	Municipal (urbanized high density area)
TN05130204016_2000	Harpeth River	Municipal (urbanized high density area)
TN05130204016_3000	Harpeth River	Grazing in riparian or shoreline zones

Sedimentation/siltation impairs every stream within the HRCW with the exception of Lynnwood Creek (TN05130204016_0100). The State of Tennessee's 303(d) list identifies high density urbanization and land clearance as primary contributors of sediment/silt to streams within the watershed (see Table 3); grazing in riparian areas is also listed as a source to a lesser extent.

Developed in 2002 for the Harpeth River Watershed, the TMDL for Siltation and Habitat Alteration stated that "the primary sources of nonpoint sediment loads come from agriculture, roadways, and urban sources" (TDEC, 2002, p. 18), which corroborates sources of impairments listed in the current 303(d) list. It is worth noting that this TMDL assessed sources within the entire Harpeth River Watershed, of which the HRSCW is a subwatershed. As the HRSCW encompasses much of the City of Franklin, TN, sedimentation impairments are to a greater extent resulting from urbanization. Though agriculture is a contributor to sedimentation, it is not as prevalent within the more urban HRCW when compared to the Harpeth River Watershed as a whole.

STEPL 4.4 was used to estimate total sediment loading in the HRSCW. Publicly available data from the NLCD 2016 dataset, the Natural Resources Conservation Service (NRCS), the City of Franklin, TN, and the EPA was used in tandem with STEPL to provide this estimate. Unavailable data was estimated using a best educated guess. Using the STEPL model, estimated total sediment loading is **5,380 tons/yr**.

Low Dissolved Oxygen, Phosphorus, and Nitrogen

Table 4: Potential Sources of Phosphorus and Dissolved Oxygen Impairments		
Phosphorus		
Waterbody ID	**Impacted Waterbody**	**Potential Source**
TN05130204016_1000	Harpeth River	MUNICIPAL (URBANIZED HIGH DENSITY AREA)
TN05130204016_1000	Harpeth River	MUNICIPAL POINT SOURCE DISCHARGES
TN05130204016_2000	Harpeth River	MUNICIPAL (URBANIZED HIGH DENSITY AREA)
Dissolved Oxygen		

Waterbody ID	Impacted Waterbody	Potential Source
TN05130204016_1000	Harpeth River	MUNICIPAL (URBANIZED HIGH DENSITY AREA)
TN05130204016_1000	Harpeth River	MUNICIPAL POINT SOURCE DISCHARGES
TN05130204016_2000	Harpeth River	MUNICIPAL (URBANIZED HIGH DENSITY AREA)
TN05130204016_3000	Harpeth River	GRAZING IN RIPARIAN OR SHORELINE ZONES

Three segments of the Harpeth River, TN05130204016_1000, TN05130204016_2000, and TN05130204016_3000, are impaired for low dissolved oxygen. Two of those segments, TN05130204016_1000 and TN05130204016_2000, are also impaired for excess phosphorus. The State of Tennessee's 303(d) list identifies high density urbanization and municipal point source discharges as primary reasons for phosphorus and low dissolved oxygen impairments (see Table 4). Grazing in riparian areas is also listed as a source of dissolved oxygen impairments.

Developed in 2004 for the Harpeth River Watershed, the TMDL for Organic Enrichment and Low Dissolved Oxygen stated that "Possible nonpoint sources of nutrients and organic materials include urban runoff (from areas not covered under an MS4 permit), atmospheric deposition, geology, failing septic systems, and agricultural runoff on land associated with fertilizer application and livestock waste" (TDEC, 2004, p. 32). Like other referenced TMDLs, this TMDL assessed sources within the entire Harpeth River Watershed, of which the HRSCW is only a subwatershed. As the HRSCW encompasses much of the City of Franklin, TN, a higher percentage of phosphorus and low dissolved oxygen impairments are due to urbanization when compared to the rest of the watershed.

As discussed in the TMDL, this watershed sits in a region (ecoregion 71h) that is "dominated by highly phosphatic limestone that creates a significant background source component. Phosphorus can be adsorbed to sediment particles, transported to waterbodies, and released to the water column under certain circumstances. This can result in high concentrations of total phosphorus during runoff events, as well as during low flow conditions" (TDEC, 2004, p. 32). In the HRSCW, sediment loads from erosion are another contributing source of nutrient pollution in impaired streams.

No segments are listed as impaired from nitrogen in the HRSCW, but excessive nitrogen levels affect dissolved oxygen in streams, and the TMDL for Organic Enrichment and Low Dissolved Oxygen provides maximum loads for nitrogen. For these reasons, we have provided total nitrogen loading estimates in tandem with phosphorus loading estimates.

There are many factors that affect dissolved oxygen in the Harpeth River, and the TMDL for Organic Enrichment and Dissolved Oxygen notes that

> [T]he only effective means of achieving the dissolved oxygen criterion of 5.0 mg/l during the summer season is to significantly reduce the SOD in the River. . . . The nutrient allocations for the subwatersheds affecting the primary reach of concern of the lower Harpeth River already require reductions in total nitrogen and phosphorous (median reductions of 44% and 81.3% respectively) which are greater than the 40 percent

> reduction in SOD necessary to achieve water quality standards. Using the conservative assumption that a percent reduction in watershed pollutant load will achieve a comparable reduction in stream SOD, the implementation of best management practices to address the nutrient controls to protect the tributary streams to the Harpeth River should produce sufficient SOD reduction in the Harpeth River. (TDEC, 2004, p. 54)

For this reason, this plan only provides phosphorus and nitrogen loading estimates and needed reductions in order to achieve the 5.0 mg/l dissolved oxygen levels required in the TMDL. Publicly available data from the NLCD 2016 dataset, the Natural Resources Conservation Service (NRCS), the City of Franklin, TN, and the EPA was used in tandem with STEPL to provide this estimate. Unavailable data was estimated using a best educated guess. Using the STEPL model, estimated total nitrogen loading is **194,430 lbs/yr** and total phosphorus loading is **32,530 lbs/yr.**

Alteration in Stream-Side or Littoral Vegetative Covers

Alteration in Stream-Side or Littoral Vegetative Covers are difficult to quantify due to the narrative criteria for their assessment, and the 303(d) list is generally unclear as to what specific sources cause this impairment. That said, the list does identify high density urbanization and site clearance as general sources of this impairment. Observations suggest that streams listed for alteration in stream-side or littoral vegetative covers are listed due to riparian buffer loss in residential and commercial areas, stream bank erosion, and channelization. Alteration in Stream-Side or Littoral Vegetative Covers will be addressed in more detail later in this plan.

Estimate of Load Reductions

E. coli

Table 5: Reductions of *E. coli* Needed to Achieve TMDL

Waterbody ID	Impacted Waterbody	Geometric Mean (MPN/100ml)	% Geometric Mean Reductions
TN05130204016_0100	Lynnwood Creek	NA	NA
TN05130204016_0200	Spencer Creek	290.46	56.6%
TN05130204016_0300	Liberty Creek	880.49	85.7%
TN05130204016_0350	Liberty Creek	NA	NA
TN05130204016_1300	Fivemile Creek	535.03	76.5%
TN05130204016_1350	Fivemile Creek	1045.68	88.0%

Total load reductions needed to reach pathogen standards were estimated by comparing the 2016 and 2017 sampling data from TDEC to their statewide TMDL for *E. coli* criteria for pathogen loading (see Table 5). The TMDL states "The geometric mean standard for the *E. coli* group of 126 colony forming units per 100 ml (CFU/100ml) and the sample maximum of 941 CFU/100 ml have been selected as the appropriate numerical targets for TMDL development"

(TDEC, 2006, p. 7).

Based on these standards, the following reductions listed in Table 5 are needed to achieve compliance with the TMDL loading goals. For the HRSCW, this plan adopts the following pathogen load reduction percentages impaired streams: **34%** reduction in Lynnwood Creek, **57%** reduction in Spencer Creek, **86%** reduction in Liberty Creek, and **88.0%** in Fivemile Creek. Though Lynnwood Creek's sampling data did not meet the criteria to calculate a geometric mean reduction, the sample maximum of 941 CFU/100mlwas utilized to estimate a percent reduction; in 2017, all individual samples met this criteria with the exception of one sample in June of 2017. A 34% reduction of pathogens during the same season will meet the individual sample criteria, and additional sampling is recommended in the future during the same time frame to provide a geometric mean calculation. For Liberty Creek, this plan utilizes segment's TN05130204016_0300 reduction as an appropriate target reduction for the entire stream. It is anticipated that meeting these percent load reductions will achieve water quality standards in all impaired streams.

Modeling load reductions from installed BMPs within the HUC12 watershed is uncertain due to various potential point and non-point sources of pathogens, in-stream pathogen die-off, seasonal variability, etc. Additionally, the EPA's STEPL model, which was used in this plan for other pollutant load estimates, does not currently provide estimates for *E. coli*, nor does it provide load reductions from installed best management practices.

That said, any activities that lower concentrations of *E. coli* will promote healthier waters and communities. Therefore, we feel that pathogen loading reduction activities are worth funding. To account for needed reductions in *E. coli* loads, this plan prioritizes BMPs that target and mitigate non-point sources of *E. coli* via urban stormwater runoff reduction and capture; septic system repair, retrofit, and maintenance; livestock exclusion; pet waste disposal education; erosion control; and agricultural best management practices.

Sedimentation/Siltation

Total sediment loading was estimated using the STEPL model at 5,380 tons/yr. Though Tennessee lacks numerical total sediment loading criteria, the existing TMDL for Siltation and Habitat Alteration has set a sediment maximum load of 660 lbs/acre/year, approximately 10,895 tons/yr for the HRSCW. This suggests that the total maximum daily load has been met for sediment. However,the TMDL was calculated by modeling sediment loads using the Watershed Characterization System Sediment Tool (WCSST). When the WCSST is used to calculate existing loads in the HRSCW, total sediment loading is estimated to be 1,895 lbs/acre/yr, or ~31,280 tons/yr. The discrepancy in loading estimates is most likely due to differences between STEPL 4.4 and the WCSST models. Because streams in the watershed are still listed as impaired due to sediment, this plan assumes that the TMDL for sediment has not been met for the watershed.The TMDL recommends a **66.0**% reduction in WCSST modeled sediment loads to achieve WCSST modeled total maximum daily loads for sediment. This same percent reduction is applied to STEPL loading estimates to achieve the projected sediment reduction needed to delist streams in the HRSCW.

Based off of STEPL loading estimates, sediment/silt loading in the watershed should be reduced by ~**3,550 tons/yr**.

A BMP list in the following section of this plan provides estimates for specific BMP sediment reduction. Additional reduction as a result of education driven, behavioral change are not included in this figure, but will supplement this total and are included in educational outreach components of this plan.

Phosphorus and Nitrogen

Table 6: Nutrient TMDL for the Harpeth River - Spencer Creek Watershed (HUC_12051302040105)			
Total Nitrogen (lbs/month)		**Total Phosphorus (lbs/month)**	
Summer (5/31 -10/31)	**Winter (11/1 -4/30)**	**Summer (5/31 -10/31)**	**Winter (11/1 -4/30)**
5864	18260	483	1505

Using the STEPL model, total phosphorus loading was estimated to be 32,530 lbs/yr, and total nitrogen loading was estimated to be 194,430 lbs/yr. Though Tennessee lacks numerical total nutrient loading criteria, the existing TMDL for Low Dissolved Oxygen and Organic Enrichment has established maximum nitrogen and phosphorus loads for the HRSCW (see Table 6). This plan utilizes these numeric target concentrations as they "were determined using data collected from reference sites within the eco-regions where the impaired waters in the Harpeth River watershed are located" (TDEC, 2004, p. iii).

Yearly maximum loads from non-point sources for nitrogen and phosphorus are 144,744 lbs/yr and 11,928 lbs/yr respectively; based on estimated loads in this plan and target goals established in the TMDL, a percent phosphorus load reduction of **63.3% (20,600 lbs/yr)** and a nitrogen load reduction of **25.6 % (49,686 lbs/yr)** are required to delist streams for phosphorus and low dissolved oxygen impairments.

Alteration in Stream-Side or Littoral Vegetative Covers

As alteration in stream-side or littoral vegetative covers is not a quantifiable pollutant, this plan does not provide a load or load reduction goal. However, utilizing the City of Franklin's Visual Stream Assessments enables this plan to identify several practices that will mitigate this water quality issue. Specifically, riparian buffer plantings will restore altered stream-side or littoral vegetative cover with native plants, and both major and minor bank stabilization projects will stabilize and revegetate eroding banks, restoring equilibrium and reducing the ongoing loss of riparian areas to erosion.

BMP List, Educational Activities and Budget

Based on above estimates for necessary load reductions and potential sources for pathogen loading, the following BMP activities should be sufficient to restore streams in the HRSCW for most impairments. BMPs will be located in subwatersheds based on the specific impairments found in those subwatersheds. These BMPs focus on sediment, nitrogen, phosphorus, and pathogen reductions.

BMPs

Major Bank Stabilization / Stream Restoration Projects: A major bank stabilization and stream restoration project is needed along Ralston Branch (also known as North Ewingville Creek) in the City of Franklin's Pinkerton Park. Starting from its confluence with the Harpeth River, an 800 foot stretch of the stream is significantly degraded. High eroding banks (10-20ft) are not only impacting sediment loads and degrading habitat, they also serve as a hazard to park goers and the City has limited public access around the stream. Future erosion can be prevented and water quality improved by reconnecting the stream to its active floodplain, constructing riffles, raising the channel bed, and by planting native riparian species in the stream buffer. This work will address sediment loading in Ralston Branch and the Harpeth River, as well as the condition of streamside vegetation along Ralston Branch.

In ongoing Visual Stream Assessment (VSA) surveys, the Franklin Stormwater department has identified 10 more stream segments and 425+ additional feet of streambank in the watershed with significant bank erosion. The average bank height of identified segments with severe erosion is 10 feet. VSA's are ongoing and more sites will be identified in years to come. Identified locations in VSA's will aid in the selection of 400 feet of additional major stream banks stabilization projects to be completed within the planning implementation period.

***Additional Streambank Stabilization*:** Streambank erosion contributes to sediment loading across the HRSCW. Stormwater flow reduction efforts will reduce the erosive power of waterways, but the existing eroded banks are vulnerable and will need repair in order to maximize load reductions. The implementation of this plan involves a minimum of 6,000 feet of bank stabilization using natural methods (e.g. cedar revetments, coir logs, etc.) on channels with minor to moderate erosion. Streambank stabilization will be conducted primarily along small tributaries to the Harpeth River and other small intermittent drainages that are not represented on the national hydrographic database.

In ongoing Visual Stream Assessment (VSA) surveys, the Franklin Stormwater department has identified 34 minor to moderate "Erosion Sites" in the Harpeth - Spencer Creek watershed from "stream bends, steep banks, upstream land use changes, or outfall locations" (City of Franklin, 2018, p. 13) with eroding banks between 1-8 feet in height. VSA's are ongoing and more sites will be identified in years to come. Identified locations in VSA's will aid in the selection of priority sites for minor to moderate streambank stabilization work.

Riparian Buffers: In many places, riparian buffers in the watershed are insufficiently narrow or nonexistent. Assuming an adequate riparian buffer width of 60ft (as is required in the City of Franklin), the 81.8 miles of waterways (163.6 miles of buffer on both sides of all waterways) in the HRSCW should have about 1190 acres of buffer within this 60 foot zone (3.6% of the total watershed area). Based on the NLCD 2016 dataset, an estimated ~64% of waterway miles are inadequately buffered. There are also numerous smaller intermittent drainages not represented on the national hydrographic database that would benefit from buffering. All considered, there is ample reason and opportunity for installation of riparian buffers, which can help minimize nutrient, sediment, and pathogen loading. Riparian buffer plantings will also help address streams impaired for alterations in stream-side or littoral vegetative covers. Where needed, riparian buffers will be co-located with streambank stabilization measures in order to provide additional protection to vulnerable areas. In total, roughly 45 acres of riparian buffers will be planted, amounting to over 32,600 linear feet, in order to create a 60 foot wide buffer.

In ongoing VSA surveys, the Franklin Stormwater department has identified 81 stream sections with inadequate buffers in the City and 21 sites considered to be good candidates for volunteer buffer plantings. Many of these sites are in the HRSCW, and the locations of all sites are available for implementing this plan.

Pet Waste Bag Dispensers: One of the main sources of pathogens in urban waterways is pet waste. Pet waste bag dispensers will be installed and stocked in highly visible public locations or high use private locations (such as large apartment complexes). This will help build awareness of the importance of pet waste control and provide residents with the easy means to do so. Implementation of the plan involves installing 30 dispensers in the watershed. A majority of dispensers will be installed in urban and suburban catchments that drain to Spencer, Liberty, Linwood, and Fivemile creeks, where streams are listed for E.coli. Strategic locations in existing or developing suburban areas will also be prioritized, where new neighborhoods could contribute to increased pathogen problems from pet waste.

Rain Gardens: Rain gardens assist with nutrient, pathogen, and sediment control, by infiltrating stormwater containing pathogens and nutrients, trapping sediment, and reducing high stormflow volumes that contribute to channel erosion downstream. Rain gardens can be placed adjacent to any impervious surface that would otherwise connect to a storm drain or wet weather conveyance, and can mitigate the effects of these surfaces. The Cumberland River Compact has had great success with our rain garden program and anticipates that finding collaborators for rain gardens will not be difficult. This plan will incorporate the installation of 40,000 square feet of rain gardens within the watershed. Rain gardens will be implemented in the urban and suburban areas of the HUC12, as these areas will benefit the most from small bioretention projects.

***Water and Sediment Control Basins and Retention Ponds*:** This class of BMPs is a catch all, potentially including detention ponds, bioretention ponds, and control basins providing water quality and quantity management for parking lots, sports fields, and large building developments . We foresee opportunities to do several medium sized projects to capture and infiltrate stormwater as an erosion and pathogen control measure. This plan approximates that 30 structures will be needed to address pathogen and sediment contaminants in the watershed. These will take place mostly in the urban and suburban portions of the watershed, but they can also be utilized in agricultural areas. These retrofits will remove nutrients, sediment, and pathogens from stormwater runoff.

Cattle Exclusion Fencing/Access Control: Roughly 20% of the Harpeth - Spencer Creek watershed is pasture land, and cattle contribute to sediment and pathogen loading if left unfenced from streams and small drainages. Horses may also be a problem and exclusion of these animals can also be addressed. There are at least two large cattle pastures with visible access to Fivemile Creek and other tributaries to the Harpeth that appear to need cattle exclusion fencing. It is anticipated that a minimum of 2,700 feet of cattle exclusion fencing is needed to address this issue. Fencing is one of the cheapest BMPs, and additional fencing needs are unlikely to greatly affect the budget or feasibility of this project.

Forage and Biomass Planting: Proper forage planting in livestock pastures is crucial to enhance the quality of local waterways and to prevent pasture soils from degrading. By improving soil structure and health, perennial species reduce soil erosion, reduce runoff by improving water infiltration (which in turn reduces nutrient and topsoil runoff), and build soil organic matter. With approximately 6,500 acres of pastureland within the watershed, proper forage and biomass planting will reduce the impacts of intensive grazing on the HRSCW. This practice will need to be implemented on roughly 5,500 acres of pastureland to achieve the needed sediment and nutrient load reductions. To maximize the effect this practice will have, pastures adjacent to impaired waterways will be prioritized over other pastures located throughout the watershed.

Filter Strips: Implementation of filter strips along drainage areas will reduce sediment, nutrient, and pathogen loads by slowing stormwater runoff and allowing it to percolate into the soil rather than wash contaminants into nearby streams. This practice will be implemented along crop and pasture land, which account for 50% of sediment sources, 35% of nitrogen sources, 33% of phosphorus sources in the watershed, according to STEPL. In addition to cropland, this practice can be utilized along other areas with high runoff and little to no established canopy vegetation, such as park land, sports complexes, large parking lots, etc. Other identified potential sources include the small, unbuffered drainage channels that are unable to be replanted with a 60 ft riparian buffer due to proximity to housing or land use restrictions by local HOA's and businesses.

The United States Department of Agriculture (USDA) and NRCS state that minimum flow lengths through filter strips should be "20 feet for suspended solids and associated contaminants in runoff and 30 feet for dissolved contaminants and pathogens in runoff" (USDA, 2016, p. 1). For the purposes of this plan, load reductions are estimated using the 30 feet filter strip width criteria to address excess pathogen, sediment, and nutrient runoff. Implementation of 25 acres of filter strips, or ~6.8 miles, will greatly reduce nutrient and sediment loading into the watershed, in addition to pathogen loading.

Urban and Rural Tree Canopy Improvements: To abate excess sediment and nutrient loads in the HRSCW, this plan calls for bolstering the forest canopy in both urban and rural areas. The goal of this technique is to re-establish forest canopy that has been lost due to urban development or agricultural land clearance. Any trees planted will be spaced at a minimum of 10' apart, assuming trees planted are medium broadleaf deciduous trees. An estimated 450 acres of canopy, or 1.4% of the watershed, should be reestablished in the watershed to achieve necessary reductions, equating to roughly 196,000 trees. Other benefits to improving canopy include reduced stormwater runoff, reduced urban heat island effect, improved native habitat, and improved community health.

Nutrient Management: Excess nutrient runoff causes algal blooms in streams, which deplete oxygen and impact aquatic organism survival. In order to delist streams from phosphorus and low dissolved oxygen impairments, implementation of nutrient management plans are necessary to reduce nutrient rich runoff from entering streams. There exist many potential non-point sources of nutrients in the HRSCW. The watershed contains approximately 820 acres of cropland and over 16,000 acres of low intensity development, which is considered developed open space (football fields, golf courses, other recreational fields) and large lot single family homes. Considering the high percentage of the watershed being comprised of urban and suburban development, proper nutrient management on privately owned lawns will comprise a major part of the nutrient reduction strategy. For this reason, this plan proposes developing nutrient management plans for 5,000 acres of land in the watershed, with plans specifically tailored to addressing nutrient management on cropland, recreational fields, and residential lawns.

Small Scale De-paving/Stream Daylighting/Channel Restoration:
According to the City of Franklin's 2018-2019 VSA, there exist numerous small channels that are lined with concrete that may make good candidates for pavement removal and restoration. Channel restoration will improve in-stream and riparian habitat.

Additionally, the removal of asphalt or concrete impervious surfaces in the watershed will reduce stormwater runoff volume, and when combined with bioretention, these projects will capture nutrients, pathogens, sediment, and other pollutants before they enter local streams.

Septic Improvements and Repair: Based on data from STEPL and the EPA, there are over 5,700 septic systems in the HRSCW. These systems have an estimated failure rate of 2.85%, meaning over 160 septic systems may be functioning improperly. Damaged drain fields can cause wastewater to surface, releasing pathogens, nutrients, and biochemical oxygen demanding materials into surface waters. Additionally, inefficient or aging septic systems can release excess nutrients like nitrogen and phosphorus into groundwater, which can result in eutrophication in nearby streams and lakes. New upgrades to older septic systems can improve the efficiency in phosphorus and nitrogen treatment, which is especially beneficial in areas where septic systems are more densely concentrated. In order to sufficiently reduce pathogen and nutrient loads in the watershed, this plan proposes upgrading, maintaining, or repairing 80 septic systems in the watershed.

Winter Cover Crops: By improving soil structure, anchoring soil, and reducing sheet and rill flow from rain events, cover crops can reduce sediment nutrient loading in local streams and rivers. This can be especially effective when coupled with proper nutrient management plans, which reduce nutrient loading by managing the amount, source, method of application, and timing of plant nutrients and soil amendments.

If farms utilize winter cover crops, they will significantly decrease agricultural sources of sediment and nutrients being washed into the river each year. This plan proposes implementation of winter cover cropping and nutrient management planning on 600 acres of crop land, or roughly 73% of agricultural land within the watershed.

Load Reductions from BMP: Without numeric criteria for alterations in stream-side habitat or littoral vegetation, and without a clear differentiation between point and non-point sources of*E. coli* pollution, this plan only provides reduction calculations for nitrogen, phosphorus, and sediment. Load reductions for nitrogen, phosphorus, and sediment were calculated using the Tennessee Department of Agriculture's (TDA) [Tennessee NPS Program - Pollutant Load Reduction Estimation Tool] (TDA, 2020, p.8), with the exception for the load reductions provided by tree canopy restoration. For this BMP, we utilized the [Center for Watershed Protection's 2017 Pollutant Load Reduction Credit Tool] (Center for Watershed Protection, 2017b, para. 6). This credit tool was developed specifically "to offer a scientifically defensible credit that encourages greater use of trees for meeting total maximum daily load (TMDL) requirements" (Center for Watershed Protection, 2017a, p. 3). All tree reduction loads are based on mature medium broadleaf deciduous trees. Tree plantings in this plan are considered to be smaller caliper sizes that will reach maturity by the end of the plan's implementation.

The majority of *E. coli* reduction will be handled by structural stormwater practices (access control, rain gardens, water/sediment control basins, stormwater filtration, etc.), septic improvements, and educational outreach programming to address livestock exclusion from streams, better fertilizer/manure management practices, pet waste. Alterations in stream-side habitat or littoral vegetation will be addressed as described in the BMP description by riparian plantings, major and minor bank stabilizations, and other structural practices, but cannot be quantified with available data.

Phosphorus

Using the Tennessee NPS Program's Pollutant Load Reduction Estimation Tool and the Center for Watershed Protection's 2017 Pollutant Load Reduction Credit Tool referenced above, the following phosphorus reductions are expected from BMPs:

Streambank/Shoreline Protection: *6,000 ft * 0.17 lbs P/foot/yr = 1,020 lbs/yr*
Riparian Forest Buffer: *45 acres * 22.6 lbs P/acre/yr = 1017 lbs/yr*
Rain Garden: *40,000* ft^2 ** 0.06 lbs P/sq ft/yr = 2,400 lbs P/*ft^2 */yr*
Access Control: *2,700 ft * 0.01 lbs P/foot/yr = 27 lbs/yr*
Winter Cover Crop: *600 acres * 2.4 lbs P/acre/yr = 1,440 lbs/yr*
Nutrient Management: *5,000 acres * 1.02 lbs P/acre/yr = 5,100 lbs/yr*
Filter Strip: *25 acres * 83 lbs P/acre/yr = 2,075 lbs/yr*
Water and Sediment Control Basin: *30 basins * 33.92 lbs P/basin/yr = 1,018 lbs/yr*
Forage and Biomass Planting: *5,500 acres * 0.66 lbs P/acre/yr = 3,630 lbs/yr*
Septic Improvements and Repair: *80 units * 12.58 lbs P/unit/yr = 1,006 lbs/yr*
Urban and Rural Tree Canopy Improvements: *196,000 trees * 0.00309 lbs P/yr/tree = 605 lbs/yr*

Total phosphorus reduction from these measures: **19,338 lbs/yr**

The above calculations do not address other structural practices that may also help with phosphorus reduction. It is estimated that the remaining 1,262 lbs/yr reduction to reach loading goals of 11,928 lbs/yr will be achieved through outreach work that will promote best management farming practices, proper fertilizer use and reduction, and better residential lawn management practices. Additionally, due to the high phosphorus content of soils in the Western Highland Rim (Ecoregion 71f), phosphorus reduction from sediment control measures are likely higher than indicated by reduction calculations provided above. Finally, the phosphorus reductions from major bank stabilization/stream restoration projects (which have not been provided above) in tandem with educational outreach are expected to contribute to the delisting of streams for phosphorus and low dissolved oxygen impairments.

Nitrogen

Using the Tennessee NPS Program's Pollutant Load Reduction Estimation Tool and the Center for Watershed Protection's 2017 Pollutant Load Reduction Credit Tool referenced above, the following nutrient reductions are expected fromBMPs:

Streambank/Shoreline Protection: *6,000 ft * 1.75 lbs N/foot/yr = 10,500 lbs/yr*
Riparian Forest Buffer:*45 acres * 308.4 lbs N/acre/yr = 13,878 lbs/yr*
Rain Gardens: *40,000* ft^2 ** 0.158 lbs N/*ft^2*/yr = 6,320 lbs/yr*
Access Control: *2,700 ft * 0.11 lbs N/foot/yr = 297 lbs/yr*
Winter Cover Crop: *600 acres * 11.4 lbs N/acre/yr = 6,840 lbs/yr*
Nutrient Management: *5,000 acres * 6.31 lbs N/acre/yr = 31,550 lbs/yr*
Filter Strip: *25 acres * 375.8 lbs N/acre/yr = 9,395 lbs/yr*
Water and Sediment Control Basin: *30 basins * 199.41 lbs N/basin/yr = 5,982 lbs/yr*
Forage and Biomass Planting: *5,500 acres * 6.78 lbs N/acre/yr = 37,290 lbs/yr*
Septic Improvements and Repair: *80 units * 119.28 lbs N/unit/yr = 9,542 lbs/yr*
Urban and Rural Tree Canopy Improvements: *196,000 trees * 0.0179 lbs N/yr/tree = 3,509 lbs/yr*

Total nitrogen reduction from these measures: **135,103 lbs/yr**

This is well in excess of the load reduction goal of 49,686 lbs/yr. Further nitrogen reduction will be achieved through outreach work that will promote best management farming practices, proper fertilizer use and reduction, and better residential lawn management practices. The above calculation does not include other structural practices that may also help with nitrogen reduction.

Sediment

Using the Tennessee NPS Program's Pollutant Load Reduction Estimation Tool and the Center for Watershed Protection's 2017 Pollutant Load Reduction Credit Tool referenced above, the following sediment reductions are expected from BMPs:

Streambank/Shoreline Protection: *6,000 ft * 0.047 tons/foot/yr = 282 tons/yr*
Riparian Forest Buffer: *45 acres * 3 tons/acre/yr = 135 tons/yr*

Rain Garden: *40,000* ft^2 ** 0.006 tons/*ft^2 */yr = 240 tons/yr*
Access Control: *2,700 ft * 0.001 tons/foot/yr = 3 tons/yr*
Winter Cover Crop: *600 acres * 0.84 tons/acre/yr = 504 tons/yr*
Nutrient Management:*5,000 acres * 0.282 tons/acre/yr = 1,410 tons/yr*
Filter Strip: *25 acres * 32.9 tons/acre/yr = 823 tons/yr*
Water and Sediment Control Basin: *30 basins * 6.109 tons/basin/yr = 183 tons/yr*
Forage and Biomass Planting: *5,500 acres * 0.175 tons/acre/yr = 963 tons/yr*
Septic Improvements and Repair: *80 units * 3.564 tons/unit/yr = 285 tons/yr*
Urban and Rural Tree Canopy Improvements: *196,000 trees * 0.000864 tons/yr/tree = 169 tons/yr*

Total sediment reduction from these measures: **4,997 tons/yr**

This brings the total estimated sediment reduction to well in excess of a 3,550 tons/yr goal, without even considering the impact of other incorporated measures, or behavioral changes driven by educational outreach.

In addition, significant load reductions are expected from the 1,200 feet of major stream restoration projects. One of these projects will be located in Pinkerton Park along Ralston Branch, correcting approximately 800 feet of degrading stream banks. Using the STEPL 4.4 Gully and Streambank Pollutant Load Reduction Tool in conjunction with data from the City of Franklin's Visual Stream Assessments, sites identified with significant bank erosion are losing on average roughly 0.24 feet of bank per year. For the proposed stream restoration projects, which have banks that average 10 feet in height and are 1200 feet in length, this amounts to 2,880 cubic feet of bank loss annually. Assuming a dry density of about 80lbs/ft3, annual sediment losses from the banks are approximately 115 tons. Assuming an equal division between total suspended sediment and bed load (which is quite conservative), a total suspended sediment reduction of **115 tons/yr** is estimated for all major restoration projects.

Educational Activities

As part of the watershed based plan, we recommend increasing awareness through educational outreach within the watershed. Outreach should be multifaceted, and, while some will be incorporated directly into BMPs, specific activities should be conducted with education and outreach in mind.

Foremost among the educational outreach needs for the watershed is a concerted effort to teach watershed residents about the need for and methods for reduction of nutrients and sediment through better residential lawn management, rain gardens/native lawns/filterstrips, riparian buffer protection, and "River Friendly" agricultural land management, and initiatives to reduce pathogens through proper septic maintenance, in-stream cattle exclusion, and proper pet waste disposal. Such outreach could involve mailers, scientific/educational presentations at local town hall meetings, and other public events.

Another area in which we have had great success at the Cumberland River Compact is educational talks. We host weekly talks (known as River Talks) in the spring and fall at our event space in downtown Nashville, dedicated to a variety of topics relating to the science, history, and preservation of the Cumberland River. These seminars are well attended and benefit both the public and other non-profits. The talks have been so successful that we have expanded them to other cities within the Cumberland River Basin. As part of this plan, we propose holding River Talks focused on the HRSCW, covering project work, water issues, and other environmental topics relevant to this Watershed Based Plan.

Youth education is of paramount importance to ensure the longevity of any work performed within the watershed. Future generations must grasp the importance of healthy habitat, biodiversity, and sustainable land management in order to protect BMPs implemented today and to support sustainable practices in the future. Without community support and interest on these issues, BMPs will be difficult to sustain into the future. Through K-12 educational programming, teacher trainings, and educational community events, youth should be taught the importance of sustainable land management. In communities across the region, The Cumberland River Compact has had success in youth engagement through our Creek Critters Program. Our Creek Critters Program teaches students about native aquatic biology, ecosystems, and the impact that various land uses have on the health of local streams. Implementing educational programming, such as our Creek Critters Program, teacher trainings, and educational community events will help current and future generations understand why implementation of BMPs is important both now and in the future.

Budget for BMP's and Educational Activities

Fully or partially implementing this watershed based plan would involve the following costs:

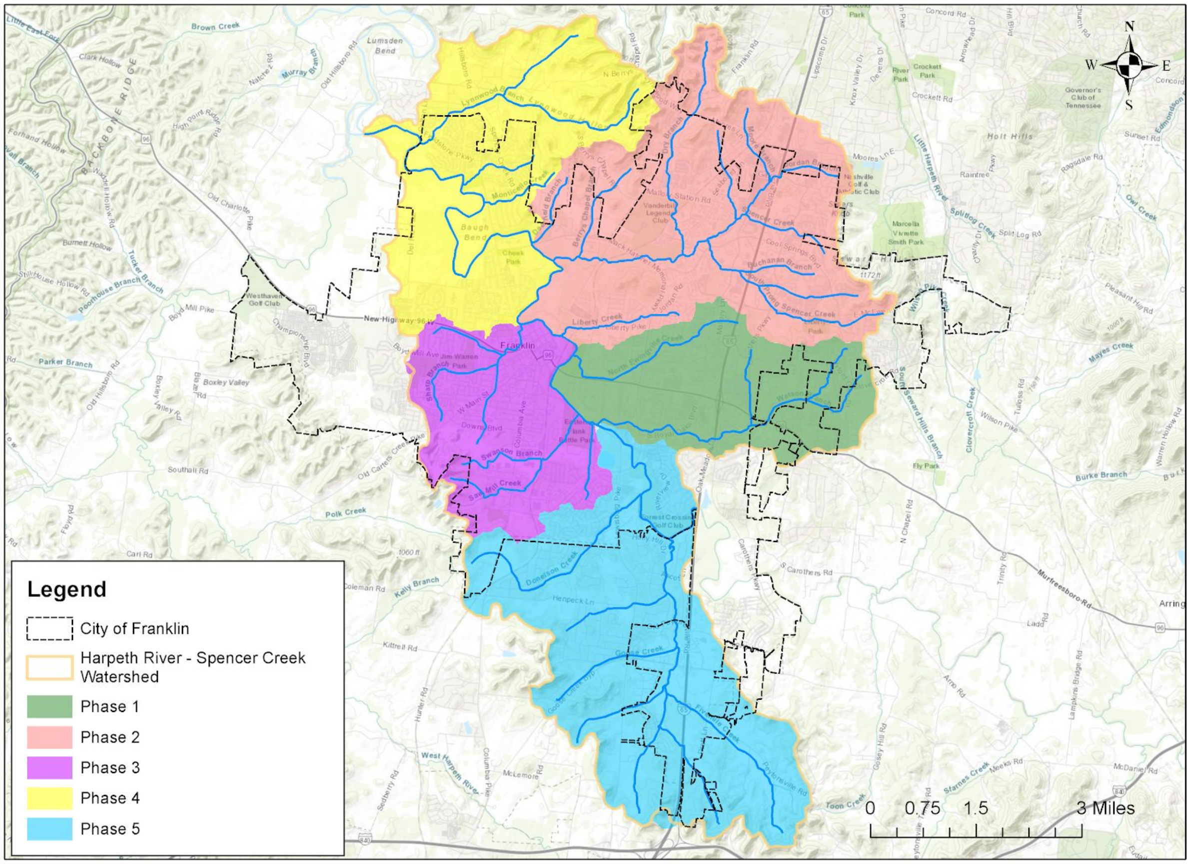
BMP Name	Quantity	Cost/Unit	Budget Estimate
Major Stream Restoration/Bank Stabilization Projects	1,200 linear feet	$234,000 total	$234,000
Streambank Stabilization with Revetments/Coir Logs	6,000 linear feet	$75/ft	$450,000
Riparian Buffers	45 acres	$2,500/acre	$100,000
Pet Waste Bag Dispensers w/ bags	30 units	$750 each	$22,500
Rain Gardens	40,000 square feet	$5/ sq ft	$175,000
Cattle Exclusion Fencing	2,700 linear feet	$5/ft	$13,500
Water/Sediment Control Structures and/or Stormwater Retrofits (detention basins, etc.)	30 structures	$24,000	$720,000
Forage and Biomass Planting	5,500 acres	$245/acre	$1,347,500
Filter Strips	25 acres	$1,000/acre	$25,000
Nutrient Management	5,000 acres	$39/acre	$195,000
Winter Cover Crops	600 acres	$29/acre	$17,400
Small Scale de-paving/channel restoration	2 units	$100,000/unit	$200,000
Septic Improvements and Repair	80 units	$2,000/unit	$160,000
Urban Canopy Restoration	450 acres	$1,010/acre	$454,500
		Total	**$4,151,900**

Educational Activities

BMP Name	Quantity	Cost/Unit	Budget Estimate
Annual Educational Festival (over 10yrs)	10	$6,000	$60,000
Educational Talks/Seminars	25	$1,000	$25,000
		Total	**$85,000**

Total Budget for Full Implementation:	**$4,236,900**

Figure 3: Harpeth River - Spencer Creek Watershed Based Plan Phases



Timeline, Tasks, and Assessment of Progress

Complete restoration of urban watersheds requires many years work and broad public support and participation from the community. This Watershed Based Plan is envisioned as a comprehensive, 18 -year long plan, to be completed by 2039. This plan will be divided into six 3-year long phases, with Phases 1-5 addressing five different sections of the watershed and Phase 6 serving as a wrap up phase to address trouble spots or neglected areas from Phases 1-5. Phase 1 - 3 are located in the most densely urbanized areas in the City of Franklin. Phases 2-5 are located in the more agricultural areas of the watershed, namely the northernmost and southernmost reaches, which include major tributaries to the Harpeth River like Fivemile Creek and Lynnwood Branch. Each phase will cost roughly $700,000 to complete. Funds will include numerous sources, including federal funding, state funding, the City of Franklin, private donors, and corporate sponsors.

See Figure 3 for visualization of project phases and BMPs involved in each phase.

Project tasks will be distributed among individual phases and subwatersheds based on specific subwatershed impairments and needs. Further assessment coinciding with Phase 1 will identify specific locations and tasks for each subwatershed in the basin.

List of proposed BMPs by phase:

1. **Phase 1**
    a. Bank Stabilization
    b. Riparian Buffer Plantings
    c. Pet Waste Bag Dispensers
    d. Rain Gardens/Sediment Control Basins
    e. Filter Strips
    f. Urban and Rural Tree Canopy Improvements
    g. Nutrient Management
    h. Small scale de-paving/Stream Daylighting/Channel Restoration
2. **Phase 2**
    a. Bank Stabilization
    b. Riparian Buffer Plantings
    c. Pet Waste Bag Dispensers
    d. Rain Gardens/Sediment Control Basins
    e. Cattle Exclusion Fencing
    f. Forage and Biomass Planting
    g. Filter Strips
    h. Urban and Rural Tree Canopy Improvements
    i. Nutrient Management
3. **Phase 3**
    a. Bank Stabilization
    b. Riparian Buffer Plantings
    c. Pet Waste Bag Dispensers
    d. Rain Gardens/Sediment Control Basins
    e. Urban and Rural Tree Canopy Improvements
    f. Nutrient Management
    g. Small scale de-paving/Stream Daylighting/Channel Restoration
4. **Phase 4**
    a. Bank Stabilization
    b. Riparian Buffer Plantings
    c. Rain Gardens/Sediment Control Basins
    d. Cattle Exclusion Fencing
    e. Forage and Biomass Planting
    f. Filter Strips
    g. Urban and Rural Tree Canopy Improvements
    h. Nutrient Management
    i. Septic Improvements and Repair
    j. Winter Cover Crops
5. **Phase 5**
    a. Bank Stabilization
    b. Riparian Buffer Plantings
    c. Rain Gardens/Sediment Control Basins
    d. Cattle Exclusion Fencing
    e. Forage and Biomass Planting
    f. Filter Strips
    g. Urban and Rural Tree Canopy Improvements

h. Nutrient Management
i. Septic Improvements and Repair
j. Winter Cover Crops

Criteria to Assess Achievement of Load Reduction Goals

If load reduction goals are met, affected streams will no longer exceed TDEC's state water quality criteria. Independent sampling coinciding with Phase 5 will allow identification of areas in need of additional work, allowing modification of the project during Phase 6 to address the most problematic locations.

Since riparian buffers, tree canopy restoration, and other natural methods take time to grow and reach full effectiveness, we anticipate that state water quality criteria may not be achieved immediately, but should be achieved for a given stream segment no later than ten years after the end of the project phase addressing that segment's subwatershed. Project completion is anticipated by 2039 and fully supporting conditions in all streams by 2049.

Monitoring and Documenting Success

The Cumberland River Compact and others involved in carrying out the watershed plan will keep the Tennessee Division of Water Resources aware of restoration activities to allow coordination of sampling. Restoration activities do not have immediate effects and positive results may take several years to appear. However, the duration of the plan means that the early phases of the plan can be assessed, allowing problem areas or unresolved issues to be addressed during Phase 6

In addition to coordinating monitoring efforts with TDEC, the Compact will coordinate closely with the City of Franklin Stormwater Management Department. The Department conducts yearly VSA surveys within the project area. These VSAs will continue to be a valuable resource for locating BMPs, measuring the success of plan implementation, and monitoring water quality within the watershed.
Observed water quality measurements are expected to be on a positive trend by the end of the plan timeline, such that extrapolating results (i.e. assuming that continued riparian buffers will trap more contaminants as they grow, etc.) will indicate a trajectory towards meeting state criteria by 10 years after the end of the plan's implementation. If observations indicate that meeting these criteria are unlikely, the program can be adjusted/extended in light of new information. During Phases 1-5, the effectiveness of the program will be assessed, enabling us to revise the plan in Phase 6 as needed. Successes and needed revisions will be documented at the end of each phase of plan implementation, allowing flexibility in implementing and improving the ongoing effectiveness of the plan.

References

Center for Watershed Protection. (2017a, December). *Making Urban Trees Count: A Project to Demonstrate the Role of Urban Trees in Achieving Regulatory Compliance for Clean Water*. https://owl.cwp.org/mdocs-posts/pollutant-load-reduction-credit/

Center for Watershed Protection. (2017b, December 28). Making Urban Trees Count - Center for Watershed Protection. https://www.cwp.org/making-urban-trees-count/

City of Franklin-Stormwater Management. (2018). Visual Stream Assessments Year 1 Report. City of Franklin.

Tennessee Department of Agriculture. (2020). NONPOINT SOURCE PROGRAM REQUEST FOR PROPOSALS FY 2021. https://www.tn.gov/content/dam/tn/agriculture/documents/landwaterstewardship/rfp/FY2021%20319%20RFP.pdf

Tennessee Department of Environment and Conservation Division of Water Pollution Control. (2002, May). TOTAL MAXIMUM DAILY LOAD (TMDL) For Siltation & Habitat Alteration In

The Harpeth River Watershed (HUC 05130204) Cheatham, Davidson, Dickson, Hickman, Rutherford, & Williamson County, Tennessee. Tennessee Department of Environment and Conservation. https://www.tn.gov/environment/program-areas/wr-water-resources/watershed-stewardship/tennessee-s-total-maximum-daily-load--tmdl--program.html

Tennessee Department of Environment and Conservation Division of Water Pollution Control. (2004, September). FINAL ORGANIC ENRICHMENT/LOW DISSOLVED OXYGEN TOTAL MAXIMUM DAILY LOAD (TMDL) FOR WATERS IN THE HARPETH RIVER WATERSHED (HUC 05130204). Tennessee Department of Environment and Conservation. https://www.tn.gov/environment/program-areas/wr-water-resources/watershed-stewardship/tennessee-s-total-maximum-daily-load--tmdl--program.html

Tennessee Department of Environment and Conservation Division of Water Pollution Control. (2006, March). *TOTAL MAXIMUM DAILY LOAD (TMDL) for E. Coli in the Harpeth River Watershed (HUC 05130204) Cheatham, Davidson, Dickson, Hickman, Rutherford, and Williamson Counties,Tennessee*. Tennessee Department of Environment and Conservation. https://www.tn.gov/environment/program-areas/wr-water-resources/watershed-stewardship/tennessee-s-total-maximum-daily-load--tmdl--program.html

United States Department of Agriculture. (2016, September). Natural Resources Conservation Service CONSERVATION PRACTICE STANDARD FILTER STRIP Code 393 (No. 393-CPS-1). https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1241319.pdf