

Executive Summary

Watershed Protection MASTER PLAN *2015 Update*



**WATERSHED
PROTECTION**

Preface

Austin and Central Texas are known and celebrated for creeks, rivers, lakes, and springs. Access to an abundant, reliable, and clean source of water played a key role in the original decision in 1835 to locate the city just downstream of Barton Springs along the Colorado River and to select it as the state’s capital in 1839. And today Austin’s water features continue to be the source of intense pride for its residents and a powerful magnet for visitors, new residents, and businesses.

Today, with Austin being among the fastest growing communities in the United States, many challenges remain in protecting Austin’s watersheds, waterways, and water supply. This extensively updated 2015 Watershed Protection Master Plan presents a systematic, objective approach to protecting these invaluable resources. It serves as the guiding document for the activities of the City of Austin’s Watershed Protection Department (WPD).

The first edition of this Master Plan was completed and approved by City Council in 2001. Since that time, much progress has been made in addressing Austin’s watershed challenges, but much work remains. The 2013 Halloween and 2015 Memorial Day Floods underscore the ongoing need to effectively prepare and respond to adversity. This Master Plan assesses the continuing challenges and documents the detailed process by which WPD prioritizes its work to meet these challenges.

This 2015 edition greatly expands the scope of the area evaluated for problem identification and solution proposal, building on the original 17 core watersheds studied in 2001 to present key parameters in 49 watersheds. Appendix A presents a full summary of all the important changes and improvements of this edition from the original 2001 Master Plan.

While study methods have improved over time, WPD’s mission and focus remains the same—to protect the lives, property, and environment of our community by reducing the impact of flooding, erosion, and water pollution. We appreciate your interest in our work and encourage your feedback and suggestions as we continuously seek cost-effective ways to protect and restore Austin’s beloved natural environment.



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1 Status of 2001 Recommendations	396
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Executive Summary

Introduction

For more than three decades, the City of Austin has been recognized as a national leader in watershed protection. From the 1970s to today, the City’s flood, erosion, and water quality protection efforts have matured with the passage of protective regulations, development of comprehensive programs, and with dedicated funding for capital projects.

This Watershed Protection Master Plan outlines a framework for the Watershed Protection Department (WPD) to address existing problems and prepare for future challenges. It uses the following approach:

1. Establish watershed protection goals;
2. Evaluate watershed conditions relative to the goals;
3. Identify problem locations and prioritize by problem severity; and
4. Identify preferred solutions to address problems.

Each component is presented below and discussed in detail in the full Master Plan.



Figure EX-1 Lady Bird Lake

Watershed Protection Goals

This Master Plan seeks to carry out **WPD’s mission: to protect the lives, property, and environment of our community by reducing the impact of flooding, erosion, and water pollution.** The Master Plan was first completed and approved by City Council in 2001. It focused on 17 Phase 1 watersheds in Austin’s core, comprising the areas with the oldest development and most dense population. This updated 2015 Master Plan expands the focus to include virtually all watersheds in Austin’s jurisdiction. The original Phase 1 and the additional Phase 2 watersheds are shown in Figure EX-2.

Sections 1 and 2 present WPD’s mission and management goals. The goals are as follows:

1. Protect lives and property by reducing the impact of flood events.
2. Protect channel integrity and prevent property damage resulting from erosion.
3. Protect and improve Austin’s waterways and aquifers for citizen use and support of aquatic life.
4. Improve the urban environment by fostering additional beneficial uses of waterways and drainage facilities.
5. Meet or exceed all local, state, and federal permit and regulatory requirements.
6. Maintain the integrity and function of Utility Assets.
7. Optimize City resources by integrating flood, erosion, and water quality control measures.

Each goal is further defined by one or more objectives. These objectives are found in Table 2.4-1 in Section 2.

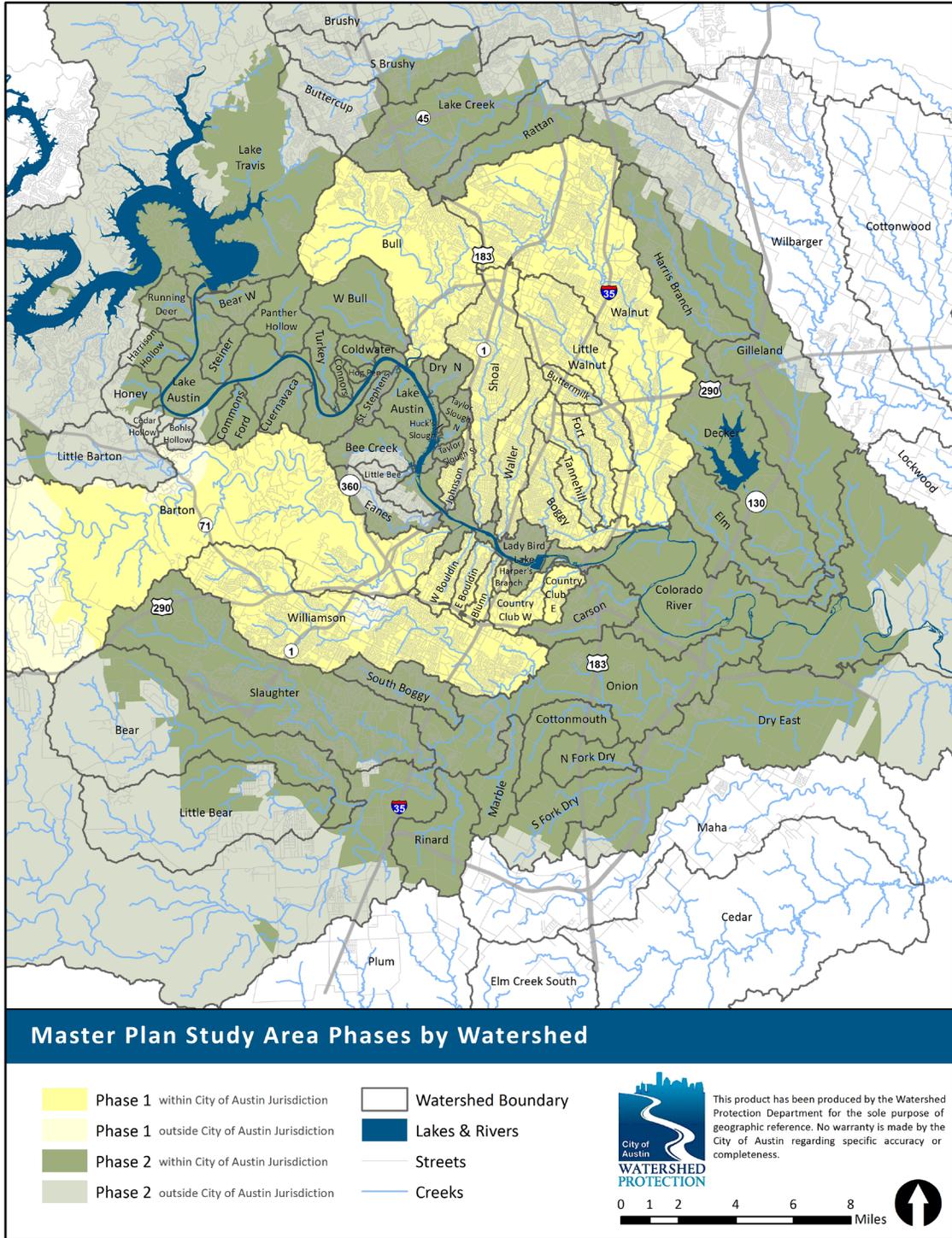


Figure EX-2 Master Plan Study Area Phases by Watershed

**Problem Area Identification:
Flood, Erosion, & Water Quality**

WPD has three primary “missions”: Flood Mitigation, Erosion Control, and Water Quality Protection. WPD performs technical studies to characterize conditions for each of these missions in the watersheds within its jurisdiction. These studies identify Problem Areas where watershed protection goals are not being achieved. This approach enables direct comparisons between watersheds and promotes consistency among the three missions. Technical assessments have been completed for all Phase 1 and many Phase 2 watersheds as follows: Creek Flood (28 watersheds); Erosion Control (26 watersheds); and Water Quality Protection (49 watersheds). Citizen complaint data and limited technical modeling assessments are available for Local Flood systems.



Figure EX-3 WPD’s three primary missions

Section 3 introduces the Problem Area identification and prioritization process. Sections 4 to 7 present methodologies and results to quantify and prioritize Problem Areas for Creek Flood, Local Flood, Erosion Control, and Water Quality Protection, respectively. For each mission, “problem scores” are developed which assign a numeric value to watershed problems, such as individual erosion sites or structures in floodplains. Problem scores range from 0 to 100, with 0 reflecting no problem and

100 representing the worst problem identified. Problem scores are a function of problem severity and the number and type of resources impacted. To enable comparisons across geographic areas, problem scores can be aggregated into larger units, such as stream reaches, project groupings, or even entire watersheds.

A central principle of this Master Plan is that the most severe problems should be considered first for solutions identification. This plan therefore outlines a “needs-based” prioritization approach using best available technical data. (At later stages of evaluation, additional factors such as solution feasibility, timing, and opportunity to share resources are also considered.)

The technical assessment methodologies used to characterize watershed conditions for each WPD mission are described below.

Flood Mitigation

Austin is located in an area known as “Flash Flood Alley.” Its unique combination of intense rainstorms, steep slopes, and slow-draining soils make it especially prone to severe flooding conditions. Most people who live in Austin have witnessed firsthand or seen reports of flooding of homes, roads, or other property. Floods in 1981, 1991, 1998, 2001, 2010, 2013 (the “Halloween flood”), and 2015 are reminders of the public safety and property hazards associated with flooding. In nearly every decade there is a record of significant flood events. **The WPD goal for Flood Mitigation is to protect lives and property by reducing the impact of flood events.** This Master Plan details how flooding problem areas are identified, prioritized, and addressed using capital, programmatic, and regulatory solutions.

Flooding can occur in both the primary and secondary drainage systems. Assessment methods to catalogue **creek flooding** problems associated with the primary system (major

creeks and their tributaries) are presented in Section 4. Methods used to investigate **local flooding** associated with the secondary drainage system (storm drains and minor channels) are presented in Section 5.

Creek Flood Assessments. Flooding problems in major creek systems are identified using hydrologic and hydraulic (H&H) computer models. These models predict when flood levels become high enough to overflow creek banks and flood nearby structures (e.g., bridges, culverts, homes, and other buildings). Over the past 35 years, the City has developed floodplain models and maps for almost all major City-managed watersheds. Flood assessments identify the depth, velocity, and frequency of flooding of all structures and roadway crossings. This problem severity data is then used to calculate flood problem scores, weighted by the frequency of flooding and the type of resource threatened. For example, the same type of structure in the 2-year floodplain (50% chance of flooding in any given year) will have a higher score than if it was in the 100-year floodplain (1% chance of flooding). A hospital would be given a higher score than a parking garage, and so forth.



Figure EX-4 Flooding on Onion Creek, 2013

Austin has 30 watersheds entirely or partially within Austin’s full purpose jurisdiction (city limits). An additional 26 are entirely or partially within Austin’s extraterritorial jurisdiction.

WPD’s models have estimated the number of structures and street crossings that are within the 100-year floodplain, as well as the number of structures that will be inundated during a 2-, 10-, 25-, and 100-year flood (see Table EX-1 below). The results of this modeling are further discussed in Section 4.

Table EX-1 Estimates of Structures and Roadways in 100-year Floodplain and at Risk of Inundation, Full Purpose and Extraterritorial Jurisdiction (ETJ) (2014)

	Located in 100-yr Floodplain	Inundated in Floodplain			
		2-yr	10-yr	25-yr	100-yr
Structures (full purpose)	5,118	48	539	1,152	2,561
Structures (ETJ)	660	17	167	306	460
Roadway Crossings (full purpose)	580	95	236	309	392
Roadway Crossings (ETJ)	125	43	65	78	88

Tables 4.6-3 and 4.6-6 in Section 4 present the Top 20 Creek Flood Problem Areas for structure flooding and street crossing flooding, respectively. As expected, the majority of these problem areas are in the older urban core or older outlying development, both built during a time that predated a modern understanding of floodplain delineation.

Local Flood Assessments. Local flooding occurs when rainfall events overwhelm smaller drainage systems, such as storm drain pipes and small open channels. WPD uses multiple sources of data to assess local drainage problems, including data from citizen complaints, GIS, video inspections, field surveys, and one- and two-dimensional storm drain models. At present, only citizen complaint information is available for many areas, but modeling efforts are progressing. One-dimensional models have been completed for 43% of the local drainage systems. However,

with approximately 1,000 miles of drainage systems to model, it will require multiple years to complete.

The annual prioritization uses citizen complaint data that has been verified by staff in the field. Complaint locations are aggregated into clusters of five or more locations within 150 feet of each other. The cluster areas are then reviewed and assigned to a final problem area by storm drain system. These are the basis for prioritizing both problems and potential capital solutions. Table 5.7-1 in Section 5 presents the Top 20 Local Flood Problem Areas. Almost all of these areas are either in older urban core or outlying annexed areas served by drainage systems that predate a modern understanding of adequate drainage design. Beginning in 1977, the City required all new systems to be built according to formal drainage criteria, which greatly reduced the creation of undersized and substandard systems.

The central urban core is also the epicenter of recent redevelopment and infill development. This increases the pressure to upgrade old and undersized local drainage systems. In 2012, WPD initiated an intensive planning study to assess existing drainage systems in the West Bouldin watershed, which runs along South Lamar Boulevard between Ben White Boulevard and Lady Bird Lake. This study serves as a pilot study to see if additional watersheds should be approached in a similarly focused manner. Future updates of this Master Plan will report on its findings and practicality for citywide application.

Erosion Control

The WPD goal for Erosion Control is to protect channel integrity and prevent property damage resulting from erosion. Many of Austin's streams exhibit erosion, especially in the older urban core in areas developed prior to the advent of protective regulations. Erosion problems typically stem from increased stormwater runoff from

urbanization and/or placement of structures and utilities too close to stream banks. Excessive channel erosion not only threatens creekside resources but also harms water quality and aquatic ecosystems.

To help identify these concerns, WPD staff conduct Erosion Assessments of existing and potential future threats to buildings, roads, trees, utilities, fences, and other resources. Field teams also note areas where a significant loss of land may occur as a result of a bank failure or where steep creek banks within park areas pose a safety threat to the public. Approximately 995 active erosion sites have been cataloged in WPD's erosion database. However, despite over 14 years of implementation of stream stabilization projects, the number of erosion problems continues to increase due to two factors. First, stream systems are dynamic and continue to change and erode—it can take many years for the impacts of uncontrolled urban runoff to be fully seen. Second, staff continue to identify additional problems in new areas on smaller tributaries, where many of the more severe erosion problems are located.



Figure EX-5 Erosion threatens property on Fort Branch

Erosion problem scores are calculated with technical assessment data for individual sites and for stream reaches identified in the assessments. The resulting scores are used to prioritize erosion concerns across Austin. Table 6.7-2 in

Section 6 presents the Top 20 ranked reaches by erosion problem score. Unsurprisingly, the highest (worst) problem severity scores are found in the urban core, where the majority of development occurred prior to the advent of Austin’s protective watershed regulations. A relatively high percentage of the erosion reach score total is located in long-developed watersheds such as Shoal, Waller, Boggy, and Williamson Creek.

Water Quality Protection

The WPD goal for Water Quality Protection is to protect and improve Austin’s waterways and aquifers for citizen use and the support of aquatic life. Exemplary surface and groundwater quality has always been and continues to be central to Austin’s identity and well-being. Clear, flowing water is vital to human and ecological health, property values, and tourism. Since at least the early 1970s, Austin recognized that uncontrolled urbanization threatens water quality and, with it, these invaluable community resources: our lakes, rivers, creeks, and springs. Sources of water quality problems are numerous and complex to study and control. Key concerns include increases in runoff, sediment, nutrients, metals, litter, bacteria, and degradation of aquatic and riparian habitat.



Figure EX-6 Barton Springs Pool

To assess this complexity, WPD developed its Environmental Integrity Index (EII) monitoring and scoring system to compare a range of conditions across Austin’s watersheds. A total of 121 reaches in 49 watersheds are currently sampled across Austin for the EII. While the EII remains the overall indicator of watershed ecological integrity, 10 individual problem scores derived from EII subcomponents are used to prioritize capital projects for the set of existing, feasible solutions used to address water quality problems in Austin:

1. Toxins in sediment
2. Litter
3. Bacteria from animals
4. Sewage
5. Nutrients (non-sewage)
6. Construction runoff
7. Poor riparian vegetation
8. Unstable channels
9. Altered hydrology: current
10. Altered hydrology: future

In addition, stream reaches in need of vegetative and soil restoration are also tracked and prioritized. Scores for each of the preceding 10 categories, plus the CIP and riparian zone restoration scores, are individually compiled to prioritize water quality concerns across Austin. As with flood and erosion, the highest (worst) problem severity scores tend to be found in the urban core, where the majority of development occurred prior to the advent of Austin’s protective watershed regulations. Table 7.4-2 presents the Top 20 EII reaches by water quality CIP problem score.

Inventory of Potential Solutions

Section 9 presents an extensive inventory of over 150 available solutions to address the many watershed problems facing Austin. It gives descriptions, effectiveness, cost, and

other implementation considerations for each solution. Solutions are grouped into capital, programmatic, and regulatory categories for the flood, erosion, and water quality missions, respectively. An additional **integrated** regulatory solutions category—those that address more than one mission—is also included. The three solution types are as follows:

- **Capital Projects** study, design, construct, and improve infrastructure and other capital-intensive assets. Examples include: storm drain systems; stream channel and riparian restoration; flood detention ponds; low water crossing upgrades; dam safety repairs; water quality controls; and buyouts of properties threatened by flood or erosion or to protect water quality.
- **Operating Programs** are a broad set of activities implemented by City staff. Examples include: infrastructure maintenance and inspections; engineering; planning and technical analysis; flood and water quality monitoring; spills response; and public education.
- **Regulations** are the legal framework to enforce City codes and rules. Examples include: peak flow and floodplain restrictions for flood control; drainage conveyance design requirements; erosion hazard protections; structural water quality controls; stream and sensitive environmental feature setbacks; impervious cover limits; control of illegal discharges; and drainage and environmental criteria to clarify how to comply with code requirements.

Identifying Preferred Solutions

Section 10 presents the screening protocol used to identify preferred solutions to address watershed problems. The protocol provides a framework to consider the nature and context of a given watershed problem; its potential solution

types (capital, regulatory, or programmatic); the strengths, feasibility, and possible negative impacts of these solutions; and community considerations for the area in which the solution is proposed.

Solutions are measured by their effectiveness in achieving the watershed protection goals outlined in Section 2. Ideally, preferred solutions:

- Meet flood, erosion, and water quality goals and objectives;
- Maintain or improve the natural character of waterways;
- Minimize required maintenance;
- Ensure compliance with local, state, and federal regulatory requirements;
- Foster additional beneficial uses of waterways and drainage facilities where possible.

Solutions are also assessed for their ability to implement the vision, goals, and priorities of the Imagine Austin Comprehensive Plan. For example, the installation of rain gardens supports two Imagine Austin priority programs: sustainably manage our water resources and integrate nature into the city with green infrastructure. WPD helps lead implementation teams for both of these programs. Solution selection also takes into consideration the context of the problem. Austin’s unique geography and history present different challenges (e.g., steep Hill Country topography vs. Blackland Prairie soils; existing urbanization vs. greenfields development; and water supply protection) which require different sets of solutions be tailored to address them (e.g., prevention vs. restoration). Potential targeted solutions are the subject of ongoing Watershed Plans, included in Appendix C, which can focus on regional and local scales.

The WPD’s **Mission Integration and Prioritization (MIP) Team** implements the solutions protocol process for capital improvement program (CIP)

solutions. The MIP Team’s mission is to identify cost-effective capital solutions to address watershed problems for all three departmental missions. Mission-integrated projects seek to:

1. Maximize solutions for the sponsoring mission (e.g., Flood Mitigation, Erosion Control, or Water Quality Protection);
2. Seek opportunities to attain goals of other WPD missions or City priorities (e.g., WPD common goals, other City departments’ capital projects, Imagine Austin Comprehensive Plan goals, and Neighborhood Plan action items); and
3. Minimize negative impacts to all missions and City priorities.

Every year, MIP Team mission representatives use updated problem score data to identify “Top 20” Priority Problem Areas and potential capital project solutions for each mission. Figures EX-7 and EX-8, and Tables EX-2 through EX-6 show the latest Top 20 Priority Problem Areas. A detailed protocol is used to pinpoint preferred solutions. The MIP team then reviews each prospective project to maximize synergistic opportunities; minimize negative, unintended consequences; evaluate various alternatives for cost-effective solutions; and seek cost-sharing opportunities with other departments, agencies, and the private sector. The resulting, integrated capital projects are reviewed by WPD’s Executive Team and, if approved, added to the WPD’s five-year CIP appropriation plan for consideration for City Council approval.

Complementary, citywide efforts by the Capital Planning Office help identify and prioritize capital project needs that span multiple departments. The goal is to use City funding wisely, minimize disruption of services to the public, and ensure newly proposed projects implement the Imagine Austin Comprehensive Plan and address legal mandates, critical infrastructure needs, and other City policy initiatives (e.g., Neighborhood and Small-Area Plans).

WPD has made several estimates of the cost to implement capital solutions for identified watershed problems. These cost estimates range from \$1.2 billion to \$2.2 billion based on solutions developed for the 2001 Master Plan, as well as limited solutions identified in Phase 2 watershed studies. These estimates serve to provide a baseline, conservative estimate for total potential costs because information for all problem areas is not available. For example, solutions and costs to resolve local flooding problems are largely limited to areas of known flooding; they do not include the full cost of assets maintenance to address aging systems. And, even where solution information is available, most is based on preliminary investigations; further study is needed to refine the expected costs.

A new methodology for cost estimates is also being developed for the Water Quality Protection mission, based on the additional solutions types developed since the 2001 Master Plan to address Water Quality Protection goals. Efforts to provide revised costs for the Creek Flood and Erosion Control capital solutions are also underway. The Capital Planning Office is leading a citywide effort to identify asset management needs and associated cost estimates. The development of updated project costs for all missions, including asset management costs and evaluation for “level of service,” is both a major undertaking and a priority to WPD; it will be available in a future Watershed Master Plan update.

Section 10 presents the WPD protocol for new and improved WPD operating programs. The 2001 Master Plan made recommendations for program enhancements and a limited number of new programs. The status of these enhancements is presented in Appendix D. With the exception of very few items, all enhancements from these original recommendations have been implemented or are underway, with

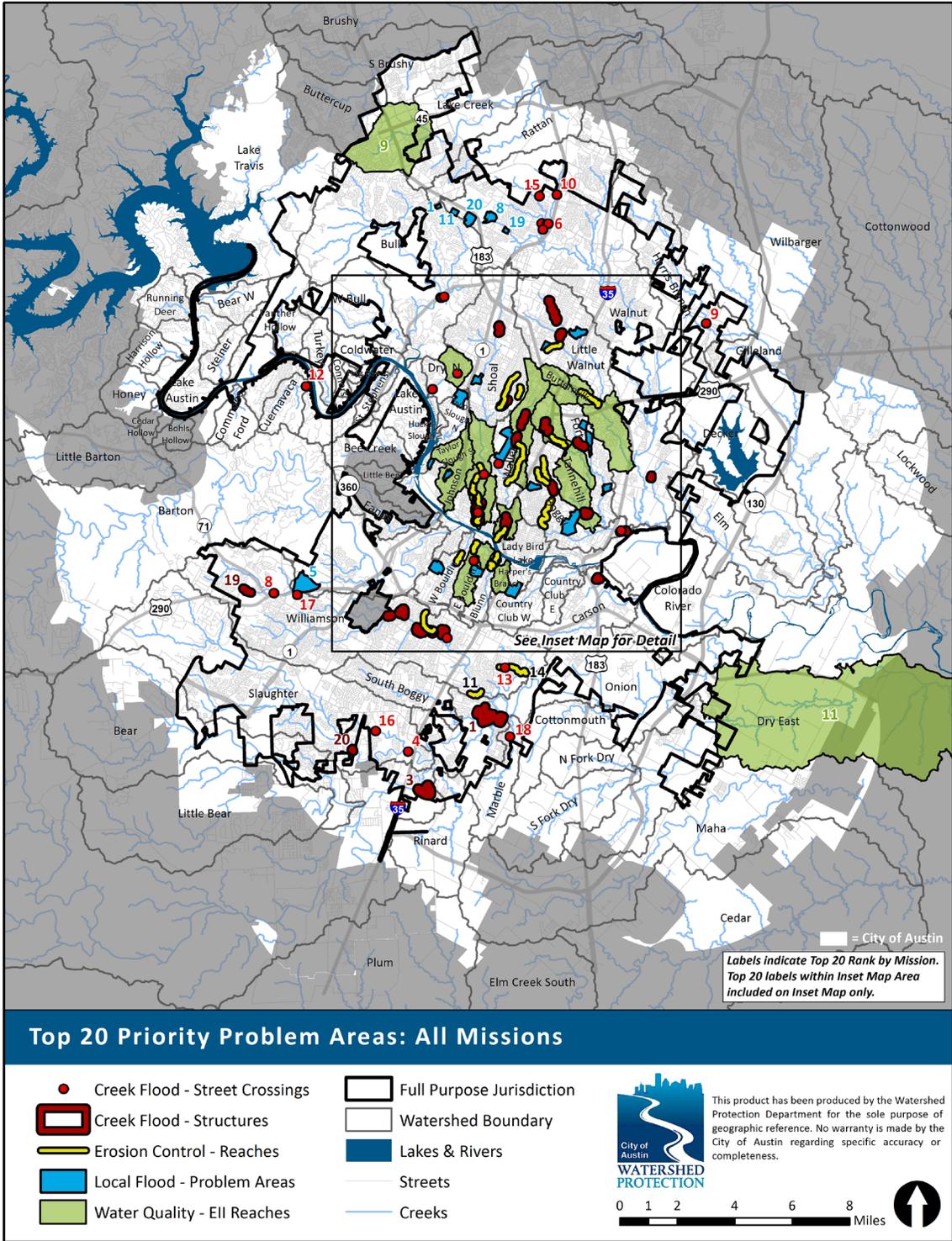


Figure EX-7 Top 20 Priority Problem Areas: All Missions (2014)

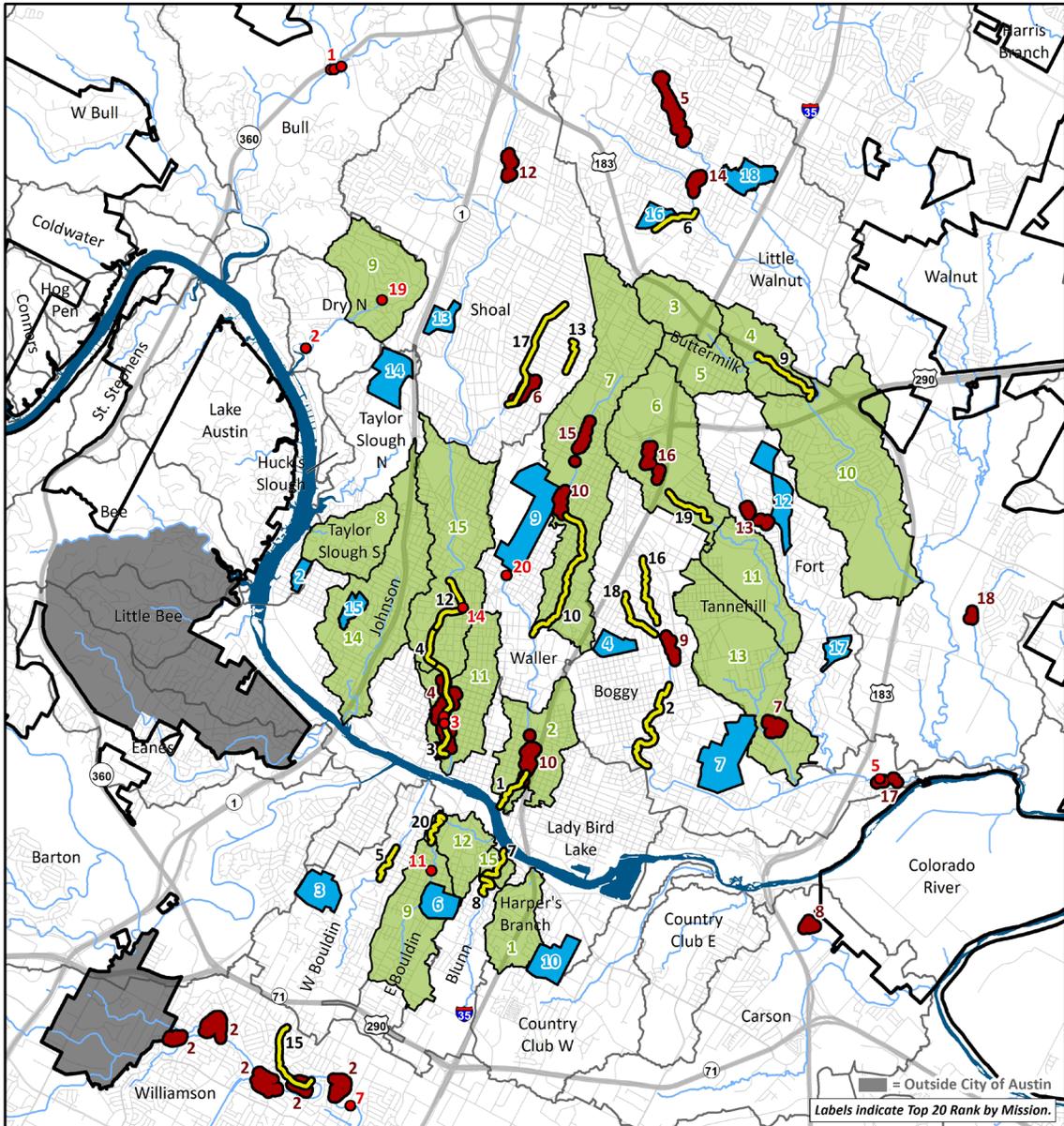


Figure EX-8 Top 20 Priority Problem Areas: All Missions Inset Map (2014)

Table EX-2 Creek Flood Top 20 Priority Problem Areas - Structures (2014)

Creek Flood Top 20 Priority Problem Areas - Structures		
Rank	Watershed	Problem Area Description
1	Onion	Onion Creek Buyouts
2	Williamson	Cherry Creek to S Congress Ave
3	Onion	Pinehurst Dr Subdivision
4	Shoal	Shoal Creek Tunnel
5	Little Walnut	Metric Blvd to Rutland Dr
6	Shoal	Hancock Tributary to Joe Sayers Ave
7	Tannehill Branch	Springdale Rd to Prock Ln
8	Carson	Thompson Lane Mobile Homes
9	Boggy	E 38th 1/2 St to E MLK Jr Blvd
10	Waller	Waller Creek Tunnel
11	Waller	Speedway from E 44th St to E 47th St
12	Shoal	Upper Shoal Creek at Steck Ave
13	Fort Branch	Berkman Dr to Waterbrook Dr
14	Little Walnut	Upper Little Walnut at Quail Cove
15	Waller	Koenig Ln to W 51st Street
16	Tannehill Branch	Reinli St to E 53rd 1/2 St
17	Boggy	Shelton Rd at Delwau Ln
18	Walnut	Johnny Morris Mobile Home Park
19	Williamson	South Brook Dr and Scenic Brook Dr
20	Slaughter	Canterbury Trails Subdivision

Table EX-3 Creek Flood Top 20 Priority Problem Areas - Street Crossings (2014)

Creek Flood Top 20 Priority Problem Areas - Street Crossings		
Rank	Watershed	Problem Area Description
1	Bull	Old Spicewood Springs Rd at 360 (3 crossings)
2	Dry Creek North	Mount Bonnell Rd south of FM 2222
3	Shoal	W 9th St, W 10th St east of N Lamar Blvd
4	Slaughter	Old San Antonio Rd west of S IH 35
5	Boggy	Delwau Ln east of Ed Bluestein Blvd
6	Walnut	Waters Park Rd, Adelphi Rd, ONeal Ln south of Parmer Ln
7	Williamson	Wasson Rd east of S Congress Ave
8	Williamson	Old Bee Caves Rd north of W US 290 Hwy east W SH 71
9	Harris Branch	Cameron Rd south of E Parmer Ln
10	Walnut	McNeil Dr east of Mopac Expy
11	East Bouldin	W Monroe St east of S 1st St
12	Cuernavaca	River Hills Rd south of N Cuernavaca Dr
13	Williamson	Nuckols Crossing Rd north of E Stassney Ln
14	Shoal	Shoal Creek Blvd at N Lamar Blvd
15	Walnut	Del Robles Dr west of N Mopac Expy, south of McNeil Dr
16	Slaughter	David Moore Dr south of W Slaughter Ln
17	Williamson	Joe Tanner Ln south of W US 290 Hwy
18	Marble	Colton Bluff Springs Rd south of E William Cannon Dr
19	Dry Creek North	Highland Pass north of FM 2222 Rd
20	Waller	W 32nd St east of Guadalupe St

Table EX-4 Local Flood Top 20 Priority Problem Areas (2014)

Local Flood Top 20 Priority Problem Areas		
Rank	Watershed	Problem Area Description
1	Bull	Charing Cross Rd
2	Lake Austin	Meredith St
3	West Bouldin	Del Curto Rd
4	Boggy	Cherrywood Rd
5	Barton	Oak Acres
6	East Bouldin	Annie St
7	Boggy	Thompson St
8	Walnut	W Cow Path
9	Waller	Guadalupe St
10	Lady Bird Lake	Briar Hill Dr
11	Walnut	Oak Knoll Dr
12	Fort Branch	Wellington Dr
13	Shoal	Bullard Dr
14	Taylor Slough North	Parkcrest Dr
15	Johnson	Stamford Ln
16	Little Walnut	Jamestown Dr
17	Fort Branch	Stone Gate Dr
18	Little Walnut	Oriole Dr
19	Walnut	Chadbury Cv
20	Walnut	Bell Ave

Table EX-5 Erosion Control Top 20 Priority Problem Areas (2014)

Erosion Control Top 20 Priority Problem Areas - Geomorphic Reaches		
Rank	Watershed	Problem Area Description
1	Waller	Confluence north to E 5th St
2	Boggy	Rosewood Park
3	Shoal	Pease Park from W 4th St to MLK Jr Blvd
4	Shoal	Pease Park from MLK Blvd to W 25th St
5	West Bouldin	Jewell St to W Johanna St
6	Little Walnut	Thurmond St to Payton Gin Rd
7	Blunn	Little Stacy Park to Confluence
8	Blunn	Little Stacy Park
9	Buttermilk	US 290 to E Anderson Ln
10	Waller	Eastwoods Park
11	Williamson	Bitter Creek Tributary
12	Shoal	Pease Park from W 25th St to W 29th St
13	Shoal	Grover Tributary along Grover Ave
14	Williamson	Copperbend Blvd to main stem
15	Williamson	Richmond Tributary
16	Boggy	E 38th 1/2 St north to Airport Blvd
17	Shoal	Hancock Branch along Arroyo Seco
18	Boggy	Clarkson Tributary
19	Tannehill Branch	West of Berkman Dr to Cameron Rd
20	East Bouldin	Barton Springs Rd to Columbus St

Table EX-6 Water Quality Protection Top 20 Priority Problem Areas (2014)

Water Quality Top 20 Priority Problem Areas - EII Reaches		
Rank	Watershed	Problem Area Description
1	Harpers Branch	Harpers Branch, EII Reach 1 (HRP1)
2	Waller	Waller Creek, EII Reach 1 (WLR1)
3	Buttermilk Branch	Buttermilk Branch, EII Reach 3 (BMK3)
4	Buttermilk Branch	Buttermilk Branch, EII Reach 1 (BMK1)
5	Buttermilk Branch	Buttermilk Branch, EII Reach 2 (BMK2)
6	Tannehill Branch	Tannehill Branch, EII Reach 3 (TAN3)
7	Waller	Waller Creek, EII Reach 3 (WLR3)
8	Taylor Slough South	Taylor Slough South, EII Reach 1 (TYS1)
9	Lake	Lake Creek, EII Reach 3 (LKC3)
9	Dry Creek North	Dry Creek North, EII Reach 2 (DRN2)
9	East Bouldin	East Bouldin Creek, EII Reach 2 (EBO2)
10	Little Walnut	Little Walnut Creek, EII Reach 1 (LWA1)
11	Dry Creek East	Dry Creek East, EII Reach 1 (DRE1)
11	Tannehill Branch	Tannehill Branch, EII Reach 2 (TAN2)
11	Shoal	Shoal Creek, EII Reach 1 (SHL1)
12	East Bouldin	East Bouldin Creek, EII Reach 1 (EBO1)
13	Tannehill Branch	Tannehill Branch, EII Reach 1 (TAN1)
14	Johnson	Johnson Creek, EII Reach 1 (JOH1)
15	Shoal	Shoal Creek, EII Reach 2 (SHL2)
15	Blunn	Blunn Creek, EII Reach 1 (BLU1)

some greatly exceeding expectations of the original recommendations. Examples include the multiple watershed education campaigns undertaken beyond the Grow Green program recommendation from 2001, as well as new riparian restoration and Grow Zone programs. Updated 2015 program recommendations are summarized in Section 11; they are primarily based on interviews with staff and feedback from the Environmental Commission. These recommendations seek to raise WPD's level of service, improve program performance, address asset management needs, and keep pace with the rate of growth in Austin.

Section 10 also presents the WPD protocol for new and improved WPD regulations. As with the programmatic recommendations, essentially all regulatory enhancements from the 2001 Master Plan recommendations have been implemented. Appendix E presents the status of these recommendations. Key regulatory improvements include the Watershed Protection Ordinance (WPO) and Imagine Austin CodeNEXT. Phase 1 of the WPO was passed by City Council in 2013 and included new protections and provisions for headwaters streams, natural floodplains, erosion hazard zones, and trail integration with greenways. With the adoption of this ordinance, the vast majority of the regulatory recommendations from the 2001 Master Plan have been addressed. WPO Phase 2 focused on synergistic opportunities to improve watershed hydrology and enhance water conservation.

CodeNEXT is a major reworking of the City's Land Development Code, called for by the Imagine Austin Comprehensive Plan and led by the Planning and Zoning Department. At the time of this report, WPD is leading the Green Infrastructure Working Group, one of five CodeNEXT public working groups. The Green Infrastructure Working Group examines how we can achieve the Imagine Austin goals of integrating nature into the city,

sustainably managing our water resources, and creating complete communities through revisions to our zoning and environment codes.

Section 10 also summarizes the creation and work of the Value Engineering Team and interdisciplinary teams for modeling, data management, and green stormwater infrastructure. Each of these focuses on cost savings and process improvements for WPD capital, programmatic, and/or regulatory solutions.

Recommendations

The Watershed Protection Master Plan presents individual and common goals for watershed protection. These goals, originally established in 2001, remain unmodified in this 2015 update. They continue to be ambitious and aspirational: to resolve flood, erosion, and water quality problems at a very high level. The 2001 Master Plan attempted to broadly quantify potential goal attainment for the cumulative benefits of capital, regulatory, and programmatic solutions. These estimates were acknowledged to be preliminary due to the conceptual nature of the capital solutions and the inherent difficulty in estimating a numeric benefit for many of the programmatic and regulatory solutions. Estimates were, of course, limited to the 17 watershed areas studied in Phase 1.

This 2015 Master Plan update reviews these estimates and makes recommendations for potential next steps. With 14 additional years of direct implementation experience and a doubling of watersheds to study, estimation of goal attainment has evolved considerably. The bottom line is that potential solutions are theoretically possible for all creek flood, local flood, and erosion problems—but come at a significant financial and/or community cost. Solution implementation and goal attainment are thus limited by cost and community support, not by technical constraints. Solutions for water

quality problems present a more challenging prospect. Contributing factors include limited available land for water quality control retrofits, lack of regulatory control beyond Austin’s jurisdiction (especially for the Barton Springs Zone, Lake Austin, and Lake Travis), and uncertainty about the degree to which structural solutions can achieve water quality goals.

Findings

1. In the Phase 1 and 2 watersheds, flood, erosion, and water quality problems continue to be widespread despite considerable commitment of resources and substantial progress by WPD and the City of Austin as a whole. WPD must continue to find ways to cost-effectively address these needs and take corrective action to avoid even greater costs if this action is deferred.
2. Over the next 40 years, a range of \$1.8 billion to \$2.2 billion in capital funds are required to construct new or improved integrated watershed protection facilities including detention ponds, channel stabilization projects, and other flood, erosion, and water quality controls.
3. Additional resources and funding are needed to provide adequate levels of assets maintenance of Austin’s drainage infrastructure; current rates of repair and replacement are not keeping pace with the growing deterioration of the system, and delays in such action only further increases eventual costs.
4. The 2013 Watershed Protection Ordinance addressed the majority of outstanding regulatory recommendations from the 2001 Master Plan. Several additional code and criteria changes are recommended to address the need for improved on-site infiltration for baseflow, reuse of water for conservation, and to address flood concerns with redevelopment.
5. Attainment of Erosion Control and Flood Mitigation goals may be technically possible, but will require significant funding and community support.

6. Water Quality Protection goals may not be attainable through implementation of solutions presently evaluated in the Master Plan. Limited regional retrofit opportunities in urbanized watersheds and inadequate regulatory controls in areas outside the City’s jurisdiction are significant constraints.

Recommendations

1. Continue to develop long-range funding proposals to support solution implementation.
2. Continue to integrate watershed solutions to effectively promote watershed protection goals across all missions.
3. Continue adherence to the core Master Plan principle that the most severe problems should be considered first for solutions identification and implementation as funding becomes available.
4. Continue to partner with others to achieve watershed protection goals, address challenges across jurisdictional boundaries, and realize economies of scale. Partnerships include those with private development and land owners; federal, state, and local governments; including other City Departments (e.g., the Capital Planning Office); community groups; and concerned citizens.
5. Develop an asset management plan in coordination with the Capital Planning Office to identify an approach and funding mechanism to address the long-term maintenance of Austin’s aging drainage infrastructure; include an evaluation of an appropriate level of service for drainage repairs and replacements to implement this approach.
6. Continue to use Master Plan results to assist in the development of proposed WPD budget increases to fund priority program enhancements.
7. Continue to involve stakeholders at a high level in the comment and review process for all proposed regulatory

modifications using the model established by the Watershed Protection Ordinance.

8. Refine watershed protection goals based on continued public involvement and experience gained in Austin and from other communities. For example, continue the evaluation of and experimentation with green stormwater infrastructure solutions to attain water quality goals. Consider revisions to Water Quality Protection goals to reflect additional evaluation and feasibility of solution implementation.
9. Update the Master Plan on a regular basis, such as a five-year cycle, to ensure that up-to-date information is included; maintain the updated Master Plan document and interactive maps with problem scoring and solutions data on the web for public access.
10. Continue to expand Master Planning efforts in Phase 2 watersheds as funding allows, including the development of more site-specific analysis via Watershed Plans.
11. Continue to support watershed and environmental protection elements in the CodeNEXT process to best implement the vision and goals of the Imagine Austin Comprehensive Plan.

In order to keep current information on high priority needs, the Watershed Protection Master Plan will continue to be revised to reflect updated information. These updates will include updates to problem scores for additional Phase 2 watersheds, results of improved modeling efforts, and current watershed conditions. An annual update regarding the plan's implementation status is provided to the Environmental Commission, which serves in an advisory capacity for the Watershed Protection Master Plan.

Environmental Integrity Index (EII) scores are now available for all watersheds wholly or partially within Austin's jurisdiction. Flood and erosion technical studies have been completed for many Phase 2 watersheds, as reflected in the updated problem scores in Sections 4 and 6. Additional studies of the Phase 2 watersheds will continue as funding is available.

WPD will continue to work with the public in developing sustainable watershed solutions for all watersheds in the City of Austin.