Evaluating the Impact of the Proposed CodeNEXT Regulations on Flood Risk Reduction

December 1, 2017

The Watershed Protection Department's (WPD) mission is to protect lives, property, and the environment by reducing the impact of flood, erosion, and water pollution. We succeed at this mission by completing projects, enforcing development regulations, and providing programs. These efforts help to mitigate existing problems, prevent future problems, and ensure problems don't get repeated. In response to the public's desire and the impetus of our mission to reduce the impacts of flooding, WPD proposes new regulations in CodeNEXT that we believe will help reduce flood risks city-wide. This summary discusses the proposed regulations in addition to discussing the results of engineering studies to determine the potential flood risk reduction benefits of the proposed regulations.

The current Land Development Code (LDC) includes regulations that require the control of post-development stormwater runoff from all development such that no development will result in additional adverse flooding to other properties. To satisfy these regulations, development typically includes one of these three options: on-site stormwater controls, usually with a detention pond; off-site improvement or addition of stormwater infrastructure; or a payment-in-lieu of detention program. When determining the amount of pre-development stormwater runoff, the regulations allow the developer to take into account the amount of impervious cover that exists on the site at the time of application.

For example, a developer desires to redevelop a 30-acre property that has 15 acres of existing impervious cover and produces a peak rate of stormwater runoff of 120 ft^3/sec. A developer originally developed the property prior to the drainage regulations that are in the current LDC. Therefore, there is not an existing stormwater control on the site. With zero impervious cover on the site—"greenfields" (undeveloped) conditions—the peak rate of stormwater runoff is estimated to have been 90 ft^3/sec. The proposed development will have 21 acres of impervious cover that will produce a peak rate of stormwater runoff of 160 ft^3/sec. Under the current LDC, the developer is either required to not increase the rate of stormwater runoff above 120 ft^3/sec. by constructing a detention pond or constructing off-site drainage infrastructure improvements to handle the post-development peak rate of stormwater runoff. In all cases, the developer is required to demonstrate that the development will not result in additional adverse flooding to other properties.

As part of the current CodeNEXT draft regulations, re-development of commercial and multi-family properties and residential subdivisions would be required to construct on-site stormwater controls to limit the post-development peak rate of stormwater runoff to that which exists with zero impervious cover. Off-site stormwater infrastructure improvements or a payment-in-lieu of detention will still be an option for the developer so long as they prove through engineering calculations that the development will not create additional flooding downstream. Using the example above, under the current CodeNEXT draft, the developer would be required to limit the post-development peak rate of stormwater runoff to 90 ft^3/sec compared to 120 ft^3/sec under the existing LDC.

The intent of these proposed regulations is to require properties that were developed prior to the current drainage regulations to do their proportionate share to reduce the risk of flooding to other properties. For decades, the LDC has required that new development do their share to reduce the risk of flooding. In large part due to development prior to regulations put in place by the City in the late 1970s and 1980s, there are more flood risks city-wide than the Watershed Protection Department has resources to mitigate. Our goal with the proposed CodeNEXT regulations is for development and re-development to assist in reducing flood risks.

WPD believed that it was necessary to complete an engineering study to better understand how effective the proposed CodeNEXT regulations would be at reducing flood risks along a typical major creek and within an urban drainage system. We refer to these as creek flooding and local flooding. More details about that study are as follows.

Local Flood Modeling

To assess the impact of the proposed CodeNEXT regulations on stormwater levels along an urban drainage system, WPD performed modeling of storm drain systems in four selected areas of the City utilizing an engineering model called StormCAD. The advantages of the StormCAD model are that it’s relatively simple to build and effectively determines how efficiently stormwater flows through the pipes of the drainage system. However, it is not the best model to predict the level of stormwater that flows along the ground when the pipes have reached their capacity. We use StormCAD as a starting point to justify proceeding with a more advanced model.

In order to represent development of properties according to the proposed CodeNEXT regulations, impervious cover for all multi-family and commercial parcels was set to zero in the model’s runoff coefficient calculations to simulate pre-development peak flow conditions. The StormCAD modeling results clearly indicated an improvement in the capacity of the storm drain system and justified using a more advanced engineering model for more detailed results.

Staff selected an area near South Lamar at Del Curto Road in the West Bouldin Creek watershed as the study area for the advanced modeling effort because it has a combination of residential and commercial properties that are generally representative of Austin’s central core. See Figure 1 at the end of the report for a map of the study area. The advanced model, also called a 2D model, is able to account for stormwater flowing through the storm drain pipes as well as stormwater flowing above ground to simulate water levels at the potentially impacted buildings.

We analyzed two scenarios to assess the impact of the proposed CodeNEXT on localized flooding. Scenario 1 simulates existing conditions in impervious cover and scenario 2 simulates the full buildout of multifamily/commercial properties under the current proposed CodeNEXT regulations. In order to represent development of properties according to the proposed

CodeNEXT regulations engineering data such as curve numbers and times of concentration were adjusted as well. The results of the 2D modeling effort show a reduction in flood risk due to the CodeNEXT regulations. The table below indicates the maximum and average reductions in the levels of the stormwater. These reductions impact the number of buildings shown in the table.

Table 1: Benefits of Proposed CodeNEXT Mitigation to Greenfield Conditions for Buildings Compared to Existing Conditions

Storm Event	No. of Buildings Removed From Flood Risk	No. of Buildings With Flood Risk Reduction	Max. Reduction in feet (inches)	Avg. Reduction in feet (inches)
2-year	5	16	0.16 (2)	0.10 (1)
10-year	5	28	0.25 (3)	0.14 (2)
25-year	4	41	0.40 (5)	0.11 (1)
100-year	3	50	0.22 (3)	0.10 (1)

Creek Flood Modeling

WPD staff selected the four areas shown in Figure 2 to analyze the impact of the proposed CodeNEXT regulations on creek flood levels: West Bouldin Creek watershed (South Lamar Boulevard), Country Club West Creek watershed (Riverside Drive, east of IH35 area), Hancock Branch of Shoal Creek (Brentwood Neighborhood), and Upper Tannehill Branch watershed (IH35 at Airport Boulevard). WPD selected these areas because they are generally fully developed, include portions of major re-development corridors identified in the Imagine Austin Comprehensive Plan, and have enough land use variety to cover the breadth of the impacts we would expect to see from the proposed CodeNEXT regulations.

Detention was selected as the most easily modeled form of mitigation to represent the proposed CodeNEXT regulations. However, in practice, the proposed mitigation approach would require that each re-development project be evaluated to determine the most effective strategy to address downstream flooding. In some cases, this would be on-site flood detention; in others, it might be the improvement of downstream conveyance either directly or through a payment-in-lieu of detention program. In all cases, the development would not be allowed to result in additional adverse flooding to other properties.

WPD staff developed a methodology for this analysis that represents the impact of detention distributed throughout the properties with the potential for re-development without modeling each individual detention pond directly. This method adjusts the Peak Rate Factor (PRF), which is a component of the NRCS Unit Hydrograph transform within the engineering model. Reduction of the PRF flattens the runoff hydrograph and reduces the peak flow produced by each subbasin. This effectively mimics the storage within the subbasin that would be provided by detention.

The Creek Flood modeling analysis shows that the proposed CodeNEXT regulations would have a measurable and beneficial impact on both flood levels and floodplain extents. The City's floodplain models, maps and regulations are based on the assumption of full development without detention in the watershed. The mitigation scenario was compared to this full development condition per the zoning recommendations in CodeNEXT. As expected, the magnitude of the benefit seen is dependent on the amount of land with the potential for re-development and on the location of this land within the watershed. The analysis shows an average peak flow reduction of up to 15% and an associated average depth reduction up to 4 inches (0.3 feet) for the 100-year storm event. Refer to figures 3 through 7 and table 1 for summaries of the average flow and depth reduction benefits for different areas within the evaluated watersheds.

Summary

The proposed CodeNEXT regulations requiring that re-developing properties mitigate to pre-development conditions has the potential to help the City address long-standing flood risk issues, especially in the urban core. Since they are dependent on the pace of re-development, the flood risk reduction benefits associated with this proposal will likely occur over an extended period of time. The analyses summarized in this memo show that mitigation for re-development, modeled for simplicity in the form of detention, provides measurable and beneficial reductions in flood risk.

- The magnitude of flood risk reduction depends, to a degree, on the location within the watershed and the amount of land area that is likely to redevelop within the watershed.
- The observed reduction is greater in the upstream portions of the studied watersheds and tends to decrease as the contributing area increases along the larger streams.
- The observed variation in flood risk reduction illustrates the need for a toolbox of mitigation measures that will allow the mitigation approach to be tailored depending on the location within the watershed and the condition of the downstream drainage system.

The proposed CodeNEXT regulations produces demonstrable flood risk reductions. However, they will not provide an immediate solution to the City's flooding problems. Over time, the requirements would reduce the risk for flooding to buildings in or near the floodplain and would, by association, reduce the cost of post-flood recovery to those affected by flooding. The proposed requirements could also make implementation of City-funded flood risk reduction projects within the urban core more cost-effective by reducing the magnitude of flows that must be managed through drainage system improvements and helping directly construct or contribute financially to such improvements.

It is important to reiterate that detention is not the only potential mitigation measure that could be associated with these proposed regulations. In practice, each re-development project would need to be evaluated to determine the most effective strategy to address downstream flooding. In some cases, this would be on-site flood detention, in others, it would be the targeted improvement of downstream conveyance either directly or via payment-in-lieu of detention towards such a project.

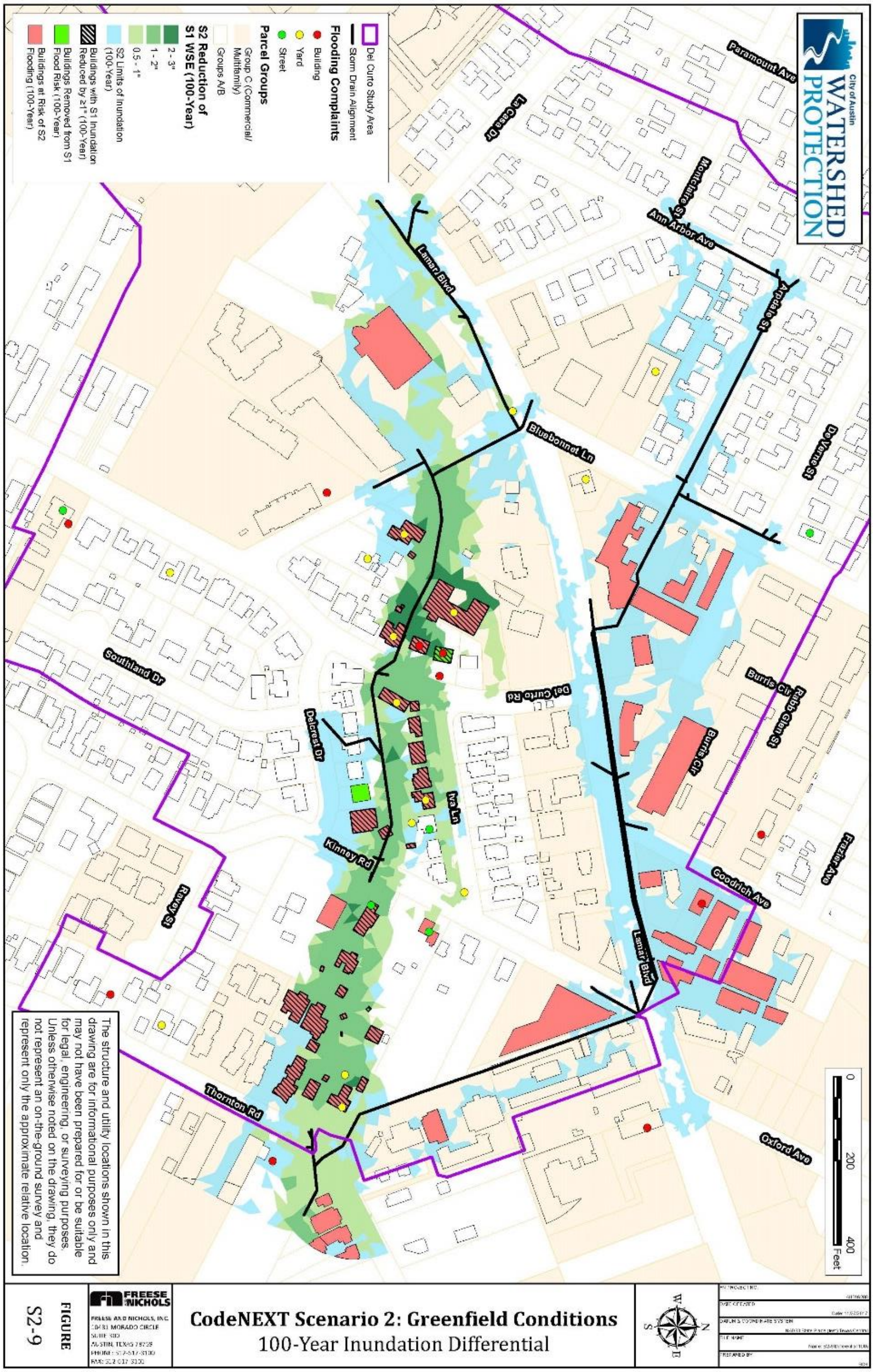

Figure 1. Del Curto Local Flood Study Area Showing Benefits of Re-development Mitigation

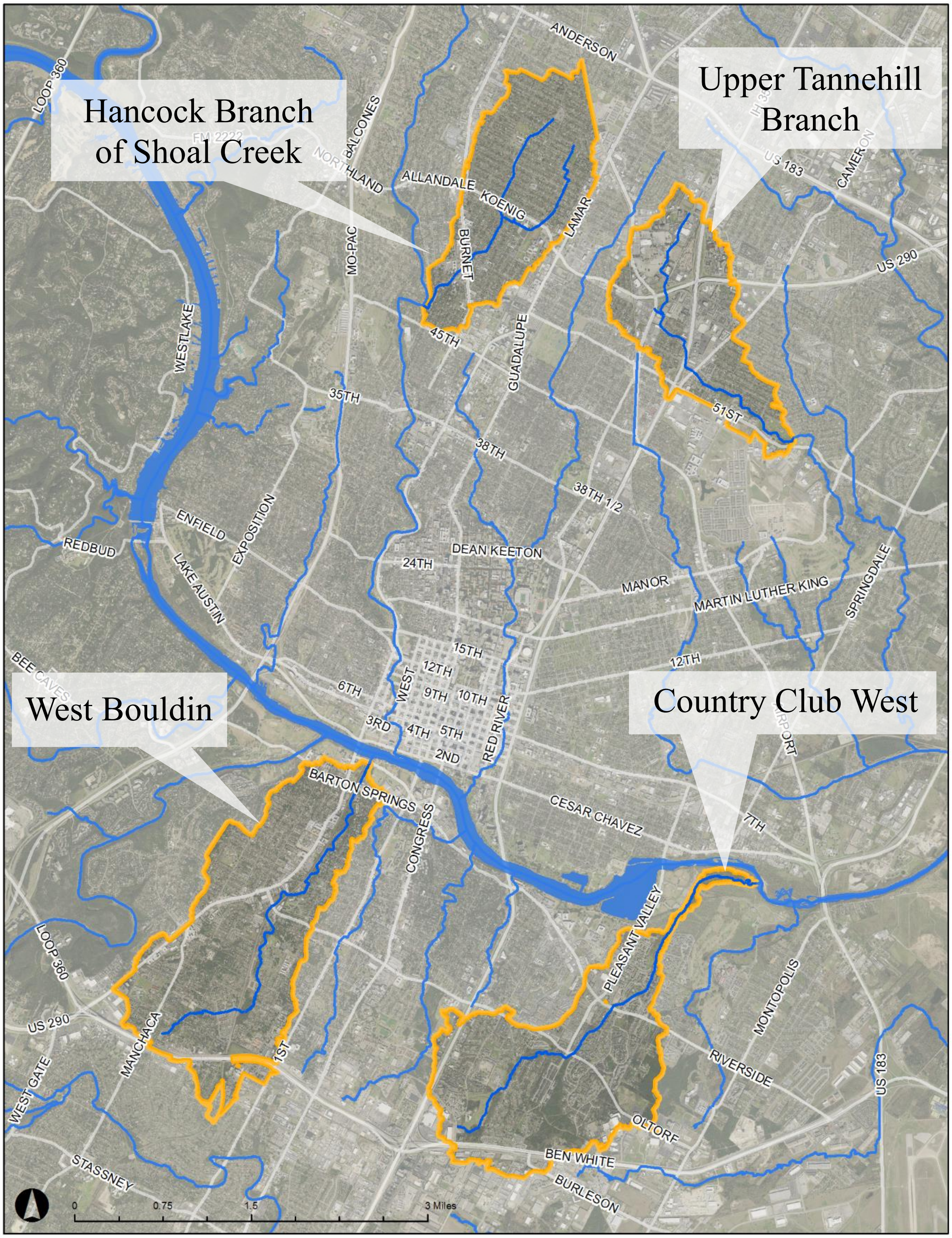

Figure 2. Four Areas of Creek Flood Analysis: West Bouldin, Country Club West, Hancock Branch of Shoal Creek, and Upper Tannehill watersheds.

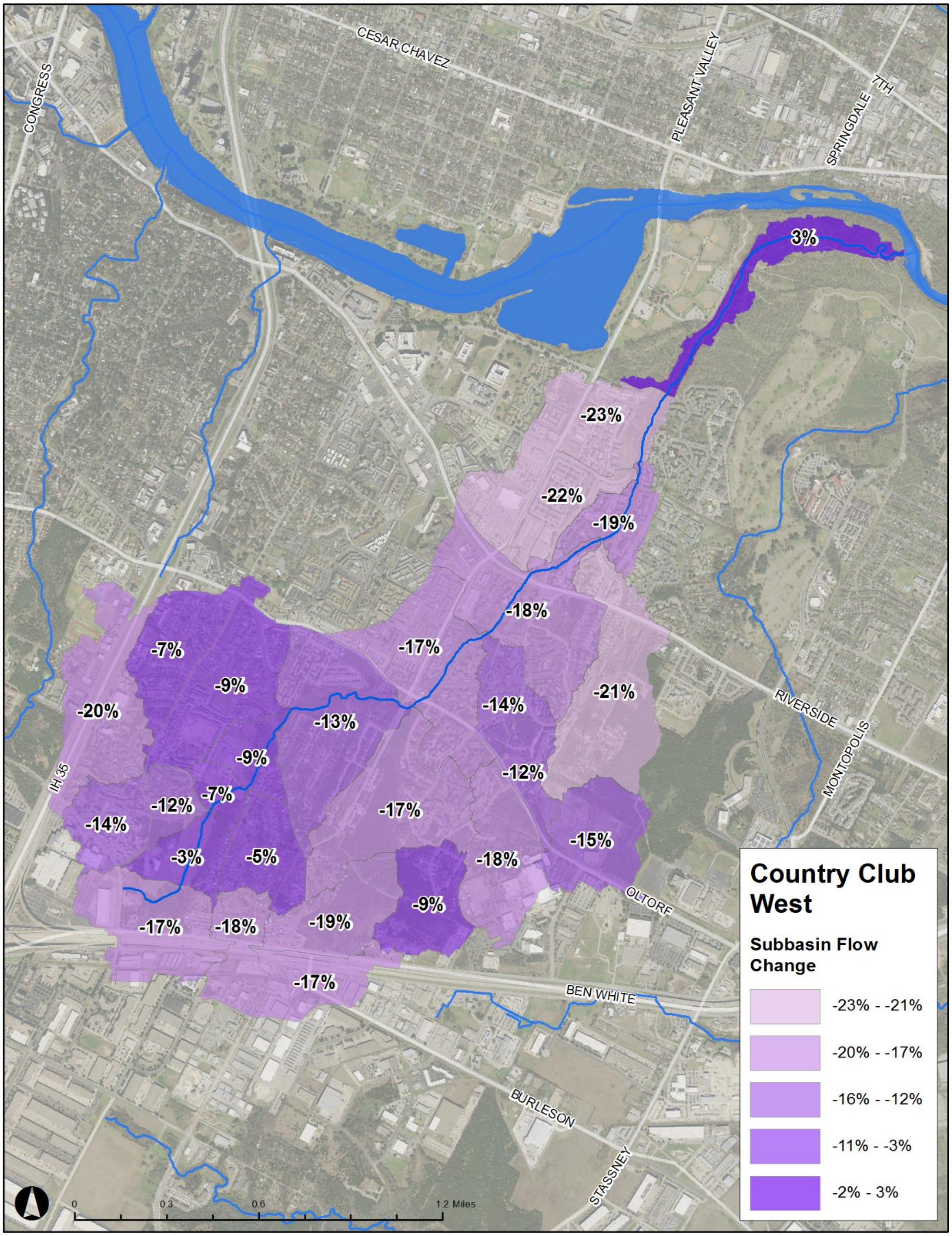

Figure 3. Percent change in subbasin flows between Mitigation Alternative (Ponds) and CodeNEXT proposed maximum allowable impervious for Country Club West. Negative numbers indicate a reduction in flow for the subbasin in the Mitigation Alternative analysis.

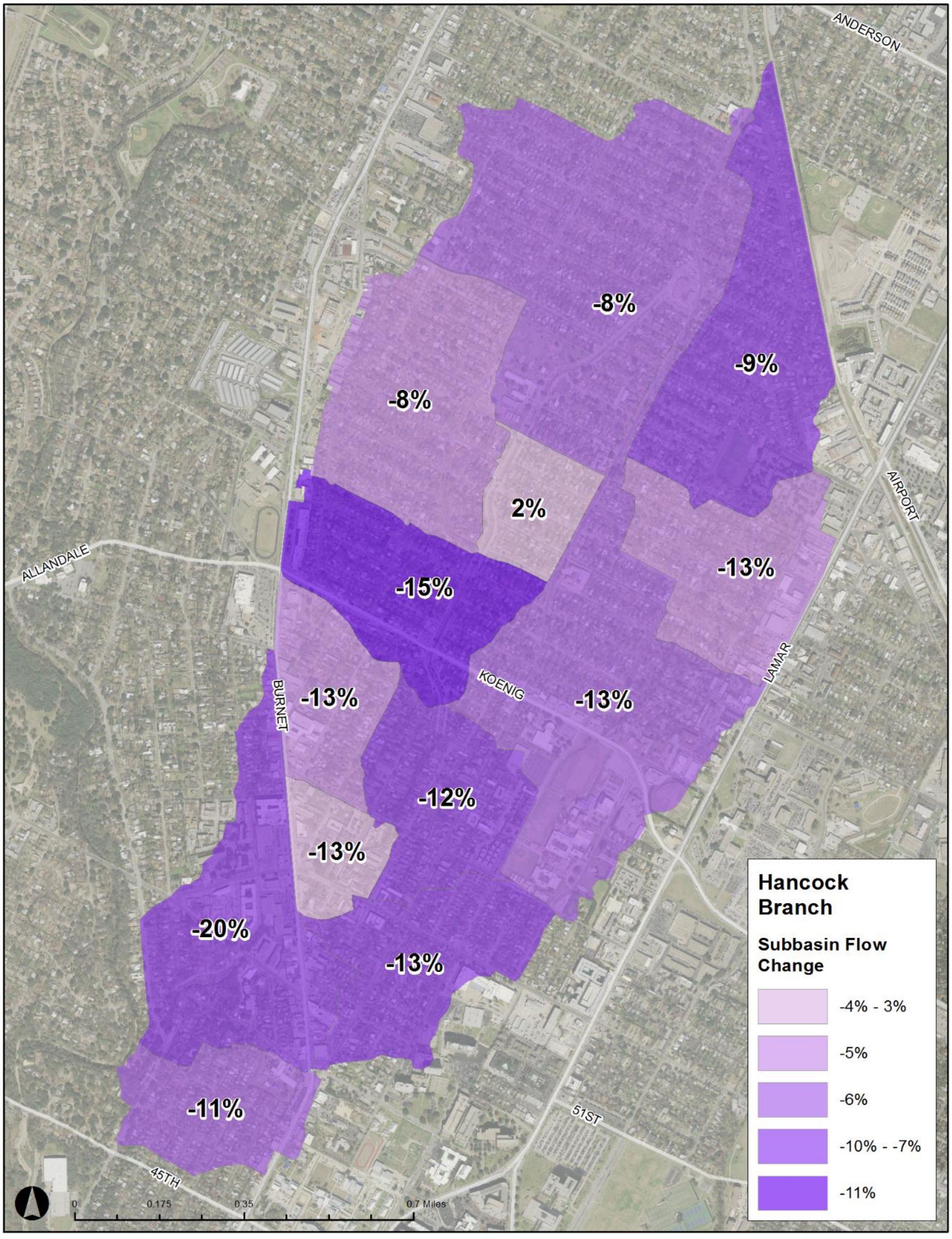

Figure 4. Percent change in subbasin flows between Mitigation Alternative (Ponds) and CodeNEXT proposed maximum allowable impervious for Hancock Branch of Shoal Creek. Negative numbers indicate a reduction in flow for the subbasin in the Mitigation Alternative analysis.

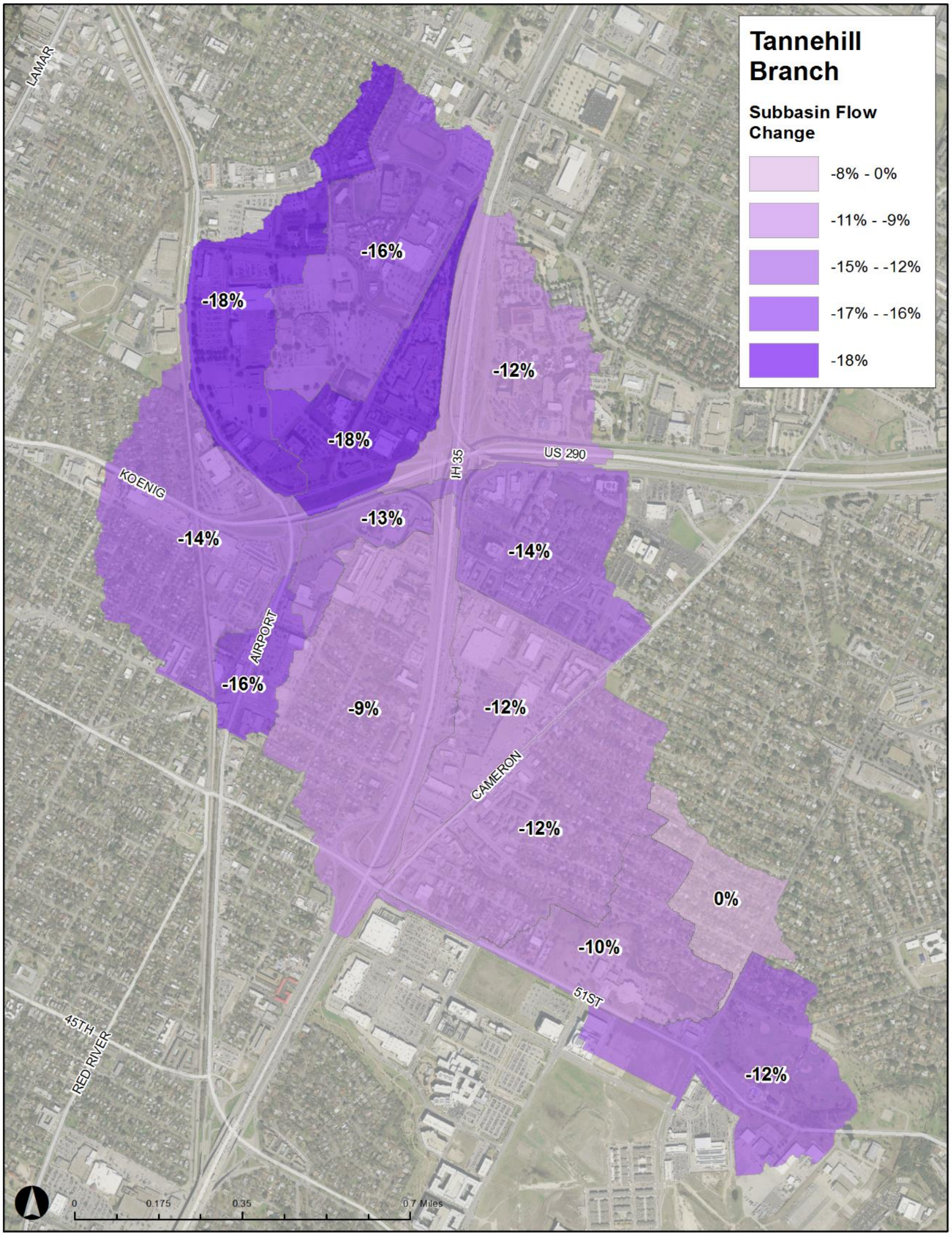

Figure 5. Percent change in subbasin flows between Mitigation Alternative (Ponds) and CodeNEXT proposed maximum allowable impervious for Tannehill. Negative numbers indicate a reduction in flow for the subbasin in the Mitigation Alternative analysis.

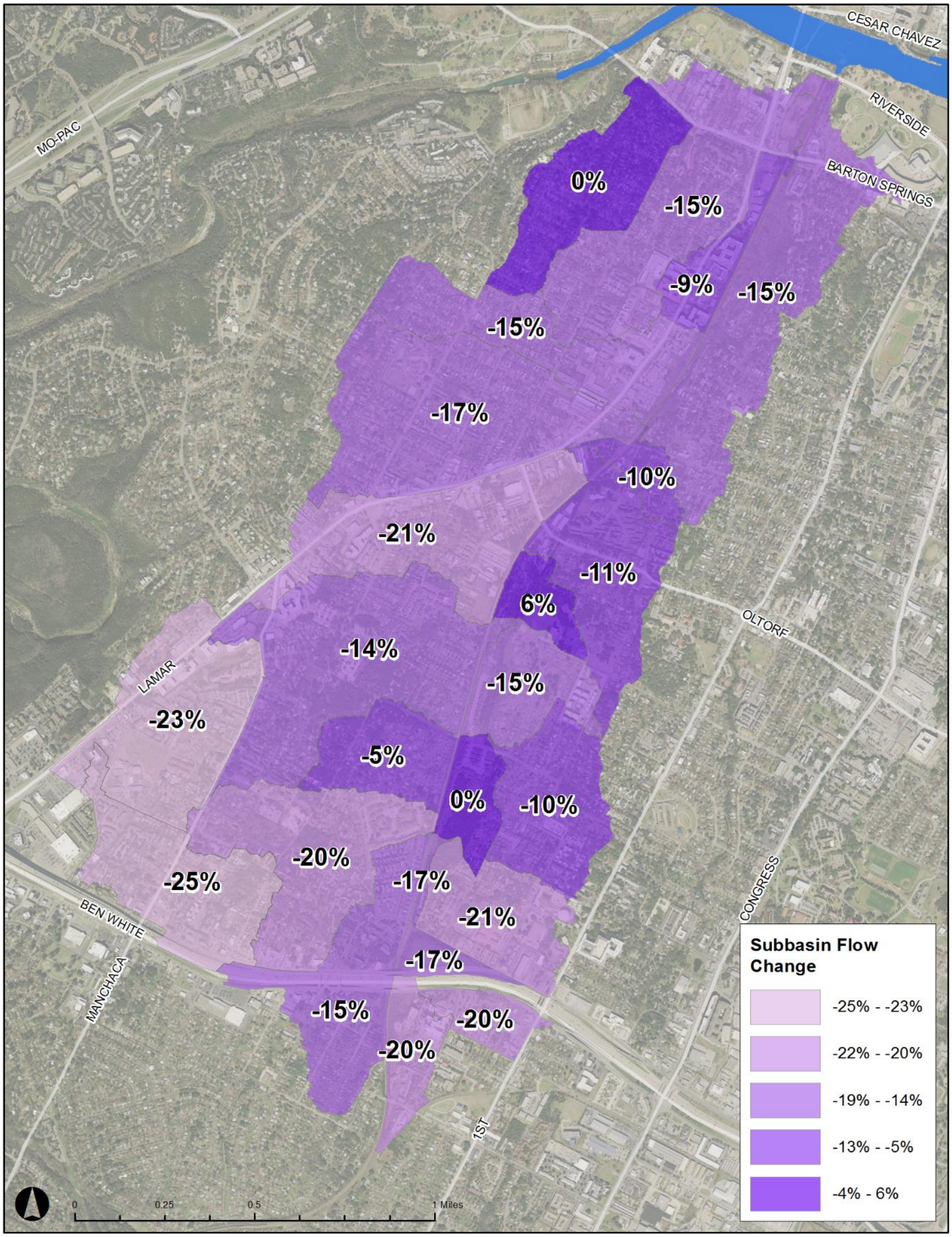

Figure 6. Percent change in subbasin flows between Mitigation Alternative (Ponds) and CodeNEXT proposed maximum allowable impervious for West Bouldin. Negative numbers indicate a reduction in flow for the subbasin in the Mitigation Alternative analysis.

Table 2: Summary of Average Flood Depth Reductions between CodeNEXT Maximums (Full Development) and Mitigation with Ponds

Waterhshed and Stream Reach	Average Depth Reductions for Selected Design Storms					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
West Bouldin						
South of North Fork	-0.23	-0.2	-0.21	-0.24	-0.24	-0.26
North of North Fork	-0.24	-0.363	-0.28	-0.41	-0.34	-0.33
North Fork Trib	-0.24	-0.35	-0.33	-0.34	-0.3	-0.33
Shoal Creek						
Hancock Branch	-0.16	-0.17	-0.17	-0.14	-0.13	-0.12
Grover Branch	-0.08	-0.07	-0.07	-0.07	-0.08	-0.09
Country Club West						
Mainstem	-0.13	-0.19	-0.19	-0.21	-0.25	-0.21
CCW1	-0.14	-0.19	-0.19	-0.23	-0.24	-0.24
CCW2	-0.18	-0.21	-0.27	-0.29	-0.27	-0.28
CCW3	-0.13	-0.17	-0.19	-0.22	-0.23	-0.24
CCW3a	-0.04	-0.05	-0.06	-0.06	-0.06	-0.06
CCW4	-0.21	-0.26	-0.31	-0.24	-0.33	-0.33
CCW5	-0.16	-0.24	-0.23	-0.28	-0.22	-0.19
Tannehill Branch						
Upstream IH35	-0.39	-0.40	-0.37	-0.32	-0.32	-0.28
Downstream IH35	-0.14	-0.14	-0.14	-0.12	-0.19	-0.14
Bartholomew Pond to Manor	-0.13	-0.10	-0.13	-0.09	-0.06	-0.12

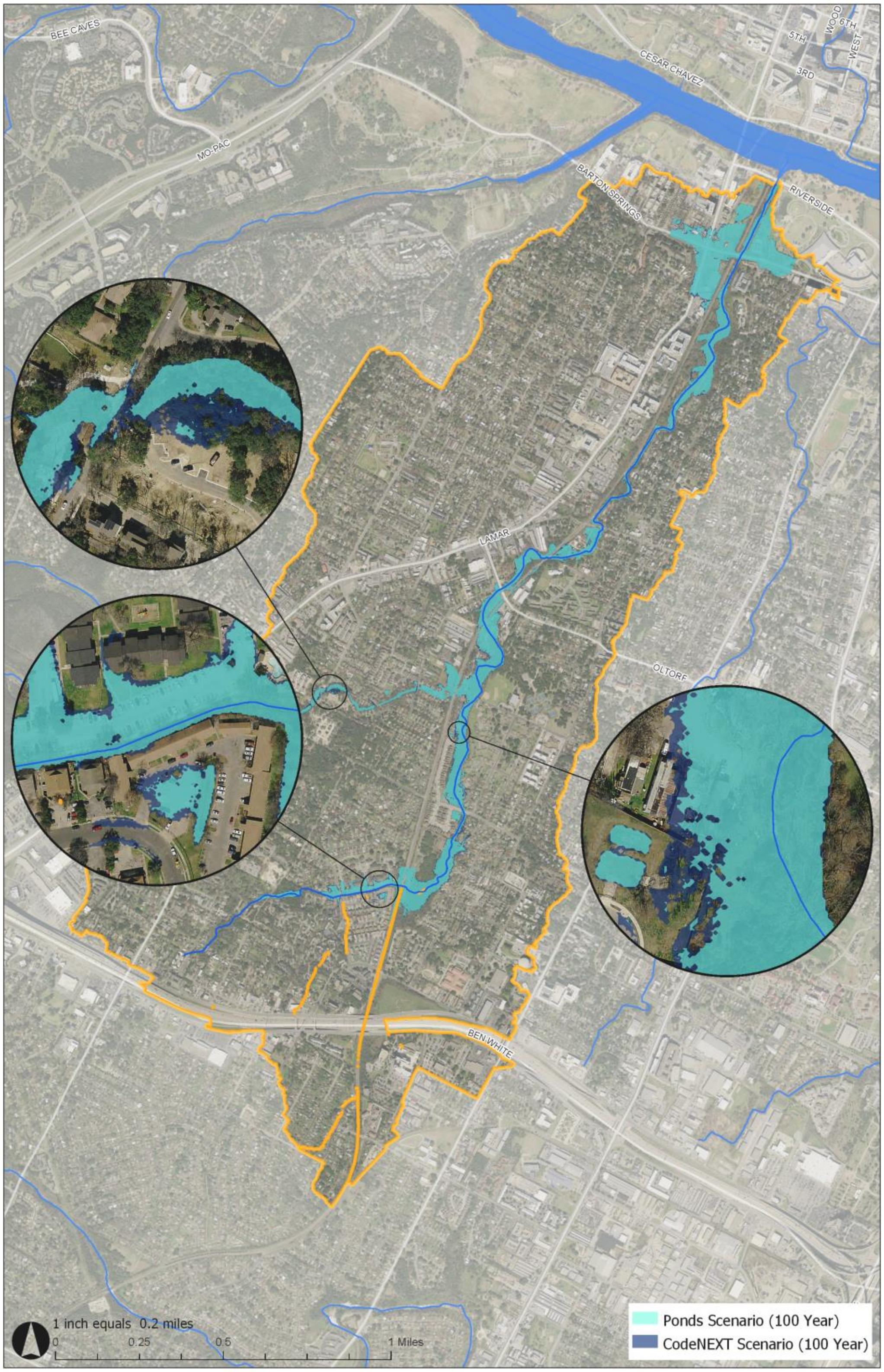

Figure 7. Floodplain comparison between CodeNEXT Maximum scenario and the Mitigation Alternatives scenario (ponds). Notice that while there are minimal floodplain delineation changes there are floodplain elevation reductions as shown in the Table