

WWE
TECHNICAL MEMORANDUM

Floodplain, Wetlands/Riparian Corridor and Water Quality Issues for Boulder Civic Area Project Update: Draft Public Realm Plan and Key Choices

Wright Water Engineers, Inc. (WWE) has prepared this memorandum to provide technical input and peer review on the May 16, 2013, memorandum to the City of Boulder (City) Planning Board from David Driskell, Executive Director, Community Planning and Sustainability and many senior City staff members regarding the *Boulder Civic Area Project Update: Draft Public Realm Diagram and Key Choices* (Project Update). Dr. Andrew Earles of WWE gained valuable insight into the planning of the Civic Area as a juror in the Civic Area Ideas Competition in January 2013 and has led the effort to draft this memorandum to comment on issues related to flood hazards, riparian wetland corridor protection and water quality.

The Civic Area planning process has involved many stakeholders. The Project Update includes many desirable aspects that will be beneficial for Boulder Creek and the riparian wetland corridor. Removal of a significant amount of parking within the High Hazard Flood Zone will improve public safety, flood conveyance and water quality. The Project Update presents a thoughtfully developed vision for the Boulder Creek corridor.

Components of the plan related to building in the Flood Fringe area (the portion of the 100-year floodplain outside of the Conveyance and High Hazard Zones) will have to carefully consider flood risk, both for the structures themselves and for surrounding structures. There may be challenges with achieving a mixed use program given floodplain constraints. There are engineering methods that likely can overcome these challenges; however, costs of design, permitting and construction will be expensive. Any construction within the Conveyance Zone should adhere to a 0.00-foot rise on any existing structures (i.e. no rise in water surface elevations beyond current levels in the 100-year flood event). Construction in the Flood Fringe may occur in accordance with City's Floodplain Ordinance and could potentially result in rises in 100-year water surface elevations of up to 0.50 feet (6 inches).

Boulder Creek has had large floods in the past and will in the future, and could be especially prone to flooding due to deforestation by pine beetle kill and/or wildfires in portions of the watershed. It is critical to remember that there are flood events larger than the 100-year event including the 500-year event and beyond. For facilities that are critical to flood management operations and public safety, protection beyond the 100-year event will likely be required, and planning efforts should proceed with an understanding of flood risk above and beyond the 100-year event since events of greater magnitudes may occur. The best strategy is to keep buildings out of the 100-year floodplain, not just the conveyance and High Hazard Flood Zones. Much of the development of the Civic Area occurred before the National Flood Insurance Program (NFIP) was established, and many buildings in downtown Boulder along the creek corridor lie within the 100-year floodplain. To achieve the activity and mix of uses

desired for the Civic Area, some buildings inevitably would be located in the 100-year floodplain. Potential flood impacts from any proposed structures should be thoroughly evaluated to avoid or minimize impacting other existing structures within the floodplain and surrounding areas.

The following sections provide detailed comments on selected elements of the Project Update.

Floodplain, Conveyance and High Hazard Flood Zones

The City of Boulder regulates floodplains along Boulder Creek (and throughout the City) through the City Code, Sections 9-3-2 through 9-3-8. The 100-year floodplain through the Civic Area is defined by three zones, with varying restrictions on development activities:

1. **Conveyance Zone**—The Conveyance Zone is the portion of the floodplain required for the passage or conveyance of the one-hundred-year flood and is determined by evaluating encroachments (fill) in the floodplain that can occur without causing a rise in 100-year water surface elevation (Base Flood Elevation [BFE]) of no more than 0.50 feet, after considering a reasonable expectation of blockage at bridges and other obstructions by flood-borne debris. The Conveyance Zone may also be referred to as a 0.50-foot rise floodway. For work in the Conveyance Zone (grading, trains, non-habitable structures, etc.) a “no rise” criterion applies and it will be necessary to conduct a floodplain study that demonstrates that improvements in the conveyance zone do not cause rises in the BFEs.
2. **Flood Fringe**—The Flood Fringe consists of portions of the floodplain that are not in the Conveyance Zone or in the High Hazard Zone. This is an area where development (fill) may occur, and with preservation of the Conveyance Zone, fill placed in the Flood Fringe would not be expected to increase BFEs by more than 0.50 feet.
3. **High Hazard Zone**—The High Hazard Zone consists of portions of the floodplain where an unacceptably high hazard to human safety exists defined as those areas where the product number of flow velocity (measured in ft./sec.) times flow depth (measured in feet) equals or exceeds four, or where flow depths equal or exceed four feet.

The Project Update includes features that reduce potential hazards to life and property associated with flooding, such as removal of a large amount of surface parking in the High Hazard Flood Zone and removal of the New Britain and Park Central buildings. These proposed measures will help to make the overall Civic Area more compliant with the floodplain requirements of the current City Code. Removal of the buildings, with replacement at a location outside of the High Hazard Flood Zone, is a critical safety need for the City and will improve conveyance in the area. Anthem Structural Engineering studied the soils, foundations and flood hydrology for these two buildings and determined

that in a large flood event, “the foundations of both buildings would be undermined due to scour, which would result in the collapse of the structures.”¹ Removal of these buildings is arguably the most important public safety component of the entire plan and should be implemented as a high priority.

Removal of surface parking in the Highland Flood Zone will lower the risk of damage to property due to the displacement of vehicles and potential loss of life, as well as reduce backwater effects that would likely occur due to parked vehicles. The removal of existing surface parking to gain additional park land and to help restore the floodplain would have many benefits including diminished floodwater velocities, reduced flood damages, and improved water quality and quantity management. To the extent that some surface parking remains within the 100-year floodplain, WWE encourages the City to investigate permeable pavement alternatives.

With regard to the options for the existing farmers’ market and proposed market hall, WWE recommends managing the floodplain such that new permanent structures and potential obstructions are limited to the extent possible. Any structures such as fencing, steel frames or other similar features as well as additional landscaping/trees that affect the grade, hydraulic roughness and potential for blockage/obstruction will need to be accounted for in the analysis of the floodplain. Additional structures may be feasible, particularly in the Flood Fringe. In the Conveyance and High Hazard Zones, planned improvements and obstructions they create would likely need to be balanced by improving conveyance in other areas. Temporary structures are an alternative that may be considered in the Conveyance and/or High Hazard Zones; however, even this approach should be accompanied by hydraulic analysis demonstrating “no-rise” on existing insurable improvements in the Conveyance Zone unless structures are for daily use and/or can be quickly disassembled and/or moved if a flood alert is issued (e.g. like the current farmers’ market, festivals and craft shows along the creek).

For temporary structures (and some that are permanent but not deeply anchored), it is important to keep in mind that in flood events, these features will tend to catch debris or become debris themselves. Obstructions and debris blockages increase flood depths that consequently increase flood hazards. Additionally, flow rates and velocities can be high enough during large flood events such as the 100-year flood to displace/dislodge structures, especially temporary structures. The conveyance of large debris items during a flood poses a threat to life and property. There are many road crossings downstream of the Civic Area as well as the Farmers’ Ditch headgate and several bridges within the Civic Area (including Broadway) where debris would tend to accumulate in flood events, so the “breakaway” philosophy for temporary structures or statues/monuments is not advised because the debris will create greater flooding problems downstream.

From a floodplain perspective, the ideal locations for the construction of new structures such as a Performing Arts/Community Events Center and/or other Arts/Cultural/Science facilities would be outside of the 100-year floodplain. For the activity and mixed-use program planned for the Civic Area, however, it is not feasible to achieve these uses

¹ Anthem Structural Engineering, as quoted in Boulder Daily Camera, December 17, 2012.

without encroachment into the 100-year Flood Fringe. New construction within the 100-year floodplain would be consistent with the City's adopted floodplain regulations and FEMA-compliant City floodplain permit². It is important to note that the displacement of floodwaters due to new structures within the 100-year floodplain will have effects elsewhere in the area. For improvements that are proposed within the Conveyance Zone, an evaluation of the effects of such improvements must be conducted prior to implementation to ensure that there are no rises in 100-year flood depths on any other structures and that any resulting rises in flood depths are acceptable, i.e. have no adverse impacts and are consistent with City regulations. It would be preferable to do this in a holistic rather than structure-by-structure manner so that flood problems are not transferred to areas planned for future development.

Improvements to Canyon Boulevard should be carefully assessed and reviewed prior to implementation. Conceptual renderings of proposed improvements show more vegetation and trees, a great improvement for pedestrians, bicyclists, and those in transit. The proposed number and density of trees is an important factor when managing floodplains. More trees can potentially decrease conveyance capacity, cause backwater and increase flood depths. Trees are important for many reasons and should not be eliminated from the Civic Area; however, they should be evaluated relative to their effects on floodwaters. An appropriate landscaping plan should be implemented – one that improves aesthetics, encourages habitat and growth, and accounts for effects to the 100-year floodplain.

Relocation of the Band Shell out of the 100-year floodplain would also be beneficial and could potentially allow for the construction of new facilities due to the compensation of floodwater displacement. The removal of the Band Shell outside of the Civic Area would reduce flood depths caused by backwater, decrease the potential of debris getting trapped during a flood event and allow for increased conveyance capacity. There are many factors to consider relative to the final disposition of the Band Shell, but from a floodplain management perspective it would be preferable that it not be located within the 100-year floodplain.

The Project Update includes flood risk management benefits, coupled with preservation of open space in the floodplain, riparian enhancement and educational elements that form a holistic approach for managing the floodplain/floodway. Changes to structures (removals and additions) within the 100-year floodplain and improvements to the riparian corridor and floodplain will need to be analyzed as a whole and on a phase-by-phase basis to thoroughly evaluate effects on flood conveyance, flows, velocities and depths, all of which need to be consistent with City floodplain regulations and should aim to promote the protection of the public, health and welfare. The Gilbert F. White Memorial, located in the Civic Area, would present an excellent opportunity for expanded public education/signage related to floodplain/floodway management principles from Boulder's own "father of floodplain management."

² Because of the scale of the project and the modifications that will occur to the regulatory floodplain, we anticipate that the project will require a Conditional Letter of Map Revision (CLOMR) (prior to construction) and Letter of Map Revision (LOMR) (following construction) from FEMA to address changes in floodplain mapping. Within UDFCD's jurisdiction, UDFCD and their contractors administer the map revision process for FEMA, and early coordination with UDFCD is advised.

Riparian Wetland Corridor

Restoration of the Boulder Creek drainageway could integrate exciting improvements to the riparian and wetland resources of the area. Section 9-3-9 of the City Code establishes requirements for stream, wetland and waterbody protection to “preserve, protect, restore and enhance the quality and diversity of wetlands and waterbodies.” For much of the past century, urban planning treated drainageways as part of the stormwater sewer system and largely deemphasized the riparian and wetland resources’ presence in the landscape. This has not been the standard in Boulder, where Boulder Creek and its tributaries have been central components of the City’s parks and trails network. Existing desirable conditions along these drainageways include greenways with native vegetation, designated wetland regulatory areas that include buffer zones, the use of natural materials to reduce erosion and educational signage promoting public awareness of the value of these areas. The comments, considerations and recommendations are offered in this section as possible enhancements to Boulder’s existing natural drainageway resources.

The Project Update identifies potential riparian restoration, which includes areas between the existing multi-use path and Boulder Creek. This riparian corridor provides an important ecological interface between aquatic and terrestrial ecosystems. It is also the area with the greatest impact on downstream water quality. The following are initial observations of existing riparian and wetland corridor conditions that detract from the ecological value of these areas:

- Current use of the corridor has resulted in mostly open access to all areas by paths and over manicured lawns. This access reduces the amount of native vegetation in the area, can lead to erosion of sediment into the creek, and diminishes “quiet areas” that are valuable to wildlife.
- The existing typical channel cross section through this area is primarily incised and mostly lacks wetland areas along the ordinary high water mark. This limits the abundance and diversity of many desirable native plants. It also limits the hydrologic connectivity between the creek and the riparian corridor, an important component of a natural stream system.
- Existing stormwater management does not consistently integrate best management practices to reduce erosion and protect water quality. This can lead to downcutting, erosion and influx of sediment and other pollutants. Further, it does not take advantage of a potential source of water for side wetland areas.

- Existing conditions can complicate drainageway maintenance, as required to allow effective flow conveyance. As a result, when the drainageway requires maintenance (e.g., when a felled tree needs to be removed), mobilizing the equipment to conduct this activity can result in undesirable impacts to the corridor.

Some considerations for enhancing this area include the following:

- **Promote controlled use of the riparian corridor through the construction of an established trail network.** As demonstrated by the widespread use of informal trails, many visitors to the corridor want to get off the beaten path and have access to the creek. If a trail network is constructed to meet this demand, it will limit the extent to which informal trails develop. Access toward the creek and important habitat areas can be managed with low-impact fencing (e.g., split rail fencing) and signage. As noted above, effects of fencing and changes to the density and character of the vegetation along the creek would need to be evaluated for floodplain impacts and conformance to the City's Stream, Wetlands, and Water Body Protection Ordinance (City Code Section 9-3-9).
- **Enhance hydrologic connectivity between Boulder Creek and the adjacent riparian corridor.** By laying back the creek's banks in targeted areas, it could be possible to create enhanced wetland areas within the riparian corridor. These areas would be above Boulder Creek's normal high water mark, but would benefit from increased hydrologic connectivity. These areas could support a diverse plant community that would be desirable from water quality and urban wildlife perspectives.
- **Integrate stormwater outfalls into the riparian corridor.** This enhancement could include transforming existing stormwater conveyance to include outfalls to newly created treatment wetland swales that would dissipate energy, slow the release of water into the creek and promote retention of sediment and other pollutants. These features could be designed to become integrated into the overall natural riparian corridor system.
- **Incorporate drainageway maintenance access into riparian corridor and trail network's design.** In considering the types of equipment that are expected to be used for drainageway maintenance, and by incorporating their width, weight and access requirements into the riparian corridor and trail network's design, reoccurring impacts to natural areas can be minimized.

The planning effort has also produced ideas regarding various education and awareness enhancements. These types of enhancements could greatly improve the recreational value of the corridor, but would also have tremendous environmental conservation value. Fostering the public's relationship with the natural drainageway is expected to lead to greater environmental stewardship both at the site and beyond. To the degree possible, WWE encourages the City to explore educational and recreational enhancements that

would promote the public's understanding and appreciation of the Boulder Creek drainageway.

Water Quality

Given that more than half of the 27 acres in the Civic Area is parkland along Boulder Creek, there are many opportunities for water quality protection as a part of the Civic Area redevelopment. Enhancements to the Riparian Corridor including limiting access to selected portions of the creek, maintaining and/or reestablishing healthy "natural" vegetative banks and establishing a vegetated riparian bumper between the creek and more manicured portions of the open space will all contribute to protecting the water quality of Boulder Creek. The elimination of large amounts of surface parking will also remove a major source of pollution to the creek by significantly reducing the amount of runoff from surface parking areas. Chapter 11-5 of the City Code establishes the City's Stormwater and Floodplain Utility and requirements for stormwater management that will be applicable to the Civic Area, and Chapter 7 of the City Design and Construction Standards address stormwater design.

Given the amount of open area available along the Boulder Creek corridor, we strongly recommend investigation of Green Infrastructure (GI) and Low Impact Development (LID) techniques for management of stormwater runoff quality from areas that will be redeveloped in the Civic Area. GI and LID practices are aimed at restoring the hydrology of an area to a more "natural" condition. Typically, this is accomplished through using stormwater best management practices (BMPs) including grass swales, grass buffers, bioretention areas and other vegetation-based BMPs to infiltrate runoff, filter pollutants and create facilities that fit into the natural landscape. For surface parking areas that will remain in the Civic Area, we urge the City to investigate permeable pavement techniques to manage water quality and runoff volume. We would encourage the use of permeable paths where practical as these will generate less runoff than concrete walkways. Permeable pavements also should be considered for plaza areas as a runoff reduction measure.

While Boulder Creek is a wonderful amenity running through the Civic Area, controlling access to designated locations will do a lot to help with the stability of the banks and with the water quality of the stream. Where access is provided, dense vegetation should be planted to discourage people from migrating upstream or downstream from the access point. "Natural" barriers integrated with the landscaping around the access points, including boulders and trees, can also be used to discourage travel up or down stream from access points, and signs, explaining the importance of maintaining a healthy riparian corridor along the creek, may also discourage access in areas where establishment and/or enhancement of riparian vegetation is desired. Boulder Creek has some water quality issues with E. coli, and fecal matter from animals and other sources associated with multiple informal "social trail" access locations to the creek which has the potential to worsen the problem.

In addition to the runoff reduction and pollutant control measures such as grass swales, grass buffers, bioretention areas and other types of BMPs, we would encourage the City to investigate options for potential water harvesting and/or grey water reuse within the Civic Area. With the amount of new Civic building space proposed, there will be a significant amount of roof area that could provide a good source of water for harvesting. Some of the earlier proposals in the process included options for Green Roofs on some of these structures. While Green Roofs can be a good BMP in some climates, there are many limitations in Colorado, and generally it is necessary to have at least supplemental irrigation to maintain healthy vegetative cover. Green Roofs also have relatively high maintenance in this climate with plant replacement, irrigation repairs, etc. For these reasons, we believe that water harvesting would be a more attractive option to investigate, especially because this is a civic project in the heart of Boulder along Boulder Creek. To implement water harvesting, it would be necessary to work out the water rights for the harvesting to be allowed under Colorado Water Law (likely an augmentation plan); however, this is a potential opportunity for the City to lead the way in the State with treating stormwater as a resource. Recent gray water applications that are being developed and studied by Dr. Larry Roesner, P.E. of Colorado State University could also be considered as ways to improve water efficiency of the overall Civic Area through reuse in appropriate locations.

Although the project is currently at a Master Planning Level, the amount of open space included in the Master Plan provides a great deal of flexibility and many opportunities for innovative stormwater quality management.

Conclusions

The Project Update presents a conceptual plan for the Boulder Civic Area that will improve public safety by reducing flood risks, enhance the riparian wetland corridor along Boulder Creek and allow for implementation of innovative stormwater management practices to protect the water quality of the creek. The greatest challenges are related to the 100-year floodplain and the High Hazard Flood Zone. Limitations on rises in 100-year water surface elevations (also referred to as base flood elevations) will constrain the extent and types of development that can occur in the area. Detailed engineering and floodplain/floodway analysis will be essential to creating a final plan that does not adversely affect neighboring properties and creates an environment where public safety is paramount. Constructing the kind of program that is anticipated on the east end of the Civic Area will not likely be feasible at grade because of the rises that would be caused to the 100-year water surface elevations. There are engineering methods, including elevating structures on piers, and other practices that may allow for construction; however, costs should be expected to be higher than typical construction because of the need for adequate flood protection.

WWE hopes that the comments and recommendations provided in this memorandum are helpful and provide information that will be useful in moving ahead to the next stages of

the Civic Area Plan. If you have any questions related to this technical memorandum, please do not hesitate to contact WWE at (303) 480-1700.