

HOUSTON STRONGER

Houston Stronger Buffalo Bayou & Tributaries Resiliency Study and Interim Report Alternative Review November 18, 2020

Houston Stronger, a coalition of associations and non-profits concerned with flood resiliency in the Houston Region, appreciates the opportunity to comment on the Buffalo Bayou and Tributaries Resiliency Study Interim Feasibility Report, released on October 2, 2020 (Interim Report) by the U.S. Army Corps of Engineers (USACE). The comments and analysis below were produced quickly and would benefit from further information and time. Houston Stronger restates its requests from October 19, 2020 and is not endorsing any alternative but is asking USACE to further evaluate its alternatives and other alternatives to address the comments below.

Summary of Requests. Houston Stronger and the organizations whose logos appear on this letter (Houston Stronger) ask that, in response to comments on the Interim Report, USACE

- Provide public access to all data and modeling before eliminating alternatives under consideration.
- Focus on alternatives that provide quicker, scalable impacts and ecological and social benefits.
- Optimize current government-owned land, minimize buyouts, and work closely with communities.
- Study other alternatives recommended by Houston Stronger partner organizations.
- Incorporate data and findings from studies performed by or on behalf of Harris County.
- Initiate a separate flood risk reduction study of the Cypress Creek watershed.
- Review whether the benefit-cost ratio (BCR) can effectively address flood risk on Buffalo Bayou.

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Summary¹

Alternative 1: No Action. The No-Action Alternative, like the rest of the Interim Report, relies on but does not disclose referenced data and models in its analysis and conclusions. The data and models are needed to meet key NEPA requirements and to provide the public the ability to meaningfully comment. USACE should continue to update its models but provide the public with access to current modeling before alternatives, such as the flood tunnel and excavation, are eliminated from further study. The Interim Report also omits modeling and data regarding current and future flood risk, loss of life, and economic losses. The No-Action Alternative fails to address issues and their implications, like the dams' current risk classifications, future socio-economic conditions, and ongoing litigation by upstream plaintiffs. Houston Stronger asks USACE to consider these issues in its draft feasibility report, set for release in spring of 2021.

Alternative 2: Cypress Creek Dam and Reservoir. The Interim Report considers constructing an 22,000-acre Cypress Creek Reservoir enclosed within a 30-foot high berm to store 190,000 acre-feet of floodwaters. As USACE notes, such a project would not eliminate flooding either upstream or downstream of the reservoirs. USACE also notes that the project would partially reduce overflows, requiring ancillary projects, and take considerably more than a decade to construct. The Cypress Creek Reservoir received the lowest BCR of the structural alternatives in the Interim Report. This project would also require a local sponsor to share a minimum of 35% of the costs and provide for operation and maintenance of the reservoir and dam. USACE should consider certain, strong public opposition to a "third reservoir"

Alternative 3: Excavation of Addicks and Barker Reservoirs. USACE should more fully explore how significant excavation may be able to provide immediate, scalable benefits within the Addicks and Barker Reservoirs. As a complementary project to a downstream conveyance project, excavation provides opportunities to operate Barker and Addicks differently in extreme events, as well as opportunities for recreational and environmental improvements. Based on available geotechnical data and previous studies, the Interim Report underestimates the opportunities for excavation within the reservoirs and overstates many environmental considerations.

Alternative 4: Tunnels. The Interim Report acknowledges that conveyance is critical and tunnels would provide an effective way to convey flows from Buffalo Bayou or the reservoirs, but recommends no further study on this alternative based mainly on cost. USACE estimates the cost of the project at \$6-12 billion, while a more robust study from HCFCD estimates the same project will cost only \$3-6 billion. A tunnel may also reduce environmental and social impacts and create benefits, like significant additional water supply and localized inlet options, in ways that other alternatives do not.

Alternative 5: Diversion. The Interim Report effectively and rightfully eliminates "Diversions" as a viable option to address flood risks associated with the Addicks, Barker and Buffalo Bayou Watersheds. Both the Brazos River and Brays Bayou face flood risks that make diversion into those watersheds ill-advised.

¹ This document was summarized and edited by: *Augustus "Auggie" Campbell (AWBD)*, Sarah Bernhardt (BPA), Michael Bloom (ASCE), Elisa Donovan (KPC), David Hagy (ACEC), Kristen Hogan (ABHR), Mark Klein (KPC), and Andy Palermo (WHA, EHRA). Contributors for each alternative are noted below.

Alternative 6: Buffalo Bayou Channel Improvements. Alternative 6 is not a realistic alternative. The Interim Report underestimates project costs and challenges. Entrenched, widespread community opposition to its social and environmental impacts, as well as regulatory and litigation risks, create considerable challenges, including possibly depriving the project of a local sponsor. The Interim Report assigns a 0.3 BCR to Alternative 6—well below the threshold required for a public investment of this magnitude. Based on the modeling information available, Alternative 6 falls short of safely handling both the Addicks and Barker Reservoir releases *and* local downstream bayou flows needed to avoid catastrophic flooding.

Alternative 7: Non-Structural. The Interim Report recommends nonstructural property buyouts along Buffalo Bayou to increase conveyance for releases from Addicks and Barker Reservoirs. The buyouts considered under Alternative 7 exclude 24,000 parcels within Addicks and Barker Reservoirs' flood pools but outside the government-owned land. While strategic, community-supported buyouts may be a sound approach, USACE should closely study and inform communities of the potential impact of these structural buyouts and work to minimize these impacts. The public prefers nature-based solutions. Houston Stronger recommends that USACE review ways to preserve natural bayou features, preserve and restore land on the Katy Prairie, and construct a series of smaller detention and retention areas using nature-based design principles.

Alternative 8: Combined Alternatives 2 and 6. This alternative combines the Cypress Creek Dam and Reservoir (Alternative 2) with Buffalo Bayou Channel Improvements (Alternative 6) to determine whether the two together would provide system-wide improvements, given the failures of the separate Alternatives on their own. However, this combination suffers from the major issues identified in both Alternative 2 and 6, including a low BCR (0.2), strident public opposition, and detrimental environmental impacts that cannot be mitigated. When combined, most of the benefits result from the conveyance improvements. The Interim Report shows that the Cypress Creek Dam provides only a small incremental benefit over a conveyance solution at triple the cost.

Other Alternatives & Recommendations. Houston Stronger asks that USACE continue to explore tunnels, significant excavation of Addicks and Barker Reservoirs, and other alternatives (such as non-structural nature-based strategies) going forward as USACE produces a draft feasibility report. Houston Stronger, its members, and others have developed several alternatives that the Interim Report did not consider or recommended not to be considered going forward. USACE should fully evaluate floodway acquisition, land preservation and restoration, distributed detention/retention, and smaller flood retention basins above Addicks Reservoir as an alternative to a Cypress Creek Reservoir, which would provide similar benefits faster and for less money. New approaches, including “smart watershed” technology, may add capacity to existing and proposed detention. USACE should also consider starting a separate flood risk reduction study on the Cypress Creek Watershed immediately. USACE, having noted the constraints of its BCR approach, should consider new FEMA guidance (Policy FP-108-024-02) and suggest BCR reforms to more effectively address flood risk and public safety. Finally, USACE needs to move quickly to address the “urgent and compelling” dam safety risks at these two dams, as it has been over a decade since these risks were first identified.

Alternative 1: No Action²

Summary: The No-Action Alternative, like the rest of the Interim Report, relies on but does not disclose referenced data and models in its analysis and conclusions. The data and models are needed to meet key NEPA requirements and to provide the public the ability to meaningfully comment. USACE should continue to update its models but provide the public with access to current modeling before alternatives, such as the flood tunnel and excavation, are eliminated from further study. The Interim Report also omits modeling and data regarding current and future flood risk, loss of life, and economic losses. The No-Action Alternative fails to address issues and their implications, like the dams' current risk classifications, future socio-economic conditions, and ongoing litigation by upstream plaintiffs. Houston Stronger asks USACE to consider these issues in its draft feasibility report, set for release in spring of 2021.

A. Introduction

The Interim Report identifies and evaluates the feasibility of several alternative federal projects that USACE may recommend to Congress to address flood risks along Buffalo Bayou and its tributaries in the Houston Metropolitan Statistical Area (MSA). The Interim Report also attempts to identify and evaluate all potential environmental impacts associated with such alternatives and the recommended project(s), in accordance with the National Environmental Policy Act (NEPA). Since the early days of NEPA in the 1970s, the “No Action” alternative (i.e. maintain the status quo by not implementing any federal project to address the problem) is one of the alternatives that USACE is required to analyze in this type of study. The No Action alternative is the “baseline” against which all other alternatives are evaluated. A key requirement of all NEPA documentation is that it fully and fairly discloses to the public the information that is known to the federal agency. This is of utmost importance as it relates to this No-Action alternative, so that the public and the decision-makers can be fully informed of the existing problem and the need for solving the problem. That requirement has not been followed in the presentation and discussion of the No-Action Alternative presented in the USACE Interim Report.

B. Definition of “No Action” Alternative

The Interim Report determines the No-Action Alternative to be the existing conditions projected out to the year 2085, labeled as the “Future Without Project” (FWOP) condition. In other words, this alternative contemplates no federal project being implemented to address the existing flood problems/risks (pg. 51). The flood problems and risks that have been observed recently as a result of Harvey 2017, and the additional risks we are now aware of in the Addicks, Barker and Buffalo Bayou watersheds, would not only continue, but would be increased in the future according to USACE due to larger effects from the same rainfall resulting from future land development (unless addressed) and from increased intensity and frequency of rainfall we have seen recently in our area from changes in our climate.³

C. Overview of Flood Risk Problems

USACE has acknowledged that the flood risks upstream of the Addicks and Barker dams beyond the government-owned land (GOL) “... pose an unacceptable risk to health and human safety, private property and public infrastructure” and that dam releases downstream into Buffalo Bayou, along with local inflows,

² Contributors: Griselda Gonzales (ASCE, TGC), Mark Kilkenny (WHA), Auggie Campbell (AWBD).

³ Interim Report, p. 51.

also “pose risks to health and human safety, private property and public infrastructure.”⁴ Given this understanding of the flood risks involved (being the thousands of homes, including hundreds of businesses, that flooded during Harvey 2017 both upstream and downstream of these two federal flood control dams as a result of their operations, and the additional thousands of homes, including hundreds of businesses, that escaped the Harvey flooding but still are at risk of flooding from being within the upper flood pools of Addicks and Barker dams), it is imperative that USACE find an alternative plan that addresses these “unacceptable” flood risks, without transferring the flood risk to other areas. Unfortunately, it appears that the alternatives carried forward by USACE in its study, per their Interim Report, do not eliminate these unacceptable risks, and fail to solve the serious problems that USACE created over the years as changed conditions affected how their flood control project operates. While USACE stated that its alternatives “reduce flood duration above government lands, which helps reduce recovery time,” they also recognized that they “do not meaningfully reduce property damages and life safety risks.” Other sections of this report will address the various alternatives and propose a plan that will address these existing flood risks and the problems they create, but here we will discuss what those existing flood risks are and how they may increase in the future if not dealt with now.

D. Questions with How Existing and FWOP Flood Risks were Determined

The Interim Study states that, “proper definition and forecasting of the FWOP condition is critical to the success of plan formulation” and that “accurate analyses are essential to other disciplines.”⁵ The Interim Study’s primary purpose is to evaluate alternatives to reduce the flood risk for the Addicks, Barker and Buffalo Bayou watersheds. Accordingly, USACE must accurately model existing regional flood risk, so that the FWOP condition can be more accurately predicted. The Interim Report raises several questions as to both the existing conditions and the FWOP conditions, or No-Action Alternative #1, as follows:

1. USACE stated that the hydrologic and hydraulic modeling, used to determine the current and future flood risk, “continues to be updated.” USACE’s modeling provides a moving target that the public has not been able to review.⁶ Appendix A to this Interim Report purportedly contains more details regarding the hydrologic and hydraulic modeling conducted for this study. Unfortunately, none of the appendices to this Interim Report have been provided for public review. The public cannot make meaningful comments without these appendices.
2. Figures 22-24 show the existing and FWOP conditions for the Addicks, Barker and Buffalo Bayou watersheds, and indicate that the FWOP conditions flood risks are much greater than they are currently. Yet it is unclear as to the cause of this increase. Is it due to changes in the climate that are expected to occur from now through 2085, or due to new development expected over that same timeframe, or is it a combination of the two? What are the individual contributions of these causes to the overall increase being shown?
3. USACE stated that the “same rain event in 2020 will have larger effects in the future unless addressed.”⁷ How does the HCFCD retention/detention criteria for new development in the Addicks, Barker and Upper Cypress Creek watersheds not address this issue to ensure No Adverse Impacts (NAI) occur downstream from new development in these watersheds? This Interim

⁴ *Interim Report*, Executive Summary.

⁵ p. 51.

⁶ P. 51.

⁷ P.51.

Report does not address or discuss the regulatory requirements placed on such new development that are intended to ensure NAI, and whether that is achieved with the FWOP condition established by USACE.

4. USACE states that the Equivalent Annual Damages (EAD) for the No-Action Alternative #1 is \$18.3M for the study area, whereas in Table 52, it shows Residual Damages for this Alternative #1 are \$191.6M.⁸ Why is there a difference?
5. The annual loss of life listed in Table 52 shows the number of lives lost for both Addicks and Barker watersheds, for both day and night conditions. There is little to nothing in this report explaining how the numbers in this table were obtained, both for the No-Action Alternative #1, as well as the other alternatives listed.

E. Three Majors Flood Risk Problems that Need to be Solved

Subject to the resolution of the above questions and issues, the “3 major problems that need to be solved” in these watersheds that stem from the existing USACE flood control projects and its operations are as follows:

1. *Flooding Private Properties Located within Addicks and Barker Reservoir Pools.* Inadequate storage capacity within GOL in the Addicks and Barker Reservoirs would cause flooding of over 24,000 parcels of private properties, including over 20,000 homes and hundreds of businesses, during the Standard Project Flood (SPF) used by USACE to design federal flood control dams. USACE notes that such federal dams constructed in urban settings are typically required to own the lands up to at least the SPF elevation within the reservoir, and for dams like Addicks and Barker with high-level spillways, the GOL should be even up to these spillways’ crest elevation. These elevations are 8-10 feet higher than what the GOL currently encompass within the Addicks and Barker Reservoirs (and 2-4 feet higher than what happened during Harvey 2017), which explains why so many homes and private properties are at such an unacceptable flood risk by being located within these reservoirs. The information in the Interim Report states that this SPF is still being updated, but this should have already been done once the determination of the maximum design flood (i.e. the Spillway Design Flood or SDF) is made, since the SPF is used to derive the SDF.
2. *Flooding of Private Properties Downstream of Addicks and Barker Dams from Releases.* Inadequate conveyance capacity exists downstream of the Addicks and Barker dams to handle the releases expected from these dams during the SPF, amounting to a total flow rate of about 15,000 cfs from the combined releases from both dams. This is what happened during Harvey 2017, which resulted in over 4,000 homes and numerous businesses flooding due either in part or solely from those releases from these two dams into Buffalo Bayou.
3. *Potential for Dam Failure due to Dam Safety Issues at Each Dam.* Dam safety issues exist at both Addicks and Barker dams, such as their emergency spillways needing repairs to their concrete linings, and the spilling of reservoir waters around the ends of the dams which bypass the concrete-lined spillways. Failure of these high-hazard dams would be a catastrophe for downstream residents.

⁸ P.109.

F. Other Flood Risk Problems that Should be Addressed

Other flood risks exist within these 3 watersheds that are not attributable to USACE federal flood control dams, and yet should still be addressed as part of a comprehensive plan for flood risk reduction in these watersheds, as follows:

1. *Cypress Creek Overflows.* Overflows from the upper portion of Cypress Creek contribute a significant amount of water that flows through Addicks Reservoir and eventually Buffalo Bayou. Capturing and retaining this overflow water would reduce the burden on the Addicks Reservoir. During Hurricane Harvey overflow from Cypress Creek amounted to approximately 50,000 acre-feet¹.
2. *Mid/Lower Cypress Creek.* Cypress Creek itself has serious flooding problems along its middle and lower portions, and the FWOP condition presented by USACE shows these problems to only increase in the future. A separate study may be needed to address this issue.
3. *Local Runoff Flooding along Buffalo Bayou.* Flooding along Buffalo Bayou from local runoff produces significant flood damages even for the more frequent flood events.

G. Effect of Federal Litigation Re: Upstream/Downstream Addicks and Barker

The Interim Report says very little about the litigation in federal court for the recovery of flood damages during Harvey 2017 due to the Addicks and Barker dams.⁹ The litigation will have significant implications on the FWOP condition and the appropriate “Baseline” against which all other alternatives are to be evaluated. For example, the federal judge in the upstream case has initially found that USACE has taken a “permanent flowage easement” on certain properties located upstream of these dams, yet failed to compensate those property owners in violation of the 5th Amendment to the U.S. Constitution. This ruling, if finalized and upheld on appeal, would result in over 10,000 homes upstream of these two dams having such an easement placed upon them, resulting in dramatic loss in property values, and reduce the local tax base, which would adversely affect all taxing entities in the area (e.g. county, city, school districts, MUDs). The same result would happen for the downstream folks if that federal judge’s initial ruling against them is ultimately reversed.

H. Other Issues with Establishing the No-Action Alternative

1. USACE should provide separate analysis of the projected change in the frequency and intensity of storms to the year 2085 due to climate change. That is a critical aspect of the No-Action Alternative that will help define the flood risk.
2. A key fact is that Addicks and Barker dams had been evaluated to have the risk classification of DSAC 1 – Urgent and Compelling. These two dams are among the most dangerous dams in the United States when considering risk of failure and consequence of failure. This is an existing condition to be evaluated if “no action” occurs. This situation needs to be fully articulated along

⁹ See *In re Upstream Addicks and Barker (Tex.) Flood Contr. Reservoirs*, (Dec. 2019), available online at https://ecf.cofc.uscourts.gov/cgi-bin/show_public_doc?2017cv9001-260-0 (last accessed Nov. 8, 2020).

with what that means in terms of the operation of the reservoirs. The consequences of dam failure need to be clearly articulated along with computer modeling demonstrating such effects. Fixing this dam safety issue needs to be a major priority in the evaluation of alternatives. Dam safety should be exempt from benefit cost determinations.

3. The evaluation of the No-Action Alternative requires an evaluation of the socio-economic consequences of not solving the problem and keeping the status quo. If USACE is required to purchase a “permanent flowage easement”, the Interim Report fails to address several issues for the future of this community. The existence of such a flood easement across thousands of homes certainly changes the starting point for the evaluation of other alternatives, including the buyout of these homes as an alternative. Similarly, if the flood easement remains the status quo, flood insurance will unlikely be available and many residents will likely move out and sell their homes which likely will become owned by absentee owners who will rent these dwellings, creating a social impact issue of a considerable dimension as lower income residents move into these excellent, but flood prone, homes, creating a serious environmental justice issue. That scenario is required to be fully evaluated and disclosed.

Alternative 2: Cypress Creek Dam & Reservoir¹⁰

Summary: The Interim Report considers constructing an 22,000-acre Cypress Creek Reservoir enclosed within a 30-foot high berm to store 190,000-acre feet of floodwaters. As USACE notes, such a project would not eliminate flooding either upstream or downstream of the reservoirs. USACE also notes that the project would partially reduce overflows, requiring ancillary projects, and take considerably more than a decade to construct. The Cypress Creek Reservoir received the lowest BCR of the structural alternatives in the Interim Report. This project would also require a local sponsor to share a minimum of 35% of the costs and provide for operation and maintenance of the reservoir and dam. **Siting in Cypress Creek vs. Addicks Watershed**

The Interim Report concludes, that based solely on USACE’s technical data, the only viable site for a reservoir was in the Upper Cypress Creek Watershed. Engineers working with Houston Stronger wonder why USACE dismissed the Upper Addicks Watershed as a location for placing flood reduction storage project. Upper Addicks projects would provide a 1:1 reduction in floodwater volume – every one acre-foot stored in the Upper Addicks Watershed reduces one acre-foot entering and having to be stored in Addicks Reservoir (and it appears that there is undeveloped land available for acquisition to locate such storage basins). Retention storage in the Upper Addicks Watershed requires fewer acres with greater benefits than providing such storage in the Cypress Creek Reservoir. The most direct and beneficial location for providing additional retention storage is within the Addicks and Barker Reservoirs themselves. Alternative 3 does not adequately explain significant additional storage in Addicks and Barker Reservoirs but only selects a few areas for excavation.

A. Speed of Project Completion

Most of the solutions proposed by USACE, including this Cypress Creek Reservoir, will take a decade or more to implement, even without permit protests or litigation or the many years it will take to secure the funding. All of USACE’s focused array of alternatives, including this reservoir, do not meet the positive BCR

¹⁰ Contributors: *Mary Anne Piacentini* (KPC), Jim Robertson (CCFCC), and David Lowe (WHA; BGE).

criteria established in USACE regulations – in fact, the reservoir received the lowest BCR of all the projects recommended for further study, and so are not viable in terms of that criterion. However, USACE also describes other criteria that must be considered when evaluating alternatives, including life-safety benefits, yet USACE states that its focused array of alternatives “... does not meaningfully reduce property damages or life safety risks.”

B. Cypress Creek Reservoir Effectiveness

The Cypress Creek Reservoir would not solve the problem of the potential for continued flooding within the Barker Reservoir’s non-GOL, nor of flooding down Buffalo Bayou – similar to the multiple storm events recently experienced by coastal Louisiana. Thus, the risk of flooding within the reservoir pools on non-GOL would remain a serious problem, such as in the event of another Harvey-level storm.

C. Benefit Cost Ratio

The Alternatives explored by USACE in the Interim Report are considerably below the BCR threshold to obtain funding. The Cypress Creek Reservoir costs an estimated \$2.1 to \$2.9 billion and has the lowest BCR of the structural alternatives, at only 0.1. This alone is a reason that Alternative 2 is not viable. The Cypress Creek Reservoir fails to meaningfully solve the issues of flooding in the Addicks Watershed. Given the competing needs for limited financial resources at both the federal and local levels, the likelihood of securing funding for a project that costs ten-fold more than it provides in benefits should be a non-starter.

D. Cypress Creek Dam Safety Risk

The construction of a dam on an active waterway poses inherent risks to those downstream – whether due to operational or structural failure, or whether a mega-storm (or series of mega-storms) were to overwhelm the system.¹¹ This risk is exacerbated due to the new development that would be encouraged by the construction of the dam – these additional structures would be constructed in lower areas that were previously within floodplains. The risk of a failure to the Cypress Creek Reservoir and Dam similar to what occurred during Hurricane Harvey would place new risk squarely on the residents of Cypress Creek and ultimately to the Addicks Watershed as well.

E. Lack of Local Sponsor Makes Project Non-viable

USACE has indicated that it would not operate the dam and that a local governmental sponsor will be required to assume responsibility for operations and maintenance.¹² HCFCD has stated that it does not intend to take on this responsibility. No other local governmental sponsor has come forward. It is not surprising that no governmental agency has stepped forward to incur this ongoing expense and responsibility, particularly the real possibility of a dam failure in the Cypress Creek Watershed where none currently exists. In addition, the minimum 35% cost-share requirement would require such local government to fund at least \$735 million to \$1.015 billion of the project costs for much less in local benefit.

F. Environmental Losses.

The Interim Report references degradation of lands upstream of the proposed embankment as well as downstream. While there is some discussion of the negative impacts of extended inundation, the report fails to adequately describe the negative impacts of the embankment, which would bisect the historic Warren Ranch. This ranch is the largest remaining working cattle ranch in Harris County, in continuous operation since the 1870s. The Interim Report does not adequately describe the value of uninterrupted

¹¹ *Interim Report*, p. 66.

¹² *Interim Report*, p. 169.

contiguous habitat, nor the impossibility of mitigating for this resource. No other sites can be acquired and protected of similar size and quality as the Katy Prairie Preserve, particularly within a one-hour's drive from downtown Houston. In addition, more than 60% of the land that would be acquired under this plan already is in some form of habitat conservation protection.

Alternative 3: Addicks & Barker Excavation¹³

Summary: USACE should more fully explore how significant excavation may be able to provide immediate, scalable benefits within the Addicks and Barker Reservoirs. As a complementary project to a downstream conveyance project, excavation provides opportunities to operate Barker and Addicks differently in extreme events, as well as opportunities for recreational and environmental improvements. Based on available geotechnical data and previous studies, the Interim Report underestimates the opportunities for excavation within the reservoirs and overstates many environmental considerations.

A. Introduction

Barker and Addicks Reservoirs, with a combined storage capacity greater than 400,000 acre-feet, and downstream inflows have the capability of overwhelming the conveyance capacity in Buffalo Bayou as was witnessed in Hurricane Harvey. Houston Stronger agrees that Barker and Addicks Reservoirs do not provide sufficient storage opportunity to eliminate the need for improved conveyance. However, the Interim Report underestimates the opportunities for excavation within the reservoirs and overstates many environmental considerations. Past studies by USACE and other entities suggest that there are substantial opportunities for excavation of areas that are not impacted by the water table. Other studies suggest that excavation will create significant additional storage without significant environmental concerns because the lands' ecological value was already significantly degraded.

Excavation of Barker and Addicks creates an excellent opportunity for conjunctive park and recreation and environmental improvements within Barker and Addicks Reservoirs that could benefit the community while providing increased flood protection. Reservoirs could improve the drainage functions, but must be coupled with downstream conveyance improvements.

B. Study Areas Within Addicks and Barker Reservoirs

USACE only selected a few areas for excavation within the Addicks and Barker Reservoirs themselves, and these areas excluded promising areas identified in the USACE 2012 Operations Manuals for the reservoirs.¹⁴ USACE should explore more locations within the reservoirs, especially those identified within USACE documents and other studies. USACE should undertake a study to maximize the excavation opportunities that can increase storage in existing reservoirs located within GOL.

We believe USACE should complete an assessment of where pockets of good habitat are and how to excavate around them. The removal of 10 feet of sediment, including all productive layers, is expected to drastically change the existing vegetation communities from dominance in trees and shrubs to herbs composed of species tolerant of low nutrient disturbed soils, many of which are expected to be non-native or invasive. However, there already are significant populations of invasive tallow trees in the reservoirs.

¹³ Contributors: *Steve Robinson* (ABHR), *David Lowe* (BGE), *Mary Anne Piacentini* (KPC), *Marlin Williford* (BFPG).

¹⁴ Water Control Manual, 3-4, 4-3 (Nov. 2012) available at <http://cdm16021.contentdm.oclc.org/utills/getfile/collection/p16021coll11/id/1867> (last accessed Nov. 8, 2020).

Creating an undulating bottom to the reservoirs is a reasonable concept, which in the long term may increase diversity by mimicking the historic undulations of the ground surface.

C. The Case for Excavation

With the water table in Addicks at least 10 to 12 feet below the surface in most areas and in some areas more than 25 feet below ground, excavation could potentially double existing storage capacity. The existing reservoir holds over 125,000 acre-feet of floodwaters without spilling over. According to engineers working on behalf of groups associated with Houston Stronger, excavation could provide up to 250,000 acre-feet of capacity on GOL in Addicks Reservoir. This new increment would have handled a Harvey-type storm.

The case for excavating the dam is that the land is already owned by the government and this increase in storage would essentially “fix” the problem of upstream flooding which would mean that the government would not have to purchase a “permanent” flowage easement over the homes that flooded upstream. It would help save the community from additional floods, allow residents to remain in their homes, retain the tax base, and keep neighborhoods intact. Transporting dirt is expensive. Where possible, USACE should consider using the dirt to create amenities within the reservoirs – perhaps “mountain” trails, amphitheaters, hills, etc. Other dirt could be used to cover nearby landfills that are closed but not remediated. The cost could be also justified given the reduction in the need to “buy out” houses or provide an expensive permanent flowage easement.

The analysis for excavation of Addicks could likely be replicated in Barker Reservoir. Any ecological losses could be mitigated offsite or could be mitigated through restoration once the excavation is complete. Again, the storage capacity of the reservoirs could be doubled by excavating the two reservoirs which would essentially solve the flooding problem upstream – at least for a Harvey-type storm. Excavation, as proposed, should be considered as a more efficient alternative to a Alternative 2.

Alternative 4: Tunnel¹⁵

Summary: The Interim Report acknowledges that conveyance is critical and tunnels would provide an effective way to convey flows from Buffalo Bayou or the reservoirs, but recommends no further study on this alternative based mainly on cost. USACE estimates the cost of the project at \$6-12 billion, while a more robust study from HCFCD estimates the same project will cost only \$3-6 billion. A tunnel may also reduce environmental and social impacts and create benefits, like significant additional water supply and localized inlet options, in ways that other alternatives do not.

A. Introduction

The Interim Report concludes that, “[c]onstruction of a tunnel would increase conveyance from Barker to the Houston Ship Channel or Galveston Bay and serve as an alternative discharge outlet alleviating pressure on Buffalo Bayou.” The report also concludes that tunnels operating as an inverted siphon by gravity can move high-flow rates from the reservoirs to the Houston Ship Channel/Galveston Bay. A tunnel provides a reliable, safe downstream conveyance from Addicks and Barker Reservoirs past

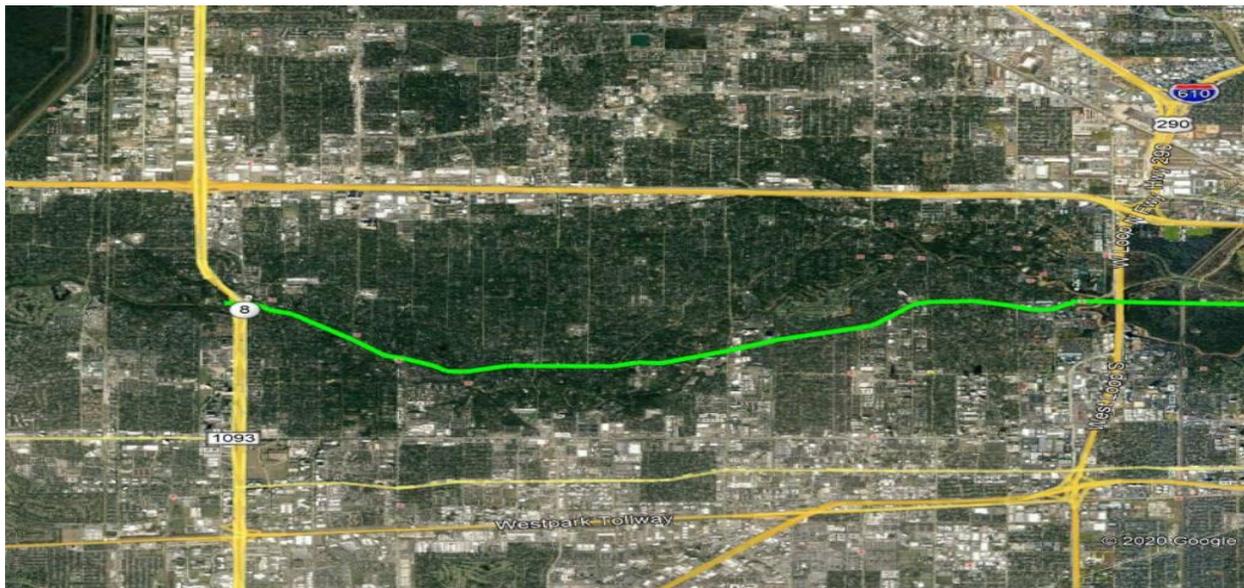
¹⁵ Contributors: Brian Gettinger (FNI), Auggie Campbell (AWBD), David Harkins (Carrollo), Ed McCarthy (McCarthy & McCarthy), Scott Jones (GBF), Jordan Macha (BCW), Marlin Williford (BFPG)

Downtown Houston with more benefits and lower costs than noted in the Interim Report. In fact, USACE’s analysis finds that Alternative 4 performs better than Alternative 6.¹⁶

Houston Stronger notes that a tunnel presents environmental considerations that USACE should review. Houston Stronger finds that USACE could eliminate most if not all community opposition to conveyance by citing a tunnel inlet inside the reservoirs with an outlet near the turning basin with special attention to water quality and environmental impacts. USACE and many other cities operate tunnels to reduce flood risk and help provide a water supply while successfully addressing community and environmental concerns.

B. Non-Cost Factors

As noted in the Interim Report, tunnels have low impact to critical infrastructure, low environmental impact and low real estate acquisition costs. Simply comparing these with the other methods studied and placing them in a “low” category does not adequately distinguish the nearly non-existent impact a tunneled solution for conveyance would have along Buffalo Bayou. Away from the shaft locations, tunnels would have a negligible impact on daily life in Houston.



Houston Stronger recommends that USACE further evaluate non-cost factors as part of the alternatives 4 analysis, including:

- Land Acquisition – including cost to acquire and time to process eminent domain claims with non-compliant sellers
- Community Impact – impact to community recreational spaces and amenities, traffic impacts due to road closures, construction disruption (noise, dust, etc.) during construction
- Speed of Implementation – how quickly can the project be delivered considering construction timeline, environmental permitting and property acquisition

¹⁶ Interim Report, p. 119.

- Potential for additional water supply – tunnels provide potential storage and water quality controls that create social, economic, and ecological benefits

The Interim Report found the tunnel’s benefits slightly greater than that of channel improvement: *“Initial rough estimates of benefits showed that Buffalo Bayou channel improvements could provide as much as 85 to 90 percent of the tunnels’ benefits.”*¹⁷

C. Tunnel Cost Analysis

As outlined in the section of this memorandum discussing “Alternative 6: Buffalo Bayou Channel Improvements,” the cost estimate for the channel improvements does not fully account for the cost. Inversely, the costs assumed for the tunnel are significantly higher than other estimates recently prepared, resulting in a combined cost discrepancy that is exaggerated.

Houston Stronger encourages USACE to re-evaluate the cost assumptions for the tunnel and adopt the rigorous cost analysis presented as part of the HCFCO Phase 1 Tunnel Study.¹⁸ The Interim Report’s cost estimates are twice as high as the HCFCO cost estimates. The cost analysis for HCFCO analyzed numerous recent tunnels of similar scale in the United States and adjusted the cost into 2019 dollars and regionally adjusted them for the Texas construction market in accordance with Civil Works Construction Cost Index System (CWCCIS) EM 1110-2-1304, March 31, 2018. The HCFCO cost analysis includes a 50% contingency.

Tunnel cost estimating at a conceptual level is typically done parametrically on a cost per foot of tunnel per inch of tunnel diameter. Backing out the cost estimates presented in the Interim Report into a cost per foot of tunnel per inch of diameter returns a cost of \$120 to \$140 per foot per inch diameter. The HCFCO study concluded that a 25 foot to 40-foot diameter tunnel cost was \$60 to \$63 per foot per inch diameter including a 50% contingency. Although USACE considers a 47-foot diameter tunnel, which is larger than the 40-foot tunnel considered by HCFCO, the cost assumptions prepared for the 40-foot diameter tunnel for HCFCO are applicable. A 47-foot and 40-foot tunnel are built by the same methods and the cost increase of the larger diameter is accounted for the scaling of the cost by inch diameter. A comparison of the two estimates is shown in the table below.

Alternative	Name	Discharge Point	Length (mi)	Max DIA	USACE Cost Estimate (\$B)	USACE Cost per Inch DIA per Foot	Cost at HCFCO Price Assumption	Difference
Tunnel 1D	River Tunnel Large	HSC Turning Basin	23	47	\$8.9	\$130	\$4.1	-54%
		Galveston Bay	34	47	\$12.0	\$119	\$6.1	-49%
Tunnel 1F	River Tunnel Small	HSC Turning Basin	23	32.5	\$6.5	\$137	\$3.0	-54%

¹⁷ Interim Report, p. 119.

¹⁸ See <https://www.hcfcdo.org/Resilience/Countywide-or-Multi-Watershed/Z-08-PRELIMINARY-ENGINEERING-STUDY-FOR-LARGE-DIAMETER-TUNNELS-FOR-STORMWATER-CONVEYANCE> (last accessed Nov. 8, 2020).

	Galveston Bay	34	32.5	\$8.8	\$126	\$4.4	-50%
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D. Tunnel Implementation Schedule

USACE report references the 16,200-foot long San Antonio River Tunnel and the 12 years it took to complete the project, implying that tunnel projects are very long and complex. The construction of the San Antonio River Tunnel in 1998 was slow and more challenging than expected. The experience on the San Antonio River Tunnel is not representative of the construction schedule that should be expected for a large stormwater tunnel in Houston. The geologic conditions are different, the tunnel methodology (pressurized face EPB TBM as described in the HCFCD Phase 1 study) is different, and the technology and construction methods have improved dramatically in the last 30 years. Although there were challenges that had to be overcome during construction, the San Antonio River Tunnel is an excellent example of the effectiveness of tunnels for flood mitigation as well as how these systems when well-designed can be operated with minimal operation and maintenance expenses. The San Antonio tunnel “paid for itself” the year it was built, when floodwaters were diverted into the tunnel, avoiding estimated damages greater than the cost of construction. The solution for Buffalo Bayou should apply these lessons.

As presented in the HCFCD Phase 1 study (Tunnel Applicability Memorandum), a 40-foot diameter tunnel has an estimated excavation rate of 50 feet per day. A 23-mile-long tunnel would be constructed in multiple segments, each segment likely no more than 5 to 7 miles in length between shaft locations. This has been validated by the recent tunnels constructed in Washington DC in very similar soil conditions with similar construction methods. If the tunnel project received full appropriation upfront, four segments each 5 to 7 miles in length could be constructed in parallel. Four parallel segments each 30,000 feet in length could be constructed in 5 years from the construction notice-to-proceed (NTP).

E. Intake

Figure 43 from the Interim Report appears to show the initial intake structure for the tunnel at the confluence of Langham Creek and Buffalo Bayou downstream of the reservoirs. Houston Stronger recommends further analysis into the intake location including consideration for an intake structure in the reservoir that would allow the tunnel to realize a greater upstream hydraulic condition. A structure within the reservoir would require a gated connection between the reservoirs be provided, potentially by tunnel. An inlet structure in the reservoir would allow USACE to release flow during storm events without the flow ever entering Buffalo Bayou. An inlet structure in the reservoir could also allow for reservoir deepening below the level of the existing reservoir gated outlet. All flow deeper than the existing outlet could be drained through the tunnel. Appropriately located and designed intakes could significantly improve water quality at the point of discharge and reduce erosion and non-point source pollution along Buffalo Bayou.

F. Discharge

The Interim Report considers two discharge locations, the Houston Ship Channel Turning Basin and Galveston Bay. Houston Stronger recommends future analyses focus on the outlet structure at the Houston Ship Channel Turning Basin. The additional 11 miles of tunnel will probably not prove to be cost effective and the additional length burns hydraulic head, limiting the conveyance capacity in the system.

Houston Stronger also recommends that USACE consider the outlet structure for water supply. Depending on sizing, the tunnel is likely to store over 1 billion gallons of water until it is pumped out. The tunnel should be dewatered between storm events as alluded to in the Interim Report. With appropriate water quality controls at the intakes and throughout transportation, the flow pumped from the dewatered tunnel could be taken directly to the City of Houston East Water Purification Plant. Depending on rainfall and other factors, a portion of the revenue dedicated from this water supply could generate millions of dollars per year to help pay the local share.

Alternative 5: Diversion¹⁹

Summary: The Interim Report effectively and rightfully eliminates “Diversions” as a viable option for addressing the flood risks associated with the Addicks, Barker and Buffalo Bayou Watersheds. Both the Brazos River and Brays Bayou face flood risks that make diversion into those watersheds ill-advised.

A. Introduction

The Interim Report effectively and rightfully eliminates “Diversions” as a viable option for addressing the flood risks associated with the Addicks, Barker, and Buffalo Bayou watersheds. USACE identified two possible federal projects involving the diversion of water away from the Addicks, Barker and/or Buffalo Bayou watersheds – one being to the Brazos River, and the other being to Brays Bayou, per Table 3 - Initial Evaluation of Alternatives – shown in the Executive Summary of the Interim Report. This table also notes that “Diversions present a high risk in long-term operation because Brays Bayou and/or the Brazos River may already be flooded.” Thus, USACE eliminated these two diversion projects from further consideration of viable anchor alternatives. However, USACE identified a “Barker to Brays Bayou diversion” as an ancillary alternative that could be added onto an anchor project, such as the Cypress Creek Reservoir (see Table 4 – Revised Array of Alternatives). Another diversion project considered was the North Canal to bypass downtown Houston, but it was dropped from further consideration since the City of Houston was pursuing this project.²⁰

B. Planning Constraints

USACE noted that one of the planning constraints for its study was to avoid transferring flood risks to other areas. All adjacent watersheds in the region have flood risk issues, including Brays Bayou and the Brazos River, that make them unavailable for use in accepting additional flood waters without increasing their current flood risk. The Interim Report correctly notes that “Diversions would not be effective because during large flood events, which are the focus of this study, adjacent watersheds would also be at flood stage and their capacity to store flood water from Buffalo Bayou is limited.”

C. Brays Bayou

Brays Bayou does not have and will not have additional conveyance capacity. During Harvey 2017, Brays Bayou had major flooding along its entire length. Even after completing an ongoing federal flood control

¹⁹ Contributors: Phil Bedient (SSPEED), Auggie Campbell (AWBD), Griselda Gonzales (ASCE).

²⁰ *Interim Report*, p. 113.

project, Brays Bayou will show a 100-year floodplain that extends beyond its banks, especially in the Meyerland area.

D. Brazos River

The Brazos River reached approximately its 100-year flood stages throughout Fort Bend County during Harvey 2017, which lasted for about a week. Significant flood damage seriously affected the flood operations of a dozen or so levee improvement districts (LIDs) located along the Brazos River in that county. These LIDs provide flood protection for tens of thousands of homes from the Brazos River flood waters. If their levees are overtopped or breached, the consequences would be catastrophic. Thus, this river does not have any additional flood carrying capacity to accept flood waters from the Addicks, Barker or Buffalo Bayou watersheds, and it would not be consistent with USACE’s planning constraint to allow for the existing flood risks along that river to be increased by diverting or transferring that risk away from these other watersheds and to the Brazos River.

Alternative 6: Buffalo Bayou Channel Improvements²¹

Summary. Alternative 6 is not a realistic alternative. The Interim Report underestimates project costs and challenges. Entrenched, widespread community opposition to its social and environmental impacts, as well as regulatory and litigation risks, create considerable challenges, including possibly depriving the project of a local sponsor. The Interim Report assigns a 0.3 BCR to Alternative 6—well below the threshold required for a public investment of this magnitude. Based on the modeling information available, Alternative 6 falls short of safely handling both the Addicks and Barker Reservoir releases *and* local downstream bayou flows needed to avoid catastrophic flooding.

A. Low BCR

Alternative 6 receives a 0.3 BCR—far short of meeting the requirements under federal law, which is a second reason why Alternative 6 is not achievable. The BCR of 0.3, means USACE considers the projects costs to be three times greater than projected benefits. Including the costs due to impacts on city parks and modifications to the channel in the downtown area, the BCR is likely to be even lower. The Interim Report makes no recommendation that can comply with the Flood Control Act of 1936, which requires that a project’s benefits be greater than its costs.²² A project that is value-engineered to reduce costs to improve the BCR would likely have even worse negative impacts on Buffalo Bayou and its surrounding parks and communities. A local sponsor’s cost share will be 35% of the project’s \$3.1 - \$4.1 billion cost or at least \$1 billion, an enormous sum for only one of Harris County’s 22 watersheds.²³

B. No Hydraulic Design

The Interim Report does not provide a floodplain hydraulic design objective for Buffalo Bayou downstream of Addicks and Barker Reservoirs. USACE’s modeling and channel evaluations do not reveal the required

²¹ Contributors: *Guy Hagstette* (BBP), *Deborah January-Bevers* (Houston Wilderness), *Steve Robinson* (ABHR), *Joe B. Allen* (ABHR).

²² *Interim Report*, p. 20.

²³ *Interim Report*, p. 169.

increase in carrying capacity of the bayou (post-Harvey) or the likely ecological and social costs necessary to achieve the proposed modifications to the channel.

C. Missing Channel Segment

The Interim Report does not review whether an 11,000-foot segment between the proposed starting point and the North Canal can accommodate flows without modification. Alternative 6 proposes to increase the channel capacity on Buffalo Bayou to accommodate 15,000 CFS starting upstream of downtown Houston, 1,500 feet east of Studemont Street.²⁴ However, Alternative 6 does not discuss whether the channel downstream of this starting point can accommodate 15,000 CFS. The Interim Report acknowledges improvements to the North Canal at White Oak Bayou, near Allen’s Landing, but does not discuss the 11,000 feet of channel between the North Canal and the start of Alternative 6.²⁵ Houston Stronger questions the implied assumption that these two miles of highly constrained channel can accommodate 15,000 CFS without flooding or social or ecological costs. Further analysis of Alternative 6 is needed to evaluate the cost of the 11,000 feet of channel between the Alternative 6 starting point and the North Canal, which is likely high because of land values near downtown. Flooding in this area of downtown has caused extensive damage to the City Hall Complex, Harris County Complex and Theater District.

D. Impact on Parks

The Interim Report is silent concerning Alternative 6’s social, economic and environmental impacts on two major city parks – Memorial Park and Buffalo Bayou Park—which would be significant. Deepening the channel by 11.6 feet and widening it to 230 feet will have major impacts on these parks, both during construction and afterward. Alternative 6 also includes Buffalo Bayou from Barker Reservoir and Addicks Reservoir to Beltway 8. The required channel and right-of-way would substantially diminish recreational and environmental benefits to west Houston at Terry Hershey Park (operated by Harris County). Analysis of Alternative 6 should consider the social, economic and environmental impacts resulting from changes to Terry Hershey Park in addition to the conveyance capacity of the channel.

E. Mitigation Unavailable

Mitigation requirements for Alternative 6 of 3,093 acres of riparian habitat are unattainable.²⁶ In-kind compensatory mitigation for riparian corridor damages cannot be created. The mitigation would have to be sought well outside of the Hydrologic Unit Code (HUC), which is counter to USACE permitting guidance.

F. Problem Statement and Planning Objectives

The Interim Report defines Problem Statement 3 as: “Pool releases from Addicks and Barker reservoirs combine with downstream inflows to pose risks to health and human safety, public infrastructure and private property.”²⁷ The Interim Report does not clearly provide a floodplain hydraulic design objective within the Buffalo Bayou reach downstream of Addicks and Barker reservoirs. As such, USACE does not

²⁴ *Interim Report*, p. 84.

²⁵ *Interim Report*, pp. 103-104.

²⁶ *Interim Report*, p. 120.

²⁷ *Interim Report*, Executive Summary p. 7 (Problem Statement and Planning Objectives).

provide the public enough information to assess the appropriateness of any solution on the above listed Problem 3 risks in any segment downstream of the reservoirs.

G. Channel Design

Alternative 6 is described as a “trapezoidal channel” with a typical section showing articulated concrete blocks throughout the channel section.²⁸ This approach will cause environmental impacts that the Interim Report fails to acknowledge and will meet strenuous public opposition. The Alternative 6 carried forward for further reevaluation is described to include (i) “terracing the bayou to create benches that would support riparian vegetation commensurate with the hydrologic frequency of that bench;” (ii) “a low flow channel would be maintained which would mimic as closely as possible the depths and bank slopes (from below the water to the surface) that is currently inundated with permanent flows and maintaining at a minimum existing aquatic habitat quality;” and (iii) “in areas of high erosion, the channel bottom and sides would be modified with stepped vegetation.”²⁹ In areas of reduced erosion, the channel bottom and sides would be modified with stepped vegetation;” and (iv) “in-stream structures and riffle complexes would be constructed to modify the overall stream structure and function more similar to unmodified streams, thereby increasing overall aquatic habitat quality and diversity.” In both versions of Alternative 6, USACE is proposing a 230-foot-wide channel with a 70-foot wide channel bottom that is 11.6 feet deeper than today. As proposed, Alternative will cause significant, lasting damage to Buffalo Bayou due to the additional excavation and enlargement required to create the proposed channel section.

Alternative 7: Nonstructural/Nature Based³⁰

Summary. The Interim Report recommends nonstructural property buyouts along Buffalo Bayou to increase conveyance for releases from Addicks and Barker Reservoirs. The buyouts considered under Alternative 7 exclude 24,000 parcels within Addicks and Barker Reservoirs’ flood pools but outside the government-owned land. While strategic, community-supported buyouts may be a sound approach, USACE should closely study and inform communities of the potential impact of these structural buyouts and work to minimize these impacts. The public prefers nature-based solutions. Houston Stronger recommends that USACE review ways to preserve natural bayou features, preserve and restore land on the Katy Prairie, and construct a series of smaller detention and retention areas using nature-based design principles. These projects can provide up to 1:1 flood reduction benefits for flows upstream of Addicks Reservoir.

A. Introduction

Alternative 7 evaluates acquiring and relocating existing structures downstream of Addicks and Barker Dams along Buffalo Bayou. USACE considered multiple scales, including at the high end, acquiring up to 441 structures (including businesses and multifamily structures) at a cost of \$2.3 billion, including relocation expenses. Houston Stronger questions the derivation of these numbers, which appear low, and whether USACE could avoid these costs through improved conveyance, upstream storage, excavation, or a combination of alternatives.

²⁸ *Interim Report*, pp. 84-86.

²⁹ *Interim Report*, p. 112 (Section 4.8.1 FRM Alternative Plans beginning on page 109).

³⁰ Contributors: Deborah January-Bevers (Houston Wilderness), Mary Anne Piacentini (KPC), Jordan Macha (BCW), Chris Browne (EHRA).

B. Downstream Property

Under Alternative 7, USACE evaluates conveying 15,000 cfs through Buffalo Bayou by large-scale property acquisitions with no physical changes to the channel at an estimated cost of \$2.3 billion. For the 2, 5, 10 and 25-year events, BCRs were greater than 1.0, and therefore economically justified. For the 50-year event, the BCR was 0.91, and for remaining plans, BCRs are well below 1.0. As shown in the table below, the only non-structural plans that are economically justified are the 2, 5 10, 25 and possibly 50-year event plans along Buffalo Bayou. Among these, the 5-year event provides the greatest net benefits, and is the national economic development (NED) plan based on existing information.

Table 23. Summary of Buffalo Bayou Acquisition Plans (\$1,000, Oct 2019 Prices, 2.75% Interest Rate)

Plan	# of Struc.	EAD	First Cost	Annual Cost	Net Benefits	BCR
2 Year	19	\$55,678	\$203,742	\$7,754	\$47,924	7.18
5 Year	33	58,046	264,326	10,062	47,984	5.77
10 Year	64	60,532	437,659	16,659	43,873	3.63
25 Year	341	77,425	1,937,351	73,744	3,681	1.05
50 Year	441	78,789	2,276,649	86,659	-7,870	0.91
100 Year	825	82,892	3,213,387	122,315	-39,423	0.68
200 Year	1,737	86,854	5,309,698	202,110	-115,256	0.43
500 Year	4,140	\$91,043	\$9,784,192	\$372,427	-\$281,384	0.24

These varying levels of property buyouts would help reduce flood risk to properties downstream of Addicks and Barker Reservoirs – with the risk eliminated or significantly reduced under all frequency events noted above. This reduced risk would also allow larger releases from Addicks and Barker which would function similarly to Alternative 6, where there would be less storage time of floodwaters and a decrease in floodplains in a number of areas throughout the study area, but there are unacceptable consequences.

The properties evaluated consist of communities that are unlikely to move and have resisted buyout efforts since at least the 1950s. Impacts to property owners would be considered significant as many families would have to relocate outside of their community. For this alternative, USACE did not make clear in Table 23 (shown above) what the frequencies meant for water release levels of the reservoirs.

USACE' Storyboard regarding Alternative 7 contains unclear and potentially contradictory comparisons of residential and commercial property buyouts and related costs (see below) compared to the data contained in the Interim Report (see Table 23 above):³¹

³¹ BBTRS Alternatives, available at <https://www.swg.usace.army.mil/Missions/Projects/BBTRS/> (last accessed Nov. 8, 2020).

Location	Residential Acquisitions	Commercial Acquisitions	Number of Real Estate Parcels	Cost (billions)
Minimum Acquisitions				
Barker	8,338	104	9,785	\$5.4
Addicks	4,435	186	5,083	\$2.7
Maximum Acquisitions				
Barker	10,023	113	11,658	\$6.5
Addicks	11,279	379	13,049	\$6.5
<i>As of 19Sept2020</i>				

Additionally, the use of BCR under Alternative 7 appears to be the same analysis that resulted in current conditions. With a patchwork approach to buyouts, there is a greater chance for the acquired areas to become vacant lots that could become extremely expensive to maintain and provide low quality habitat sites with minimal to no productive use. Patchwork buyouts would also contribute to the decline in community values and the loss of community cohesion.

C. Upstream Property and Litigation

The Interim Report does not analyze the cost of acquiring the properties upstream of the reservoirs, which are part of ongoing litigation.³² The upstream properties include 24,700 parcels, with a total affected population of approximately 64,000 – roughly the population of the City of San Marcos, Texas. Judge Lettow ruled that USACE condemned a flood easement across the upstream properties, which include homes, businesses, schools, and an airport.³³ The condemned parcels have an estimated value of over \$10 billion, and condemnation would have significant adverse impacts on upstream communities.

USACE should evaluate the cost of flood easements in these cases in its other alternatives. The cost of a flood tunnel, for instance, is likely far less than the cost of condemning communities with combined populations larger than the City of Conroe, Texas. These communities also have billions of dollars of bond obligations for schools, roads, utilities, and other public infrastructure, which may be unserviceable if condemned. USACE should consider the costs related to litigation and how alternatives, as a component of settlement, may avoid these litigation costs and damages.

D. Nature-based Alternatives

USACE received over 89 comments related to nature-based alternatives and considered them to be “main themes identified during scoping.”³⁴ In spite of this, the Interim Report did not consider nature-based alternatives. Nature-based alternatives allow for the storing of water and mitigation of flooding risks in lieu of or in concert with traditional engineered solutions. HCFCD is already several years into bond projects along Buffalo Bayou where channel improvements, with some nature-based features, have taken

³²In *Re Upstream Plaintiffs Addicks and Barker (Tex.) Flood Contr. Reservoirs*, Case 1:17-cv-09001-CFL (Dec. 17, 2019).

³³ See Alternative 1 above at H.3.

³⁴ Early scoping meetings were held in May 2019. Four hundred and seventy-three people attended the five public meetings held upstream of Addicks and Barker reservoirs and between the dams and downtown Houston. During this period, public comments were accepted during a 30-day period, in which 279 comment letters were submitted and 541 substantive comments were identified. There were 69 comments listed in the Scoping Report related to nature-based alternatives to consider (see p. 14 of Scoping Report - attached), and Table 6 in the Scoping Report provided 6 objectives associated with non-structural/nature-based measures (see p. 24 of Scoping Report).

place and will continue to take place downstream from the reservoirs. USACE does not make clear what baseline conditions it is using to determine the property buyout impacts.

These HCFCD projects should have been considered in USACE analysis. In the BBTRS Early Scoping Report published by USACE-Galveston District, in partnership with the HCFCD, the Corps stated “NEPA requires an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.” USACE should evaluate the nature-based alternatives proposed in the Scoping Report:

- Preserving the Katy Prairie through land acquisition
- Restoring native habitats and bayous
- Using green infrastructure in place of gray infrastructure
- Preserving natural features such as oxbows and meanders
- Removing invasive trees from the reservoirs
- Constructing a series of detention ponds throughout the system – taking into account the work already being performed by HCFCD
- Preserving and restoring the Katy Prairie and other important wetland, grassland and forested habitat types.

Any and all of these nature-based alternatives would allow for a substantial cost-savings by implementing nature-based features, protecting of existing green space from future development, and providing opportunities for additional outdoor recreation in addition to other community benefits such as improvements in air and water quality.

E. FEMA Mitigation Programs & BCR

USACE’s BCR calculation provides valuable information but takes a highly constrained view of benefits and ignores relevant costs.³⁵ USACE should consider better methods. In line with FEMA’s revised policy for *Ecosystem Service Benefits in Benefit-Cost Analysis for FEMA’s Mitigation Programs* (see attached FEMA Policy FP-108-024-02), USACE can take into account consideration of ecosystem service benefits for a project regardless of BCR value, in order to allow for easier inclusion of nature-based solutions into risk-based mitigation projects.

Alternative 8: Combined Alternatives 2 and 6³⁶

Summary. This alternative combines the Cypress Creek Dam and Reservoir (Alternative 2) with Buffalo Bayou Channel Improvements (Alternative 6) to determine whether the two together would provide system-wide improvements, given the failures of the separate Alternatives on their own. However, this combination suffers from the major issues identified in both Alternative 2 and 6, including a low BCR

³⁵ See TEX. TRANSP. INST., *How Project Selection in the Corps of Engineers is Affected by Benefit-Cost Ratio (BCR) Analysis*, 83 (Jan. 2018; published for the National Waterways Foundation).

³⁶ Contributors: *Mary Anne Piacentini* (KPC), *Jim Robertson* (CCFCC), *David Lowe* (BGE), *Guy Hagstette* (BBP), *Deborah January-Bevers*, *Steve Robinson*/Joe B. Allen (ABHR)

(0.2), strident public opposition, and detrimental environmental impacts that cannot be mitigated (see Alternative 2 and 6 discussions above). When combined, most of the benefits result from the conveyance improvements. The Interim Report shows that the Cypress Creek Dam provides only a small incremental benefit over a conveyance solution at triple the cost.

General Comments

Alternative 8's 0.2 BCR does not come close to meeting the requirements under federal law. Alternative 6 (Buffalo Bayou Channel Improvements) leaves \$65.879 million in residual damages, and Alternative 8 (Alternative 2 Cypress Creek Dam + Alternative 6 Buffalo Bayou Channel Improvements) reduces damages to \$63.299 million. This is an incremental damage reduction of only \$2.58 M. This alternative is a non-starter if one were to consider only the cost (\$946 million to \$1.2 billion) and impacts of Alternative 6 Buffalo Bayou Channel Improvements, and it is even more evident that the sizeable additional investment (\$2.1-2.9 billion) in the Cypress Creek Dam and all of the resulting environmental harms are difficult to justify for the small increment of flood risk reduction.

Houston Stronger requests USACE's complete BCR calculation of Alternative 8, including the incremental addition of the Cypress Creek Dam & Reservoir, if one were to assume that the conveyance option had already been constructed. Only with this information can the public fully understand and evaluate the resources involved and limited benefit of Alternative 8.

See discussions of Alternative 2 and Alternative 6, above, for other significant feasibility issues, including: (1) lack of a willing local sponsor; (2) major environmental impacts; (3) impossibility of mitigation; (4) community opposition; and (5) high likelihood of litigation for Alternatives 2 and 6.

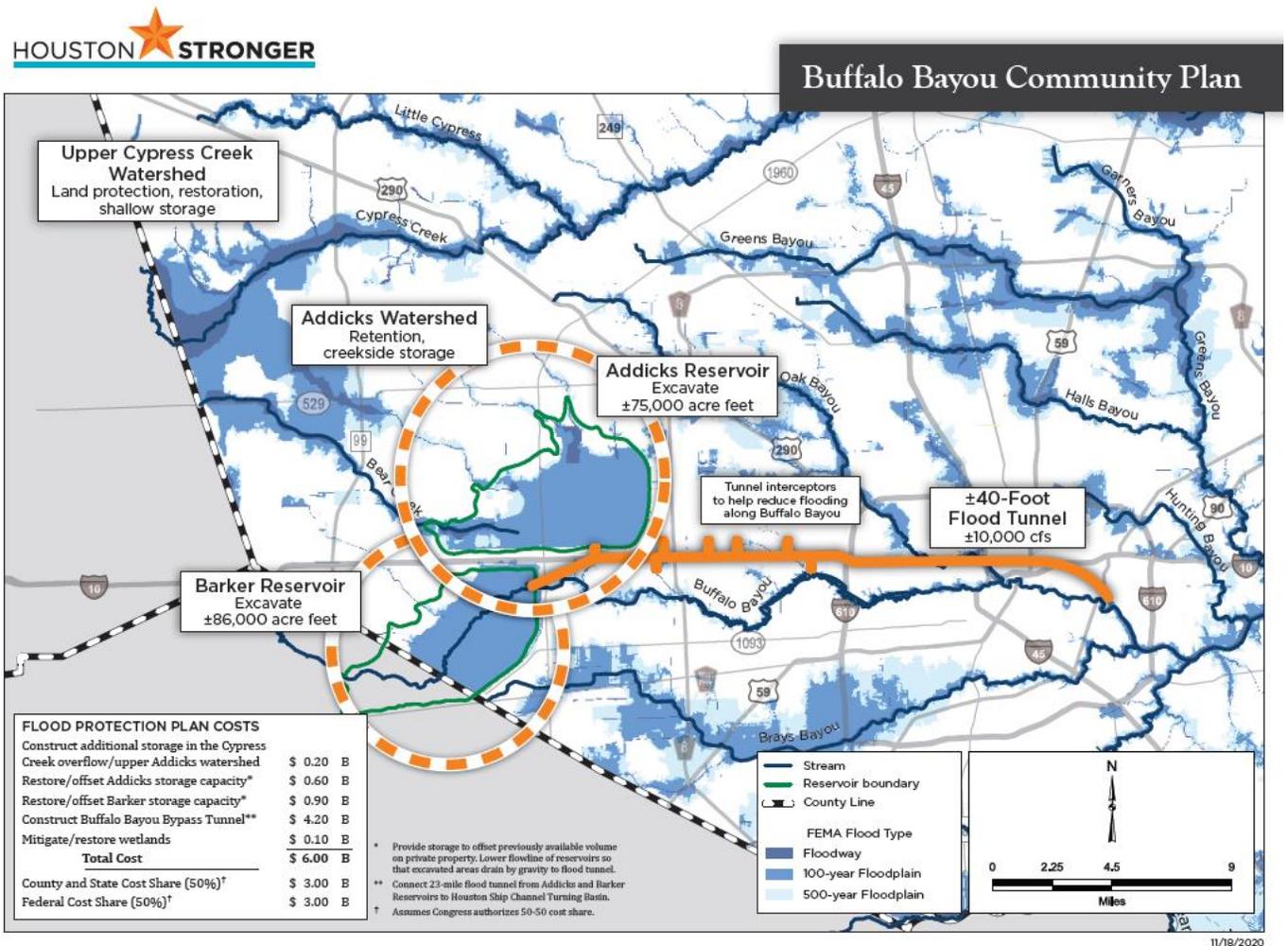
Alternative 9: Other Alternatives and Recommendations³⁷

Summary: Houston Stronger asks that USACE continue to explore tunnels, significant excavation of Addicks and Barker Reservoirs, and other alternatives (such as non-structural nature-based strategies) going forward as USACE produces a draft feasibility report. Houston Stronger, its members, and others have developed several alternatives that the Interim Report did not consider or recommended not to be considered going forward. USACE should fully evaluate floodway acquisition, land preservation and restoration, distributed detention/retention, and smaller flood retention basins above Addicks Reservoir as an alternative to a Cypress Creek Reservoir, which would provide similar benefits faster and for less money. New approaches, including "smart watershed" technology, may add capacity to existing and proposed detention. USACE should also consider starting a separate flood risk reduction study on the Cypress Creek watershed immediately. USACE, having noted the constraints of its BCR approach, should consider new FEMA guidance (Policy FP-108-024-02) and suggest BCR reforms to more effectively address flood risk and public safety. Finally, USACE needs to move quickly to address the "urgent and compelling" dam safety risks at these two dams, as it has been over a decade since these risks were first identified.

³⁷ Contributors: Natalie Chaney (ASCE, RPS), *Griselda Gonzales* (ASCE, TGC), Mary Anne Piacentini (KPC), Richard Seline (Accelerate H2O), Brian Gettinger (FNI), Steve Robinson (ABHR), David Lowe (WHA, BGE)

A. Houston Stronger: Buffalo Community Plan³⁸

1. **Formulation and Goals.** Working with Houston Stronger members, the West Houston Association (WHA) developed most components of the 2018 Houston Stronger Plan.³⁹ WHA, with input from others, has updated elements of this Houston Stronger Plan to focus attention on alternatives for the Buffalo Bayou Watershed that the local community can support (the Houston Community Plan). The Buffalo Bayou Community Plan is formulated with the following goals: (1) contain and convey the storm events similar in magnitude to Hurricane Harvey; (2) contain flood waters within the boundaries of Federally owned lands for Barker and Addicks Reservoirs; (3) add conveyance downstream of Barker and Addicks Reservoirs without channelizing Buffalo Bayou; (4) reduce flooding conditions in Buffalo Bayou watershed downstream of the reservoirs resulting from local rainfall; (5) minimize environmental impacts and enhance long term environmental benefits; and (6) have broad and prolonged community support from a diverse group of stakeholders.



³⁹ Houston Stronger Plan, March 2018, available at <https://houstonstronger.net/resources/> (visited Oct. 2020).

2. **Components.** The Buffalo Bayou Community Plan consists of four components:

Component 1: Construct a 40-foot diameter tunnel capable of conveying 10,000 cfs of flood water from Barker and Addicks Reservoirs to the Houston Ship Channel. Tunnel interceptors along I-10 and Buffalo Bayou will significantly increase flood protection for Harvey-type events. A force main and expansion at the City of Houston’s East Water Purification Plant can create a new water source and funding for the tunnel without adding any additional cost to the project. (Estimated Cost: \$4.2 billion)

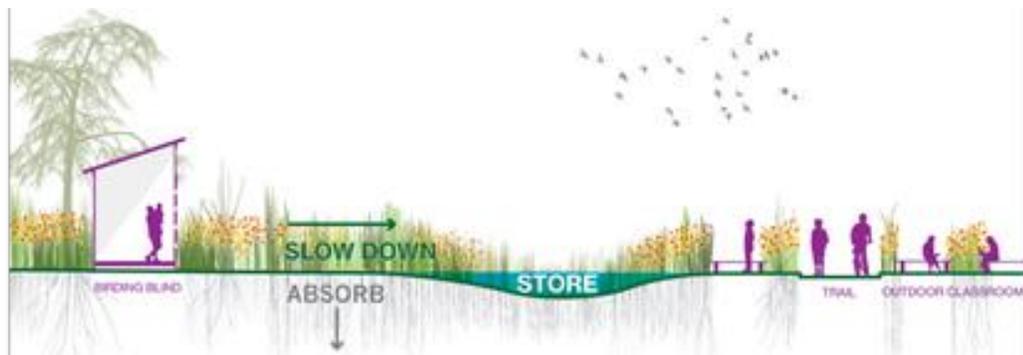
Component 2: Provide 86,000 acre-feet of compensating storage within Barker Reservoir to offset the loss of volume on private property. (Estimated Cost: \$900 million)

Component 3: Provide 75,000 acre-feet of compensating storage within Addicks Reservoir to offset the loss of volume on private property. (Estimated Cost: \$600 million)

Component 4: Land protection and restoration, shallow storage areas in the Upper Cypress Creek Watershed, and retention and creekside storage in upper Addicks watershed for a total storage of approximately 25,000 acre-feet. (Estimated Cost: \$300 million, including mitigation)

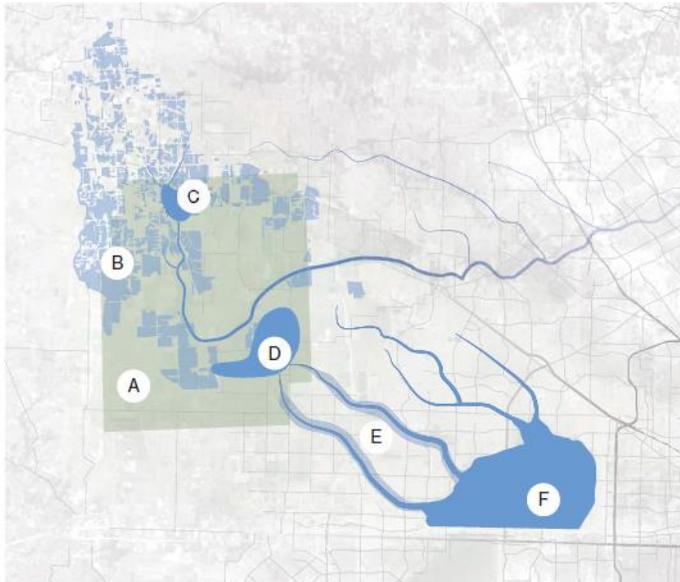
B. Katy Prairie Conservancy

The Katy Prairie Conservancy (KPC) developed recommendations after meeting with USACE right after the beginning of the study as KPC was selected to serve on the resource agency team. Dr. Edmond Russo, USACE, suggested that KPC undertake an alternatives study (sometimes called a locally sponsored plan) to identify solutions to upstream and downstream flooding. The detail is provided for those solutions that KPC studied.



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- B SHALLOW RETENTION**
FLEXIBLE & AFFORDABLE
- C UPPER CYPRESS DETENTION**
RETAINS FLOODWATERS
- D UPPER ADDICKS RETENTION**
HABITAT & RECREATION
- E CREEK RETENTION**
ACCESSIBLE GREEN CORRIDORS
- F ADDICKS EXCAVATION**
AVAILABLE & EFFICIENT

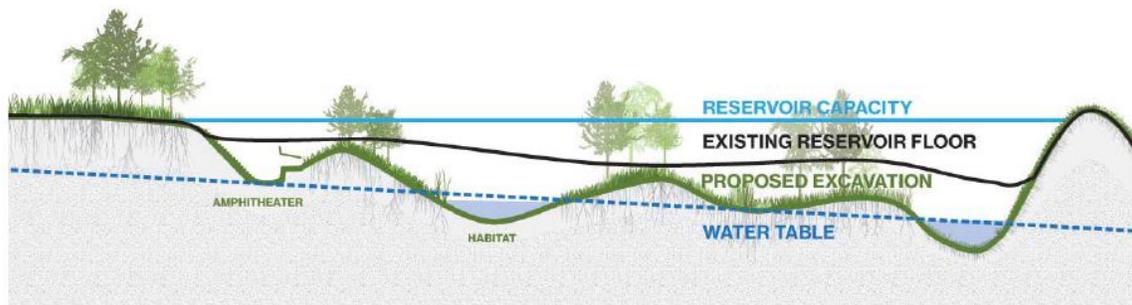
1. **Protect and Restore.** KPC and other conservation organizations propose expanding protected lands from 20,000 acres to 50,000 acres and increasing restored lands to a total of 21,000 acres. The conservation and restoration of these lands will absorb, slow down, and store waters. The tallgrass roots can infiltrate between 6 to 8 inches of water within an hour (in field tests) as opposed to other types of vegetation (pasture, approximately 2 inches per hour and turf grasses, around ½ inch per hour). The tall grasses and other standing vegetation also slow down floodwaters due to the Manning coefficient effect. The natural depressional wetlands store water. The Natural Resources Conservation Service notes that an acre of wetlands can store up to 330,000 gallons of water, the equivalent of filling up Houston’s Astrodome with water. Existing wetlands on KPC-owned lands total 5,000 acres which could mean that more than 1.6B gallons of water could be held which would fill the Astrodome 5,000 times. The expansion and restoration of the prairie could provide an additional 10,000 acre feet of storage.
2. **Permanent Flood Easements.** KPC also recommends implementing efforts to hold water on the prairie studied by HCFCD to acquire permanent easements for detention rights from landowners who agree to reduce runoff on land by creating shallow storage areas by means of low berms. The detention easements would be purchased by HCFCD and would enable the permanent storage of water during flood events. The study was undertaken by Arcadis, a firm with offices here in Houston, that develops projects to reduce flood risk in the United States and internationally. The amount of water that could be stored if the plan is implemented would total 26,000 acre-feet.
3. **Floodplain Acquisition.** KPC also studied the acquisition of floodplains and land along the upper reaches of Cypress Creek where Mound and Snake Creeks come together that could provide further detention benefits. All the proposed activities would also provide additional community benefits such as recreation, wildlife habitat, air and water quality enhancements, local

agricultural products, and economic development (tourism and agriculture). These lands would provide nearly 8,000 acre-feet of floodwater storage.

4. **Combined Benefits.** The above three projects are located in the Upper Cypress Creek Watershed and combined would absorb, slow down, or store approximately 40,000 acre-feet of floodwaters, of which 16,000 acre feet of storage or 40% would benefit downstream in the Addicks Watershed.



5. **Upper Addicks Watershed Floodway/Floodplain Retention/Floodway/Floodplain Preservation.** This plan proposed to acquire floodways and floodplains along South Mayde and Bear Creek to hold up to 50,000 acre-feet of water. Again, the storage of water in the Upper Addicks Watershed offers a 1:1 reduction in floodwaters in Addicks Reservoir. These projects would also provide community benefits in addition to flood storage, including recreation and wildlife habitat similar to Buffalo Bayou Park. The acquisition and preservation of these areas would also keep people and property out of harm's way. If additional storage is needed and/or desired, small retention reservoirs (under 1,500 acres) could be constructed which would provide an additional 60,000 acre-feet of storage – again benefiting the reservoirs at a 1:1 flood reduction rate.
6. **Excavate Addicks and Barker Reservoirs.** Addicks and Barker Reservoirs are valuable assets that need to be restored and enhanced. Storing additional floodwaters in Addicks Reservoir can keep homes upstream from flooding and prevent extreme floodwater releases that destroy downstream properties. Through strategic excavation, storage capacity in Addicks Reservoir can be increased. Excavated dirt can be used nearby to create new recreational assets, like an amphitheater, lookout hills, trails and more. Existing homes and businesses can remain, while the reservoir continues providing recreational opportunities when the area is not holding storm water. Similar efforts to hold additional floodwaters could be accomplished in Barker Reservoir.



C. Re-Evaluate BCR

1. **Introduction.** USACE’s BCR analysis, developed in the 1930s, is wholly inadequate in analyzing the need to solve Houston’s flooding problem. Hurricane Harvey is not even close to the worst case event upstream of Barker and Addicks Reservoirs. The BCR does not measure the existential threat that a catastrophic failure of these reservoirs poses to Houston, including the tens of thousands of lives and hundreds of billions in property potentially impacted downstream. It also does not account for the more than \$10 Billion in properties upstream of the reservoirs that are subject to flooding due to USACE’s failure to acquire the necessary land for operations of the reservoirs. These impacts must be acknowledged, accounted for and be determined to be unacceptable to the future of Houston.
2. **Update Methodology.** USACE should request an update of the BCR methodology to disregard metrics that exclude benefit and loss parameters that can be monetized and quantified under different methodologies. Given that the guidance manuals for developing BCR were developed in the early 1930s, USACE should produce metrics based on more updated methodologies. The State Comptroller estimated \$16 billion in economic losses in the Houston Galveston Area Council of Governments region first year following Hurricane Harvey.⁴⁰
3. **Triple-Bottom-Line Net Cost/Benefit Estimations.** USACE should evaluate its Alternatives using a more comprehensive assessment of net benefits and costs. Net costs should be estimated for traditional engineering economics inputs, such as construction costs, operations costs, maintenance costs, land acquisition costs, and labor costs. USACE should also include environmental costs for each alternative, such as the value of any diminished ecosystem services, lost habitat, lost carbon sequestration, lost oxygen production, lost heat island mitigation, lost recreational opportunities, and similar well-studied metrics. Finally, USACE should include social costs for each alternative, such as displaced cultural or historical features, lost recreational opportunities, lost or diminished employment opportunities, diminished views and character, light pollution impacts, diminished social equity, and similar aspects.

Net economic, social, and environmental benefits should also be estimated for each alternative. These would include the value of avoided property damage (times the likelihood of loss), the number of people benefiting from a reduced risk of inundation, the value of any increase in social values or benefits (recreation, views, safety, equity), and the value of any increase in environmental values or benefits (habitat, ecosystem services, etc.). The net

⁴⁰ State Comptroller Report, available at <https://comptroller.texas.gov/economy/fiscal-notes/2018/special-edition/impact.php#:~:text=The%20storm%20hit%20the%2013,this%20region%20as%20disaster%20areas>

present value of all economic, social, and environmental BENEFITS minus the net present value of all economic, social, and environmental COSTS should be calculated for all alternatives and the alternative with the highest net present value of total triple bottom line NET BENEFITS should be recommended for implementation.

D. Buyouts and Land Preservation

USACE should consider community-supported buyouts so that homes are never again flooded upstream of the reservoirs. The upstream litigation held that the government should buy a permanent flowage easement barring an alternative resolution to the flooding problem. The excavation of Addicks and Barker along with increased conveyance, mentioned previously, would provide relief for upstream and downstream properties. Additional efforts to hold water on the prairie include the proposal from the Harris County Flood Control District to (2) acquire permanent easements for detention rights from landowners who agree to reduce runoff on land by creating shallow storage areas by means of low berms. The detention easements would be purchased by the District and would enable the permanent storage of water during flood events. (3) Acquisition of floodplains and land along the upper reaches of Cypress Creek where Mound and Snake creeks come together could provide further detention benefits. Similar efforts in the Upper Addicks Watershed along Bear and South Mayde creeks along with smaller ponds would also retain significant volumes of storm water. All the proposed activities would also provide additional community benefits such as recreation, wildlife habitat, air and water quality enhancements, local agricultural products, and economic development (tourism and agriculture).

E. Tunnel—Additional Considerations.

USACE could reduce the cost of the tunnel and increase the benefit of the tunnel by considering several ideas.

1. **Water Supply.** A force main (approximately 54 inches) to take water to the City of Houston (Houston) East Water Purification Plant. Houston may be able to add thousands of acre-feet of water to its annual supply, thereby increasing availability and flexibility of Houston's water supply portfolio and accounting plan. Assuming a yield of 50,000 acre-feet, this new supply could generate \$10 million annually, excluding treatment costs. These dollars, in whole or part, could help pay local cost share. Houston would need to conduct studies to address yield, water quality, and operational issues in the East Water Purification Plant. This water supply would be variable in quantity and quality, depending on rainfall. Houston could potentially avoid or delay other more expensive water supply projects.
2. **Localized Inlets.** Consider additional shaft locations along Buffalo Bayou for flow drop structures. The tunnel will need a drop structure every 6,000 feet for access and maintenance. Additional drop structures along the route could present opportunities to connect tributary tunnels for urban drainage, increasing the overall project flood damage reduction benefit. Communities could pay for capacity in the tunnels, helping to provide local cost share.
3. **Shorter Tunnel.** While a shorter tunnel will present undesirable social and ecological impacts, reducing its length is an effective way to reduce its cost. USACE could shorten the tunnel by

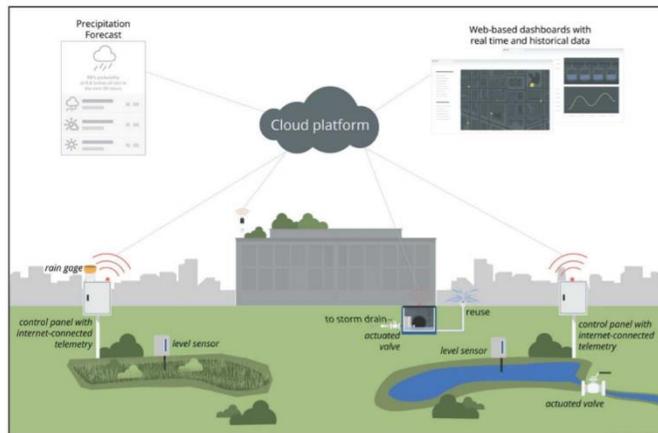
five miles to the west by moving the initial intake structure to immediately west of Beltway 8 on Buffalo Bayou while improving the Buffalo Bayou channel from SH-6 to BW-8 to convey 15,000 cfs. Buffalo Bayou from SH-6 to BW-8 is an improved channel section and there is an existing drainage easement. This section has significantly more channel capacity than the section east of BW-8, although USACE should consider recreational and environmental benefits of Terry Hershey Park. USACE could shorten the tunnel by 3.5 miles to the east by moving the outlet structure from the Houston Ship Channel Turning Basin (Turning Basin) to immediately east of South Jensen Drive on the east side of Downtown Houston. Few structures between South Jensen Drive and the Turning Basin would be impacted if the water surface elevation is increased. Buffalo Bayou has a wide cross section and is navigable in this reach but subject to severe erosion. The outlet structure should be located to minimize impacts.

F. Cypress Creek Watershed and Tributaries Preservation

Expanding protected lands from 20,000 acres to 50,000 acres and increasing restored lands to a total of 21,000 acres on the Katy Prairie will help absorb, slow down, and store waters. Permanent easements for detention rights from landowners upstream of Addicks Reservoir and in the Cypress Creek Watershed could provide an ancillary alternative. Landowners would agree to reduce runoff on land and create shallow storage areas by means of low berms would enable the permanent storage of water during flood events. All the proposed activities would also provide additional community benefits such as recreation, wildlife habitat, air and water quality enhancements, local agricultural products, and economic development (tourism and agriculture). USACE should immediately undertake a new flood risk reduction study that would analyze flooding issues along Cypress Creek, especially in the mid and lower reaches of the creek.

G. Smart Watershed.

Houston Stronger further supports the investigation of a Smart Watershed Network Management and Risk Mitigation into all alternative analyses. This alternative includes connecting up-stream, at-point, and down-stream existing built-infrastructure of public and private detention-ponds, green infrastructure, drainage assets. Once connected, these components are connected to a grid of predictive analytics and real-time data capture across gauges-sensors. This information support decision-making of wet-weather pre-release and/or hold times for post-event release using active controls (valves, gates, pumps) along the entire watershed. With over 6,700 ponds and 130,000 drainage manholes throughout Harris County, coupled with natural settings as identified by Houston Wilderness and the Katy Prairie Conservancy, the Smart Watershed Network Management



approach has shown a Cost-Benefit Analysis of 1:4+ by optimizing the capacities of existing and maximizing future infrastructure through ‘right-sizing’ design.⁴¹

Abbreviations

ABHR	Allen Boone Humphries Robinson LLP
ACEC	American Council of Engineering Companies of Texas
ASCE	American Society of Civil Engineers
AWBD	Association of Water Board Directors – Texas
BCR	Benefit-Cost Ratio
BBP	Buffalo Bayou Partnership
BBTRS	Buffalo Bayou and Tributaries Resiliency Study
BCW	Bayou City Waterkeepers
BFPG	Barker Flood Prevention Group
BGE	BGE, Inc.
BPA	Bayou Preservation Association
CCFCC	Cypress Creek Flood Control Coalition
cfs	Cubic feet per second
EAD	Equivalent Annual Damages
EHRA	EHRA Engineering
FEMA	Federal Emergency Management Agency
FNI	Freese & Nichols, Inc.
FWOP	Future Without Project
GBF	Galveston Bay Foundation
GOL	Government-owned land
HCFC	Harris County Flood Control District
HREC	Houston Real Estate Council
KPC	Katy Prairie Conservancy
LID	Levee Improvement District
MSA	Metropolitan Statistical Area
MUD	Municipal Utility District
NAI	No Adverse Impacts
NEPA	National Environmental Policy Act
SDF	Spillway Design Flood
SPF	Standard Project Flood
SSPEED	Severe Storm Prediction, Education, & Evacuation from Disasters Center
TGC	The Goodman Corporation
USACE	United States Army Corps of Engineers
WHA	West Houston Association

⁴¹ See James Lefkowitz, *From Passive to Dynamic Storage*, WATER ENVIR. & TECH., (Jul. 2017) available at <https://d1qmdf3vop2l07.cloudfront.net/merry-lime.cloudvent.net/hash-store/2c5b6fcc7cd76d656beeae13362fb6f3.pdf> (accessed October 31, 2020).

Support and Appendices⁴²

A. Support

The organizations and individual below support further investigation by USACE consistent with this document:



⁴² Communications: Kristen Hogan (ABHR), David Hagy (ABHR), Suzy Hargrove (HREC), Mary Anne Piacentini/Ali Dodson (KPC), Mark Solano (Bayou City Initiative), Auggie Campbell (AWBD).

B. Alternative 2 Specific Comments

Specific Comments/Questions

Table 3Alt 2 – Does the cost of the reservoir include values based on when the project would actually be initiated, removal of then-existing structures, long-term operations and maintenance, and estimate of replacement activities? Estimates seem low, especially given that it may take more than a decade or two to initiate the project and appraisal district prices valued in today’s dollars would not be relevant.

Page 66 - USACE noted in the report that it does not put forward projects that transfer the risk from one area to another and yet, this is what would be created through the construction of the Cypress Creek Dam, and the creation of a risk of dam failure on Cypress Creek.

Page 86, Table 21 – The Cypress Creek Dam cost numbers (\$1.6M - \$2.2M) don’t appear to be consistent with the cost numbers (\$2.1M - \$2.9M) in Table 3 in the Executive Summary.

Page 87 – USACE notes that “restoration of one acre of prairie would offset the impact of two acres of single-family land use or an acre of commercial development” so why not recommend restoring the prairie instead of placing a reservoir over it?

Page 88 – The Interim Report noted that prairie and wetland restoration could provide benefits to the watershed, but then stated: “For this study, however, land required for prairie and wetland restoration is outside the authorized study area.” Why is land for prairie and wetland restoration within the upper Cypress Creek Watershed outside of the study area, when this part of the watershed is included in the study area as outlined in Figure7, pg. 23? We request that this alternative be considered.

Page 88 Table 22 – Does not acknowledge that you have to store much more water in the Cypress Creek watershed to get the same flood reduction benefit as if that same amount of water were stored in Addicks watershed.

Page 107 – Can USACE detail how the impacts to T + E species are higher in Addicks and Barker than on the Katy Prairie? It should also be noted that we have asked USACE if they actually did any on-the-ground evaluation of conservation values on the Katy Prairie; we are not aware that they have done any.

Page 107 Table 37 – Here USACE is claiming that the Cypress Creek Reservoir has system-wide benefits. We need to get clarification on how that is, since it seems that it primarily, if not exclusively, benefits Addicks and then only to a certain extent (not a 1-to-1 reduction).

Page 107 – The chart shows required mitigation for Cypress Creek Dam as “M”. Please explain the rationale for setting this as a “Medium” level of required acres of mitigation when this alternative will

require over 7,500 acres of mitigation, and also explain the potential mitigation plan for such a large amount of mitigation acreage.

Page 107 – This chart shows a “High” impact to T & E for the excavation of Addicks and Barker. We would like to understand these impacts. Do they affect both reservoirs equally? Why does this alternative get a “High” impact rating for excavating about 3,000 acres within the reservoirs, yet the over 7,500 acres of mitigation required for the Cypress Creek Dam alternative only gets a “Medium” impact rating?

Page 109 – The description of the benefits of the Cypress Creek Reservoir states that “Initial screening level estimates for expected annual damages utilizing HEC-FIA are reduced by just under \$1 million in the study area.” What does this mean? How does this compare to the stated \$37 million in annual damages avoided?

Page 109 – The Katy Prairie Conservancy requests more detail on why certain alternatives were screened but the Cypress Creek dam was not screened. Please provide the BCR information for all screened alternatives.

Page 110 – USACE notes importance of habitat and vegetation in the reservoirs but makes little mention of the importance of the same on the Katy Prairie. Also, there is a lot of Chinese Tallow – at least within Addicks Reservoir. Much of what they claim is good about Addicks is truer of the prairie where they want to put this reservoir.

Page 110 – Talking about loss of habitat through excavation of the reservoirs. The removal of 10 feet of sediment, including all productive layers, is expected to drastically change the existing vegetation communities from dominance in trees and shrubs to herbs composed of species tolerant of low nutrient disturbed soils, many of which are expected to be non-native or invasive. Already there are lots of tallow trees in the reservoirs. Couldn't USACE do an assessment of where pockets of good habitat are and excavate around them? Creating an undulating bottom to the reservoirs is a reasonable concept, which in the long term may increase diversity by mimicking the historic undulations of the ground surface, rather than just picking an area to excavate and then saying good habitat would be lost.

Page 113 – The cost numbers throughout this document seem to be all over the place and don't seem to match up from one place to the next. It should be noted that the costs of the Cypress Creek Reservoir are likely significantly higher, as USACE indicated that the County Appraisal District values are being used to calculate land acquisition prices. Appraisal district values have significantly lagged behind the actual market prices in this area due to the fast pace of development, and actual costs would be higher than indicated – even if the project were constructed today. Give that the project may take years to be initiated, land prices would most like be much higher than estimated in the report.

Page 112 – Much lower annual operating costs for KPC's alternatives would be expected given use of nature-based solutions wherever possible and that fact that natural infrastructure can either withstand extreme weather events and are resilient.

Page 112 Alternative 8 – The annual costs for the Cypress Creek Dam are estimated at \$231 million while the annual costs for the channel improvements are estimated at \$157 million. How is it that the annual costs for the total are only \$267 million, when \$157 million + \$231 million = \$388 million? Please explain whether ancillary measures are included in these costs.

Page 113 – The cost numbers throughout this document are not consistent. It should be noted that the costs of the Cypress Creek Reservoir are likely significantly higher, as USACE indicated that the County Appraisal District values are being used to calculate land acquisition prices. Appraisal district values have significantly lagged behind the actual market prices in this area due to the fast pace of development, and actual costs would be higher than indicated – even if the project were constructed today. Give that the project may take years to be initiated, land prices would most likely be much higher in future years than estimated in the report.

Page 114 – What is the full cost of the Alternative 8 – Combination Plan and how much of the benefit is from the ancillary measures?

Page 120 – Mitigation estimates are based on desktop analyses and not field visits. KPC's own expert, Steve Apfelbaum of AES (Taken from February 13, 2018 Email from Steve Apfelbaum to KPC) noted:

Having the land inundated by floodwaters at seasonally unpredictable times and for periods of time longer than a few days at a time will disrupt the life cycles of the protected rare ecosystems and species. If the inundation frequency, depth-durations, and timing are operated in a manner similar to Addicks and Barker Reservoirs this would:

1. Eliminate or displace the current reliable water infiltration, evaporation and storage functions that the land currently provides for stormwater storage and flood damage reduction provided by the protected prairies and wetlands. Will result in the diverse ecosystem being simplified over time, including declines and losses of rare plants and wildlife.
2. Result in a decline in plant and soil biology diversity and as the flooding use increases, the health of the land declines, soils become less absorbent of flood water, and become compacted, and this typically contributes to increased rate and volumes of generate floodwaters, and increased downstream flooding.

Page 120, Table 43 – How can the acres of mitigation be about the same for Alternative 8 (7,593 acres) as it is for Alternative 2 when it is a combination of Alternatives 2 (7,523 acres) and 6 (3,093 acres)? Shouldn't Alternative 8 be the sum of those two, i.e., 10,616 acres?

Page 122 – Table 45 depicts the annual costs for Alt 2 and 6, as well as Alt 8. Why are these costs different than those presented on Page 112? Again, why is the annual cost of Alt 8 (\$260 million) not equal to the sum of Alt 2 (\$225 million) and 6 (\$153 million) (which add to \$378 million)? Please explain whether ancillary measures are included in these costs.

Page 125 – Can USACE explain why they would be recommending any of the alternatives when they note “The takeaway is that the alternatives under evaluation do not have an appreciable impact on the inflows at Addicks?” The impact to Buffalo Bayou is also worth questioning: Figure 61 shows that the Cypress Creek Reservoir does not reduce the inflows in a 100-year or 500-year event on Buffalo Bayou at Piney Point.

Page 126 – Table 47 indicates that peak inflows to the Barker Reservoir will increase slightly with the existence of a Cypress Creek Reservoir (Alternative 2) as well as Alternative 6, while the peak inflows to Addicks Reservoir will slightly decrease. Please explain.

Pages 126 -129 and associated figures (62-66) Tables (47-49) - These indicate that none of the projects significantly change the peak inflow to Addicks and Barker during the 100- or 500-year event; so what does that mean? These graphs are very confusing. What are “outflows into Addicks”? They also seem to indicate that the outflows are greater for With projects than Without projects; please explain how that happens.

Page 128 – Table 48 - How does the Cypress Creek Dam result in an increase of outflows compared to the “No Action” alternative at Addicks? This option does not include any Buffalo Bayou Channel Improvements but shows outflows increasing at both reservoirs for both the 100- and 500-year storms. Also, the outflows are identical between Alt 6 and Alts 2 & 6. This table does not make sense.

Page 149 – 4.10 Environmental Consequences

Beneficial impacts – USACE notes that the proposed Cypress Creek reservoir is good because it will preserve open space that would otherwise be lost to development in the future. However, a significant portion of the reservoir would be on lands protected by the Katy Prairie Conservancy (easement and fee lands) and these lands are not subject to future development. They are protected in perpetuity either under conservation easement agreements or by being owned by KPC, an accredited land trust.

USACE also notes in reference to this proposed reservoir that “the open space is expected to provide recreational opportunities that either currently do not exist or would have been reduced in future because of development?” KPC lands do already have recreational opportunities (trail, viewing platform, special events) and many more public activities are planned in the near and mid-term future.

USACE states: “Ceasing grazing and agricultural practices...These habitat changes would create more suitable habitat for wetland-dependent and riparian-obligate species.” First of all, KPC provides extraordinary habitat in its nearly 5,000 acres of wetlands on its preserve system, and is actively restoring grasslands. Second, sustainable grazing is an effective land management tool, and, when correctly managed, may be used to control invasive species and improve soil health and plant biodiversity. To see the impacts that grazing has on proper land management, one need only look to Addicks and Barker Reservoirs which have become overrun by invasive brush and trees after the removal of cattle.

USACE notes also that borrow areas will enhance wetland habitats and includes this as a benefit. The Katy Prairie Conservancy already has many natural and restored wetland habitat on its properties, which are designed to benefit the native species. The excavation of additional areas for the purpose of this proposed reservoir's berm construction is not providing a needed benefit. Further, the berm itself would be constructed over floodplains and wetlands, creating much more harm than benefit. This should not be considered a benefit.

Adverse Impacts

Page 149 – USACE states: “The chance for inducing development within the floodplains is likely in undeveloped areas.” Such development apparently would contribute to additional runoff from the Addicks watershed, negating some of the benefits, according to USACE’ future without project (FWOP) condition. KPC asks if this has been modeled, and questions whether the model used by USACE takes into account the infiltration and detention benefits of a natural vegetated surface.

It is not true that only 20,000 acres of prairie remain in Harris and Waller Counties. What is true is that nearly 20,000 acres of the prairie have been protected, and there are another about 20,000 acres of lands within the upper Cypress Creek Watershed that currently are open space or agricultural lands that if protected, could be restored to the historic prairie/wetland complex.

USACE notes that, with regards to the KPC lands where the proposed reservoir in upper Cypress Creek would be located, “Construction and operation of the reservoir would prevent future development;...” Again, the Katy Prairie Conservancy already prevents development on its protected lands through the permanent protection of its conservation easement lands and because of the land ownership of its preserves.

USACE is correct in that “These impacts would also apply ... downstream of the embankment, where the embankment would sever hydrologic connections thereby affecting hydrologic regimes, sediment and nutrient inputs and fragmenting habitats.” (See earlier section on Steve Apfelbaum’s analysis of what a reservoir would do to the Katy Prairie preserves).

USACE noted that “the proposed alignment of the reservoir would bisect the highest concentration of all known populations and result in direct and indirect mortality of Texas Prairie Dawn flower.” Earlier USACE noted that highest concentration was in the reservoirs. KPC believes that the Katy Prairie has the highest concentration of this plant.

Page 150 – USACE report states that while the Katy Prairie is not formally defined as a park or wildlife refuge, it has been identified by natural resource agencies (US Fish and Wildlife Service and Texas Parks and Wildlife) and conservation groups (Katy Prairie Conservancy, Bayou Land Conservancy (formerly Legacy Land Trust), and Sierra Club) as an area of special cultural and ecological significance. Implementation of the Cypress Creek Reservoir would significantly alter and degrade more than 75 percent of the remaining range-wide Katy Prairie habitat and a significant portion of the actively managed and preserved remaining habitat. Approximately 90 percent (about 10,400 acres) of the project area is operating under Habitat Conservation Plans, including mitigation banks, in which funding

has been provided to maintain and enhance Katy Prairie, stream, riparian, and wetland habitats in perpetuity.

By the admission of USACE study team in this Interim Report, the development of the Cypress Creek reservoir would significantly damage the conservation values of the Katy Prairie and would not solve the problem of eliminating flooding upstream and/or downstream. So why go to the extraordinary expense to build it if the Cypress Creek Reservoir will not solve the problem yet cause significant damage?

The Katy Prairie area which would be impacted by Alternative 2 is located in the middle of the Central Flyway and boasts more than 300 resident and migratory bird species; 110 species of mammals, amphibians, and reptiles; 600 species of wildflowers and grasses, and thousands of terrestrial insects and aquatic invertebrate species. The Katy Prairie has been designated a Global Important Bird Area by National Audubon – one of only 20 sites in Texas – due in large part to the incredible habitat available to upland species in decline on the prairie.

Page 150 – The Interim Report notes that the creation of the Cypress Creek Reservoir would lead to degradation of this resource and the invasion of weeds and undesirable species. The removal of cattle would actually further degrade the land, as properly managed cattle not only provide an important local food source, but also keep invasive species like Chinese Tallow at bay. (One need to only look at the condition of Addicks and Barker reservoirs to recognize that the removal of grazing cattle has allowed invasive species to proliferate, diminishing the storage capacity of those projects.)

Page 150 – The report references 6,000 acres of Katy Prairie conservation lands that are immediately downstream of the embankment, and the disruption to the hydrologic connections. The report states “These indirect impacts would also cause the lands to underperform in expected habitat quality for conservation and could result in conflicts with the conservation easements and mitigation banks.” This statement does not adequately describe the negative impacts of the embankment.

The embankment is proposed to bisect the Warren Ranch, which is the largest remaining working cattle ranch in Harris County which has been in continuous operation since the 1870s and is operated by the Katy Prairie Conservancy in partnership with descendants of the original Warren family. The ranch is operated as a working cattle ranch that includes a sustainable grazing plan to manage the land for wildlife habitat. The proposed embankment and associated excavation are proposed to cross directly across this historic cattle ranch, impacting cattle operations, some of the last few remaining areas of undisturbed native coastal prairie. The land on which the embankment would be constructed and as well as the land from which material would excavated provides extraordinary habitat, including prairies, wetlands, and wooded creeks, which would be both destroyed and greatly altered.

The report fails to adequately describe the value of uninterrupted contiguous habitat. Unfragmented and contiguous lands are critical to the health of many wildlife populations and the functionality of working lands. Land fragmentation impacts not only farms and ranches, but also the many plants and animals that live on the prairie. Smaller degraded fragments do not support the diverse wildlife communities that flourish on larger undeveloped and undivided areas. Connections between habitat areas are also extremely important to maintaining healthy populations.

It has taken the Katy Prairie Conservancy, with substantial federal and private support, over 28 years to protect the land that comprises the Katy Prairie Preserve. The results of these efforts have resulted in the preservation a healthy connected ecosystem within a one-hour drive from downtown Houston. Unfortunately, the fact that these lands remain largely undeveloped makes them an attractive target for infrastructure projects, including transportation and energy projects, and now a costly dam and

reservoir that, while providing a good political sound bite, does not come close to solving the problem of flooding being faced in the Addicks and Buffalo Bayou watershed.

It will be impossible to mitigate the impacts to this system, as there are no other sites that can be acquired and protected of similar size and quality of the Katy Prairie Preserve. The public must be informed of the extent and severity of the losses that would result from this action. Per our estimates, 6,429 acres of KPC fee-owned lands and an additional 4,428 acres of conservation and KCP-supporter lands will become part of the Cypress Creek Reservoir should it be built – that is 60% of the proposed land mass of the reservoir will be composed of lands protected by the Katy Prairie Conservancy.

Page 154 – USACE states: “The aggregate impacts of implementing the complete alternative (ALT 8) are considered Adverse and Significant with unavoidable long-term impacts. If so, why is this alternative being forwarded?”

Pages 155 to 158 – Mandatory buyouts would not be required if a solution to reducing flood risk could be found – for example with the KPC’s nature-based plan along with improving the carrying capacity downstream of the Addicks and Barker Reservoirs. Will USACE consider other alternatives than the ones currently considered as part of the initial scoping?

Page 165 - Table 51 depicts the residual damages after implementation of the different alternatives. Alt 6 leaves \$65.879MM in residual damages, and Alt 7 (adding the Alt 2 Cypress Creek Dam) reduces damages to \$63.299 MM. This is an incremental damage reduction of only \$2.58 MM. The sizeable (\$2.1-2.9 billion) additional investment in the Cypress Creek Dam and all of the resulting environmental harms do not appear to justify this small incremental reduction. (See also Pages 166-167, Table 52).

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Resource agency concerns have predominantly been concerned with implementing any proposed measures within Katy Prairie habitat and along Buffalo Bayou. The Katy Prairie is the last remaining coastal prairie in Harris County and less than 1 percent remains throughout the state. The Cypress Creek Reservoir would impact nearly all of the known high-quality Katy Prairie habitat remaining. An environmental team began working on a conceptual ecological model to understand the function and productivity of the Katy Prairie better; however, no models were ever built and no data collected due to the removal of the Cypress Creek Reservoir measure from further consideration. Since USACE noted that no models were built and no data collected because they had removed the Cypress Creek Reservoir measure from further consideration, why is it still one of the Focused Alternatives being discussed without those studies? Why did it appear that this alternative was dropped from consideration initially but then later recommended as a top priority alternative?

Page 172 – USACE notes: “Even with the temporal accounting in the impact and mitigation analyses, the loss of mature habitat is significant in this urban environment and may be unavoidable.” If this is the case, why not take the same tact and destroy the “habitat” in the reservoirs so as to increase storage? Also, why not construct a tunnel so as to avoid damaging urban (and prairie) habitat?

Page 173 – USACE notes there was “Strong support for implementing Nature-Based Features (e.g. preserving the Katy Prairie through land acquisition, restoring native habitats and bayous, using green

infrastructure...” and for the reduced cost of using nature-based features, but USACE did not seem to take any of these comments to heart and use them to better define their study. Why?

C. Alternative 6 Specific Comments

Page 112 alternative 8 – The math is off here for combined costs? Shouldn't the individual costs be added to each other?

Page 114 – What is the full cost of the Alternative 8 – Combo Plan and how much of the benefit is from the ancillary measures?

Page 120, Table 43 – How can the acres of mitigation be about the same for Alternative 8 (7,593 acres) as it is for Alternative 2 when it is a combination of Alternatives 2 (7,523 acres) and 6 (3,093 acres)? Shouldn't Alternative 8 be the sum of those two, i.e. 10,616 acres)?

Page 122 – Table 45 depicts the annual costs for Alt 2 and 6, as well as Alt 8. Why isn't the annual cost of Alt 8 the sum of Alt 2 and 6?

Page 165 - Table 51 depicts the residual damages after implementation of the different alternatives. Alt 6 leaves \$65.879MM in residual damages, and Alt 7 (adding the Alt 2 Cypress Creek Dam) reduces damages to \$63,299 MM. **This is an incremental damage reduction of only \$2.58 MM.** The sizeable (\$2.1-2.9 billion) additional investment in the Cypress Creek Dam and all of the resulting environmental harms do not justify this small incremental reduction. (See also Pages 166-167, Table 52).