Chapter 6: Impact and Contribution of the Regional Flood Plan

Task 6A – Impacts of the Regional Flood Plan

The goal of ***Task 6A*** is to summarize the overall impacts of the Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs) recommended in the Trinity Regional Flood Plan. This includes potential impacts to:

- Areas at risk of flooding
- Structures and populations in the floodplain
- The number of Low Water Crossings (LWCs) impacted
- Future flood risk
- Water supply (more detail provided in ***Task 6B***)
- Overall impact on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation within the Trinity Region

The Trinity Regional Flood Plan fosters the preservation of life and property and the development of water supply sources, where applicable. This chapter describes the processes undertaken by the Trinity Regional Flood Planning Group (RFPG) to evaluate these impacts and summarizes the outcomes of this effort.

The impacts will generally be determined based on two, before-and-after comparisons considering implementation of the Trinity Regional Flood Plan. The comparisons are made for the 1% and 0.2% annual chance storm events for the same types of information provided under ***Task 2A*** and ***Task 2B***. These two comparisons may, for example, also indicate a percent change in flood risk faced by various elements, including critical infrastructure. The comparisons illustrate how much the region's existing flood risk will be reduced through implementation of the plan, as well as how much additional, future flood risk (that might otherwise arise if no changes were made to floodplain policies) will be avoided through implementation of the Trinity Regional Flood Plan, including recommended changes/improvements to the region's floodplain management policies. This effort included:

- A region-wide summary of the relative reduction in flood risk that implementation of the Trinity Regional Flood Plan would achieve in regard to life, injuries, and property.
- A statement that the FMPs in the plan, when implemented, will not negatively affect neighboring areas located within or outside of the region.
- A general description of the types of potential positive and negative socioeconomic or recreational impacts of the recommended FMSs and FMPs within the region.

- A general description of the overall impacts of the recommended FMPs and FMSs in the Trinity Regional Flood Plan on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation.

Summary of Flood Risk Reduction

Flood Mitigation Project Impacts

Seven FMPs were identified and recommended, as discussed in ***Chapters 4*** and ***5***. As proposed, the recommended FMPs within this plan, when implemented, will not negatively affect neighboring areas located within or outside of the Trinity Region. The local sponsor will ultimately be responsible for proving that the final project design has no negative flood impacts prior to construction.

Six of these recommended projects are infrastructure improvement projects that have the potential to increase flows downstream by adding and expanding channels, culverts, storm drain systems, and/or bridges. One of the recommended FMPs is a regional detention project that would replace an existing undersized detention pond and provide sufficient storage capacity to mitigate for flood events associated with the 100-year flood (1% annual chance storm event).

To make certain that there will be no negative impacts to neighboring areas, conveyance mitigation measures (such as detention and water quality ponds) have been included in the projects and should be analyzed and designed by the sponsor when the projects are funded. The comparative assessment to determine “no negative flood impact” on upstream or downstream areas or neighboring regions was performed based on currently available planning level data.

Table 6.1 provides a summary of the expected reduction in flood risk (100-year flood) that would result from the implementation of the seven recommended FMPs. These FMPs will provide flood risk reduction benefits to over 6,000 people within their zone of influence and help alleviate roadway flooding conditions. It is anticipated that these exposure reduction results will significantly increase as additional FMPs are further developed and added to the plan in the future.

Table 6.1: Summary of Impacts of Recommended Flood Mitigation Projects to Flooding in the Trinity Region for the 1% Annual Chance Storm Event Flood

Flood Exposure*	Existing Conditions	After FMP Implementation	Exposure Reduction from FMPs
Exposed structures	792	530	262
Exposed population	17,788	6,272	11,516
Exposed LWCs	9	8	1
Number of road closure occurrences	253	190	63
Road length (mile)	13	2	11

An analysis of the 0.2% annual chance storm event was not included in the Hydrologic and Hydraulic (H&H) models that supported the recommended FMPs. These models were provided by the potential FMP sponsors and did not include simulation runs using the 500-year flows. Therefore, 500-year pre-project and post-project floodplain boundaries are not available for these FMPs. The specific flood exposure parameters called out in ***Table 6.1*** cannot be quantified for this storm event at this time. However, it is anticipated that positive impacts similar to the 1% annual chance storm event would result from the implementation of the recommended FMPs for the 0.2% annual chance storm event for flood exposures.

If fully implemented, this plan will have profound and lasting impacts on flooding in Trinity Region. It is important to note that ***Table 6.1*** only demonstrates the flood exposure analysis for the seven recommended FMPs.

Flood Management Strategy Impacts

One hundred forty-three FMSs have been recommended by the Trinity RFPG, in six comprehensive categories. While not readily quantifiable, these strategies and measures will generally:

- Protect the health, safety, and well-being of individuals within the region while simultaneously improving the economic well-being by reducing the flood frequency and severity
- Provide advanced warning of flood risks
- Minimize the number of drivers on flooded roads
- Give community officials the resources they need to prevent construction in flood prone areas
- Alleviate known flooding issues

Development, especially in the floodplain, leads to increases in flood flows that can cause downcutting and erosion of streams – both of which ultimately lead to environmental issues. The FMSs in the Trinity Region will help minimize and prevent future damage, which will help

preserve developable land, protect agriculture, reduce erosion, and reduce downstream sedimentation. Most flood mitigation measures have the potential to adversely impact neighboring areas, especially when conveyance is increased. These impacts will be mitigated during design and construction to verify that no adverse impacts occur. Many of the FMSs will require more active floodplain management by communities in the region which will burden community officials who must enforce regulations and will likely meet some resistance from citizens and developers wishing to engage in construction within the floodplain. These issues can be overcome and lead to more resilient communities, and full funding of the recommendations in the Trinity Regional Flood Plan would aid in providing the tools needed to accomplish these goals.

Regulatory and Guidance

There are 55 FMSs that are classified in this category. Actions listed within this category will improve regulation of development to decrease current and future flood risks. Some sample FMSs include National Flood Insurance Program (NFIP) participation, stormwater management criteria development, and stormwater utility fee development. Positive impacts include:

- Reducing the number of structures and roadways built in the floodplain
- Minimizing expansion of future floodplains
- Protecting riparian areas from development – which supports the environment, water quality, erosion, and sedimentation
- Providing more regulatory certainty and consistency across the region

Potential negative impacts include increased regulatory burden on citizens and increased staff workload for communities.

Property Acquisition and Structural Elevation

These actions acquire properties or raise structures to project against flooding. There are 28 FMSs in the Trinity Region that fall within this category. Example FMSs include flood-proofing or buying flood-prone structures for demolition to remove them from the floodplain. Anticipated positive impacts include reducing the number of structures in the floodplain; increasing protection of citizens, allowing people to remove themselves from the floodplain without losing their investments; and ultimately protecting riparian areas from development, which in turn protects natural environments and water quality while reducing erosion and sedimentation. Potential negative impacts include increasing the regulatory burden on citizens, increasing staff workloads for each community, causing “blight” in certain neighborhoods if not handled appropriately, and creating politically objectionable appearances in some circumstances.

There are three property acquisition FMSs in this category with detailed evaluations regarding the estimated effects of implementing these strategies. As detailed in ***TWDB-Required Table 14***

*(**Appendix A**)* and summarized in ***Table 6.2***, these three recommended FMSs would remove 183 structures, 69 of which are residential structures, from the 1% annual chance storm event floodplain. Doing so would help protect over 200 people within the 100-year floodplain. This table quantitatively demonstrates how property acquisition minimizes the number of repetitive flood loss properties, prevents new structures from being built in the floodplain, and removes existing structures from the floodplain. Moreover, these flood risk reductions can be increased as additional FMSs are further developed and added to the plan in the future.

Table 6.2: Flood Exposure Reduction of Flood Management Strategies in the Trinity Region for 1% Annual Chance Storm Event

Flood Exposure*	Existing Conditions	After FMS Implementation	Exposure Reduction from FMSs
Exposed structures	23,840	23,657	183
Exposed population	185,050	184,843	207

**This table only demonstrates reductions for FMSs 032000061, 032000062, and 032000074.*

The potential 0.2% annual chance storm event flood exposure reduction for these FMSs is currently unknown and will depend on the property acquisition programs defined by the sponsors. Typically, property acquisition programs focus on properties that are within the regulatory 100-year floodplain, but the sponsors may decide to expand their programs to include properties in the 500-year floodplain. As such, there is potential for these FMSs to have an impact in the number of structures located within the 500-year floodplain, but the exact number cannot be determined at this time.

Education and Outreach

Some strategies considered in this category will increase awareness of flooding issues, risks, and regulation to citizens and other entities. There are 22 Education and Outreach FMSs for the Trinity Region, including:

- Turn Around Don't Drown campaigns
- Public awareness campaigns
- County-wide flood education programs

Anticipated positive impacts include reduced floodplain regulation violations which can decrease flood risks, increased public awareness of flood hazard areas, and increased awareness of imminent flood events. These activities would promote early evacuations and mitigation measures to prevent damages, save lives, and minimize risky behavior during floods. A negative impact of this strategy category is that it could increase staff workloads for communities.

Flood Measurement and Warning

There are 20 of these strategies for the Trinity Region. This type of FMS involves the installation and operation of rainfall and streamflow measurement devices. These devices provide real-time or near real-time measurements that can be sent to entities for further analysis. Such information provides first responders with advanced notification to set out barricades to block streets, check that automated gates operated as expected, confirm flashing lights activated, and issue other warnings, as appropriate. Example FMSs include installing rain and stream gauges and flood warning systems, in addition to general safety improvements. The anticipated benefits of implementing this FMS would be allowing first responders to better advise people at risk of anticipated flooding to better prepare for potential flooding or to evacuate the area based on the conditions at the time. Flashing lights and barricaded roads reduce the number of vehicles driving across flooded roads. All of these measures can help save lives. Potential negative impacts include increasing staff workloads for communities and possible false alarms or failed warnings if the system is not properly maintained and calibrated.

Other

This category is comprised of any other type of FMS that does not fall within the five categories previously outlined. Examples of types of FMSs that fall within this category are dam and levee inspection programs, nature-based solutions (i.e., green infrastructure), site-specific maintenance programs, and county-wide maintenance programs. Thirteen FMSs were identified in this category. Some of the potential benefits include:

- An established, routine-level maintenance plan/program to clear debris from flood-prone areas such as bridges, box culverts, and drainage systems to prevent overtopping and backup during flood events
- developing plans to increase channel and bank stabilization by reducing erosion impacts
- Preparing an inspection program to look for any maintenance problems or levee and dam failure issues

A potential negative impact includes increasing local staff workloads to maintain these areas routinely and properly.

Flood Management Evaluation Impacts

A total of 342 FMEs were recommended by the Trinity RFPG in four broad categories. Descriptions of these categories, examples, and their positive and negative impacts follow.

Preparedness

Preparedness conducts evaluations pertaining to preparing for flood events. Example FMEs in this category are inundation studies, dam compliance assessments, and a hazard/vulnerability

assessment. These actions can provide a positive impact by having preemptive evaluations and strategies to better prepare an area or community in the event of flood. A potential negative impact of these types of FMEs is that they could increase staff workloads for communities. There are five FMEs in this category.

Project Planning

Evaluations marked as project planning are those associated with feasibility assessments and preliminary engineering studies to evaluate alternatives and/or perform designs up to 30 percent for specific flood prone areas that were previously identified by sponsors. There are 238 FMEs in the Trinity Region in this category. Typical FMEs in this category include storm sewer upgrades, culvert upsizing, and channel modifications. Expected positive impacts include reducing properties at risk of flooding, reducing existing facilities exposure, and reducing roadway overtopping. One negative impact is that all conveyance improvement projects have the potential to increase flooding downstream. Mitigation measures will need to be considered during the development of these actions.

Watershed Planning

Actions conducting watershed studies to establish accurate floodplain modeling and mapping and evaluation of potential flood mitigation measures are marked as watershed planning. This includes Flood Insurance Studies (FIS), watershed studies, and city-wide and county-wide drainage master plans. Typical positive impacts include:

- More accurate flood maps, which promote risk avoidance and improved regulations and planning
- Understanding the needs for flood reduction in a watershed for better allocation of resources
- Providing design details needed for eventually converting a FME into an FMP that can be funded and implemented
- Reductions in flood exposure

All conveyance improvement projects have the potential to increase flooding downstream; therefore, mitigation measures will need to be considered if any such projects are identified during the FME analysis. In addition, more projects are usually identified than can be funded.

Most of the Trinity Region has floodplain mapping, but approximately 70 percent of mapped areas are considered outdated and/or approximated. A total of approximately 38,000 stream miles were classified as outdated and/or approximated in the Trinity Region. The Trinity RFPG recommended 35 county-wide FMEs to improve mapping coverage, each of which identifies the areas in need of flood risk identification and/or updates. The Trinity RFPG determined that the stream miles to be included in this initial set of FMEs would be 25 percent of the total within a

given county. This determination was based on the adopted short-term goal of reducing areas identified as having gaps in flood mapping by 25 percent. Overall, the recommended FMEs would provide up-to-date mapping for approximately 9,500 stream miles.

Flood mapping data helps communities quantify and manage their flood risk. It also provides communities a pathway to access flood insurance administered through the NFIP. Improved mapping and models would allow the public, developers, planners, and local officials to consider their flood risks, while balancing the desire to develop in such areas. The model availability will help communities evaluate potential FMPs to reduce flood risks and impacts in the area. These models, along with flood gauges and flood early warning systems, will also help bring awareness to flooding and allow for more rapid and accurate road closures.

Other

The one evaluation outside of the categories previously discussed, is a dam study. This action focuses on increased awareness on the condition of Natural Resources Conservation Service (NRCS) dams and rehabilitating the dams that are not in compliance. The scope and scale of a dam study can vary widely, and there is uncertainty in terms of the number of dams that could potentially be rehabilitated and further studied. A positive impact of this action is that it can lead to better prioritization of the dams for continued and future maintenance. A negative impact is that this evaluation does not directly address flooding issues. Also, these NRCS dams require both federal and local government participation to maintain data and allocate resources such as budget, staff availability, and time.

Existing Flood Risk Exposure

Table 6.3 demonstrates the existing flood risk exposures for all FMEs in the boundaries of the Trinity Region. The watershed studies and project specific FMEs will provide the information needed to verify that cost-effective flood mitigation measures are implemented in the Trinity Region that do not adversely impact other areas. These projects will reduce flood risks, save lives, and protect valuable infrastructure.

Flood mapping will help communities quantify and manage their flood risk and provide a pathway to access flood insurance administered through NFIP. Watershed planning will help distribute resources equitably throughout the region to implement plans, programs, and projects that maintain watershed function and prevent adverse flood effects. Moreover, the detailed modeling and mapping will also help protect recreational resources and agriculture by identifying flood risk to these areas and allowing evaluation of impacts of future development.

Table 6.3: Summary of Existing Flood Risk Exposure in the Trinity Region

Flood Management FME Exposures	1% Annual Chance Storm Event	0.2% Annual Chance Storm Event
Population	241,489	444,808
Agricultural land (square miles)	1,888	234
Critical facilities	342	474
Road length (miles)	3,952	1,940
Structures	85,859	55,581
Residential structures	72,930	36,454
LWCs	1,626	110

Until all FMEs are completed, their specific benefits cannot be quantified; however, the initial analysis shows that over 70,000 residential structures are currently in the 1% annual chance storm event floodplain impacted by the proposed FMEs. These structures house approximately 242,000 people. Tens of thousands of additional people are exposed to risk as they travel across flooded roadways and over 1,600 LWCs. These FMEs will help reduce the risks to the Trinity Region and help prevent additional people from being exposed to the 1% annual chance storm event floodplain due to expansion of the floodplain and uncontrolled development. By providing more accurate information on the flood risks, the communities will be empowered to control development within the floodplain.

None of the FMSs, FMEs, or FMPs specifically address water supply issues and are not expected to have an impact on the water supply.

Effects of Regional Flood Plan Implementation

Avoidance of Negative Effects

Potential negative effects were analyzed in detail for each FMP. The Trinity RFPG reviewed the models submitted for adherence to the Texas Water Development Board (TWDB) guidance on determining negative effects. While impacts were discovered for six out of seven FMPs, the Trinity RFPG determined that the impacts were minor based on professional engineering judgement. Some FMPs included high-level mitigation measures in the preliminary design, while other FMPs may still need mitigation measures prior to funding or execution of a project. The Trinity RFPG agreed with the findings and chose to recommend these FMPs. The impacts were reasonable based on the scope of the individual projects, and the overall project benefits exceeded the impacts.

Potential negative effects were also a consideration for the FMEs and FMSs. The planning-level assessment for these actions included a review of the potential impacts, based on the limited data available. The FMEs must consider any potential negative effects of the proposed action. There are no negative effects for completing a study or evaluation to gain a better

understanding of the proposed flood mitigation action. Like the FMEs, the FMSs will also identify negative impacts if the proposed action is executed. However, there are no negative effects to implement new FMSs. The sponsors for all actions will be responsible for demonstrating a commitment to no negative effects before they can receive state or federal funding. Ultimately, it will be the responsibility of the local sponsor to demonstrate the final project design has no negative effects prior to construction.

Potential Future Benefits

Many of the proposed actions included in this plan will reap benefits now and long into the future. Evaluations and strategies are the best candidates for actions that include current benefits, future benefits, and no adverse effects. Examples of these actions include flood warning systems, buyouts, higher design standards, education and outreach programs, and flood preparedness. These types of actions will increase the community's resiliency by providing knowledge in advance of a storm, removing development in the floodplain, and preventing future development in the floodplain. With basic floodplain standards, population growth and economic development would occur in areas outside of the floodplain and further away from the flooding source. Together these actions will remove people and structures from the existing floodplain and reduce the future flood risk.

Regional detention, when sized for future development conditions, is an example of a FMP with current benefits, future benefits, and no adverse effects. This allows for future development to occur upstream, while the increased flows have already been mitigated with a detention pond that has been sized to accommodate the increased flows and increased volume of runoff. No negative effects are anticipated for this type of project, as the downstream discharge and volume can be controlled by the outlet structure on the pond.

The policies, developed in ***Chapter 3,*** are another example of how this plan can provide long lasting benefits. The implementation of these policies will reduce future flood risk throughout the region. Collectively, the recommended policies will protect the riparian areas of the floodplain from encroaching development, providing a buffer between development and the flooding source now and in the future.

The implementation of this plan cannot remove all risk associated with flooding. As discussed in ***Chapter 3***, there will be some residual risks that remain even if all actions were pursued and constructed. However, this residual risk would still be much lower in the future with the implementation of the plan, as compared to a no action scenario.

Socioeconomic and Recreational Impacts of the Regional Flood Plan

Flooding can result in significant damage to the economy, environment, infrastructure, property, and people. Various types of flooding can include flash floods, coastal floods, urban floods, riverine floods, and pluvial floods. Several types of flood strategies and projects have been developed to protect against flooding. However, the management of flood risk and the development and implementation of flood defenses has both advantages and disadvantages recreationally and socioeconomically.

There are several types of proposed FMSs and FMPs that could provide recreational or socioeconomic impacts. As stated in ***Chapter 4***, FMS types include education and outreach, flood measurement and warning, infrastructure projects, property acquisition and structural elevation, regulatory and guidance, as well as other strategies like preventative maintenance, erosion control programs, and nature-based solutions. FMPs can include stormwater infrastructure improvements, roadway drainage improvements, regional detention facilities, property acquisition, and flood warning systems.

Ultimately, flood evaluations and the resulting projects protect homes and people, and decrease the rate of erosion, preventing foundation and structural damage in the long run. They also save money in terms of roadway infrastructure repairs due to the effects of flooding.

Socioeconomic Impacts

According to the American Psychological Association, “socioeconomic status can encompass quality of life attributes as well as the opportunities and privileges afforded to people within society” (APA). Studies of socioeconomic status reveal inequities of resources which could prevent people from accessing the services required to plan, respond, and recover from flood events.

Flooding does not only result in destroyed infrastructure and damaged property, but also has an adverse social impact on residents affected. The short-term and long-term impacts on physical and mental health result in changes to the livelihoods of affected citizens creating greater socioeconomic disparity.

The FMSs and FMPs listed can provide region-wide benefits to the disadvantaged or socially vulnerable population by reducing risk and promoting recovery. Watershed planning can contribute to the region’s ability to prepare for, respond to, and recover from flood events. Reducing socioeconomic disparities through the implementation of equitable measures can be initiated through planning.

Considering equity of property in the development and implementation of strategies and projects reduces any perceived disadvantages. Any disadvantages would occur if the socioeconomically disadvantaged population was not served directly or indirectly by the FMSs or FMPs.

Recreational Impacts

Using natural or man-made water bodies for recreation is highly valued in the region and throughout Texas. Many waterfront parks are spaces that are designed to be flooded with minimal damage during storm or flood events. Additionally, urban river restorations focus on restoring aquatic and riparian habitats, increasing flood protection, and enhancing recreational potential. Wetlands also play an important role in water resources as these areas store and filter water pollutants. When floodplains are not full of water, they can be used as grazing areas or for other agricultural purposes. Floodplains and wetlands can support tourism, recreation, and agriculture.

While flood defense or protection projects do protect homes, infrastructure, and people, they also protect natural habitats. Many shorelines are conservation areas, and flood defenses help preserve these areas. Maintaining floodplains in their natural states can create positive impacts through potential recreational, environmental, and biological benefits. Several types of flood projects, mainly those that are classified as natural systems, promote biodiversity. Wetlands that function as floodplains support a wide range of bird species, while ponds support a range of reptiles, amphibians, and fish. Riparian systems also sustain several types of animal life.

There are potential disadvantages to using the floodplain and waterfront parks for recreation. If damages were to occur to recreational waterbodies, they could become dangerous to use. While flood strategies and projects can be effective at protecting people, property, and resources, the initial installation and ongoing maintenance costs could be prohibitive. These costs can overwhelm communities struggling to find funding for long-term flooding solutions.

Summary of Regional Flood Plan Impacts

The Trinity RFPG created a Technical Subcommittee that performed a comprehensive evaluation and selection process to make recommendations on flood mitigation actions and reported their findings to the Trinity RFPG. After a thorough screening, keeping all the TWDB requirements in mind for inclusion in the Trinity Regional Flood Plan and other additional considerations established by the Technical Subcommittee, the Trinity RFPG made final recommendations. Only 7 out of 33 potentially feasible FMPs and 136 out of 143 potentially feasible FMSs were recommended. Each of the recommended FMPs and FMSs demonstrated no negative impacts on its neighboring area, which means the action will not increase the flood risk of surrounding properties and will have no negative impact on an entity's water supply. While evaluating the FMPs, the Trinity RFPG confirmed that each of the recommended FMPs

supports at least one of the regional floodplain management and flood mitigation goals established in ***Chapter 3*** and each FMP does not have any anticipated impacts to water supply or water availability allocations as established in the most recently adopted State Water Plan. Only 7 FMPs out of 33 potential ones complied with the TWDB data requirements. For the FMSs, some were not recommended if they were redundant with another recommended FMS or if their purpose was primarily related to stormwater quality. In some cases, multiple FMSs were combined into a single FMS for recommendation. These merged FMSs included the development of county-wide educational programs and updates to land use planning and zoning regulations.

Six of the recommended FMPs did not strictly comply with the no negative impacts requirements. However, they were still considered by the Trinity RFPG as not having adverse impacts due to various justified conditions and based on professional engineering judgment. Since no structural FMSs were identified within the region, no negative impacts are anticipated from them. Overall impacts and benefits from these recommended FMSs or FMPs in the regional flood plan were explored for the Trinity River Region from the standpoint of environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation in the following section.

Environmental

According to Senate Bill (SB) 3 (Texas Legislature, 2007), all major river basins and bay systems in Texas should be able to maintain an environmental flow to sustain a good ecological balance. To maintain flows, the necessary quantity of flow must be defined and protected while maintaining balance with human and other uses. ***Chapter 4*** mentioned multiple studies on the Trinity Region's environmental flow needs. Per those studies, recommended FMSs and FMPs should be able to maintain the environmental flow in the Trinity River at the Grand Prairie, Dallas, Oakwood, and Romayor gauge locations as established in SB 3.

According to a Trinity River Authority (TRA) study (TRA, 2017), floodplain management is more impactful on riparian areas than high pulse flow management and return flows at the base flow level to satisfy subsistence and base flows. Recommended FMSs or FMPs at or upstream of the above-mentioned locations will focus on managing floodplain and maintaining return flows to satisfy SB 3 subsistence and base flows. Furthermore, by ensuring an increase of base flow, FMSs and FMPs can increase Dissolved Oxygen (DO) in the water. Increased base flows can also keep the water temperature within a goal range and to meet the Texas Instream Flow Program (TIFP) temperature goals in select shallow areas in Oakwood. At Romayor, maintaining the required baseflow will provide continuous sand transport. Apart from these, the recommended FMSs or FMPs are expected to reduce the extreme peak flows of the high pulse flow SB 3 values at the above locations and maintain the periodic high pulse flows required to flush sediment and to sustain ecological and habitat functions.

Agricultural

While the occasional seasonal flood can provide benefits to agricultural lands such as depositing nutrient-rich sediment onto the floodplain, flood water can also be harmful to crops and livestock. Some harmful outcomes include destroying millions of dollars' worth of agricultural investment, stranding or even drowning livestock, creating water-logged conditions that delay planting or harvesting, washing away productive topsoil, and damaging farm equipment and infrastructure.

Implementing the recommended FMSs or FMPs will potentially reduce extremely high flows in rivers and streams, thereby preventing flood waters from inundating areas outside of the overbanks including agricultural areas. Structural FMSs or FMPs, such as small flood control ponds, also have the potential to assist in agricultural production by serving the dual purpose of flood mitigation and water supply. Non-structural FMSs or FMPs include agricultural conservation practices such as conservation tillage, residue management, cover crops, and furrow dikes which can contribute to flood peak flow reduction and reduce the overall impact of flooding. These practices not only reduce downstream flooding by containing or delaying surface runoff and increasing infiltration on agricultural lands, but also reduce soil and nutrient losses, thereby improving downstream water quality.

Recreational Resources

When operated to mitigate flood risk, recreational use of the lakes and reservoirs in the Trinity Region can be significantly reduced. Flood control reservoirs hold water at the flood pool level (which is considerably higher than the normal pool) during peak runoff periods until the impounded water can be safely released downstream. During these periods, recreational use of adjacent parks, playgrounds, campgrounds, boat ramps etc. may be vastly reduced. Flood risk management through FMSs or FMPs may consist of creating additional flood control reservoirs with the intent of impounding water to mitigate flood risk.

Water quality in the waterbodies may also impact recreational use in flood control reservoirs. The Texas Commission on Environmental Quality (TCEQ) 2020 Texas Integrated Report classifies 69 of the 159 assessment units as "non-supporting" or do not recommend contact recreational use. Recommended FMSs or FMPs include actions that focus on reducing runoff and therefore reducing export of bacteria to waterbodies. Implementing those actions has the potential to improve the recreational use of segments that are currently identified as non-supporting.

Water Quality

The TRA Clean Rivers Program 2020 Basin Summary Report (TRA, 2020) hypothesizes that light penetration in the turbid waters rather than nutrient availability is the limiting factor for algal growth in many of the reservoirs in the Trinity Region. The report also identified the reasons for

this additional light penetration and eventually increased algal growth in the presence of abundant nutrients. Proactive watershed protection programs and extensive use of best management practices can counter this nutrient loading and risk of harmful algal blooms. By capturing stormwater runoff and pollutants, structural FMPs - such as small flood control ponds - are expected to improve the water quality of the water supply reservoirs. However, excessive nutrients in these reservoirs may cause algal blooms. In such cases, non-structural FMEs or FMPs that reduce stormwater runoff production are recommended to reduce the amount of nutrient runoff.

Since intermittent streams are not frequently washed out or assimilated, many can have high bacteria levels. Recommended non-structural FMPs and FMSs will reduce the runoff and subsequently, not provide transport for the bacteria; conversely, structural solutions will help to maintain small levels of flows, flushing out the downstream intermittent streams and improve assimilation.

Erosion

The TWDB funded the Trinity River Basin Environmental Restoration Initiative 2010 (Wang, et al., 2010) which studied the rates and sources of sediment (and nutrient) loading to 12 major water supply reservoirs in 10 watersheds of the Upper Trinity Region. The initiative identified a few basins with a wide range of annual overland, bank, and bed erosion. Some of those basins are within the recommended FMS and FMP areas. One of the other relevant findings of this study was identifying the positive impact of small flood control reservoirs on the reduction of total sediment load delivered to those reservoirs.

Recommended structural FMSs or FMPs are expected to have similar impacts as small flood control reservoirs identified in the TWDB study. Location, drainage area, and watershed characteristics of the structural FMSs or FMPs are some of the factors that will influence the severity of erosion. Conservation practices, which are part of the recommended non-structural FMSs or FMPs, may also contribute to reducing erosion and transport of sediment in the Trinity Region. Practices like ‘no rangeland grazing’ can reduce source sediment loads to the waterbodies in the Trinity Region.

Sedimentation

Sedimentation is a natural process by which surface water runoff transports small particles of soil from upstream to downstream. As the water slows down, the particles settle to the bottom of the river or lake. Sedimentation has been reported for most major reservoirs in the Trinity Region based on surveys conducted by the TWDB.

Structural FMSs or FMPs, such as a small flood control reservoir, receive and impound water (and sediment) from the respective drainage area. Long residence time in a flood control pond

results in settling of large proportions of the incoming sediment. Periodic discharges from small flood control projects are generally expected to carry smaller sediment loads than the influent runoff. Therefore, structural FMSs or FMPs are expected to reduce sedimentation in downstream water supply reservoirs by trapping sediment in their pools. While sedimentation in the large downstream reservoirs potentially reduce, sedimentation is expected to occur in the individual flood control projects.

Non-structural FMSs or FMPs, such as conservation practices that reduce sediment production at the source, are expected to reduce sedimentation in both structural FMSs or FMPs and large downstream reservoirs.

Navigation

In 1963, the United States Army Corps of Engineers (USACE) approved making the Trinity River navigable by barges. In 1965, Congress and former President Lyndon B. Johnson approved the project as a package of flood control and navigation projects including a barge canal connecting the Dallas-Fort Worth (DFW) metroplex with the Gulf of Mexico. The barge canal was estimated to cost approximately $1 billion. In 1973, voters rejected to finance the barge canal and USACE subsequently abandoned the project. Therefore, the Trinity River is not used for commercial navigation. Only recreational navigation - such as canoeing and kayaking in the rivers and creeks and boating in the lakes and reservoirs - was observed in the Trinity Region. These activities are impacted when flows in the Trinity River and water levels in the reservoirs are being actively managed to mitigate flood risk. Recreational activities are restricted when the rivers and reservoirs are at or above flood stage. Structural FMSs or FMPs that recommend building flood control structures or any other measures that capture the additional water are expected to increase recreational navigation in the Trinity Region. None of these structural improvements are located along the main stem of the Trinity River.

Task 6B – Contributions to and Impacts on Water Supply Development and the State Water Plan

The goal of ***Task 6B*** is to evaluate potential impacts of the regional flood plan on water supply development and the State Water Plan. This section describes the processes undertaken by the Trinity RFPG to achieve these tasks and summarizes the outcomes of this effort. This effort included:

- A region-wide summary and description of the contribution that the Trinity Regional Flood Plan would have on water supply development, including a list of specific FMSs and FMPs that would measurably impact water supply
- A description of any anticipated impacts that the recommended FMSs and FMPs may have on water supply, water availability, or projects in the State Water Plan

Contribution of the Regional Flood Plan on Water Supply Development

RFPGs must list recommended FMSs or FMPs that, if implemented, would measurably contribute to water supply, such as:

- A direct increase of water supply volume available during drought of record
- A direct benefit to water availability
- An indirect benefit to water availability
- No anticipated impact on water supply

Examples of FMSs and FMPs that could measurably contribute to water supply include those that:

- Recharge aquifers (directly or indirectly)
- Modify large stormwater detention structures to include a water supply component for irrigation or other needs
- Implement stormwater management ordinances that manage flooding and also include a water supply aspect of beneficial reuse for irrigation purposes
- Implement green infrastructure, natural channel design, stormwater detention, low impact development, and other measures that – while not generating a measurable water supply impact – can help mitigate flood flows and protect water quality

These solutions can help manage downstream water treatment costs and benefit rate payers. Additionally, RFPGs must also list recommended FMSs or FMPs that, if implemented, would negatively impact and/or measurably reduce water availability volumes that are the basis for the most recently adopted State Water Plan or water supply volumes.

An example of an FMS or FMP that could measurably reduce water availability involves reallocating a portion of existing reservoir storage that is currently designated for water supply purposes to be used for flood storage instead. No such actions are recommended for the Trinity Region. Additionally, land use changes over time could potentially reduce groundwater availability due to less naturally occurring aquifer recharge. Alternatively, an FMS that preserves open space or limits additional impervious cover could help maintain aquifer recharge.

As noted in ***TWDB-Required Table 13*** and ***TWDB-Required Table 14*** in (***Appendix A***), the Trinity Region determined that no recommended FMSs or FMPs that would measurably contribute or have a negative impact and/or measurably reduce water supply.

Flood Management Strategies

Several nature-based FMSs that could potentially be applicable to water supply are recommended in this plan, including the implementation of green infrastructure, low impact development, and regional detention ponds. These nature-based FMSs could help mitigate flood risk by slowing and reducing stormwater discharges while improving water quality. Other FMSs that could be applicable include property acquisition and/or preservation of open spaces as these types of FMSs could limit impervious cover and help maintain aquifer recharge. Additionally, erosion control and/or channel maintenance strategies could impact sedimentation and improve water quality. Regulatory and guidance FMSs may affect water supply through floodplain ordinances that manage flooding but could also include reuse or green infrastructure aspects. Ultimately, it was determined that these strategies would not have a measurable impact on water supply.

Other FMS project types, such as education and outreach strategies and flood measurement and warning strategies, do not apply to water supply development.

Flood Mitigation Projects

Additionally, several FMPs could be relevant to water supply. FMP 033000007 involves the design and construction of an off-line dry detention pond which will reduce peak flows and improve water quality. Although not currently planned, the design phase of the detention pond could potentially be modified to include a small-scale water supply component for irrigation or other nearby needs. Infrastructure FMPs, such as channel and drainage improvements, could increase peak discharges downstream, allowing stormwater to flow faster into a state water course and impact water supply. While these FMPs could potentially impact water supply, the region determined that the potential impacts are insignificant.

Anticipated Impacts to the State Water Plan

In response to the 1950's drought, the Texas Legislature established the TWDB in 1957 to prepare a comprehensive long-term plan for the development, conservation, and management of the state's water resources. The TWDB recently produced the 2022 State Water Plan based on the TWDB-approved regional water plans. As stated in SB 1 Section 16.053.a (Texas Legislature, 1997), the purpose of the regional water planning effort is to:

> *"…provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."*

The TWDB established 16 RWPGs and appointed members who represent 12 key interest categories to each RWPG. This grassroots approach allows planning groups to evaluate region-specific risks, uncertainties, and potential water management strategies from the local water providers. The Trinity Region primarily overlaps the Region C, Region H, and Region I RWPGs as shown in ***Figure 6.1***. Additionally, a small portion of the Trinity Region (less than 11 percent) falls within the Region B, Region G (Brazos G), and Region D (North East Texas) RWPGs. ***Table 6.4*** shows the RWPGs within the Trinity Region along with associated areas. The Trinity RFPG determined that the recommended FMSs and FMPs are not anticipated to have any measurable impact on water supply, water availability, or projects in the State Water Plan.

Region C

The majority of the Trinity Region is located within Region C. Region C covers all or portions of 16 counties located in North Central Texas. Two major aquifers along with four minor aquifers are located in the region. About 90 percent of the water use in Region C is supplied by surface water. According to the 2021 Region C Plan, there are 34 major reservoirs with conservation storage over 5,000 acre-feet in the region. Major existing reservoirs in Region C that are also located within the Trinity Region flood planning area are listed in ***Table 6.5.*** These reservoirs are permitted for various uses, such as water supply, conservation, irrigation, industrial, navigation, and recreation purposes. Some reservoirs also have additional operational goals that support flood control and/or flood regulation. None of the Trinity Region's recommended FMSs or FMPs impact the operation of these existing reservoirs. A new major reservoir, Bois d'Arc Lake, located in Fannin County is currently impounding water. Bois d'Arc Lake's primary purpose is water supply.

Figure 6.1: Trinity Region Associated Regional Water Planning Groups

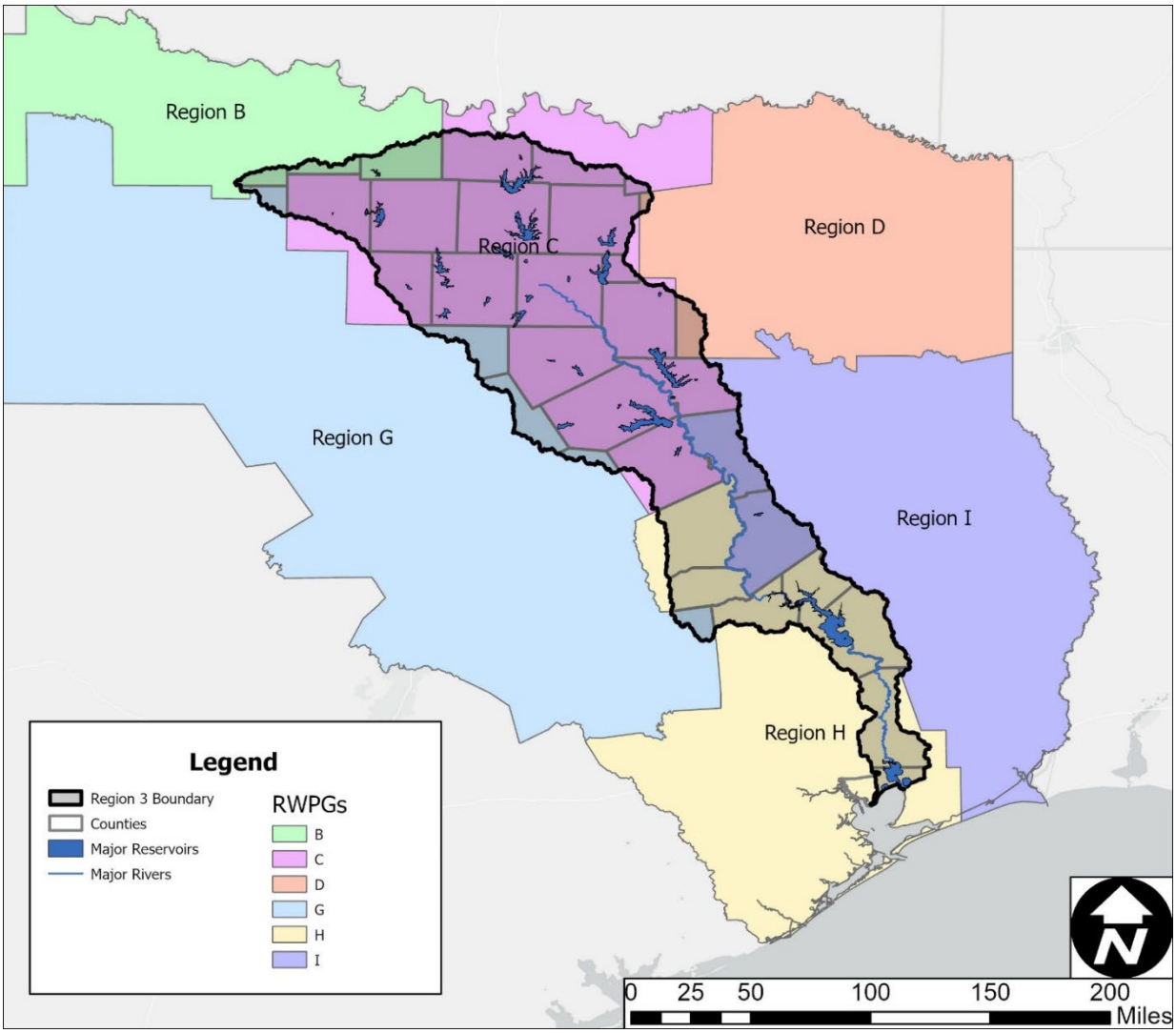

Table 6.4: Regional Water Planning Areas within the Trinity Region

Regional Water Planning Area	Overlapping Area Within Trinity Region (sq. mi.)	Percent of Overlapping Area within Trinity Region (%)
Region C	10,900	61
Region H	3,600	20
Region I	1,400	8
Region G	1,000	6
Region B	600	3
Region D	300	2
Total	**17,800**	

Table 6.5: Major Existing Reservoirs Associated with the Trinity Region

Lake/Reservoir	County	Regional Water Planning Area
Bardwell Lake*	Ellis	Region C
Benbrook Lake*	Tarrant	Region C
Cedar Creek Reservoir	Henderson/Kaufman	Region C
Eagle Mountain Lake	Tarrant	Region C
Fairfield Lake	Freestone	Region C
Forest Grove Reservoir	Henderson	Region C
Grapevine Lake*	Tarrant/Denton	Region C
Joe Pool Lake*	Tarrant/Dallas/Ellis	Region C
Lake Arlington	Tarrant	Region C
Lake Bridgeport	Wise/Jack	Region C
Lake Halbert	Navarro	Region C
Lake Ray Hubbard	Collin/Dallas/Kaufman/Rockwall	Region C
Lake Ray Roberts*	Cooke/Denton/Grayson	Region C
Lake Waxahachie	Ellis	Region C
Lake Weatherford	Parker	Region C
Lake Worth	Tarrant	Region C
Lavon Lake*	Collin	Region C
Lewisville Lake*	Denton	Region C
Lost Creek Reservoir	Jack	Region C
Mountain Creek Lake	Dallas	Region C
Navarro Mills Lake*	Navarro	Region C
New Terrell City Lake	Kaufman	Region C
North Lake	Dallas	Region C
Richland-Chambers Reservoir	Navarro/Freestone	Region C
Trinidad Lake	Henderson	Region C
White Rock Lake	Dallas	Region C
Lake Kiowa	Cooke	Region C
Lake Livingston	Trinity/Walker/San Jacinto/Polk	Region H
Wallisville Lake	Liberty/Chambers	Region H
Lake Anahuac	Chambers	Region H
Cedar Bayou Generating Pond	Chambers	Region H
Alders Reservoir	Liberty	Region H
Houston Country Lake	Houston	Region I
Lake Amon G Carter	Montague	Region B

**Reservoir is permitted to provide flood control and/or flood regulation benefits.*

Region H

The southern portion of the Trinity Region covers the northeastern part of the Region H water planning area. Eight counties from Region H fall fully or partially within the Trinity Region. Region H has two major and four minor aquifers. The major existing reservoirs in Region H that are also within the Trinity Region are listed in ***Table 6.5***. These reservoirs have various uses such as salinity control, water supply, fish and wildlife enhancement, conservation, irrigation, industrial, navigation, recreation, and cooling purposes. None of the Trinity RFPG's recommended FMSs or FMPs impact the operation of these existing reservoirs.

Region I

The Trinity Region flood planning boundary overlays a small part of the Region I water planning area. Only two counties from Region I (Anderson and Houston) fall fully or partially within the Trinity Region. These two counties are on the western side of Region I. Two major and three minor aquifers are located within Region I and the Trinity Region. Only one major reservoir, Houston County Lake (***Table 6.5***) is located in both Region I and the Trinity Region. None of the recommended FMSs or FMPs impact the operation of this existing reservoir.

Region B

The north-western portion of Trinity Region covers part of the southern counties in Region B. Only three counties (Archer, Clay, and Montague) in Region B partially fall within the boundary of the Trinity Region. There are two major aquifers and two minor aquifers within the Region B planning area. One major aquifer (Trinity) and one minor aquifer (Cross Timbers) intersects the Trinity Region. Only one major reservoir, Lake Amon G Carter, is located in this part of Trinity Region (***Table 6.5***). This reservoir is permitted for municipal and industrial mining water supply and recreational purposes. None of the recommended FMSs or FMPs impact the operation of this existing reservoir.

Region D

The north-eastern portion of the Trinity Region covers very small parts of two western counties in Region D. Those two counties are Hunt and Van Zandt. Only two percent of the Trinity Region falls within this Region D boundary. Among the two major and four minor aquifers in the North East Texas Region (Region D), part of both the major aquifers (Trinity and Carrizo-Wilcox) and one minor aquifer (Woodbine) fall within the Trinity Region boundary. None of the reservoirs in the Region D area included in the Trinity Region.

Region G

The western portion of the Trinity Region covers small portions of five counties from the eastern and south-eastern part of Region G. Six percent of Trinity Region falls within the Region

G boundary. Portions of six major and eleven minor aquifers extend into the Brazos G Region and among them two major aquifers (Trinity and Carrizo-Wilcox) and three minor ones are part of the Trinity Region. None of the reservoirs in Region G are included in the Trinity Region.

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