Technical Memorandum ECO-5

To: Woody Frossard, TRWD

From: Bob Brashear, CDM

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Subject: Water Aesthetic and Quality Management

Status: Final Draft

1.0 Introduction

The Fort Worth Central City Project consists of a bypass channel, levee system and associated improvements to divert flood flows around a segment of the existing Trinity River adjacent to downtown Fort Worth. The proposed bypass channel is approximately 8,400 feet long and approximately 300 feet wide between the top of levees. The bypass channel will be approximately 30 feet below existing grade. **Figure 1** shows the bypass channel and other significant project components.

Water levels in the bypass channel will be controlled by a dam with crest gates. The dam is proposed on the West Fork of the Trinity River just east of the Samuels Avenue bridge and will be designed to maintain normal water level of approximately 525 feet above sea level in the bypass channel and interior area. Flood isolation gates will be incorporated into the levee system to protect the interior area, otherwise known as Trinity Uptown. The gates are located upstream at the confluence of the bypass channel and the Clear Fork (Clear Fork Gate), at the midpoint of the bypass channel and the West Fork confluence (Trinity Point Gate), and downstream at the confluence of the bypass channel and the West Fork (TRWD Gate).

Construction of the bypass channel, dam and isolation gates will create an approximately two-mile segment of the existing West Fork Trinity River as a controlled, quiescent watercourse. A water feature or urban lake, approximately 900 feet long, is proposed for the interior area (Trinity Uptown). The water feature will extend from the bypass channel southeast to the existing West Fork and Clear Fork confluence of the Trinity River.

This technical memorandum addresses several water aesthetic- and quality-related aspects of the proposed project:

- Water balance for the proposed impoundment;
- Options for augmenting water supply if needed to be considered during final design;

- Options to be considered during final design for managing water quality if needed in the proposed impoundment; and
- Characteristics of existing stormwater quality management requirements applicable to the proposed project area; and
- Options to be considered during final design for managing stormwater quality.

2.0 Water Balance

The impact of the proposed project on water losses via evaporation may translate to the need for additional water for the project. This, coupled with the desire to maintain the water surface elevation (WSEL) as close to 525 feet as is practicable during dry to drought conditions, necessitates an assessment of evaporative losses.

The regional hydraulic model created and maintained for the Upper Trinity Study by the US Army Corps of Engineers (USACE 1998) was used to establish water surface area and volumes for the existing condition. The current proposed project hydraulic model was used to establish water surface area and volumes for the post-project condition

The extent of water surface impacts by the proposed project is shown in **Figure 2**. Those extents were used for determining the water surface area and volumes for both the existing and post-project conditions in order to compare the relative differences between the two. For both conditions, low flows of 5 cubic feet per second per tributary were used in the model to establish WSELs. The hydraulic model (HEC-RAS) calculated surface area and volumes from these WSELs.

Evaporation characteristics were obtained from the Texas Water Development Board (TWDB 2004) for the station closet to the project area, Benbrook Dam. Those characteristics are shown in **Table 1**. **Table 2** provides precipitation characteristics for the same location.

Results of the water surface area and volumes calculations are shown in **Table 3**. The proposed project creates an additional 113 acres of water surface and an additional 2,114 acre-feet of volume within the system. Using the mean annual evaporation (59.32 inches, 4.94 feet), the increased water surface area of the project will result in an additional 558 acre-feet of evaporative losses. This will be offset by 283 acre-feet of mean annual precipitation (30 inches, 2.5 feet) that falls on the water surface directly. Therefore, the net additional loss of water that results from the proposed project is 558 acre-feet minus 283 acre-feet, or 275 acre-feet.

3.0 Water Supply Options

The State of Texas will require that the additional evaporative loss of water resulting from the project to be covered by one or more water rights. An assessment of existing water rights available to the project indicates that existing rights will be able to easily compensate for the additional evaporative loss. Beyond the water right(s) associated with the additional evaporation incurred, the project will also investigate the means to provide additional water flowing through the waterway and to also help maintain the level of the waterway (avoiding drawdown in dry periods) and to assist in maintaining the aesthetics of waterbody.

Several means of inducing additional flow within the system will be considered during the design phase of the project:

- *Augmenting flow with reclaimed wastewater*. Reclaimed wastewater, either from a new satellite wastewater treatment facility located in the project area in an upstream tributary or conveyed from existing treatment facilities, could be used to supply additional water to the waterbody. This would be high quality water that could also be used for landscape irrigation and other non-potable demands in the area, thereby reducing the consumption of potable water.

- *Augmenting flow with additional surface water*. Additional water rights might be cost-effectively secured that allow for additional releases from upstream reservoirs during dry periods to supplement flow in the proposed waterways.

- *Augmenting flow with raw drinking water supplies*. The City of Fort Worth derives a substantial portion of the raw water it needs for treated drinking water from two reservoirs upstream of the project area. Raw water from these reservoirs could be released into the Clear and West Forks of the Trinity and this water could flow through the proposed waterways before being withdrawn for treatment at the City of Fort Worth's Holly Water Treatment Plant. Reconfiguration of the raw delivery system in such a manner would provide substantial additional flow through the project.

- *Augmenting flow with groundwater*. The Trinity Aquifer can produce water of suitable quality at rates up to 300 gallons per minute per well. Wells could be placed in the area to draw water from the aquifer to supplement the surface water supply.

4.0 Water Quality Management

Ongoing water quality assessments of the Clear Fork and West Fork stream segments associated with the project demonstrate that water quality standards set by the U.S. Environmental Protection Agency (USEPA) and the Texas Commission on Environmental

Quality (TCEQ) are being met (TRWD 2005). The exception to this is a one mile stretch of the Clear Fork going upstream from its confluence with the West Fork where chlordane has been found in fish tissue, prompting a fish consumption ban. Chlordane, which takes a long time to degrade in the environment, is no longer used but was previously applied widely for termite control. This contamination is the result of chlordane being released into the environment from erosion of soils in the watershed. The State of Texas has issued a management plan that calls for long-term monitoring of fish tissue to track the dissipation of chlordane from the environment with the expectation that the fish consumption ban will be unnecessary in the near future.

The impact on water quality for the proposed project configuration was analyzed as a part of the preliminary design of the project. The analysis demonstrates that the project will have no significant impact on water quality (TRWD 2005). The assessment did recognize that because flows during dry periods are slight (approximately 5 cubic feet per second), it may be beneficial to implement practices to manage circulation in the system. Several options are available to accomplish this:

- *Augmenting flow with other sources*. The supply augmentation options discussed in Section 3.0 will provide the benefits of increasing circulation within the system.

- *Inducing large scale circulation mechanically*. Several mechanical means could be used to induce circulation throughout the waterway. Subsurface pumps could be employed to force large volumes of water to move within the channels associated with the system. The proposed stormwater pump station for the interior waterway could be configured to accomplish this in addition to its primary function of conveying larger storm flows.

- *Inducing localized circulation mechanically.* Surface aerators (commonly seen as fountains) could induce circulation in localized areas if needed. Pumps could be used to pull water from the waterway and allow it to return to the waterway over cascades or other aesthetic features on a localized basis.

- *Provide additional hydraulic structures to direct flow as needed.* Hydraulic structures could be configured within the waterway such that low flows are distributed as desired to have complete circulation within the system. These structures, likely subsurface and analogous to grade control structures, would have no effect on the performance of the system in regards to larger flood flows.

The urban design plan articulated for the Trinity Uptown Plan (TRWD 2004) identifies maintenance of the water aesthetics and quality of the Trinity River as critical to the successful implementation of the Trinity Uptown concept. While assessments discussed earlier have demonstrated that existing water quality is high and that the proposed project will not impact this, it is recognized that management strategies may need to be employed to maintain the aesthetics of the waterbody in a high manner. The chief aesthetic concerns are odors, algal growth, sedimentation, and floatable material.

4.1 Water Odors

When naturally-occurring, less desirable water odors typically happen when deeper, cooler water at the bottom of a water body reverses and rises to the top, bringing stagnant odors to the surface. This happens because of seasonal temperature changes. In warm weather, cooler water sinks to the bottom and warmer water stays at the surface resulting in thermal stratification. Stratification is broken up by cooler weather which reduces the temperature of surface water to nearer that of the deeper water in the waterbody, allowing them to mix.

One option to limit the potential for odor from the interior waterbody is to limit the water depth to 8 to 10 feet, which will keep the water temperature nearly uniform and minimize temperature stratification. This could be accomplished by filling in the river channel in the interior waterway. In the bypass channel and the reach between the bypass channel and Samuels Avenue Dam, the water will be much deeper (as much as 30 feet deep at Samuels Avenue Dam). Stratification is much more likely at depths above 10 feet. Three options are available to minimize this:

- *Increase flow through the system*. The options discussed above for augmenting water supply will also help to minimize stratification by creating additional circulation.

- *Use mixing devices*. Mechanical devices designed to pull water from deeper depths and bring it to the surface can be employed.

- *Release water from lower depths*. Samuels Avenue Dam is being designed such that water can be released from the dam at lower/bottom depths as well as over the crest of the dam. At low flow conditions, releasing from the bottom will help to break up thermal stratification.

4.2 Algal Growth

Algae or phytoplankton are microscopic plants which contain chlorophyll and live floating or suspended in water. Like all plants, algae require nutrients (nitrogen and phosphorous) to grow. Excess algal growth can be a real water quality concern as algae can significantly reduce dissolved oxygen at night, threatening other aquatic life. Fortunately for the Central City project area and upstream, nutrient loads are relatively low. There are no discharges of wastewater effluent (which is typically high in nutrients) in the watershed and watershed management strategies are working to reduce nutrient contributions from diffuse sources (runoff from urban and rural land uses). In the Trinity Uptown area, the urban design concept has recommended control of locally-contributed nutrients through instituting development standards for the new development that minimize nutrients in local drainage by using stormwater best management practices and using native plants in landscaping (which require less fertilization).

As such, algal growth in the proposed system will be more of an aesthetic issue than genuine water quality issue. During periods of extended low flow, algae growth could result in the water being less clear and more of a green color. If desired, this could be minimized by increasing flow through the system, removing nutrients from the system by harvesting nutrients through periphyton gardens, or by chemically treating the water to limit algae growth or to force algae to settle to the bottom to decompose.

4.3 Sedimentation

During storm events, the Trinity River through the Central City project area carries significant amounts of suspended sediment. In the current system, this is carried downstream. In the proposed system, changes to the flow regimes of the river may result in some of this sediment being deposited within the project area, necessitating more frequent maintenance.

An assessment of the sedimentation characteristics of the proposed system was performed and compared to that of the existing system (TRWD 2005). This assessment showed that in the proposed system, large amounts of deposition would not occur. However, additional analyses will be conducted to predict whether or not sediment might be deposited in significant amounts on a localized basis (e.g., around flood control gates or other structures). Additional hydraulic and sediment transport assessments are planned as a part of final design to minimize the likelihood of this happening.

4.4 Floatable Material

A universal impact to water aesthetics in urban areas is floatable material. Typically litter that has washed into drainageways with stormwater runoff, floatable material can aggregate on waterway banks and collect on structures creating unslightly clutters of trash. In conjunction with the additional hydraulic assessments associated with final design of the project, the project will investigate how floatable material will interact within the system and implement design strategies to minimize this. This may be in the form of refining how flow moves through the system or in the form of floatable control practices (e.g., netting, booms, etc.) design to catch and remove floatables.

5.0 Stormwater Quality Management

5.1 Existing Programs and Policys

5.1.1 Stormwater Discharge Permit

In December 1996, the USEPA issued the initial NPDES Storm Water Discharge Permit for its municipal separate storm sewer system to City of Fort Worth, the Texas Department of Transportation (TXDOT), and the Tarrant Regional Water District (TRWD) as co-permittees. The permit will be reissued as a TPDES permit through the Texas Commission on Environmental Quality (TCEQ), to whom EPA delegated the program. The permit requires the monitoring of stormwater quality and the development and implementation of a management plan to manage stormwater quality within the City of Fort Worth.

The City is responsible for managing stormwater from the majority of the City while TXDOT and TRWD are responsible for coordinating with the City to manage stormwater quality from facilities that they own and operate – bridges, roads, and ancillary facilities for TXDOT and the Trinity River floodway and its ancillary facilities for TRWD.

Some of the major elements of the TPDES permit for stormwater runoff being implemented by the City of Fort Worth, TRWD, and TXDOT are listed below (COFW 2005):

- Storm water collection system (operation and maintenance)
- Areas of new development and redevelopment (minimize pollutants)
- Roadways (minimize de-icing pollutants)
- Flood control projects (assess water quality improvements / retrofitting)
- Pesticide, herbicide and fertilizer application (educate staff / contractors)
- Improper discharges and disposal (enforce, collect, etc.)
- Spill prevention and response (prevent, contain, and respond to spills)
- Industrial and high risk runoff (conduct inspections and monitoring)
- Construction site runoff (ordinance, inspections / enforcement, and training)
- Public education (promote pollution prevention and public reporting)
- Monitoring programs (conduct six types of monitoring)

- Computer modeling (seasonal loadings in watersheds)

- Annual report to EPA/TCEQ.

5.1.2 Regional Stormwater Quality Management Initiatives

Fort Worth exists as one community among of over 225 entities in the North Central Texas Council of Governments planning area (approximate division: 16 counties, 157 cities, 25 independent school districts, and 24 special districts). Included among the many functions that NCTCOG provides is a forum for discussion of regional stormwater quality and quantity issues and needs. Through NCTCOG, area communities (including the City of Fort Worth) have coordinated regionally to address common stormwater management issues in the development of the integrated Storm Water Management (iSWM) program. The iSWM program provides guidance for all development and redevelopment- related storm water initiatives in North Central Texas (NCTCOG 2005). The purpose of this program is to provide comprehensive guidelines for integrated storm water quantity and quality management throughout each phase of development and redevelopment, including planning, design, construction, and maintenance.

The initial iSWM manuals consist of the:

- iSWM Policy Guidebook;

- iSWM Design Manual for Development/Redevelopment; and

- iSWM Design Manual for Construction.

The iSWM Policy Guidebook is designed to provide guidance for the local jurisdictions and developers on the basic principles of effective urban storm water management. The iSWM Design Manual for Development/Redevelopment is a detailed design document to guide developers, consultants, and government agencies on the preparation of an integrated Storm Water Management Plan including design techniques for the control and management of storm water quality and quantity for new developments, redevelopments, or retrofitting developed areas. The iSWM Design Manual for Construction provides guidance on the control of sediment and other pollutants on construction sites. The guidance provided by the iSWM program is customized and adopted by participating entities based on local drainage characteristics.

5.1.3 Local Stormwater Quality Management Requirements
The nature of stormwater quantity and quality management from the Central City project area will be governed by current City of Fort Worth drainage requirements and by several emerging initiatives:

- Customization of the regional iSWM program;
- Evolution of the stormwater quality management plan associated with the TPDES stormwater permit (City, TRWD, and TXDOT as co-permittees); and
- Design standards articulated for the development associated with the Trinty Uptown area (a subset of the Central City project area).

5.2 Options for Stormwater Quality Management

5.2.1 During Construction
TCEQ requirements issued through the TPDES permitting program will require the management of stormwater quality for all construction sites associated with the Central City project. TPDES requirements for construction activities necessitate the development and implementation of a stormwater pollution prevention plan. Enforcement of these requirements by TCEQ ensures that construction activities and construction wastes do not pollute waterways.

5.2.2 Post Construction
The City's current drainage ordinances date principally back to 1967. While there have been periodic updates and refinements through the years, the basis of managing stormwater remained largely unchanged. However, the City of Fort Worth is currently customizing guidance in the regional iSWM program for its use through a planning effort designed to significantly update the City's drainage ordinances and criteria (COFW 2004). The iSWM guidance is being paired with information generated through a series of watersheds studies currently underway.

For the City of Fort Worth, customization and adoption of the regional iSWM guidance provides the principal means by which the City will comply with the TPDES permit requirement to manage the quality of runoff from areas of new and redevelopment in the City (including that associated with the Central City project). Since the City is scheduled to finish customization and adoption of its updated stormwater program in the next few years, robust stormwater quality management requirements for new and redevelopment are anticipated to be in place by the time the Trinity Uptown area begins to redevelop.

As co-permittee to the TPDES stormwater permit, TRWD contributes to the activities associated with the permit for facilities that they own and operate. For the Central City project these are the current or proposed entry ways where local drainage enters the Trinity River floodway. Several of these current or proposed entry ways are sumps where water is detained before entering the floodway. As a part of its permit responsibilities, TRWD has assessed each of these sumps for ways to cost-effectively improve their performance to benefit stormwater quality without impacting their quantity function. Based on this assessment, TRWD will pilot changes as a part of its TPDES permit to operation and maintenance procedures for these sumps and will test devices designed to remove floatable material within the sumps before it can enter the floodway.

6.0 References

COFW; Stormwater Quality: Storm Water Permit Requirements; Environmental Management Department; City of Fort Worth, Texas; http://ci.fort-worth.tx.us/dem/permit.htm; 2005

COFW; verbal communication with City of Fort Worth Department of Transportation and Public Works staff; October 2004

NCTCOG; Integrated Storm Water Management Policy Guidebook, Review Draft; North Central Texas Council of Governments; Arlington, Texas; September 2004

TRWD; Water Quality Assessment of the Fort Worth Central City Project (Attachment D) - Appendix A, Hydrology and Hydraulics, Fort Worth Central City Preliminary Design; Tarrant Regional Water District, Fort Worth, Texas; January 2005

TRWD; Sediment Transport and Scour Analysis (Attachment C) - Appendix A, Hydrology and Hydraulics, Fort Worth Central City Preliminary Design; Tarrant Regional Water District, Fort Worth, Texas; January 2005

TWDB, Surface Water Data: Lake Evaporation and Precipitation Data, http://www.twdb.state.tx.us/data/surfacewater/surfacewater_toc.asp; 2004

TXDOT; Storm Water Management Guidelines For Construction Activities; Texas Department of Transportation; Environmental Affairs Division; July 2002

USACE, Upper Trinity HEC-RAS Model, Upper Trinity Study - 22 May 1998

7.0 Attachments

Tables

Table 1 – Monthly and annual evaporation statistics for Quadrangle 509 (TWDB 2004).

Table 2 – Monthly and annual precipitation statistics for Quadrangle 509 (TWDB 2004).

Table 3 – Water surface and volumes for the existing conditions and post-project conditions

Figures

Figure 1 – Overview of the Central City Improvements

Figure 2– Extent of water surface created by Samuels Avenue Dam.

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Table 1 – Monthly and annual evaporation statistics for Quadrangle 509 (TWDB 2004).

Monthly Evaporation Statistics

	n	Min	Max	Median	Mean	10th percentile	90th percentile
	588	1.24	11.54	4.8	4.94	2.23	7.99
Month	n	Min	Max	Median	Mean	10th percentile	90th percentile
Jan	49	1.24	3.94	2.2	2.28	1.66	2.98
Feb	49	1.25	4.69	2.5	2.65	2.04	3.79
Mar	49	2.47	6.39	4.21	4.29	3.13	5.47
Apr	49	2.94	7.21	5.17	5.19	4.11	6.44
May	49	3.06	7.49	5.25	5.25	4.14	6.17
Jun	49	4.79	8.95	7.07	7.08	5.67	8.46
Jul	49	5.01	11.54	8.14	8.37	6.63	10.33
Aug	49	5.5	10.52	7.76	7.71	6.38	9.26
Sep	49	4.1	8.66	5.92	5.91	4.66	7.02
Oct	49	3.2	7	4.79	4.84	3.76	5.87
Nov	49	2.24	4.52	3.21	3.31	2.7	4.01
Dec	49	1.54	4.14	2.41	2.45	1.74	3.2

Annual Evaporation Statistics

	n	Min	Max	Median	Mean	10th percentile	90th percentile
	49	46.93	73.6	58.34	59.32	52.99	65.63

Table 2 – Monthly and annual precipitation statistics for Quadrangle 509 (TWDB 2004).

Monthly Precipitation Statistics

	n	Min	Max	Median	Mean	10th percentile	90th percentile
	756	0	14.1	2.06	2.5	0.48	5.03
Month	n	Min	Max	Median	Mean	10th percentile	90th percentile
Jan	63	0	7.21	1.4	1.55	0.19	3.04
Feb	63	0.1	7.78	1.56	1.89	0.38	3.69
Mar	63	0.15	5.1	1.63	2.03	0.47	4.2
Apr	63	0.55	9.51	2.46	2.89	1.12	5
May	63	1.03	12.48	4.08	4.3	2.01	7.09
Jun	63	0.24	7.34	2.76	3.16	0.91	6.35
Jul	63	0	6.92	1.67	2.16	0.42	4.47
Aug	63	0	7.46	2.04	2.2	0.47	4.24
Sep	63	0.31	7.16	2.73	2.96	0.73	5.85
Oct	63	0.03	14.1	2.32	3.21	0.74	6.61
Nov	63	0	7.03	1.42	1.91	0.16	4.46
Dec	63	0.04	8.5	1.49	1.72	0.32	3.29

Annual Precipitation Statistics

	n	Min	Max	Median	Mean	10th percentile	90th percentile
	63	17.01	45.27	30.17	30	20.76	38.04

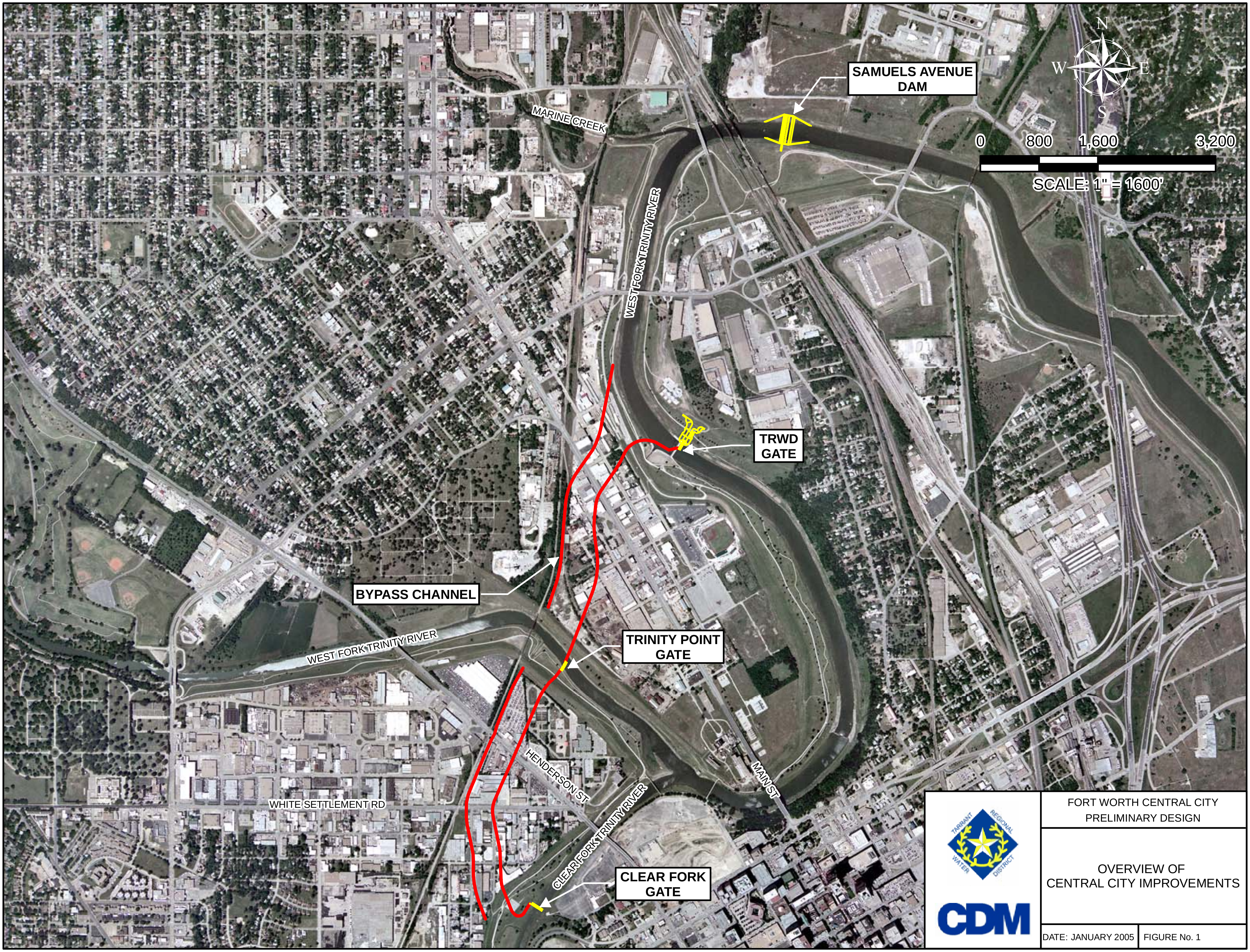
Table 3 – Water surface and volumes for the existing conditions and post-project conditions

Existing Conditions

Reach	Reach Limits		Volume (acre-feet)	Surface area (ac)
	Downstream Station	Upstream Station		
Clear Fork	0	6707	98.2	19.6
West Fork 3	241255	254346	360.6	61.3
West Fork 4	254346	281871	429.2	62.2
Total			888.0	143.0

Post-Project Conditions

Reach	Reach Limits		Volume (acre-feet)	Surface area (ac)
	Downstream Station	Upstream Station		
Lower Bypass	0	3656	490.85	28.11
Upper Bypass	4096	8421	206.07	18.68
Clear Fork	3590	6707	70.18	10.88
West Fork 3	241255	244898	696.94	40.19
West Fork 4	257426	281871	641.47	74.18
Interior area			896.26	83.89
Total			3001.77	255.93

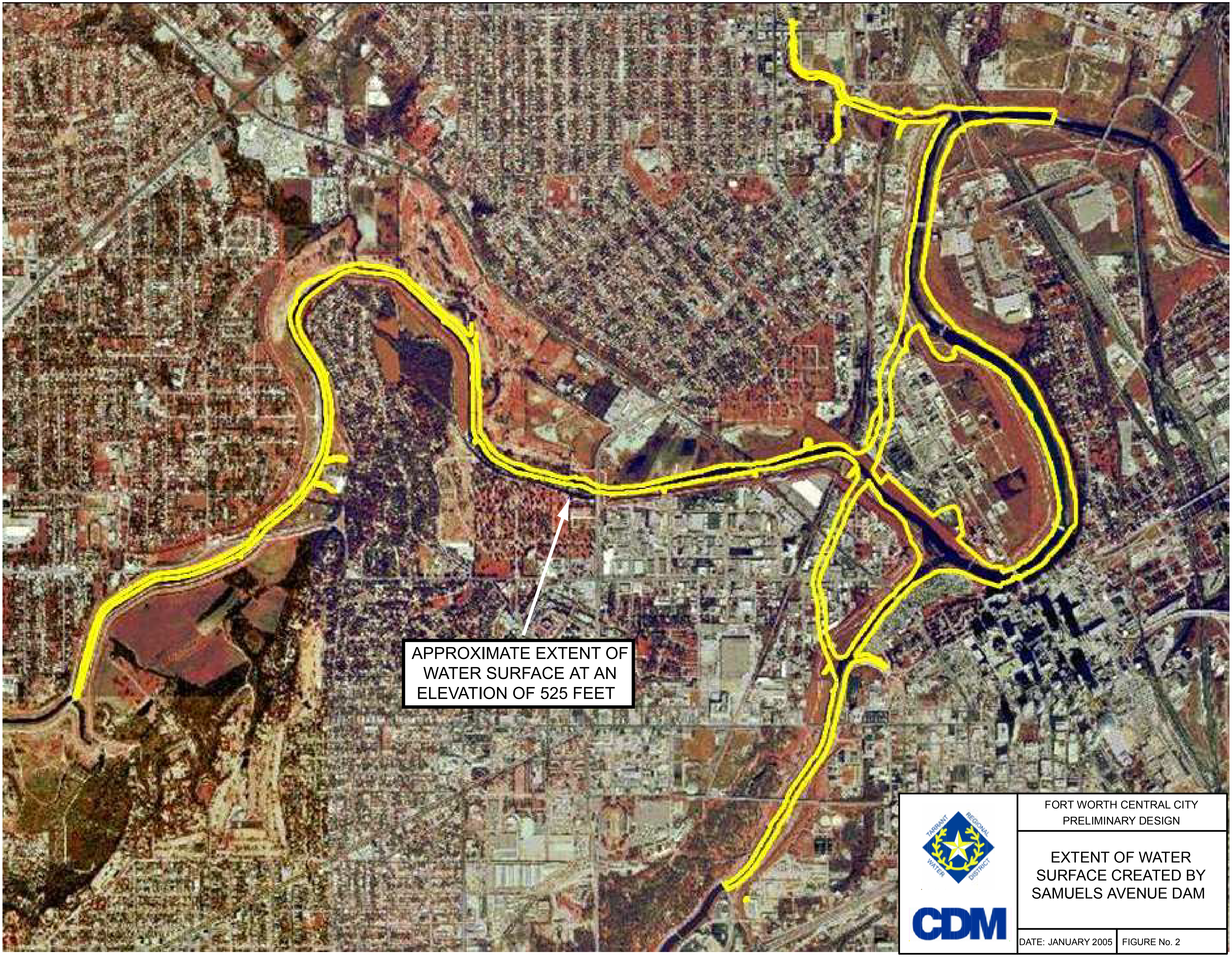


FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

OVERVIEW OF
CENTRAL CITY IMPROVEMENTS

DATE: JANUARY 2005

FIGURE No. 1



FORT WORTH CENTRAL CITY
PRELIMINARY DESIGN

EXTENT OF WATER SURFACE CREATED BY SAMUELS AVENUE DAM

DATE: JANUARY 2005 | FIGURE No. 2