# ENGINEER'S FLOODPLAIN MODELING REPORT

**FOR**

# WALNUT CREEK TRAIL IMPROVEMENTS
# TRIBUTARY 7 CROSSING

AUSTIN, TEXAS

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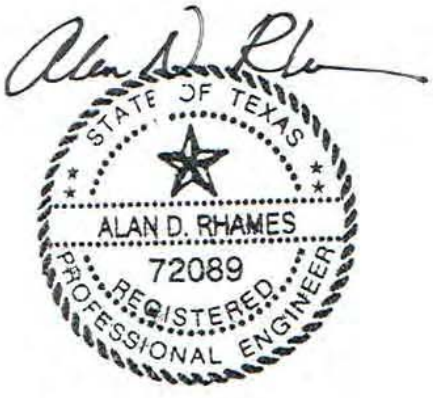


JULY 2, 2015

## 1.0 INTRODUCTION

The City of Austin Parks and Recreation Department is constructing a concrete hike and bike trail along Walnut Creek stretching roughly from Walnut Creek Metropolitan Park on the east to Amherst Drive on the west. The project is bound on the south by a large apartment complex (Barrington at Park Place) and on the north by the City of Austin Balcones District Park. The subject segment of trail is intended to connect an existing trail in the park to the northwest with an existing trail along the Mopac Expressway to the southeast. The proposed trail system contains a crossing of Walnut Creek Tributary 7 about 700 feet upstream (west) of its confluence with the main stem of Walnut Creek. The crossing location is approximately one-quarter mile northeast of the intersection of Duval Road and the southbound service road of the Mopac Expressway (Loop 1) in north Austin. A *Project Location Map* in attached as Exhibit 1.

Axiom Engineers Inc. ("Axiom"), in coordination with a project team lead by K. Friese and Associates, Inc. of Austin, Texas, was contracted to prepare a design for the trail segment detailed above. The trail crosses Tributary 7 generally in a northeast to southwest meandering alignment. Approximately 1,475 linear feet of trail will lie within the classified floodplain of Tributary 7. In conjunction with the design effort, Axiom performed a hydraulic modeling study of Tributary 7 to determine the impact of the proposed improvements on projected 100-year water surface elevations along the affected segment of creek. The scope of the modeling study was limited to estimating the impact of proposed trail construction. The methodologies, analyses, conclusions and results presented herein are not intended for any other purpose. Axiom Engineers Inc. does not authorize use of this report for any purpose except for support of permit applications for the trail project. This report shall not be used as the basis for floodplain delineations along adjoining properties or for the assessment of the broader flood hazard in the surrounding area.

## 2.0 GENERAL STUDY APPROACH

The proposed trail project is located along a waterway containing a classified FEMA floodplain. An excerpt of the FIRM Map of the area is attached as Exhibit 2. Floodplain studies of both Tributary 7 and Walnut Creek to the east have been conducted and updated many times in the past. The City of Austin maintains a library of established HEC-RAS hydraulic models for most major creek systems within the metropolitan area. The current City of Austin HEC-RAS model for Tributary 7 was utilized for this study. The following approach was followed:

A. A copy of the current Tributary 7 HEC-RAS model was obtained from the City of Austin. The model (denoted "*Case A*") was run as-is, without any modifications.

B. The HEC-RAS model cross sections were updated to include the on-the-ground topography collected for the trail design. Cross sections were added to the model (approximately halfway between existing cross sections) to allow for a finer assessment of trail impacts. The updated model (denoted "*Case "B*") was run and the results recorded.

C. The results of the updated *Case B* model were compared with the stock *Case A* model (from the City) to determine the impact of simply including more accurate topographic data.

D. Further updates were performed to the *Case B* model to include Manning's roughness coefficient variations for improvements not reflected in the City's stock model. The improvements include the presence of an existing concrete trench cap (about 10 feet wide, over a wastewater line) running along the channel and asphalt parking lots along the south fringes of the model cross sections. The updated model (denoted "*Case "C*") was executed and the results were recorded. As the model which most accurately represents existing conditions, *Case C* results were used as the background condition against which the proposed condition model was compared.

E. The *Case C* model was modified to reflect the proposed hike-and-bike trail improvements. For most cross sections, the new trail will be placed centered over the existing concrete trench cap. The updated model (denoted "*Case D*") was executed and the results recorded.

F. The *Case C* and *Case D* results were compared to support a conclusion regarding the impact of construction the proposed trail.

## 3.0 CASE B HEC-RAS MODEL UPDATES

Exhibit 3 contains an excerpt of the *Walnut Tributary 7 Workmap* (WCT7-4) prepared by Halff Associates as part of the FEMA FIS Restudy of Travis County, Texas (2004). The *Workmap* depicts the location of the HEC-RAS model cross sections (in red) relative to the Tributary 7 floodplain. Although the cross sections are georeferenced, a graphical comparison (relative to visible, existing structures) of the cross sections in the Workmap and in the AutoCAD file was performed and the *Workmap* and AutoCAD design file were found to match with insignificant deviation. The subject stream segment lines are *Reach 2* in the HEC-RAS model.

The proposed trail enters the Tributary 7 floodplain from the south at approximate Stream Station 6+64 and exits the north side of the floodplain at approximate Stream Station 12+03. The corresponding hike-and-bike trail stationing at these points are 23+95 and 9+20, respectively.

Exhibit 4, the *Trail Improvement Map*, depicts the proposed trail alignment, one-foot contour topography (from an on-the-ground survey), the existing concrete trench cap, stock two-foot contour topography outside of the surveyed area and the HEC-RAS model cross sections. As detailed previously, cross sections were added to the model to allow for a more detailed simulation of the trail improvements. Within the project area, the stock HEC-RAS model contains five cross sections including 6+24, 8+06, 9+73, 11+58 and 13+44. Four new cross sections (7+15, 8+89, 10+65 and 12+38) were added approximately half-way between existing sections. Because the field surveyed topography is more accurate that the lidar topo used in the City HEC-RAS model, four of the existing cross sections were completely recoded into the model using the newly available topography. One existing cross section (13+44) was not modified except to adjust the downstream reach lengths to reflect the fact that cross section 12+38 was added to the model. New cross sections were also coded using the most current topographic information. A small gap in the field surveyed topography exists near the creek centerline at cross section 6+24. Surveyed topography is available both upstream and downstream of this location however and the creek flowline at 6+24 was interpolated from this data following visual verification of the general slope of the channel in this area. All new and recoded cross sections utilize a stationing basis based on the left edge of the cross section being at 0+00.

In order to maintain consistency with the stock model, *Case B* utilizes the same hydraulic characteristics as the original *Case A* model. Exhibit 5, the *Hydraulic Characteristics Table*, provides a summary of the original model input versus the proposed (*Case B*) model input. The table also contains the hydraulic characteristics assumed for the new cross sections. Under the "original" tab, these values were estimated by averaging the values from the adjacent cross sections. Under the "proposed" tab, the values represent the data contained in the updated models. Comparing the values for channel width and Manning's coefficient reveals that the values in the new model are consistent with those from the original model.

Exhibit 6 contains the results of the *Case A* and *Case B* models. Although neither of these models include any of the trail improvements nor the existing concrete trench cap or parking lots, the side-by-side comparison of the results was prepared to demonstrate that recoding of the cross sections (and adding new ones) using updated topography does not result in a major alteration of HEC-RAS results. Note that only original cross sections can be compared as the *Case A* model does not contains the added cross sections. Exhibit 9 contains the HEC-RAS profile summary table, cross section plots and a channel profile for *Case A.* Similar information for *Case B* is contained in Exhibit 10.

## 4.0 CASE C HEC-RAS MODEL UPDATES

As detailed previously, the project area currently contains a concrete trench cap that is generally aligned parallel to the creek centerline. Further removed from the creek, asphalt parking lots exist adjacent to the south edge of the floodplain. The

*Case B* model was further refined to reflect the presence of these improvements (which are not currently contained in the City model). In general, the Manning's roughness coefficients contained in the original model are as follows:

| | |
|---|---|
| Left Overbank | 0.120 |
| Channel | 0.070 |
| Right Overbank | 0.100 – 0.102 |

The concrete trench cap exhibits a rough surface profile and also contains numerous cracks and breaks, resulting in vertical displacements on the surface. A roughness coefficient of 0.015 was therefore utilized for areas of the creek covered by existing concrete. Asphalt areas were assumed to have a roughness of 0.016 in accordance with the *City of Austin Drainage Criteria Manual*. Portions of the cross sections occupied by asphalt are all above the adjacent 100-year water surface elevation however, so depicting the asphalt in the models has no actual impact on the results.

Exhibit 11 contains the profile summary table, cross section plots and a channel profile plot for *Case C.* These results most closely represent the actual on-the-ground condition of Tributary 7 today (prior to any trail improvements) and therefore represent the background condition against which the *Case D* (developed condition) results will be compared.

## 5.0 CASE D HEC-RAS MODEL UPDATES

The proposed hike-and-bike trail improvements were added to the *Case C* HEC-RAS model to create *Case D*, the proposed condition model. Throughout the length of the Tributary 7 crossing, the proposed trail will be constructed of cast-in place concrete with a broom finish. The trail will be 14-feet wide and will contain a short turn-down grade beam on the edge to match finished grade where the trail is slightly above grade. In areas where the trail is slightly below grade, the concrete edge will contain a turn up curb to match existing ground. Upon close inspection, the trail location is visible in each affected cross section at the flowing locations:

| Cross Section | Left Station | Right Station |
|---|---|---|
| 7+15 | 172.2 | 188.9 |
| 8+06 | 151.3 | 165.3 |
| 8+89 | 128.0 | 142.2 |
| 9+73 | 116.0 | 130.2 |
| 10+65 | 141.6 | 155.8 |
| 11+58 | 130.8 | 153.1 |
| 12+38 | 0.0 | 51.4 |

The trail section lies outside of the 100-year floodplain at cross section 12+38, being situated at the far left end of the section.

Note that areas adjacent to the concrete pavement *will not* be regraded to match the trail surface. For the most part, the new trail will be placed directly over the alignment of the existing concrete trench cap. The existing trench cap will therefore be removed and essentially replaced with the new trail. Because the trail will have a broom finished surface and will be steel reinforced, a Manning's coefficient of 0.013 (typical concrete) was utilized in areas occupied by the pavement.

Exhibit 12 contains the profile summary table, cross section plots and a channel profile plot for *Case D.* These results represent the anticipated water surface elevations *after* construction of the proposed trail. The location of the trail is visually depicted in the cross section plots contained in Exhibit 12 as detailed previously. The trail is centered below the n-value labeled "0.013" at the top of each plot. Note that the trail will be slightly above grade in some locations and slightly below grade in others. This is the result of the fact that the vertical profile to the trail centerline must be designed for 20 miles-per-hour and therefore cannot exactly match the existing ground surface.

## 6.0 RESULTS AND CONCLUSIONS

Exhibit 7 contains the HEC-RAS modeling results for *Case C* (existing condition) and *Case D* (proposed condition). Comparison of the results reveals that the proposed improvements will result in a slight lowering of the 25-year and 100-year water surface elevations for most affected cross sections. Across the nine affected cross sections (6+24 to 13+44), the modeling indicates an average 100-year water surface change negative 0.04 feet. Two cross sections indicate a fractional increase (0.15 feet at 12+38 and 0.08 feet at 6+24), however, these apparent increases lie below the accuracy of the model and are therefore not statistically significant. Five of the nine affected cross section show a 100-year water surface decrease with the largest (-0.23 feet) occurring at 10+65. No change is indicated at the first cross section (13+44) upstream of the project area. This result indicates that the proposed improvements should not impact 100-year water surface elevations upstream of the project area.

Exhibit 8 contains a comparison of *Case A* (existing condition model with no changes) and *Case D* (proposed condition). A reduction is indicated at each of the affected cross section locations for both the 100 and 25-year storm events. The average reduction indicated for the 100-year event is on the order of eight inches. While direct comparison of the model results for these two scenarios is not being presented here as the most appropriate evaluation approach, it does serve to document that 100-year water surface elevations after construction of the proposed trail will be lower than the water surface elevations as defined by the currently accepted regulatory model.

The model results are consistent with expectations. Installation of a 14-foot wide, smooth concrete surface along the bottom of the channel should render the waterway as a whole more hydraulically efficient. This increased efficiency should

manifest itself with lower average water surface elevations for any given flow value. The modeling results would appear to support the following conclusions:

A. The City of Austin HEC-RAS model of Tributary 7, which represents the most current regulatory model of the waterway, does not contain completely accurate information with respect to the current in-field watershed conditions.

B. The inclusion of more accurate topographic (and structure) information should render the HEC-RAS model more accurate.

C. The modeling results indicate that the proposed improvements should render the affected segment of Tributary 7 slightly more hydraulically efficient.

D. The modeling indicates that construction of the proposed hike-and-bike trail across Tributary 7 will not result in statistically significant water surface increases at any given cross section and should result in a marginally lower average water surface elevation across the reach as a whole.

Copies of trail plan and profile sheets are included in Exhibit 13. Digital copies of the HEC-RAS models are included in Exhibit 14.