EBDLKUP-2019 USER MANUAL

EBDLKUP-2019 is a Microsoft Excel-based tool designed to help hydraulic design engineers working in Texas to predict location-specific rainfall intensities for a specified time of concentration (storm duration) and specified storm frequencies.

This tutorial provides information on how to use the EBDLKUP-2019 spreadsheet and assumes the user is familiar with concepts of hydraulic design for small watersheds using the rational method. The tutorial also assumes that users are familiar with Microsoft Windows operating system, have access to a local installation of Microsoft Excel, and have successfully downloaded EBDLKUP-2019 and associated electronic files from the TxDOT Hydraulic Design website.

USING EBDLKUP-2019

EBDLKUP-2019 is compatible with Microsoft Windows versions of Microsoft Excel versions 2007 and above (version releases 2007, 2010, 2013 and Office 365).

Enabling Macros or Active Content

The EBDLKUP tool uses Visual Basic for Applications (VBA) code. By default, Microsoft Excel warns users if a workbook contains VBA code (Figure 1).

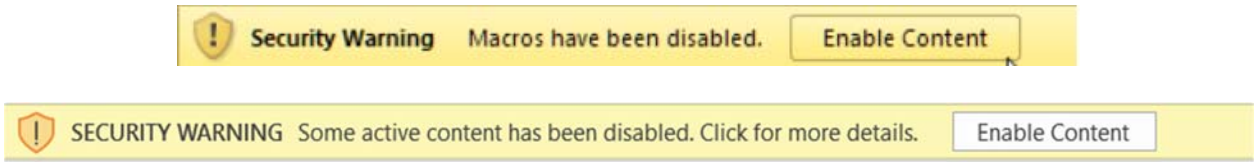

Figure 1 - An example of a message bar prompting that macros in the file are disabled. Click "Enable Content" to activate macros in the EBDLKUP-2019.xlsm to function properly.

Clicking on the "Enable Content" button will enable the full functionality of the tool. Saving the *enabled* worksheet onto a local drive will usually be enough to prevent the messages appearing again – although this depends on the security settings of individual computers.

For more information about automatic warnings or restrictions of excel sheets use Excel's Trust Center (available through File->Options->Trust Center) to view and modify these settings.

The EBDLKUP-2019 USER Interface

Figure 2 shows a screenshot of the user interface. The user interface is the only worksheet visible in the workbook. Other worksheets that contain the database of *ebd* coefficients are hidden and protected. The user interface on the **IDF_Input** worksheet contains three main areas:

1) The user input area contains controls used to enter information on the location of a project, working units (English or Metric) and the Time of Concentration (t_c) of a watershed.

2) The map area contains a static map of IDF rainfall zones within a selected county. The area above the map provides some additional information about the county and its rainfall zones.

3) The results table displays predicted rainfall intensities (in selected units) for a set of user defined inputs. Rainfall intensities are provided for seven storm frequencies ranging from 2- to 500-year recurrence intervals. The table also displays the *ebd* coefficients used to generate the rainfall intensity predictions.

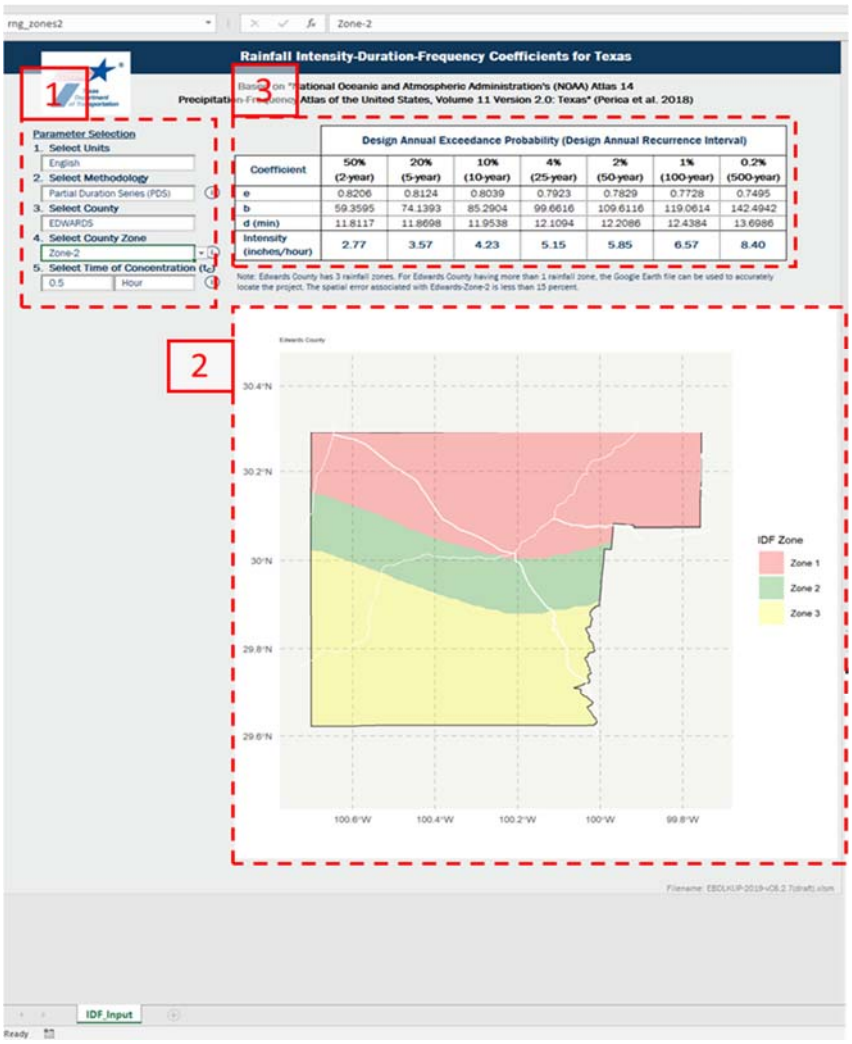

Figure 2 - Interface of the EBDLKUP-2019.xlsm spreadsheet. This interface provides all the information needed for the tool to estimate rainfall intensity.

Using EBDLKUP-2019

To generate a rainfall intensity prediction, a user sequentially alters or populates the information in the "user input area" of the tool. Five categories of information are required to be entered or checked:

1) Select Units (Metric or English).

2) Select whether rainfall intensity predictions should be estimated using the partial duration or annual maximum series methodology (consult the TxDOT Hydraulic Design Manual for more information and guidance).

3) Select the county that a project is located. This selection will display a map of the county and its rainfall zone. The maps show major roads, waterbodies, and gridlines for locating

projects by longitude and latitude. A Google Earth file (***TxDOT_IDF_Zones.kmz***) is also provided for more detailed searches (see following section).

4) Select the rainfall zone (within the selected county) that the project is located in. In some cases, counties will contain only one zone. In others, there may be multiple zones.

5) Select the time of concentration (t_c) for the watershed of interest along with the appropriate time units (hours or minutes).

The information symbols (i) next to the input areas provide additional information and help for a selection. Any information entered into the user input area automatically update information displayed in the results table.

The results table shows rainfall intensities for seven storm frequencies defined by Annual Exceedance Probability (AEP) or Annual Recurrence Interval (ARI). The last row of the table displays the predicted rainfall intensity for each storm frequency (columns). Rainfall intensity for a specified storm frequency is read as shown in Figure 3. Rainfall intensity is provided in the units specified by the user (in metric or English), but is always expressed as an hourly rate.

	Design Annual Exceedance Probability (Design Annual Recurrence Interval)						
Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)	0.2% (500-year)
e	0.8260	0.8246	0.8222	0.8185	0.8149	0.8118	0.8105
b	46.4729	60.6541	72.4005	88.6190	100.7112	113.6954	128.9867
d (min)	10.0339	10.0270	10.0016	9.9598	9.8860	9.8761	9.9940
Intensity (inches/hour)	3.25	4.26	5.13	6.37	7.34	8.37	9.50

Figure 3 – Identifying a rainfall intensity prediction for a specified storm frequency-in this case, a 50-year or 2% storm.

Using Google Earth

If the maps available within ***EBDLKUP-2019*** are not detailed enough to locate a project, a Google Earth file (***TxDOT_IDF_Zones.kmz***) is available for detailed searches. To open the file, double click on it from Windows Explorer, or open it through the Google Earth interface (File-> Open selected through the menu).

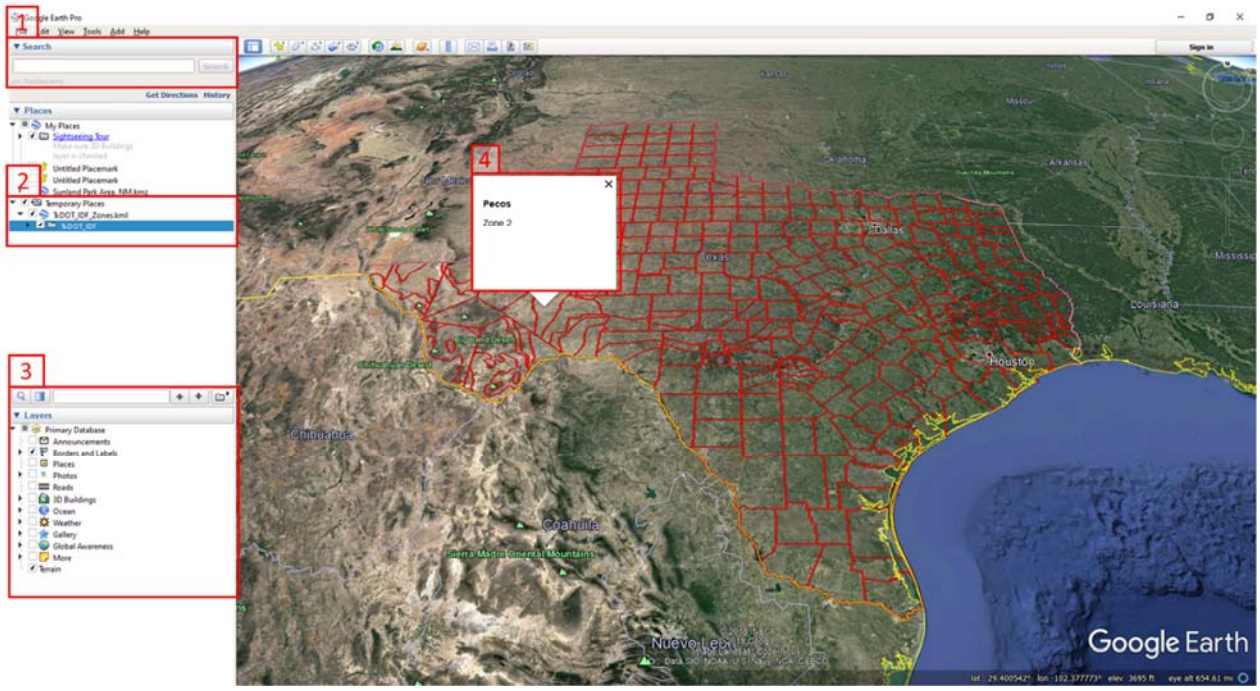

Figure 4 – Screen shot of Google Earth with the TxDOT_IDF_Zone.kmz file loaded.

Figure 4 shows the ***TxDOT_IDF_Zone.kmz*** file loaded into Google Earth. The Google Earth interface enables a user to zoom or pan the map to find the location of a project, or enter an address, zip code, or latitude-longitude coordinate using Google Earth's built-in search interface (annotation 1 in Figure 4). When a user left clicks on the map area, a dialog box appears showing the name of the county and rainfall zone (Figure 4 – annotation 2). The name of the layer is shown in ***Temporary Places*** section of Google Earth's ***MyPlaces*** section of the interface (Figure 4 – annotation 3). The layer can be configured to appear automatically when Google Earth loads by right clicking on the layer name and selecting ***Save to My Places***. Closing Google Earth will also result in a prompt to save the file into ***MyPlaces*****.** Instructions for downloading, installing and using Google Earth (such as changing the color of the rainfall zone map, and adding other layers) can be found at**:** https://www.google.com/earth/

Saving and Printing

It is recommended that users save a single, local copy of the worksheet on their local computers. Information in each input box of the sheet will be saved, and recovered when the workbook is reopened. To retain functionality, the workbook must always be saved using the ***Macro Enabled Workbook*** format option (i.e., with an .xlsm file extension).

The workbook has also been designed to print to a single, letter sized sheet of paper by default (Figure 5).

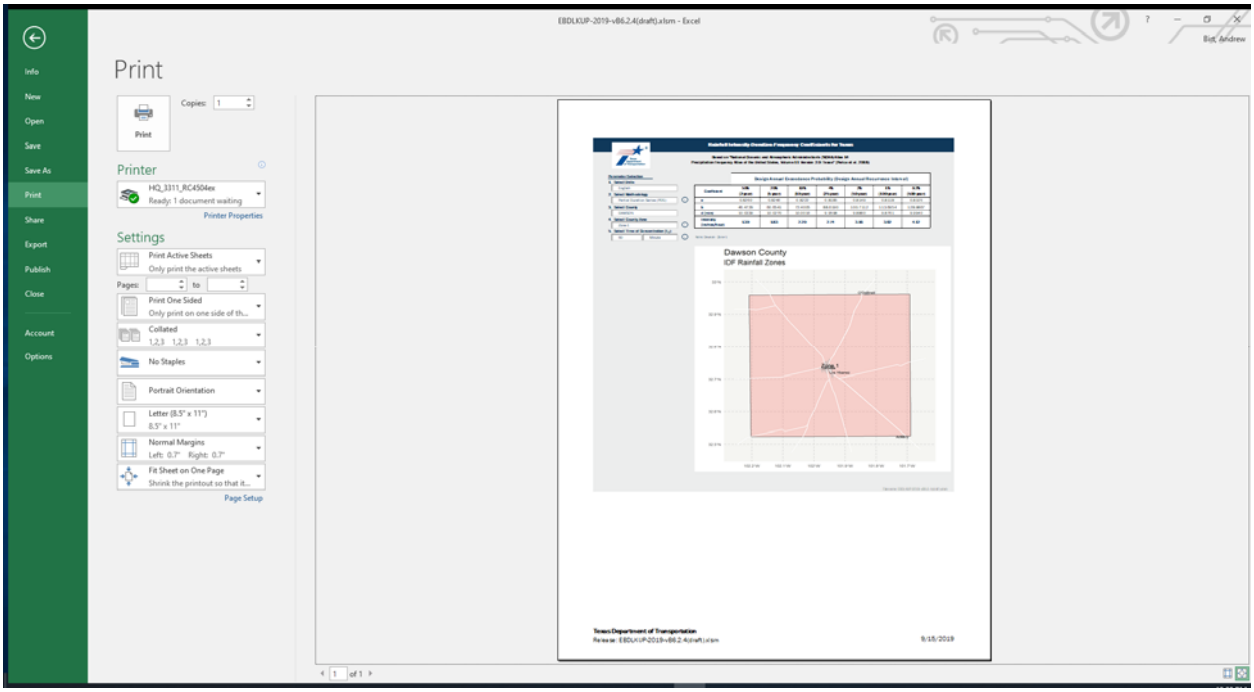

Figure 5 – Print preview of worksheet using Microsoft Excel built-in print controls.

EXAMPLE PROBLEM

This example problem can be worked through by a user wishing to learn how to use EBDLKUP-2019. The example assumes that the designer has already determined a time of concentration (t_c) for their project using methods in the TxDOT Hydraulic Design Manual (Texas Department of Transportation, 2019). The example design problem is as follows:

Use EBDLKUP-2019 to determine non-exceedance rainfall intensities for 25-year and 100-year storm frequencies in Georgetown, Williamson County, using a time of concentration of 50 minutes. The rainfall intensities should be for the annual maximum series, and expressed in inches per hour.

1) Select the appropriate units for the design using the ***Select Units*** input. Because results are required in inches/hour, select ***English*** units.
2) Select the type of rainfall intensity prediction (partial or annual maximum) from the ***Select Rainfall Series*** input. Annual maximum series data is currently the TxDOT standard (see TxDOT Hydraulic Design Manual).
3) Select the county in which the watershed/project is located. In this case, Williamson County.
4) Find the IDF rainfall zone given the physical location of the watershed/project. In this

case, the location is in Georgetown, Texas, on I-35 close to FM 2243 (Latitude 30.627, Longitude -97.688). Use the static maps in EBDLKUP-2019 to identify the appropriate rainfall zone. Because (in this case) it is difficult to locate the rainfall zone with certainty, it is recommended to use any of the following search terms to find the approximate location of the project using Google Earth:

- "I-35 Georgetown Texas"
- "30.622, -97.688"
- "Leander Road, Georgetown Texas"

Left click on the Google Earth map to display the county name (Williamson) and the rainfall zone (San Gabriel River) (Figure 6).

5) Enter the county rainfall zone (San Gabriel River) into the ***Select County Zone*** input. Only the zones specific to the selected county (Williamson) will be available.

6) Enter the time of concentration in minutes into the ***Select Time of Concentration (t_c)*** input. Ensure minutes are selected as the time unit.

7) Check all inputs and read off the rainfall intensity predictions. The results will be returned in inches per hour and should be read from the results table as shown in Figure 7. The estimated non-exceedance rainfall intensities are approximately:

    a. 3.97 inches per hour (25 year ARI or 4% AEP)

    b. 5.32 inches per hour (100 year ARI or 1% AEP)

8) Print a copy of the analysis for records. Use Microsoft Excel menu items to print a full page copy of the workbook.

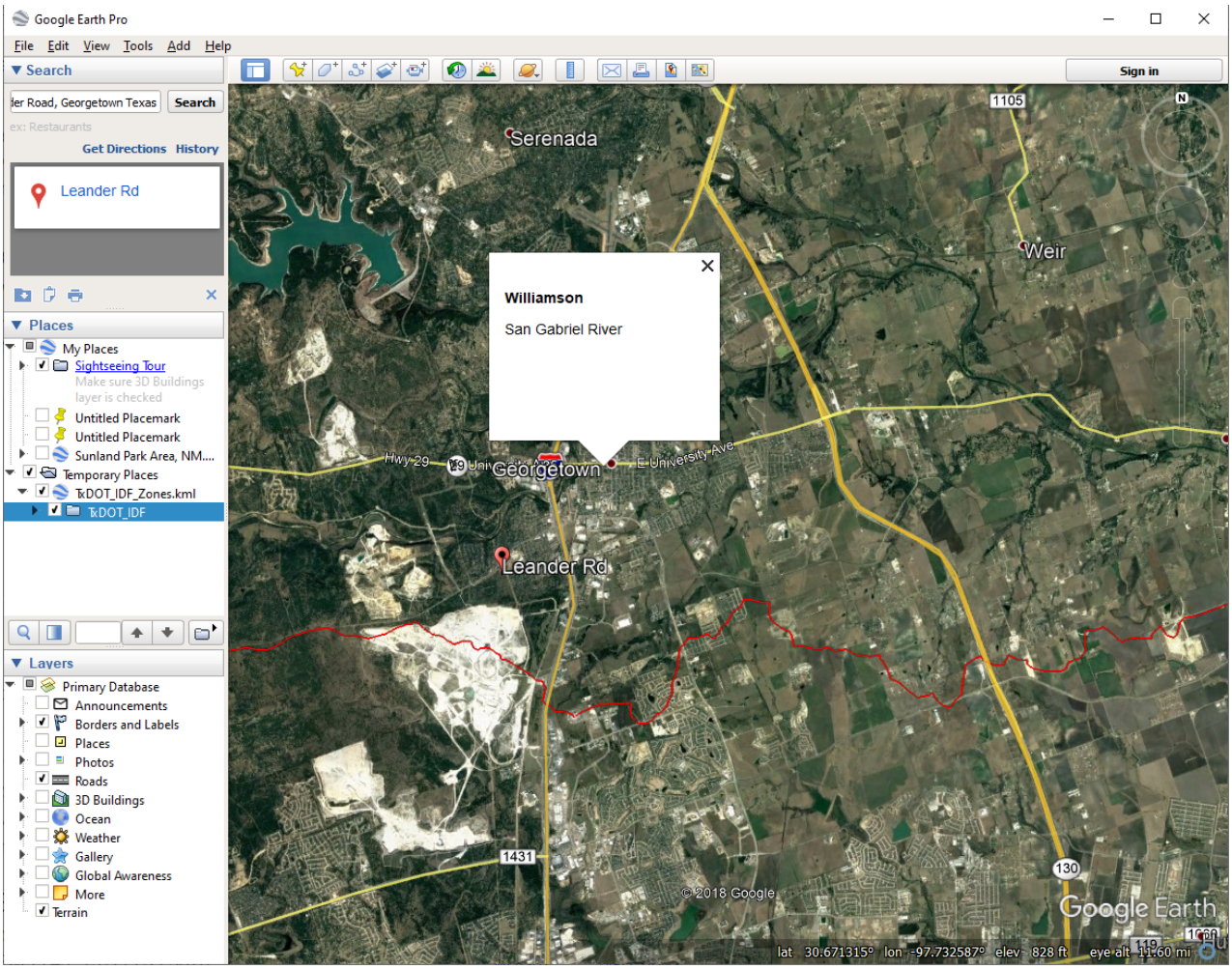

Figure 6 – County rainfall zone (San Gabriel River, Williamson County) determined using Google Earth.

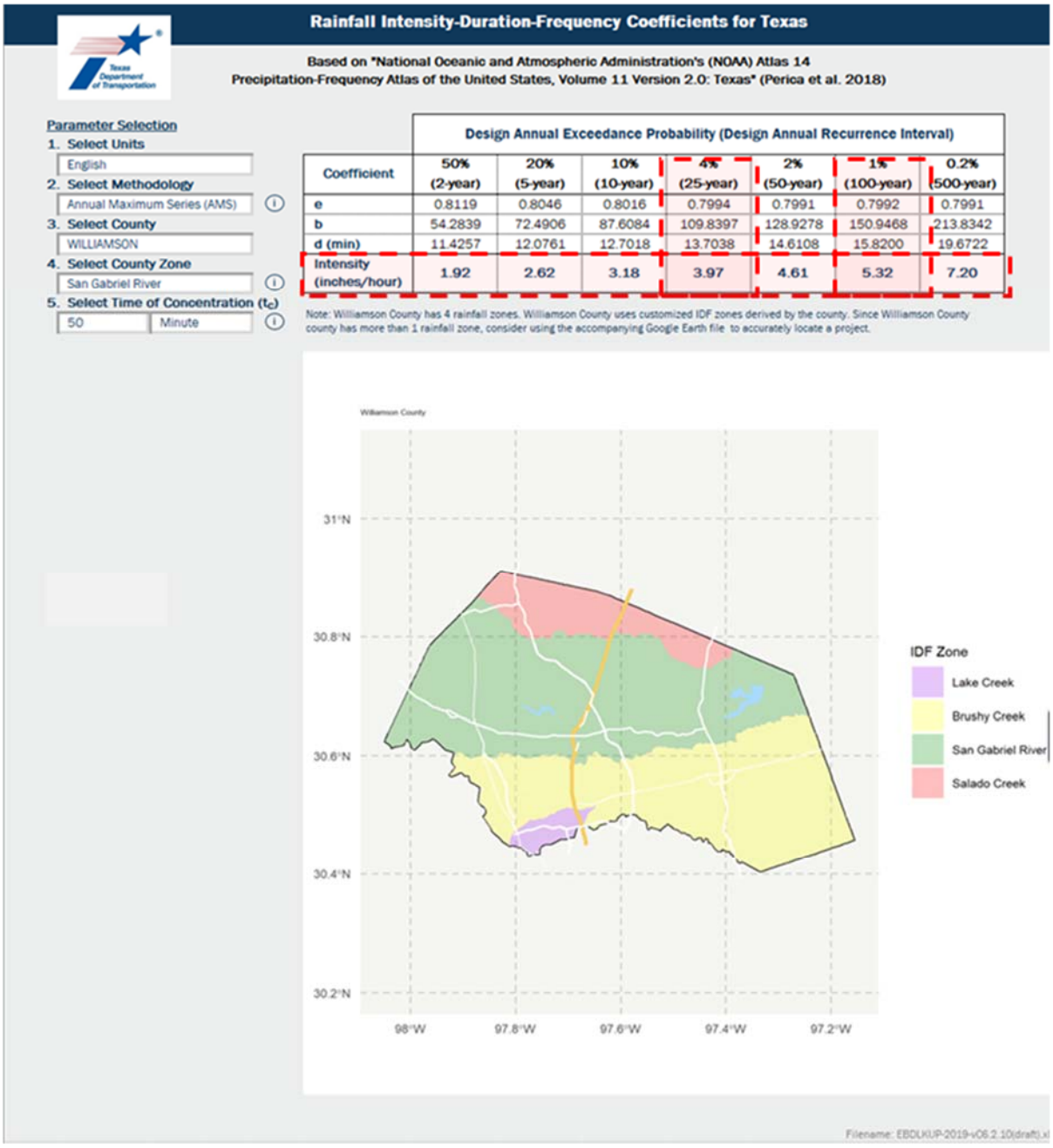

Figure 7 – Reading the rainfall intensity for the example problem's 25-year and 100-year values. Note the red annotations have been added to the screen shot and are not included in EBDLKUP-2019.

RESOURCES

- TxDOT Hydraulic Design Manual (Texas Department of Transportation, Revised September 2019). http://onlinemanuals.txdot.gov/txdotmanuals/hyd/hyd.pdf.

- NOAA Atlas 14 Precipitation-Frequency Atlas of the United States Volume 11 Version 2.0: Texas (2018). https://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume11.pdf