Brazos Basin and Bay Expert Science Team

Proposed Analysis Methodology for Providing a Geomorphology Overlay

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Stream morphology can influence and even control critical habitat for many species. In addition, stream morphology can impact the frequency and magnitude of overbank flooding and the connection between the stream and riparian habitat. If a channel is incised, the frequency and magnitude of overbank flooding is reduced and there is less connection between the floodplain and the stream channel. In addition, channel incision can reduce the frequency of occurrence of bars, riffles, and pools which form critical habitats. Conversely, channel aggradation can increase overbank flooding, and create wider, shallower channels, reducing the depths of pools and, in extreme cases, causing channels to become braided.

Neither situation is desirable, and an instream flow regime should be selected that has the best chance of ensuring that a stream channel will maintain a form that will provide appropriate habitat for focal species and provide a reasonable frequency of connection with overbank areas.

The geomorphology overlay that will be provided by the BBEST should ascertain the potential impacts to stream morphology from various potential flow regime recommendations to inform the discussion during the selection of the Brazos BBEST's instream flow recommendations.

The SAC has recommended the use of some fairly standard sedimentation engineering techniques to facilitate a geomorphology overlay. In general, I agree with the principles laid out in the SAC guidance. The following is my recommendation for specific application of the SAC guidance that will provide a geomorphology overlay to inform our decision-making process.

In general, the process will evaluate sediment transport capacity (bed load) at several gages, under flows subject to baseline conditions and one or more candidate instream flow regime recommendations. Comparison of flow and sediment load frequencies, and integrated mean annual sediment loads under various flow regimes will inform the Brazos BBEST of the potential impacts of the instream flow regimes under consideration for recommendation. The analysis typically is done using daily data.

1. **Selection of gages.** At our May 23 meeting, we selected the following gage locations at which to provide a geomorphology overlay. My notes from that meeting noted the selection of 6 sites, but my notes included 7 sites on the list. We should discuss this list. We may be better off choosing a smaller number of more broadly representative sites.
    - Brazos River at Seymour
    - Clear Fork of the Brazos River at Fort Griffin
    - Brazos River at South Bend

- Brazos River at Waco
- Little River at Cameron
- Navasota River at Easterly
- Brazos River at Richmond

2. **Background Information.** Present summary background information regarding the following data that would be available for each gage:
    - **Comparison of annual flood frequency.** I recommend that annual flood frequency be computed at each gage, and an analysis of the historical changes in annual flood flow frequency be presented. Frequencies pre- and post-reservoir development can be compared. This will lead to a largely qualitative discussion of the potential impacts of those changes.
    - **Long-term rating curve adjustment.** I recommend that instantaneous streamflow measurement data and gage height be obtained from the USGS for each gage, and plotted to show changes in the discharge-gage height relationship over time. This would be an indication of the presence, or lack thereof, of long-term channel adjustment.
    - **Specific stage analysis.** Compute the gage height for a specific discharge for each year of the period of record, something on the order of the 2-year or 10-year event, and plot the change over time. This will provide another indication of long-term channel adjustment processes.
3. **Development of daily flows.** Each scenario will be developed from monthly flows. Daily hydrology for each scenario will be developed using daily patterns from historical hydrology. This is a flawed approach, in that the daily flows are affected by upstream reservoir development since the 1960s, but it is the best available data to establish daily flow patterns.
4. **Selection of scenarios for analysis.** I recommend keeping the number of comparisons down to a reasonable number to facilitate digestion of the information. For this reason, I recommend we compare sediment transport characteristics for the following scenarios:
    - Current – this would be flows based on the most current version of the TCEQ WAM Run 8, Current Conditions.
    - Baseline – this would be flows from the version of the Brazos WAM used by the Brazos G Regional Water Planning Group in developing the 2011 Brazos G Plan. Flows under this scenario could occur in the future regardless of instream flow requirements established by TCEQ. This assumes full utilization of existing water rights, with some consideration given to future return flows.
    - Candidates – we might develop several candidate flow regime recommendations. For each one, I suggest that two alternative analyses be performed:
        i. Infinite Infrastructure – the only remaining flows in the stream would be the candidate instream flows recommended. This is an unrealistic scenario, but provides an "envelope" of the maximum potential effects of a particular instream flow regime recommendation.
        ii. Hypothetical project – develop a hypothetical example project upstream of the gage location. This may be a project evaluated in the Brazos G Regional Water

Plan, or could be a hypothetical project of reasonable size developed specifically for this analysis.

5. **Analysis of scenarios.** Use the standard sediment transport analysis techniques proposed by the SAC to compute average annual potential sediment loads for each scenario, and sediment load exceedance frequencies. Comparison of these two pieces of information between scenarios would provide an indication of the potential effects of various candidate flow regimes. Refinements to the SAC guidance I recommend include:
    - Vary stream slope with discharge. Some form of stream energy or slope is a dominant factor in most sediment transport formulae. As flood levels increase, the slope of the energy grade line often increases substantially. The examples in the SAC guidance do not vary the slope with discharge.
    - Utilize bed-load transport formulae. The Brazos River, in particular the lower Brazos, tends to carry a substantial suspended sediment load, consisting largely of silts and clays that remain in suspension. These silt and clay loads are not pertinent to stream channel formation and can safely be ignored.
    - Do not utilize effective discharge as a measurement parameter. The resulting effective discharge is often too sensitive to the number of bins selected, and can often provide misleading results.
    - Ensure that the daily frequency curve for each scenario is appropriately discretized. Lower frequency exceedance flows (higher flows) require smaller frequency intervals to appropriately describe the frequency curve.

I propose requesting that the TWDB perform these analyses, with review by the BBEST.

With the above general scope, I believe we can provide a geomorphic overlay that will inform our decisions regarding what instream flow regimes to recommend.

Note that the sediment transport formulae that might be utilized compute the sediment transport "capacity" of the stream, not the actual transport, which depends upon a supply of sediment entering from above. There is wide variation in sediment transport formulae, and in the absence of calibration or verification data, results should be viewed for the relative differences between scenarios, taking into account what might be occurring upstream and in the watershed in general. We will need to dispense with the "rule of thumb" that flow regimes that result in changes greater than 10 percent of transport capacity be avoided. There is little technical support for that concept, as stated in a recent technical memorandum developed by the SAC (18 July 2011).