Field Identification of Ordinary High Water Mark in Relationship to the Field Identification of Bankfull Stage for the Galveston District's Tiered Stream Condition Assessment Standard Operating Procedure

Introduction

Field Indicators are used to determine both Ordinary High Water Mark (OHWM), which is required for establishing the lateral extents of U.S. Army Corps of Engineers (Corps) jurisdiction in non-tidal streams, and the determination of bankfull stage (BFS), which is used to assess stream condition. While many field indicators of OHWM are also field indicators for bankfull stage, the two terms are not interchangable.[1,9] BFS is also statistically associated with a mean recurrence interval of 1.5 years.[1,2] The mean recurrence interval is associated with perennially flowing, natural stream channels where precipitation is evenly distributed and is based on a nationwide dataset. In contrast, there is no hydrologic definition of ordinary high water, and the identification of OHWM relies entirely on physical features of streams.[9,6] The purpose of this paper is to assist the investigator in identifying the similarities and differences in field characteristics of OHWMs and BFSs in most stream conditions present within Galveston District by further defining OHWM and BFS and identifying a few of the similarities and exceptions. This paper is meant to illustrate the though process necessary to make a field determination. Similar to the implementation of the 1987 Corps of Engineers Wetland Delineation Manual[16], best professional judgment should be used in conjunction with established data that may be available when characterizing the physical features associated with OHWM and BFS. The investigator must rely on their observations, experience, and available data to identify the characteristics that best represent the entire stream reach.

Definitions

Ordinary High Water Mark (OHWM)

Corps regulations for the Clean Water Act identify the lateral extents of non-tidal streams at 33 CFR 328.3(e), which states:

> "The term *ordinary high water mark* means that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."

This definition is virtually identical to the definition of the term "ordinary high water mark" found at 33 CFR Section 329.11(a)(1), describing the lateral extent of Federal jurisdiction over non-tidal traditional navigable waters of the United States subject to Sections 9 and 10 of the Rivers and Harbors Act of 1899 (RHA).

Pursuant to these regulations and an inter-agency agreement[4], the Corps determines, on a case-by-case basis, the extent of geographic jurisdiction of non-tidal streams for the purpose of administering its regulatory program by identifying physical evidence. These physical indicators include the features listed in the definitions at 33 CFR 328.3(e) and 329.119(a)(1), and other appropriate means such as gauge data, historical records, flood predictions, and statistical analysis. The following physical characteristics should be considered when making an OHWM determination:[5]

Scour	Sediment sorting
Deposition	Water staining
Shelving	Changes in the character of soil
Destruction of terrestrial vegetation	Natural line impressed on the bank
Presence of litter and debris	Multiple observed flow events
Wracking	Bed and banks
Vegetation matted down, bent, or absent	Leaf litter disturbed or washed away
Change in Plant Community	

This list of physical characteristics is not all inclusive and there is no "required" physical characteristic that must be present to make an OHWM determination.[5] In some cases, recent changes in channel morphology or manipulation of water levels and/or flows may make physical characteristics absent or misleading. In cases where physical characteristics may be inconclusive, misleading, unreliable, or not evident, OHWM may be determine by using stream gage data, elevation data, historic water flow records, and statistical evidence.[5] Regardless of the characteristics, investigators should generally try to identify two or more characteristics.

Bankfull Stage (BFS)

The term "bankfull" was originally used to describe the incipient elevation on the bank where flooding begins. In many stream systems, the bankfull stage is associated with the flow that just fills the natural channel to the top of its banks and at a point where the water begins to overflow onto the active floodplain.[1] For stream classification purposes, the commonly accepted and universally applied definition of BFS is:

> "The bankfull stage corresponds to the discharge at which the channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphological characteristics of channels."[2]

The bankfull stage and its attendant discharge serve as consistent morphological indices which can be related to the formation, maintenance and dimensions of the channel as it exists under the modern climatic regime. Since natural streams are self-formed and self-maintained, it is important to relate measurable features one can identify in the field to a corresponding BFS. By accurately identifying the BFS, the investigator is able to accurately assess the stream channel condition.

Since the active floodplain defines the limit of BFS, identification of the active floodplain is the most consistent field indicator for a BFS determination. As depicted in Figure 1, the active floodplain is the surface adjacent to and receiving frequent over-bank flow from the low-flow channel.[1,7] The active floodplain in not synonymous with flood hazards mapped for Flood Insurance Rate Maps by the Federal Emergency Management Agency. In humid regions, the active floodplain is typically inundated during low to moderate (2- to 10-year recurrence interval) events, [10] and is characterized by high-flow channels, generally unvegetated surfaces, and frequently a break in slope at either bank margin.[3] Where active floodplains are not well developed, BFS must be determined by two or more other physical indictors at correlative elevations. The following physical characteristics should be considered when making any BFS determination: [1,7,8]

Scour line	Change in particle size distribution
Depositional bench (active channel)	Staining of rocks
Inflection point	Upper limits of sand-sized particles
Lower limits in perennial vegetation	Top of point bars
Valley flat	Middle bench for braided rivers
Exposed root hairs below an intact soil layer	Break in slope of banks (floodplain break)
Active floodplain	Undercuts

When using physical indicators of bankfull stage, adherence to four principles is recommended, but not required:[1]

1) Seek physical indicators in the locations appropriate for specific stream types. In general, the best location to measure BFS is at the narrowest segment of the selected reach. However, deflectors such as debris, nickpoints, or unusual constrictions that make the stream especially narrow, or that create exceptionally wide backwater conditions, should be avoided.
2) Know the recent flood and/or drought history of the area to avoid being misled by poor indicators such as colonization by pioneer vegetation or flood debris located above the active floodplain. Many species of riparian plants occur across a variety of landscape positions. While some common riparian species are reliable as indicators, using vegetation must be done cautiously. Small woody plants, grasses and forbs can colonize on suitable substrate within the channel during periods of drought or low flow.
3) Use multiple indicators on multiple reaches of the stream.
4) When evaluating a complex stream, the investigator may benefit from the calibration of a field determined BFS with known recurrence interval discharges at gaged stations. The recommended procedure for calibrating field indentified bankfull stage with known stream flows may be found in Dave Rosgen's *Applied River Morphology*.

<u>Exceptions</u>

<u>Introduction</u>

Watershed characteristics and the local hydrologic regime influence the geometry of the channel and the surrounding floodplain by dictating the amount of sediment deposited and eroded in the channel. This sediment load is a product of the stream's state of equilibrium which is a classification of the status of a system between aggradation and degradation, which extends beyond the standard range of erosion and deposition of sediment. The stream equilibrium is a balance of sediment size and sediment load with the product of stream slope and stream discharge. The dynamic equilibrium of natural erosion and deposition is upset when one of these variables shifts excessively. For example, if stream slope increases due to removal of meander bends and straightening of the channel, then degradation will likely occur. Eventually, sediment load increases to the degree that the balance may reestablish, or given the sensitivity of the system, swing back too far and into aggradation as that extra sediment settles out downstream.[1] Stream channel morphology is influenced by the hydrologic regime and by the tendency of the channel to establish a state of equilibrium.[12] These components drive the quantity of sediment deposited and eroded in the channel, in turn influencing the geometry of the channel and the surrounding floodplain and ultimately the field indicators for both OHWM and BFS.

Whether in flashy (episodic) arid environments or humid regions with more evenly distributed channel discharges, several common fluvial features are associated with stream channels. These features include bankfull zones, active floodplain zones, and terrace zones (Fig. 1). In stream channels, the bankfull zone is where the majority of the impact (via erosion and sedimentation) takes place, owing to the presence of the dominant channel-forming discharge. The active floodplain zone receives frequent overbank flood flow. The terrace zone ranges from paleo surfaces that are completely abandoned to modern surfaces that infrequently receive flood waters, typically referred to as the 100-year floodplain.[6] The following example stream types have characteristics that may cause confusion when the investigator applies the Galveston District's Tiered Stream Condition Assessment Standard Operating Procedure (SOP).

Ephemeral and Intermittent Streams

For the purpose of the SOP, ephemeral and intermittent streams are those streams whose primary source of water is from precipitation. Ephemeral streams have no connection to a water table and intermittent streams have a limited connection to a water table. In ephemeral and intermittent channels, the dominant channel-forming discharge is conveyed by one or more low-flow features in the active floodplain zone.[6] This hydrologic regime causes common fluvial features such as bankfull channel, active floodplain, and the terrace floodplain to be less well defined. Because of the difficulties identifying these fluvial features, the SOP does not require the investigator to identify BFS in order to assess the stream. However, the physical characteristics of the OHWM should be sufficiently present to establish the lateral jurisdictional extents of the stream.

Upper Texas Coast and Texas Coastal Bend Perennial Streams

Generally speaking, the upper Texas coast and Texas coastal bend are located in the humid subtropical climate zone with a mean annual precipitation total of 40 to 60 inches.[12] The humid subtropical climate is noted for its warm summer months, and relatively mild winters.

The fluvial morphology of many natural streams in these regions are generally at equilibrium at the frequent flows associated with BFS.[11] Because of this, numerous features have been reported in the literature to identify the BFS of a non-tidal stream, which in many instances is equivalent in landscape position to the OHWM in humid regions.[3,6,9] Because of this equilibrium and resulting similarity in landscape position, the investigator may find that field indicators common between BFS and OHWM will be the strongest indicators for both. However, while the BFS is generally the dominant discharge in humid regions and therefore primarily responsible for the formation of the physical features associated with the OWHM in this region, one should not assume that this similarity holds true for every channel in these regions. [9] The investigator should be able to justify their observations when identifying the characteristics of OHWM and BFS that best represent the entire stream reach.

Lower Texas Coast Perennial Streams

Generally speaking, the lower Texas coast is a semi-arid climate zone with a mean annual precipitation of 26 or less inches.[12] Cyclic climatic patterns in semi-arid regions are similar to arid regions in that they can lack rainfall events for extended periods of time; however, when they do occur, they may be intense. These unevenly distributed and sometimes extreme precipitation and discharge patterns are in contrast to the more evenly distributed discharges associated with humid regions, such as the Upper Texas Coast. Also, the ultimate timing and magnitude of runoff into arid and semi-arid streams has many controlling factors that contrast with the discharge rates and patterns of streams in more humid areas.[3]

The geomorphic effectiveness of floods in semi-arid and arid regions means that morphological features associated with the OHWM in these climates are more likely the result of extreme events, not the frequency common in humid climates and often associated with BFS. The highly variable and intense discharges cause the stream to constantly strive to achieve equilibrium. This presents difficulties for defining what is meant by "ordinary" and for accurately delineating the OHWM versus BFS. [9] Because of these extreme floods or short-term, high intensity events, channel morphology and, as a consequence, the physical features associated with OHWM are frequently higher in the landscape than the physical characteristics of BFS or the recurrence interval of 1-2 year associated with BFS in these streams. Generally speaking, many of the physical indicators for the OHWM of arid and semi-arid streams are found in the active floodplain, or at a recurrence interval of 5-8 years. [3,13] Therefore, instances where the OHWM and BFS are at the same elevation will be rare in semi-arid and arid regions. For assistance in identifying physical characteristics of OHWM versus the physical characteristics of BFS for semi-arid and arid streams found in the lower Texas Coast, we recommend *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States: A Delineation Manual.*[6]

Anthropogenic Modification of Perennial Streams

A common practice to alleviate flooding is to modify the stream by straightening and lowering it in the landscape position so the will contain larger stream flows. This is generally referred to as an incised or entrenched stream.[1] Streams that are deeply entrenched do not exhibit significant changes in channel width as flood flows increase. As a result, larger flows which would normally spread their energy across an active floodplain are now confined. With increasing flood stage, stream depth generally increases at a more rapid rate than the corresponding channel width. This may confuse the investigator when a criterion suggests a BFS at an elevation that is not close to the top of either bank. This is because the BFS is located lower than the top of the bank in man-made channels. BFS may still be observed and determined within these man-made channels by identifying; benches, changes in bank material and vegetation, the top of point bars, or a scour line located within the boundary of the active channel.[14] The investigator should consider the top of the high bank as the abandoned floodplain or terrace within the incised channel.[15]

If physical characteristics of the BFS are not present and field determination of BFS are impractical or impossible, local regional bankfull relationships, such as regional curves, developed for gaged streams in our region may be very useful in establishing BFS. However, if these relationships are not available, the investigator should select a specific gage with similar land use in the same hydro-physiographic region and field calibrate it in order to apply a proportional area calculation to estimate discharge on the ungaged stream.

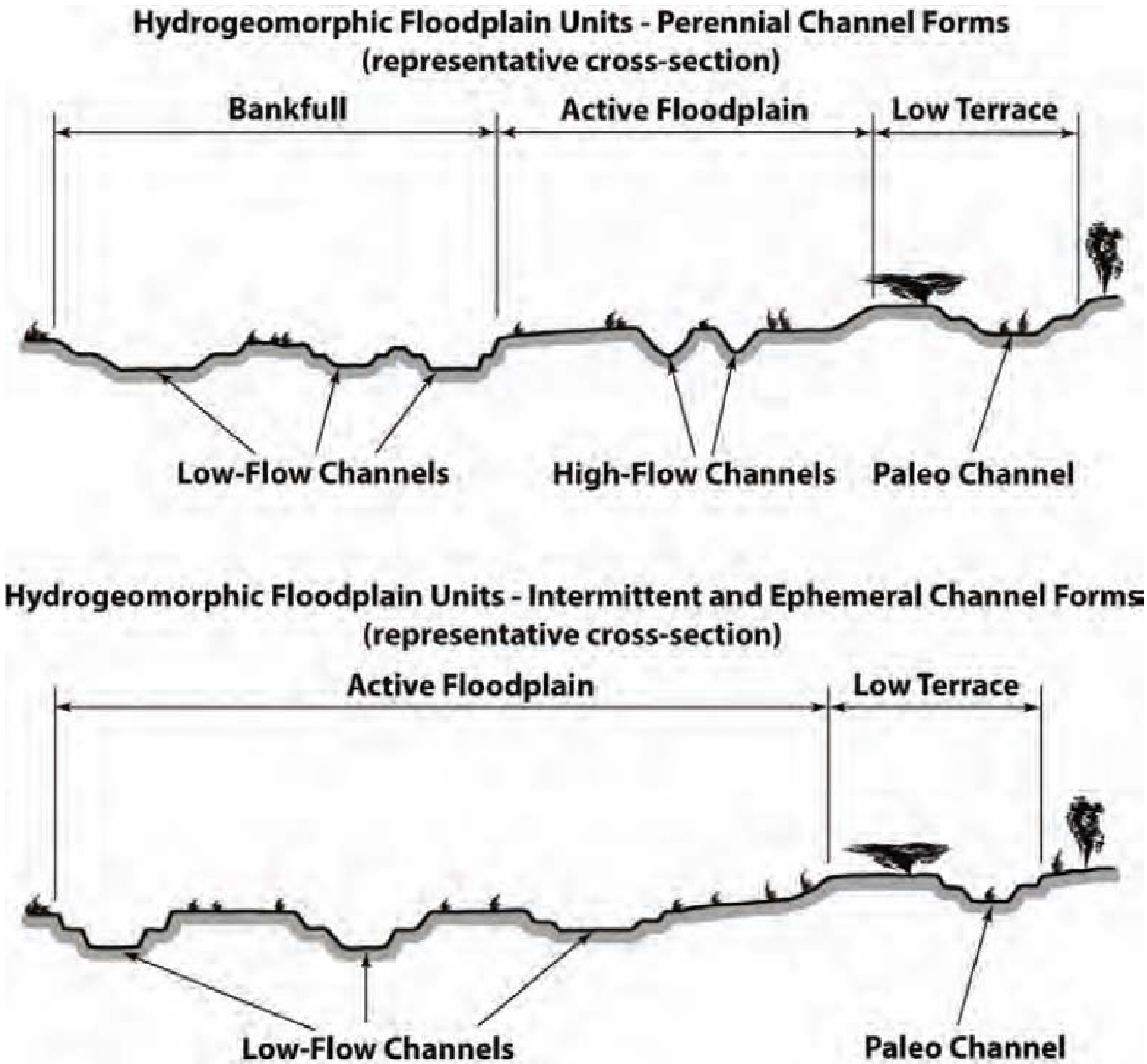

Figure 1. Representative cross sections depicting Hydrogeomorphic floodplain units for perennial channel forms (top) and intermittent/ ephemeral channel forms (bottom).[6]

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