NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Ecosystem Enhancement PROGRAM

Guidance Topics for the Development of EEP Mitigation Plans

The overall purpose of this document is to provide guidance for certain topics in the development of Mitigation Plans, the name now standardized to describe the project design and permitting deliverable as part of the Federal Rule enacted July 28, 2010 (Federal RegisterTitle 33 Navigation and Navigable Waters Volume 3). The following guidance focuses on topics that should be considered and accounted for when developing goals and objectives, documenting the pre-construction baseline to help characterize functional improvement and to justify the level of intervention/approach. These topics have been part of the commentary from prior mitigation plan reviews and first articulated and released as part of the EEP Project Implementation Manual for design-bid-build projects in April of 2009. It is also provided here as stand alone document to compliment the EEP Mitigation Plan Template.

1.0 Project Components and Structure

Delineating the proposed components/assets should include a properly segmented map (e.g. Figure 1 in App.A) and corresponding table (Table 1 in App. A taken from the EEP Mitigation Plan Template) is essential to understanding the structure of the proposed project. The map should be in overview format and the proposed project assets/components. It is possible to delineate these pieces in a good vicinity map, but if clarity is compromised it may require a distinct figure.

Project structure is comprised of restoration components that are contiguous areas or reaches consistent in their restoration level (e.g.. P, C, EI, EII, R etc.), approach (e.g. PI, PII, for streams etc.) and target type (i.e. B, C, and E for streams and community system types for wetlands). In the case of streams, a distinct piece of hydrology, such as a tributary will always be treated as a distinct stream project component. For streams, there have been examples in the past where certain restoration reaches/components have demonstrated an intermingling of restoration approaches (e.g. PII/PIII). A distinct restoration component should be created for any continuous stream segment that demonstrates consistency in the above characteristics for 500 feet or more.

Inflections or changes in other characteristics, which may influence the response or performance within a component delineated according to the above criteria may merit further segmentation. For example, in the case of a stream restoration segment with a consistent level, approach, and type (e.g. R, PI, E), but a distinct inflection in the valley type/characteristics, it would be advisable to create a distinct component in the table given that the valley type may be expected to yield performance differences. A large increase in the drainage on a project mainstem due to a tributary contribution would be another example. Typically a sustained shift in valley characteristics would often generate a distinct design stream type, negating the need for this additional consideration, but this is not always the case given that multiple valley types can include the same stream type. A distinct shift in soil type longitudinally over the valley may warrant the same kind of consideration or in the case of wetlands, a topographic feature that may isolate 2 tracts from one another may warrant their distinction.

2.0 Historical Land Use and Development Trends

Watershed Trajectory and Stream Design – The design firm must demonstrate in the narrative and data presentation that they not only understand the state of the watershed, but understand the extent, nature and effects of likely changes as well as their spatial distribution. This has and will continue to involve the designer acquiring municipal and county planning data and making use of EEP and DWQ planning documents where they apply. It may also involve using modeling tools and local watershed models, which may have been developed by others. In addition to connecting these factors to channel evolution, the designer must indicate whether the projected rates and types of change represent a potential threat to the designs sustainability and any stated project goals, and if so, what design considerations were incorporated to address these concerns. So, in terms of watershed trajectory, the plan document must demonstrate more than just the makeup of land use/land cover (i.e. where the watershed currently is in its trajectory), but must demonstrate an understanding of what type of changes are likely to occur as well as where and over what time frame (i.e. where its going). It is understood that as with any data, there is uncertainty in watershed planning data, but due rigor with the best available data in hand is a key factor in managing uncertainty and the attendant risks. The degree to which these factors were articulated in prior submissions has been variable and therefore merited additional emphasis.

3.0 Watershed Planning

EEP, DWQ, and other agencies have put a lot of time and effort into watershed planning throughout the state. These are important resources for developing successful restoration projects, and a key element to link a specific project to overall watershed protection and restoration. This section should state whether the project is located in an LWP or TLW. If it is not located in an EEP planning area, this should be stated and references to other planning documents that were reviewed (e.g. DWQ Basinwide Plan, 319 or CWMTF planning projects, etc.) should be provided. Include information on project site location as it relates to watershed priorities (priority catchment areas, 303(d) streams, etc.) and state the major stressors identified in watershed plan.

4.0 Existing Conditions Survey

EEP wishes to emphasize the point that great care should be taken to make sure that the sample that contributes to the distributions (e.g. morph, stability, habitat, and bio) in the existing conditions survey is representative. For example, it should not be limited to the areas of greatest disturbance nor should it be limited to the measurements from stable zones that simply facilitate design. It must facilitate accurate, meaningful comparisons of the pre-existing distributions with design, As-built and monitoring distributions.

<u>The morphological parameters of primary interest for this pre and post comparison include those found in the morphology summary tables in the format guidance documents for EEP Baseline Monitoring Documents and Annual Monitoring Reports</u>. These tables also accommodate or should house other parameter distributions including stability parameters and biological parameters in the event the site/reach is compatible with the latter (see section 8 below). The morphology parameters are either a direct subset or derivations of morphology parameters found in a typical natural channel design table (e.g. example Table 2 in App. A), but have been extracted and formatted with varying degrees of utility in the past. The tables referenced above will not actually come into use until the Baseline Monitoring Document (Task 6 in full delivery terminology) and are not intended to replace standard design tables, but are simply referenced here to provide those involved in design survey to understand what parameters will be required to have robust sample distributions for clear, consistent comparisons between the existing and rehabilitated condition.

5.0 Valley Classification

The valley type must be specified and discussed. Assure the reader in the narrative and data presentation that the proposed channel design is an appropriate match for the valley type.

6.0 Channel Evolution

The design must include a summary of the streams evolutionary trajectory/scenario. http://www.epa.gov/warsss/sedsource/successn.htm. Coupled with a proper sample in the existing conditions survey (section 4.0), defining the channel trajectory provides a means to justify the need for the proposed level of intervention (i.e. Restoration Level).

In addition to adequately sampling the existing conditions, the designer must describe the reach(s) evolutionary stage, scenario, and trajectory. EEP wishes to understand whether the measurements surrounding the candidate stream reach(s) exist in a system that is near the beginning, end or some midpoint in the current phase of deterioration and how the designer's understanding and projections of the watersheds trajectory supports the channels proposed evolutionary scenario. Together with the existing conditions summary, this will help EEP understand whether the proposed restoration level/effort is appropriate, timely and proportional.

7.0 Overarching Goals and Applications of Mitigation Plans

7.1 The timely, cost effective delivery of sustainable ecological uplift for the purpose of meeting compensatory mitigation requirements.

7.2 Link project specific goals to watershed goals as provided in planning documents (LWP, RBRP, DWQ Basinwide Plans, etc.).

7.3 Articulate how the proposed approach or levels of intervention are proportional and optimized in terms of 7.1

7.4 Demonstrate that the factors of influence and the data streams that are part of the design effort converge (or provide explanation when they don't) to justify the proposed level of intervention (7.3).

7.5 Define project level goals and objectives

7.6 Provide a pre-restoration baseline to which monitoring data can be compared for the purpose of demonstrating attainment of goals and objectives.

7.7 Provide impact and other information necessary to obtain regulatory permits.

7.8 Document whether or not the project will result in a rise in flood elevations.

7.9 How do project goals and objectives address stressors identified in watershed characterization section of the plan.

8.0 Mitigation Project Goals and Objectives

This section provides guidance related to concepts and formats for the tailoring of project goals and development of clear linkages between functional needs, goals and objectives and the validation of their attainment in stream and wetland rehabilitation projects

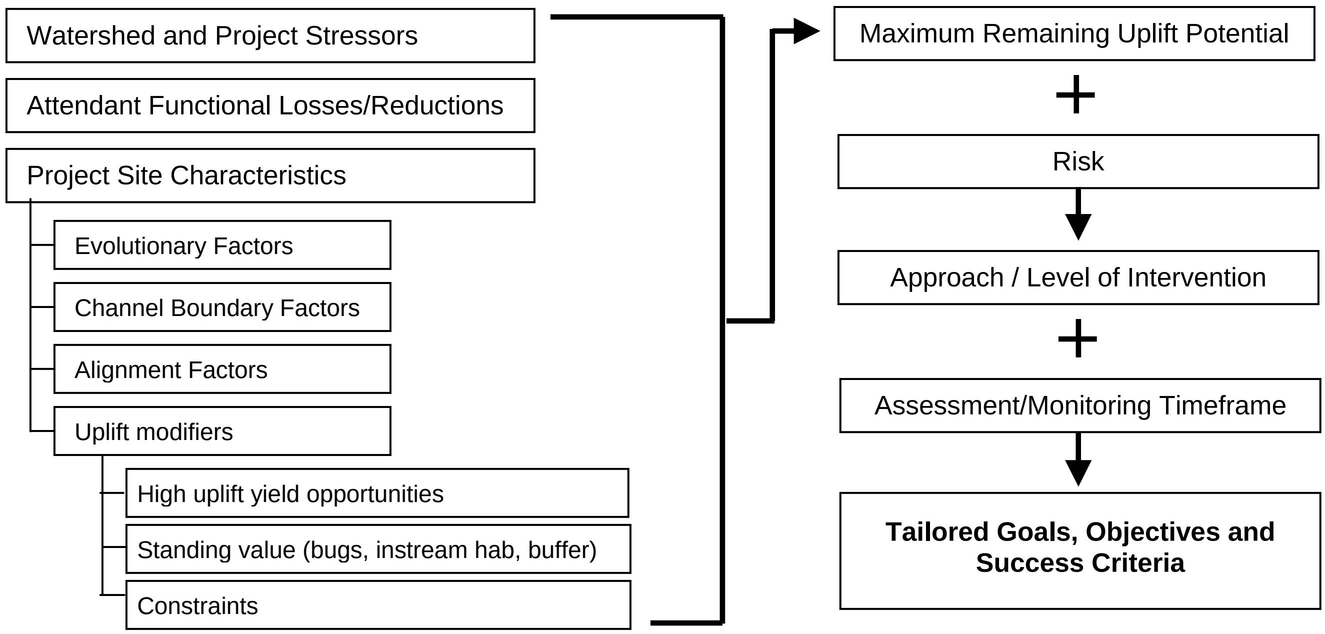
8.1 Characteristics of goals and objectives.

In prior mitigation plan submissions there has been confusion at times as to the difference between project goals and objectives. For EEP stream and wetland rehabilitation projects, goals and objectives can be described as having the following characteristics:

Goals	Objectives
Goals are better described as ends	Objectives are better described as a Means/Method by which the Goals are implemented
Goals tend to be more broad	Objectives tend to be narrower
Goals tend to be more abstract	Objectives tend to more tangible
Goals lend themselves to direct validation to a lesser extent	Objectives lend themselves better to more direct validation and tend to serve as a linkage between the more abstract nature of goals and the success indicators/criteria
See Exhibit Goals and Objectives 1 and 2 in Section VI for a potential format to delineate these aspects of Goals and Objectives and their linkages to elements of their attainment	

8.2 Factors for tailoring goals and objectives

In truth, the main stressors and impacts to our watersheds are pervasive and to a large extent transcend physiography. As such this can create a good deal of overlap in the goals formulated to address them. However, even though goals tend to be more overarching and abstract than objectives, it is sometimes observed that this relationship can be taken to an extreme and project goals can be too broadly stated and overly standardized, completely ignoring specific site or watershed conditions. Although goals have this broader quality to them that does not mean they cannot or should not be effectively tailored. In addition, goal statements sometimes do not consider the systems and practical constraints necessary for their measurement. For these reasons, watershed planning and other relevant resources/data should be consulted thoroughly in the development of project goals. Understanding the issues, stressors, and concerns specific to the project and its watershed is not only essential for developing an appropriate project design, but is instrumental in the development of tailored, measurable (through objectives) and achievable goals. The following box model describes some major factors that should influence the formulation of project goals and objectives with an emphasis towards streams, given the more challenging nature of stream ecosystem rehabilitation/restoration. These factors should be considered, even in a very qualitative sense, as early in the development process as possible even if measurements have yet to be made. This will likely reduce the uncertainty and variability in the determination of the approach/level of intervention, which in turn will limit the extent of revisions to the plan document and credit yield estimates.



One example of how the above factors may interact to influence the development of meaningful, tailored goals has to do with the integration of the approach (level of intervention) represented by the design approach, associated uplift expectations and the likely timeframe for its realization. For example, the opportunity for incorporating bio/biogeochemical factors into goals, objectives and monitoring endpoints is dependent upon the degree to which the following elements are in place or can be realized within the assessment/monitoring timeframe.

8.2.1. *Overall water quality* (chem. and fine sediment) sufficient to permit a distinction between a watershed control/reference sampling site and restoration/recovery sites is a pre-requisite. If water quality is very poor and insufficient to support communities of any quality, thereby "muting" the overall biological signal, then biological endpoints are less plausible; however, sites within catchments such as these may be stabilized for the purposes of limiting stressors to the receiving watershed leading to a focus on physical stability for goals and success criteria.

8.2.2 *Capacity for maintenance of instream hab (transport equilibrium)*

8.2.3. *Sufficient adjacent fine organic matter input*

8.*2.4* *Large woody debris*

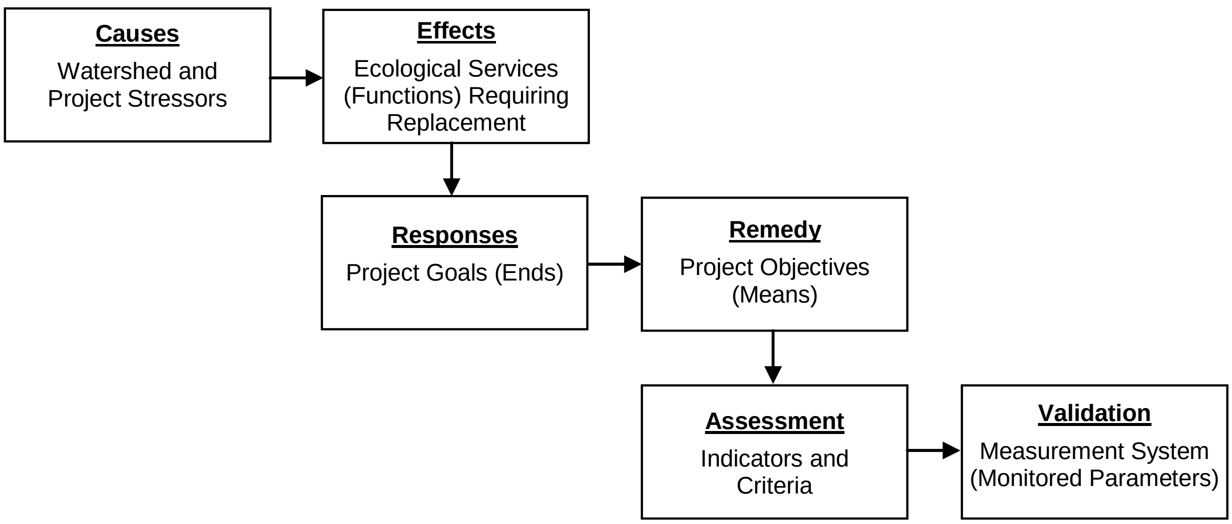
8.*2.5* *Complex, integrated cover/refugia*

8.*2.6* *Canopy derived thermoregulation*

Assuming the watershed in question is not considered untenable in terms of the pre-requisite watershed and stability factors (8.2.1-8.2.2.) and considering the 5-year timeframe under the current guidance, one can also see that channel size relative to the starting buffer condition (or buffer biomass) will be a main factor in determining the expectation of realizing 8.2.3 – 8.2.6 within the standard monitoring timeline and in turn the potential for discerning biological uplift within that timeframe. Put another way, a channel in a moderate to large drainage that was the subject of a significant relocation of its alignment, surrounded by young vegetation is less likely to be compatible with biological goals and endpoints in standard timeframes than a smaller channel or a channel with some adjacent mature vegetation at the outset.

8.3 Development of clear linkages between functional needs, goals, objectives and the validation of their attainment.

The following simple box model represents an overview of the key elements and their linkages (a project map of sorts) that should be central to the thinking of those involved in the development of goals statements, and designs for ecosystem rehabilitation projects. Deliverables such as Mitigation Plans currently represent the primary record for the development of functionally based project goals and also include the justification for the design approaches that should originate from them. Therefore these elements should demonstrate clear alignment, and the Mitigation Plan should clearly articulate the specific way these elements and their linkages apply to the subject project or project component. This model should be in the forefront of designer thinking and should shape the data collection, assessments and analysis that go into design and the development of the associated deliverables.



The format in the guidance section (App. B – *Guidance Exhibit 1*) below includes a detailed example of the above overview and represents one potential mechanism to explicitly elucidate these elements and their linkages. It is detailed, because some prior submissions have been lacking in describing these linkages and it isn't always fully clear to many consumers of these plans as to exactly which measurement parameters are addressing which goals and specifically those goals are designed to address which functional reductions/losses. The format below is one format provided as an example/exhibit, and there is certainly other ways to elucidate these linkages, but the reason for its inclusion in this guidance is to emphasize the central importance of the need for clarity and specificity for this topic.

9.0 Project and Design Justification (Stream Projects)

This section can be characterized as a functional 'balance sheet' of sorts. Project and design justification should be clearly detailed in the mitigation plan making it evident that the approach or level of intervention is proportional and appropriate to the conditions of the site and the watershed, such that the functional uplift is optimized. Optimization of uplift means that a maximum level of improvement is realized for any given level of disturbance, which is demonstrated by contrasting and comparing the existing impairment, impacts (to any sustainable standing value), and the sustainable uplift yields expected with the level of intervention being proposed. (i.e. enhancement versus more intensive measures).

9.1 Factors for consideration of reach treatment justification

It must be demonstrated in the document that these aspects of impairment:

- Nature/type (hydrological, mechanical)
- Degree (severity of impairment)
- Extent (proportion)
- Stage (what evolutionary stage)
- Rate (Expected rate of deterioration)

Are then contrasted and compare with existing features of value such as these

- Standing ecological value of instream habitat complexity
- Standing ecological value of mature vegetation
- The biological state of the channel

Although the state or standing value of some features like these may demonstrate some positive characteristics at the time of their assessment in the design phase, their sustainability given watershed trajectory, evolutionary factors, and channel boundary factors, need to be considered with at least as much weight as their current status is afforded. High uplift opportunities related to a given approach, even with some standing value, needs to be contrasted and compared as well. For stream projects, the following represents a framework of factors that the designer should demonstrate have been carefully weighed against one another or integrated.

9.1.1 Evolutionary Factors

- Reach evolutionary stage and morphological impairment
  - e.g. bank height, entrenchment ratios, W/D
- Rate of watershed change - trajectory
  - e.g. extent and projected extent of drainage network buffering
  - e.g. projected amounts, types and spatial distribution of LULC change.

9.1.2 Boundary Factors (Resistive Forces)

- Buffer & Banks – (Lateral)
  - e.g. longitudinal continuity of at least top of bank buffer
- Substrate
  - e.g. Soil (Lateral) soil erodibility factors
  - e.g. Bedrock (Vertical) Reach density of control points

9.1.3 Uplift Modifiers

e.g. High riverine wetland yields from a stream project
e.g. Good standing instream habitat features
e.g. Existing biological status
e.g. Restored groundwater infiltration through a root zone

9.1.4 Alignment Factors

- Valley Position
- Pattern

A key point to the above is that the streams that are typically described as impaired (G&F types), occur in nature. Although they may not often exist in a highly functional state, these forms are naturally occurring. What is unnatural and at least as important in describing impairment, opportunity and sometimes paradoxically, risk, is the rate at which a channel is expected to progress through these transitional stages of deterioration. The rate, due to various watershed and boundary factors, is what can be unnatural and be characterized as the man factor of impairment.

This is not to say that troubling bank height and entrenchment ratios related to floodplain access/relief are to be ignored when determining the level of intervention. On the contrary, these are of course key parameters for consideration. However, when examining the evolutionary stage in concert with the expected watershed trajectory (9.1.1) and then integrating that with the boundary factors (or resistive forces), one can at least get a coarse sense as to the likely rate that the reach will progress through these transitional phases of deterioration (e.g. incision /widening) and then get a sense as to whether or not any standing value that may currently exist is sustainable.

Should the integration of key factors of channel evolution (9.1.1) and boundary (9.1.2) still leave substantial uncertainty as to the optimized level of intervention, other factors that can help characterize the impacts or the gains/yields should be considered. These are loosely given the term "uplift modifiers" (9.1.3) for the sake of this discussion. These should always enter the calculus in some fashion and should be influential, but may be particularly useful when uncertainty still remains after integrating 2 key elements such as evolutionary factors and boundary factors.

For example, if a reach has some morphological impairment, but meaningful amounts of standing value (9.1.3) and the likely rate of it's transition through the phases of incision/widening will be modest because of the watershed trajectory, then the reach may be able to maintain some level of standing value/function and therefore uplift may be best optimized through less intense levels of intervention (e.g. enhancement). This may be especially true if some major stressor (e.g. livestock) to the system is removed as part of the enhancement measures.

Another example of this, but from the perspective of taking a more intensive approach could be a candidate reach that exhibits the following characteristics:

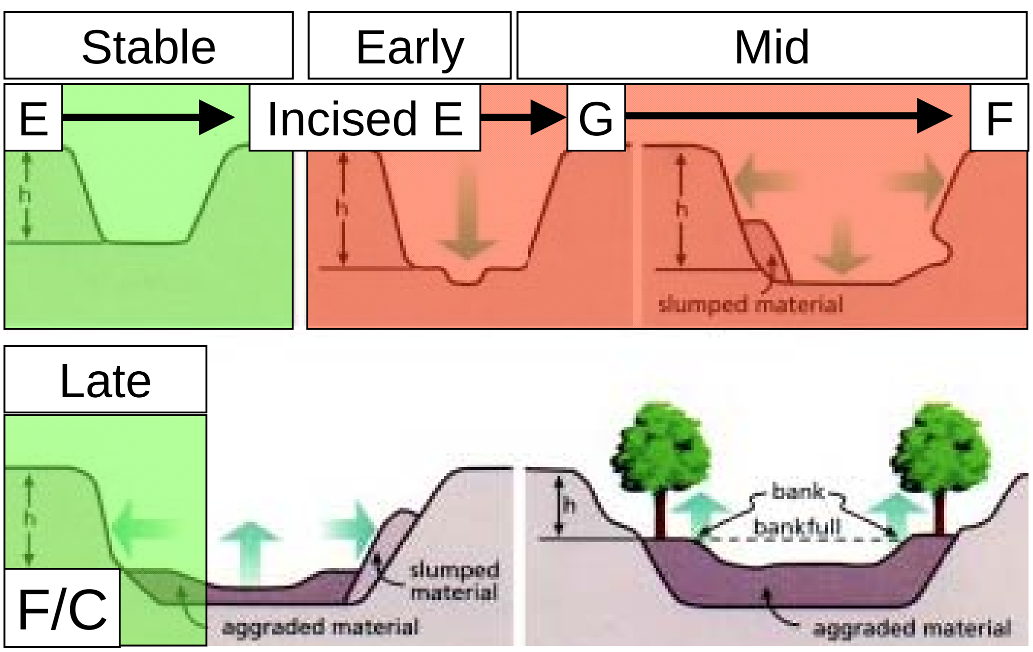
- Some meaningful secondary instream habitat features (not classic riffle pool sequencing, but scour pools, secondary channels, sustainable modest undercut banks and wood/leaf derived habitat)
- Some mature, but discontinuous vegetation along the top of bank, but exhibiting little buffer width.
- Incision and floodplain detachment, and
- Modest treefall rates into the channel.

When evolutionary factors and boundary factors are then integrated, the level of intervention may still remain somewhat unclear because of the mixture of impairment and standing value the above characteristics represent. However, if site elevations and access to the relict channel location will facilitate the re-hydration of large riverine wetland acreages, this may be one example of where expected yields may justify intervening with a priority I type restoration effort. This may impact some of the standing value, but the uplift yields may justify it. Before finalizing any such decision, another key element to consider is whether the boundary and evolutionary factors indicate that any resident standing value is likely transient or sustainable without intervention.

Another scenario which has been encountered in some prior submissions is where morphological data indicates a stable stream type, such as a Rosgen E, but the reach is demonstrating levels of incision that represent a borderline concern (e.g. BHR=1.3-1.4). Collectively however, the morphological state (ER, W/D) was not that concerning, but when evolutionary factors (e.g. watershed trajectory) and boundary factors (e.g. absent buffer, non-cohesive soil, no vertical control) were integrated with the threshold of concern for the incision, the designer determined that the combination of these factors warranted a more intensive restoration effort to include significant benching, reference pattern as well as structures for habitat and vertical control. Under this scenario it was surmised that the reach was at the onset of a period of deterioration likely to demonstrate continued incision and widening at a rate not likely to be characterized as "reference". Soil conditions and lack of vertical controls made it unlikely that plantings or bio-engineering methods alone would prevent reach deterioration and therefore any elements of standing value were not likely to be sustainable.

Although intensive intervention usually occurs further along the continuum of incision and/or widening than this example, intervening at this stage when other factors support it, likely means that the maximum amount of deterioration can been circumvented. In other words, this scenario can represent the ideal point to intervene (see graphic below). <u>However, great care should be taken to examine and integrate these factors into a decision framework before arriving at such an approach</u>. The modest morphological impairment creates a somewhat higher standard of proof using the other factors in order to have confidence that the more intensive approach would be the correct course of action.

A similar example to the one above, but at the other end of the evolutionary spectrum is a case where the channel classifies as an F, but is on the verge of re-stabilizing at its new elevation. This is described in both the Simon and Rosgen channel evolution models (see graphic below). The vast majority of the incision and widening has occurred and although the entrenchment ratios may be typical of an entrenched F, the slumped bank material from the widening phase is stabilizing into new bankfull benches, with base flow developing pattern in the bed. The F characteristics however, may prompt an observer or consumer of the plan document to call for significant, systemic intervention in the form of channel modification or even relocation. Although the condition described may not represent high function, the opportunity for bypassing the bulk of the deterioration has passed, and localized resloping of shear banks that are now serving as terrace risers coupled with some planting may be the extent of the intervention that is advisable (i.e. maximum remaining potential-optimization). Any standing value in the form of mature top of bank vegetation or any instream complexity would only reinforce this enhancement approach. If site elevations permitted a high yield opportunity such as a significant increase in bed elevation as part of a high quality priority 1, the aforementioned factors/reasoning might be outweighed by this, but the functional improvement potential would have to be very significant and extremely well characterized.



Finally, channel alignment factors (9.1.4) represent another major category to integrate. While the absence of pattern and idealized valley positions can and do have functional consequences, the same basic question applies as to whether evolutionary factors, boundary factors, and standing features of value would outweigh or support the impetus for channel relocation. In some cases inadequate pattern and non relict valley position has been a driver for intensive levels of intervention in the form of significant channel modification and/or relocation without it being made clear that the other factors described in this section were integrated into the decision framework. This can leave uncertainty in the justification for the chosen level of intervention.

The overriding point to the narrative in this section and these examples is that it must be made very clear to the consumers of these plan documents that these factors are being considered and integrated in a logical and comprehensive way (i.e. functional balance sheet) to support justification of the level of intervention and in fact, the project itself. The degree to which this has been accomplished in some prior submissions has been variable.

9.2 <u>Functional Uplift/Improvement characterization as a component of reach treatment justification</u>

As indicated in section 4.0, the existing conditions survey needs to include a representative sample of the reach morphological variables beyond those stable areas facilitating design, because of the functional uplift baseline that the pre-existing condition represents. Likewise, other elements of design development and site assessment including stability analyses, sediment transport analyses, soil assessments, hydrologic modeling, vegetation assessment, and biological assessment among others, may provide a resource for demonstrating the uplift potential of the proposed reach treatment.

Another limitation of some prior submissions is that there has been an overabundance of poorly justified qualitative statements surrounding characterization of reach impairment/condition. Given that post-construction monitoring captures the proportionality of reach performance, having a quantitative pre-construction analog is important to characterization of uplift potential and in turn justification for reach treatment. This not only services justification, but the very important task of regulatory closure.

EEP needs its designers to examine the data collection that they plan to perform for design development purposes, consider the functional categories that can/will be addressed, and “mine” those data resources for uplift statistics and uplift exhibits to support reach treatment justification and closeout applications. Moreover, and in addition to the direct development of goals and objectives, these considerations should actually factor in to what the designer plans to collect to characterize the pre-existing state and should not necessarily be limited to only “mining” byproducts of design centric data collection. If standard design data collection activities are sufficient to support justification and closeout applications then those resources will suffice, but careful consideration should be given to other types of data.

Section 4.0 identifies where the subset of morphological design parameters that are of interest for pre and post comparison can be found. Appendix B provides some guidance exhibits for the types of parameters that might support reach treatment justification and demonstration of functional improvement. These exhibits are elements that were either provided by certain design firms or asked for by EEP on specific projects for the purpose filling gaps in the kinds of decision framework elements described in section 9.1.

Guidance exhibit 2 is a simple graphic representation of different density levels of secondary habitat features. This kind of information is one potential uplift modifier as described in section 9.1.3 that should be part of an integrated decision framework for determining and justifying the level of intervention. Depending upon the level observed it could also serve as a means to characterize the potential for functional uplift directly, by comparing the amount and diversity of these features to the bedform habitat yields expected from the design. These data need not necessarily be mapped as the exhibit indicates, but the kind of data that the graphic represents should be tallied into distributions to service such comparisons. On a similar functional topic, guidance exhibit 3 provides a contrast between the existing, featureless profile and the proposed profile. While this is somewhat qualitative it still provides the reader with a tangible linkage as to how an expected form of functional improvement is supporting functionally based goals. The quantitative distribution of bedform is a parameter that is included in the morphology baseline tables in the monitoring baseline and annual report templates, so designers should be extracting these data as part of their characterization of functional uplift potential.

Guidance exhibit 4 provides the spatial distribution of BEHI hazard ranking categories. Table 3 in App. A provides the reach tallies for this kind of data potentially making the mapping that exhibit 4 represents, unnecessary. Given that EEP tracks the proportions of active bank erosion within each reach as a standard part of monitoring, the proportion of actively eroding bank as opposed to BEHI should be a statistic that is captured and mapped pre-construction. Each design should provide a complete site assessment for BEHI, not just at cross-sections, and provide proportions by reach of eroded failing banks to provide a robust baseline for comparison to later monitoring.

In guidance exhibit 5, HEC-RAS models that were run for design purposes or flood study purposes (assuming necessary resolution) can be run at discharges between bankfull and some small multiple of bankfull for the purpose of characterizing flood capacity or attenuation potential of the design condition as compared to the pre-existing condition. Depending on the nature of the approach and the degree to which hydrologic function is an expected uplift component, this may be a reasonable uplift exhibit or statistic. The difference between flooding acreages before and after could represent the "take-away" statistic. Given that these models are being run with regularity explicitly for design purposes, this exhibit or something like it could simply be a byproduct of those activities. Other statistics of interest could be peak flow reductions or the proportion of a given discharge that exists over a floodplain feature before and after the design is constructed.

Guidance exhibit 6 can provide the reader with an understanding of the level of riparian enhancement through aerial mapping of existing buffer condition and the extent to which invasive species have impacted the site, providing a contrast to future plan views in the monitoring phase.

These examples were provided to stimulate designer's thoughts on these subjects and undoubtedly, design providers can conceive of other statistics or exhibits that might apply to their projects, which would support the applications described in this section.

9.3 Design coherence/convergence of stream projects

Within the context of the requirements of a technically thorough stream design, the best examples make it evident that the designer has thoughtfully optimized the design in terms of section 9.1 and cost/risk benefit (e.g. $$ in - sustainable functional uplift out). It is evident that the design is coherent by demonstrating convergence between different lines of evidence providing confidence in the approach and design targets. That is, for stream projects, the final design demonstrates convergence between site indicators, photos, reference data, hydraulic geometry relationships, sediment transport assessments, and process models or any other techniques, tools, and approaches utilized in the design. Just as important, when some divergence is encountered there is a defensible rationale for how and why the design has been influenced and adjusted. The most useful designs in terms of review and approval include a narrative in the mitigation plan that makes all of this clear, tying the various data streams together supporting the assertions about the design approach and expected functional yields.

APPENDIX A

Table 1. Project Components and Mitigation Credits
Project Name/Number

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals									

Project Components

Project Component -or- Reach ID	Stationing/Location	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration						
Enhancement						
Enhancement I						
Enhancement II						
Creation						
Preservation						
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes

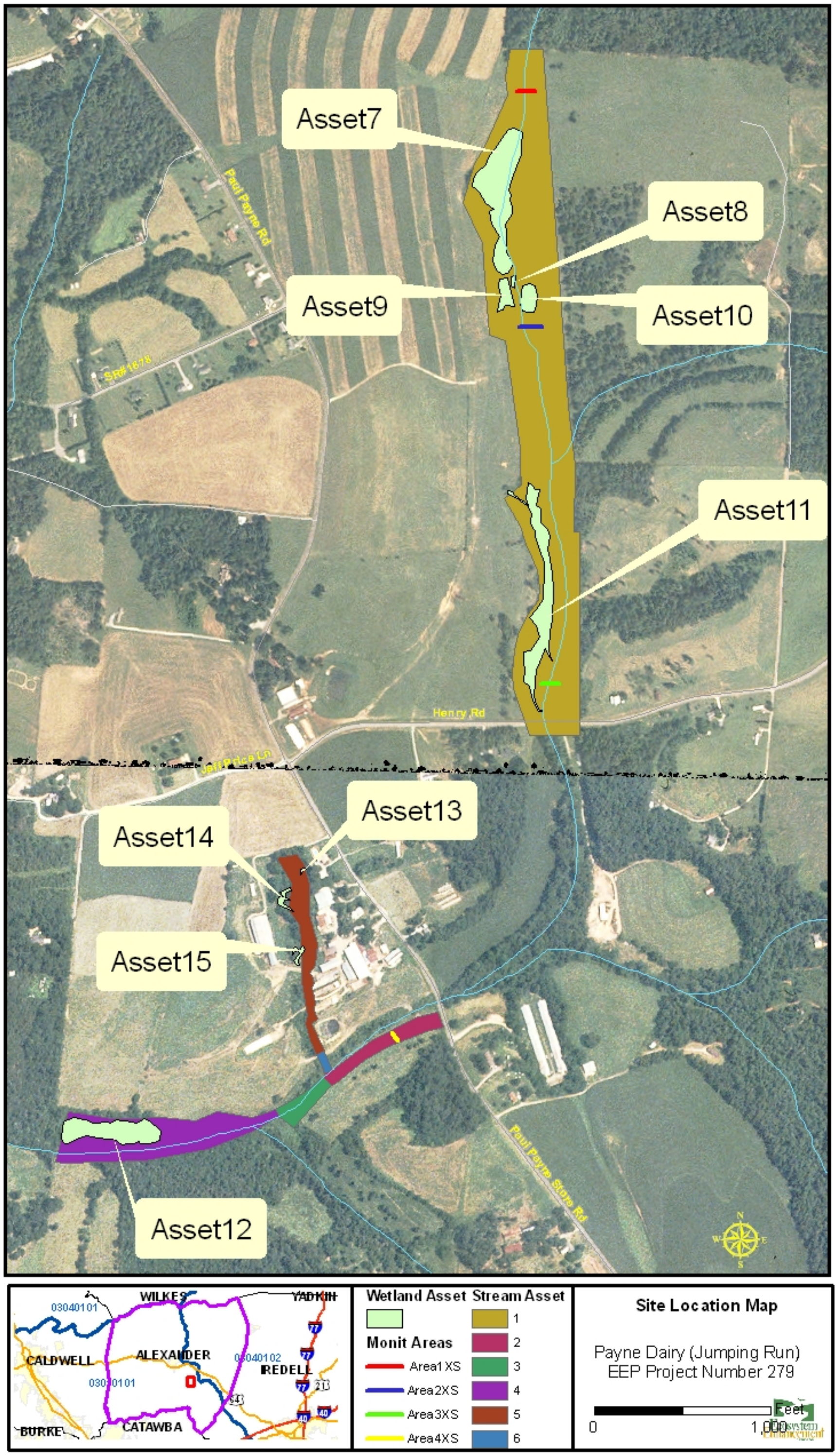
BMP Elements
BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

Table 2. Describes the existing conditions, reference conditions, and design condition. Note the sample table is incomplete. EEP expects full morphology table inclusive of BHR and all typical dimensionless design ratios etc.

Table 2. Morphological Table Project Number 123456 (UT to Crooked Creek)			
Item	**Existing Conditions**	**Designed Conditions**	**Reference Reach**
LOCATION	UT to Crooked Creek	UT to Crooked Creek	South Unnamed Trib. To Marks Creek
STREAMS TYPE	F5	C5	C5
DRAINAGE AREA, Ac	341.00 Ac	380.00 Ac	65.02 Ac
BANKFULL WIDTH (W_{bkf}), ft	16.4 ft	15.0 ft	11.1 ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.81 ft	1.15 ft	0.72 ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	20.2	13.0	15.4
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	13.3 ft^2	17.3 ft^2	8.0 ft^2
BANKFULL MEAN VELOCITY, fps	4.3 fps	3.9 fps	2.1 fps
BANKFULL DISCHARGE, cfs	56.6 cfs	61.2 cfs	17.2 cfs
BANKFULL MAX DEPTH (d_{max}), ft	1.91 ft	1.50 ft	1.80 ft
WIDTH Flood-Prone Area (W_{fpa}), ft	24.8 ft	67.5 ft	59.1 ft
ENTRENCHMENT RATIO (ER)	1.5	4.5 – 4.6	5.3
MEANDER LENGTH (Lm), ft	6 – 29 ft	45.0 – 135.0 ft	19.7 – 42.0 ft

Table 3. Describes BEHI/NBS and sediment export estimates for project site streams and reference streams.
Note: <u>In addition to BEHI, consultants will minimally provide proportions of bank that has exhibited or is exhibiting actual instability (scour, erosion, mass wasting etc.) instead of just the potential that BEHi represents in each reach in order to provide a parameter that is a true analog to data from annual monitoring</u>.

Table 3. BEHI and Sediment Export Estimates for Project Site Streams Project Name/Number (XYZ)															
Time Point	**Segment/ Reach**	**Linear Footage or Acreage**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very low**		**Sediment Export**
			ft	**%**	**ft**	**%**	**ft**	**%**	**ft**	**%**	**ft**	**%**	**ft**	**%**	**Ton/y**
Pre-Construction	Reach I	1000 lf	200	20	Etc.										
	Reach II	400 lf	100	25											
	Reach III-trib	400 lf	300	75											
	Project Total	1800 lf	600	33											



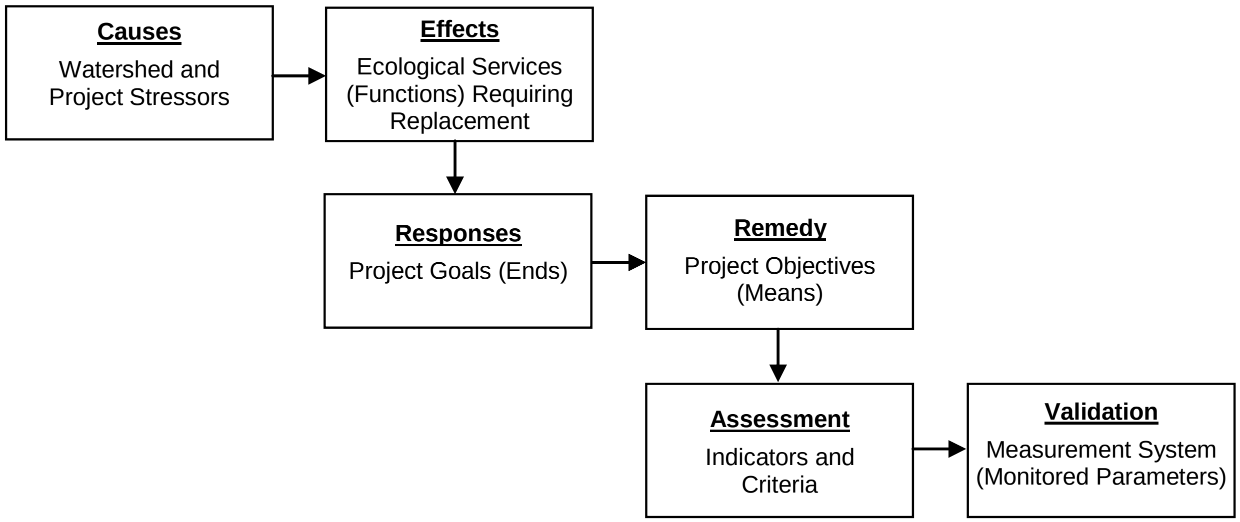
<u>Exhibit Figure 1</u>. Combination vicinity and restoration component/asset map. Just an example, a second figure at another scale may be needed/advisable.

APPENDIX B

Guidance Exhibit 1

Concepts and Formats for the Development of Clear Linkages between Functional Needs, Goals, Objectives and the Validation of their Attainment in Stream and Wetland Rehabilitation Projects

The following model represents an overview of the key elements and their linkages that should be central to the development of goals statements, and designs for stream and wetland rehabilitation projects. Deliverables such as Restoration Plans currently represent the primary record for the development of functionally based project goals and also include justification for design approaches. Therefore the Restoration Plan should clearly articulate the specific way these key elements and their linkages apply to the subject project or project component. This model should be in the forefront of designer thinking and should shape the data collection, assessments and analysis that go into design and the development of the associated deliverables.



The format below includes a detailed example of the above overview and represents one potential mechanism to explicity elucidate key elements and their linkages. The detail and specificity of the linkages has been lacking in some prior submissions, and often it isn't fully clear to many consumers of these plans as to exactly which measurement parameters are addressing which goals and specifically which goals are designed to address which functional reductions/losses. The goals in this example are still somewhat general, but with actual projects site and watershed conditions coupled with ERTR information they would be tailored further. It should also be noted that the linkages between the goals, objectives, indicators and measurement systems provides another aspect or level of tailoring in and of itself. This is one format provided as an example/exhibit, and there are certainly other ways to elucidate these linkages, but the reason for its inclusion in this guidance is to emphasize the central importance of the need for clarity and specificity. The specific indicators and criteria were provided as examples and should not necessarily be taken as standard criteria. Designers can use them if they feel they are appropriate to their project, but does not absolve a designer/provider from a thorough, careful and independent development of goals, objectives and monitoring elements. The examples related to stream components are centered on channel morphology, because of the relatively large channel in this example given the riparian biomass expected within normal monitoring timeframes. This precluded more integrative, dependent endpoints such as biological endpoints in this example, but if site conditions and approach are compatible with such endpoints then they should be considered as well. Some of the indicators overlap, but many were provided for thoroughness given the exhibit nature of this guidance. The numbers in the cells on the right side of the tables below represent relevance to the numbers in the group above it. So, as an example, in the Effects Group (group 2.0), item 2.7 is a reduced function/ecological service, that was the result of stressors 1.6, 1.7, and 1.3 with the first (1.6) representing the most direct linkage. Those that follow (1.7 and 1.3) become increasingly indirect, albeit still valid. Given the degree to which establishment of a hierarchy is possible, this could provide another means of tailoring this goals and success format. Each group/element is linked to the one above it in this way with the exception of the indicators and criteria (Groups 5.0 and 6.0), which are linked in a one to one fashion. The indicators (Group 5.0) are also linked to functional categories to which they are expected to support.

Exhibit Goals/Success Table. If a table such as the example below is utilized to delineate goals/success linkages as opposed to some other format/mechanism it will assume the header of Table 2 in the table sequencing and the other tables listed above will adjust

Example Structure for Reach Level Goals/Success for Development in Planning and/or Early Design Phase

Scenario- Piedmont, Rural, Pasture, 20-25 W_{bkfl}, PII, New Alignment, Riverine Wetland, Minimal Mature Veg)

			1	2	3	4	5	6	7	8	9
1.0		**(Causes) Watershed and Project Stressors**									
	1.1	Mechanical channel degradation and widening by livestock									
	1.2	Systemic Sedimentation									
	1.3	Buffer deforestation									
	1.4	Relocation of channel to unnatural valley location and alignment									
	1.5	Riparian compaction									
	1.6	Disconnection of wetland hydrologic features									
	1.7	Mechanical destruction and compaction of wetland vegetation and soils									
	1.8	Livestock derived eutrophication									
	1.9	Promotion of invasive, non-native vegetation biomass and seed sources									
2.0		**(Effects) Ecological Services / Functions Reduced and Requiring Enhancement**									
	2.1	Transport of watershed bedload sediments in equilibrium	**1**	**2**	**3**	**4**	**6**	**5**	**7**	**9**	
	2.2	Management and dissipation of flood flows	**1**	**4**	**3**	**5**	**6**	**7**	**2**		
	2.3	Hydrologic and biogeochemical attenuation of lateral overland flow	**3**	**4**	**5**	**6**	**7**	**8**	**9**		
	2.4	Biogeochemical attenuation of groundwater	**3**	**1**	**5**	**4**	**6**	**7**	**9**	**8**	
	2.5	Maintenance of instream habitat	**1**	**2**	**4**	**3**					
	2.6	Support of wetland habitat	**7**	**3**	**4**	**6**	**5**	**9**			
	2.7	Support of wetland hydrology	**6**	**7**	**3**						
	2.8	Provision of riparian buffer habitat	**3**	**9**							
	2.9	Processing of organic matter inputs	**1**	**2**	**3**	**7**	**6**	**8**	**9**		
	2.10	Floodplain storage of fine sediments	**4**	**1**	**3**	**5**	**6**	**7**			
3.0		**(Responses) Project Goals**									
	3.1	Improve and sustain hydrologic connectivity/interaction	**2**	**4**	**7**	**6**	**8**	**5**	**10**		
	3.2	Better manage/attenuate site impacts of storm flows	**2**	**5**	**7**						
	3.3	Reduce nutrient and sediment stressors to the reach and receiving watershed in the near term	**10**	**1**	**3**						
	3.4	Provide for uplift in water quality functions over the long-term	**4**	**9**							
	3.5	Improve instream and wetland aquatic habitat in the near term	**5**								
	3.6	Provide for greater overall instream and wetland habitat complexity/quality in the long term	**6**	**8**							
	3.7	Improve and maintain riparian buffer habitat	**8**								

The above represent rough rankings (1.6, 1.7, 1.3) in that order for the watershed and project stressors that relate to the functional reduction 2.7 below. The other groups/levels on the following pages are linked in a similar fashion

Example Structure for Reach Level Goals/Success for Development in Planning and/or Early Design Phase

Scenario- Piedmont, Rural, Pasture, 20-25 W_{bkfl}, PII, New Alignment, Riverine Wetland, Minimal Mature Veg)

			1	2	3	4	5	6	7	8	9
4.0		**(Remedies) Project Objectives**									
	4.1	Implement a sustainable, reference-based, rehabilitation of the reach dimension, pattern and profile to provide needed capacity and to support bedload transport equilibrium.	**1**	**2**	**5**	**4**	**3**				
	4.2	Strategically install stream structures and plantings designed to maintain vertical stability, lateral stability and habitat to the stream channel	**1**	**5**	**3**						
	4.3	Provide a sustainable and functional bankfull floodplain feature	**1**	**2**	**4**	**5**					
	4.4	Install vernal floodplain pools to provide riparian habitat diversity and hydrologic storage	**1**	**2**	**4**	**5**	**6**	**7**			
	4.5	Enhance and maintain the hydrologic connection of riverine wetland features to stream hydrology	**5**	**6**							
	4.6	Install, augment and maintain appropriate riparian buffer and riverine wetland community types with sufficient density and vigor to support native succession.	**7**	**6**	**4**	**5**					
	4.7	Provide sustainable livestock exclusion from the channel and riparian zone via fencing of the projects conservation easement and through off-site needs/BMP support	**3**	**4**	**6**	**7**					
	4.8	Decommission a livestock waste pond that represents a risk to the projects resources	**3**	**4**							

			Stability		WQ	Hydro		Habitat										
5.0		**(Assessment) Success Indicators**	VS	LS	WQ	FA	WH	BIH	RH									
	5.1	Proportion of downcut/headcut segments within the profile	x			x				**3**	**1**	**2**	**5**					
	5.2	Bank Height Ratio distributions	x			x				**3**	**2**	**1**						
	5.3	Integrity of grade control structures	x			x		x		**2**	**3**	**1**						
	5.4	Proportion of mid channel bars within bed/profile		x				x		**1**	**3**	**2**						
	5.5	Maintenance of a distinctive and diverse profile (bed faceting)						x		**2**	**1**	**7**						
	5.6	Bedform distributions						x		**2**	**1**	**7**						
	5.7	Bed substrate distributions			x			x		**1**	**2**	**7**						
	5.8	Proportions of active bank erosion		x	x	x		x		**2**	**1**	**3**	**5**	**7**				
	5.9	Channel bankfull width distributions		x	x	x		x		**2**	**1**	**3**	**5**	**7**				
	5.10	Bankfull area distributions	x	x	x	x		x		**2**	**1**	**3**	**5**	**7**				
	5.11	Entrenchment Ratio distributions				x				**3**	**4**	**5**						
	5.12	Bankfull overbank frequency/duration				x				**3**	**5**	**4**	**1**	**2**				
	5.13	Woody stem density		x	x	x	x	x	x	**6**	**2**	**7**						
	5.14	Diversity of woody stems					x	x	x	**6**	**7**							
	5.15	Stem vigor		x	x	x	x	x	x	**6**	**7**							
	5.16	Site status of high threat invasive species						x	x	**6**	**2**							
	5.17	Wetland hydrology					x		x	**4**	**5**	**6**	**7**					
	5.18	Site status of WQ and HAB stressor reduction measures (BMP)			x			x	x	**8**								

Stream Function Prerequisites – Those elements upon which the attainment of higher function is fundamentally dependent

- VS – Vertical Stability (dynamic)
- LS – Lateral Stability (dynamic)

Direct Functional Categories – The indicator has a more direct relationship with or implications for the functional category listed

Water Quality
WQ – Water Quality

Hydro
FA – Stream Floodplain Access and Flood Attenuation
WH – Wetland Hydrology

Habitat
BIH – Bedform/Instream Hab
RH – Riparian Habitat

Example Structure for Reach Level Goals/Success for Development in Planning and/or Early Design Phase (Scenario- Piedmont, Rural, Pasture, 20-25 W_{bkfl}, PII, New Alignment, Riverine Wetland, Minimal Mature Veg)		
6.0		**(Assessment) Criteria**
	6.1	**Proportion of downcut/headcut segments within the profile (Dynamic Stability of Reach Profile)** – Profile should exhibit stable patterns of variation, that is, occurrences of change in bed elevation over the monitoring period are vertically small (generally <20% of max riffle depths), localized, and vary year to year in their longitudinal position within the profile, simply representing bedload transport related to storm processes as opposed to an overt trend in the elevation of significant continuous segments (15-20%, ~400 feet for your average 2000 foot reach). These guidance criteria may be exceeded if there was an initial adjustment in response to a rare storm event shortly after construction and subsequently the reach does not exhibit additional degradation or 'arrests' when challenged by additional events ≥ bankfull in the ensuing years.
	6.2	**Bank Height Ratio distributions** - Mean Bank Height Ratios (BHR) should not exceed 1.4. If adjustments do occur that lead to averages in this range, determination as to whether this is an acceptable new equilibrium point must be made through additional monitoring to demonstrate that no additional downcutting occurs in response to 2 additional bankfull events. Care is to be taken to discern BHR increases that are the result of actual downcutting versus the healthy construct of natural levee features. Cross-sections and long pro should be examined and cross-referenced to help make these distinctions.
	6.3	**Integrity of grade control structures** – Projects that include grade control structures should not demonstrate multiple, sequential grade control failures with any frequency. Should the reach demonstrate continuous segments (i.e. 1 or 2 segments totaling 20-25% of the reach, ~500 feet for your average 2000 foot reach) threatened by future downcut risk, this would constitute a barrier to final success determination without remediation. Threshold tolerances should generally decrease as the project slope increases, particle size decreases, and/or the at-risk segment occurs downstream, thereby putting the bulk of the reach above it at future risk. Some level of disparate grade control failures is acceptable. The absence of these conditions would represent a positive success indicator. Loss of grade control constitutes physical deconstruction of the structure, very significant piping and/or evidence of actual grade loss in the bed upstream of the structure.
	6.4	**Proportion of mid channel bars within bed/profile** – The reach should not exhibit the frequent occurrences and maintenance of mid channel bar features that are clearly above base flow and/or exhibit recruitment of significant levels of herbaceous or woody vegetation. Bars of this type should not represent more than 10% of the reach bedform. The spatial distribution of these formations should also be considered with high spatial concentrations (clustering) leading to greater concern.
	6.5	**Maintenance of a distinctive and diverse profile (bed faceting)** – A qualitative observation made from the profile describing the degree to which distinct faceting in the bed is evident and maintained or re-develops towards then end of the monitoring period. Monitoring profiles are to be compared to the pre-existing and/or appropriate reference profiles for the purposes of this indicator/criterion. Using the same horizontal and vertical display scales the profile should exhibit a greater distinctiveness or diversity of bedform than the pre-existing condition more in keeping with the design profile and/or reference profile. Given that stream projects that involve significant alignment changes can often require a year or 2 to achieve their new equilibrium, evidence of this characteristic may be muted during this initial period. This is particularly true as many designers have learned/chosen to be cautious by slightly undercutting bankfull benches to address uncertainty in design and err on the side of allowing some lesser channel competency in the near-term to avoid degradation risk in the long term.
	6.6	**Bedform distributions** – Quantitative extract from 6.1 that represents 6.5 quantitatively. Distributions of bedform types should demonstrate migration towards design and/or reference distributions. Pools should demonstrate maintenance of maximum depths or deepening or if some shallowing has occurred the ratios of max pool depths to mean bankfull depth should demonstrate maintenance within 25% of the design/reference values.
	6.7	**Bed Substrate distributions** - Indicates sediment transport equilibrium/efficiency and is an integral element to in-stream habitat. Should indicate that distributions (primarily D50 and D84) are migrating towards distributions described as part of the pre-existing conditions survey used to support bedform assessment and sediment transport calculations. Generally, riffles should coarsen and pools remain finer.
	6.8	**Proportions of Active Bank Erosion** - The cumulative occurrence of erosion and mass wasting should not exceed 15% of the project bank footage as a criterion or the proportions should represent a clear improvement over pre-restoration rates. The 15% guidance criteria may be exceeded slightly (5%) if there is evidence that prior instances of bank instability have arrested and are vegetating/stabilizing adequately through challenge by subsequent events ≥ bankfull.
	6.9	**Channel width distributions** - Maintenance or reductions of bankfull width (without concomitant increase in mean riffle bankfull depths) represent success related to this stability parameter. The bankfull channel may exhibit mean width increases (no higher than 20%) as long as there is evidence any systemic adjustment has arrested through challenge by subsequent events ≥ bankfull. Increases in width at the bankfull elevation should also be carefully viewed in the context of narrowing below that elevation such as via development of an inner berm feature. This can leave the impression of widening when these width values are examined independent of cross-sectional area and cross-section plots.

Example Structure for Reach Level Goals/Success for Development in Planning and/or Early Design Phase
(Scenario- Piedmont, Rural, Pasture, 20-25 W_{bkfl}, PII, New Alignment, Riverine Wetland, Minimal Mature Veg)

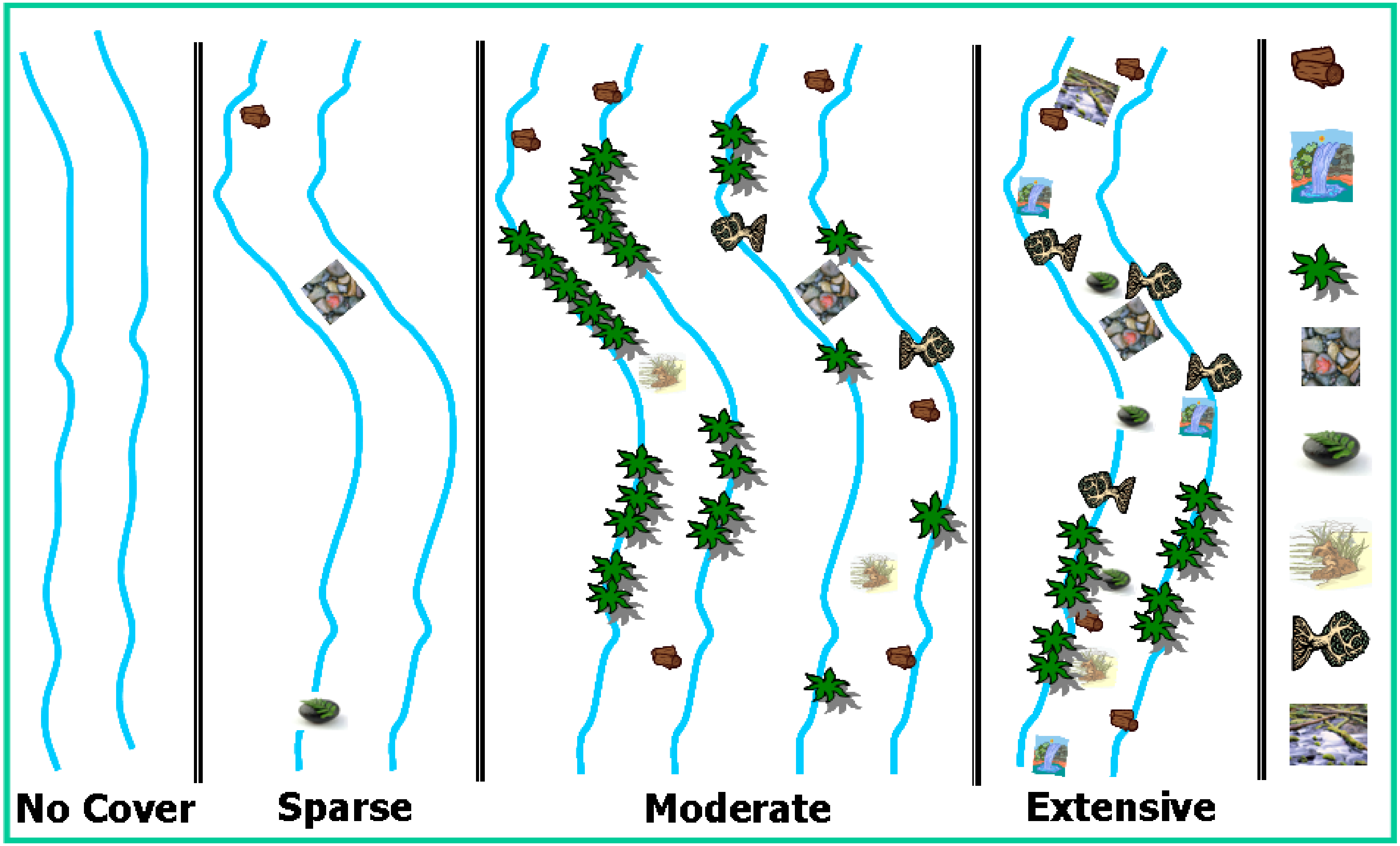
6.0 Con't		**(Assessment) Criteria**
	6.10	**Bankfull Area Distributions** – Considering criterion 6.1, 6.2, 6.6, 6.7, this can be somewhat of a redundant parameter, but it does integrate the cross-section capturing information that vertical or lateral parameters may not elucidate alone. It also more holistically indicates the degree to which floodplain access has been maintained. The mean riffle areas for the reach ideally should be maintained or decrease The bankfull channel may exhibit some aerial increases (no higher than 25%) as long as there is evidence any systemic adjustment has arrested through challenge by subsequent events ≥ bankfull.
	6.11	**Entrenchment Ratio Distributions** – Describes lateral flood relief extent and is a significant factor in stream classification under the NCD system. Values should be ≥ 2.5 for stable C/E floodplain stream types and ≥ 1.5 for B/Bc stream types or should not exhibit reductions > 25% compared to As-built values unless the reduction was this was the result of constructive floodplain deposition processes.
	6.12	**Bankfull overbank frequency/duration** – Describes floodplain access and the means to determine if the reach has been "challenged" and whether the geometry is stable and sustainable under storm pressures.
	6.13	**Woody stem density** – Regulatory guidance indicates a stem density of 260/acre at year 5
	6.14	**Diversity of woody stems** – the majority of the species identified within the planting plan should be present on site and represent a mixture of early and late successional species.
	6.15	**Stem vigor** – Where available, data should indicate that the stems are exhibiting healthy rates of growth
	6.16	**Site status of high threat invasive species** – Only trace amounts of high threat invasive species such as Kudzu, Knotweed, and other climbing species that represent a physical threat to the buffer as a whole should be present at any given time. The project must also include a long-term maintenance plan for the control of high threat species.
	6.17	**Wetland hydrology** – Hydrology data should indicate saturation within 12 inches of the surface for the hydro-period dictated by the project reference or 12% of the growing season, whichever is less.
	6.18	**Site status of WQ and HAB stressor reduction measures (BMP)** – The project easement must be spatially verified to be correct. Livestock fencing with signage marking the conservation easement must demonstrate integrity at the time of regulatory closure to ensure protection from livestock. Evidence must be provided that any prior hydrology diversions by landowners to livestock ponds within the easement were eliminated and any berms or topography are stabilized with vegetation such that the pond is decommissioned and eliminated as a water quality threat to the project.

Example Structure for Reach Level Goals/Success for Development in Planning and/or Early Design Phase
(Scenario- Piedmont, Rural, Pasture, 20-25 W_{bkfl}, PII, New Alignment, Riverine Wetland, Minimal Mature Veg)

			1	2	3	4	5	6	7	8	9
7.0		**(Validation) Monitoring and Measurement Systems**									
	7.1	Longitudinal profile	**1**	**2**	**5**	**6**					
	7.2	Cross-sections	**2**	**9**	**10**	**11**					
	7.3	Visual assessment/inventory of stream features	**1**	**8**	**12**						
	7.4	Visual assessment/inventory of channel structures	**3**								
	7.5	Visual assessment/inventory of the riparian zone	**12**	**13**	**14**	**15**	**17**				
	7.6	Substrate analysis	**7**								
	7.7	Vegetation Plots stem counts and vegetation assessments	**13**	**14**	**15**						
	7.8	Stream gauge for stream hydrology	**12**								
	7.9	Gauge data and wetland hydrology	**16**	**12**							
	7.10	Photographs	**18**	**17**	**3**	**4**	**8**	**12**	**15**		

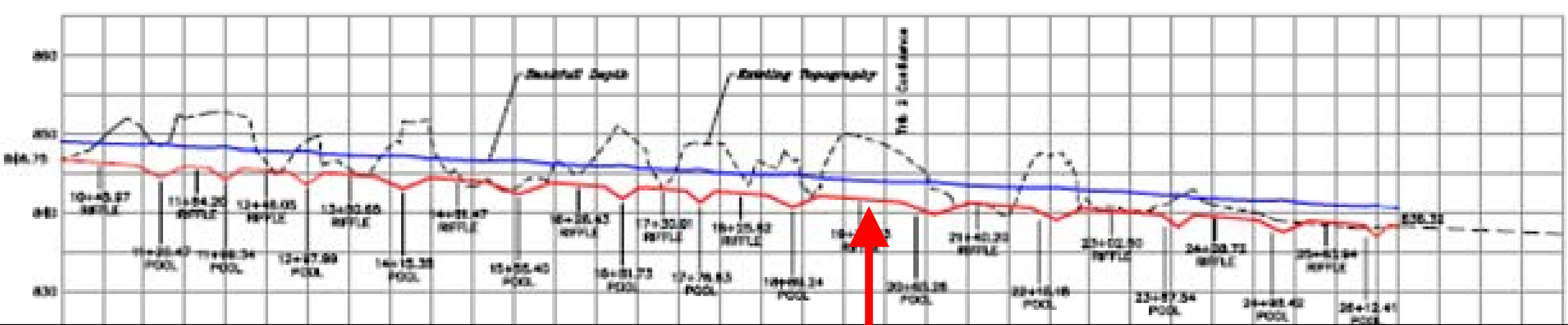
Guidance exhibit 2

Modifier - Existing Habitat Complexity (Standing Value)



Guidance Exhibit 3

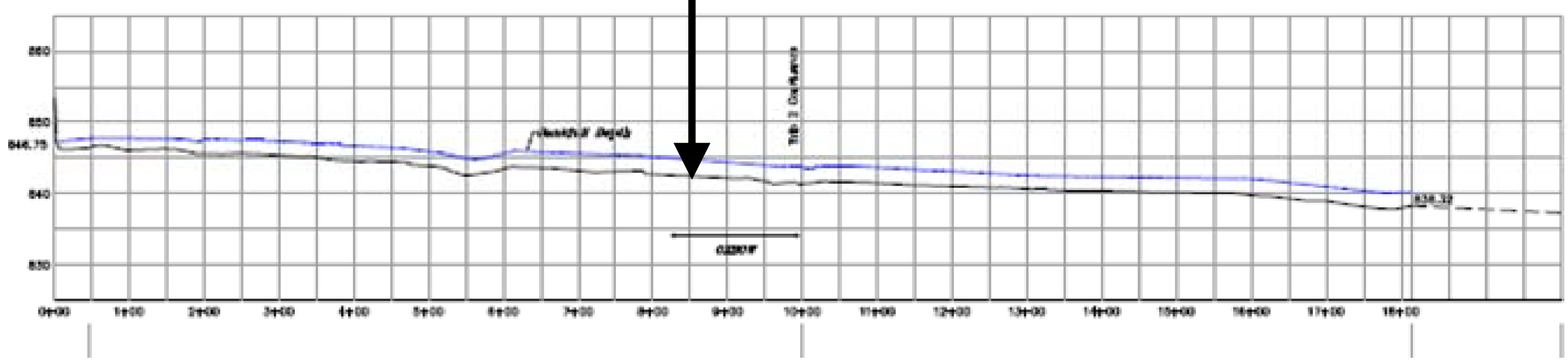
PROPOSED LONGITUDINAL PROFILE



Uplift in bedform diversity, faceted nature of bed profile existing and proposed

Instream Habitat Potential

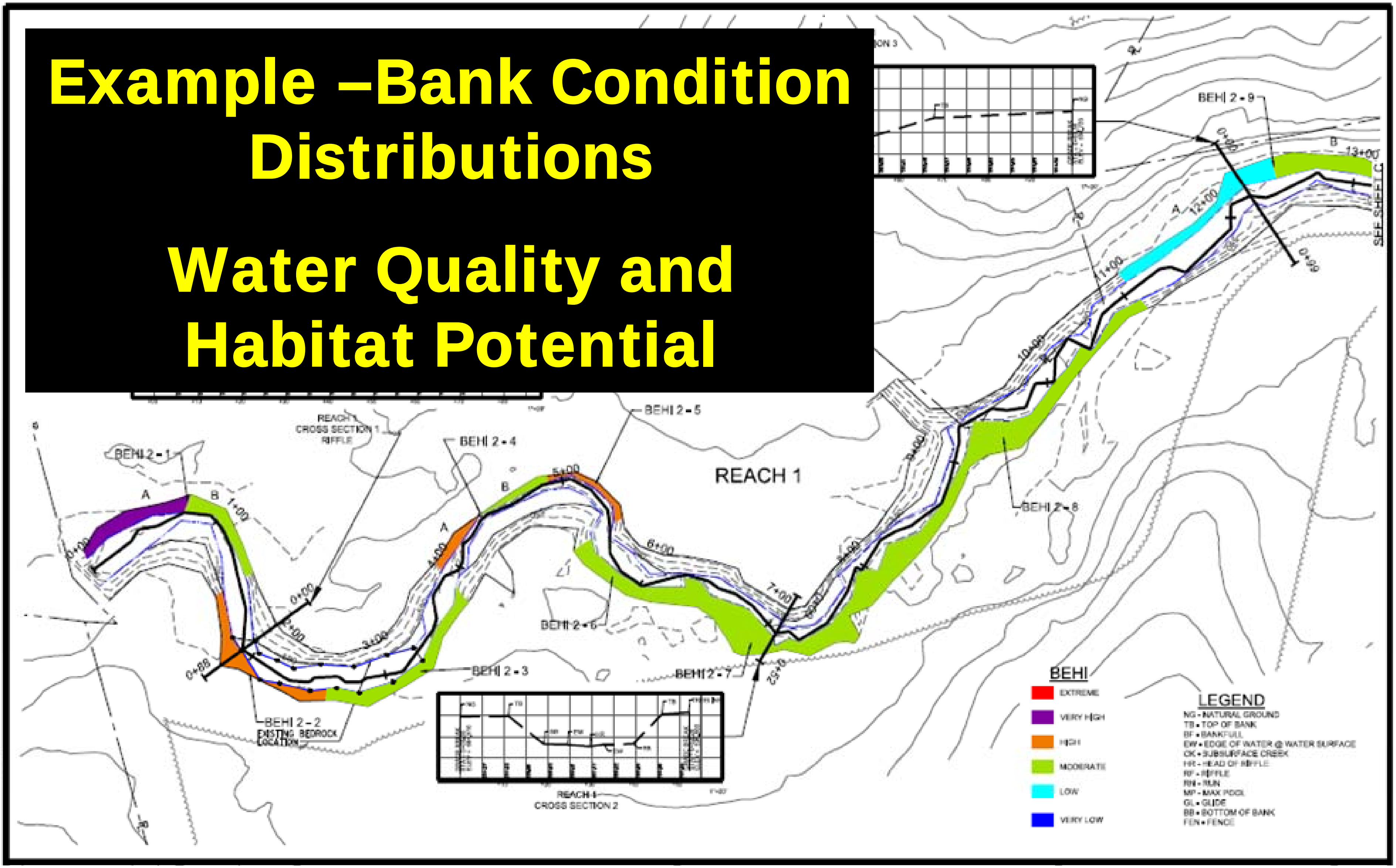
EXISTING LONGITUDINAL PROFILE (FOR COMPARISON)



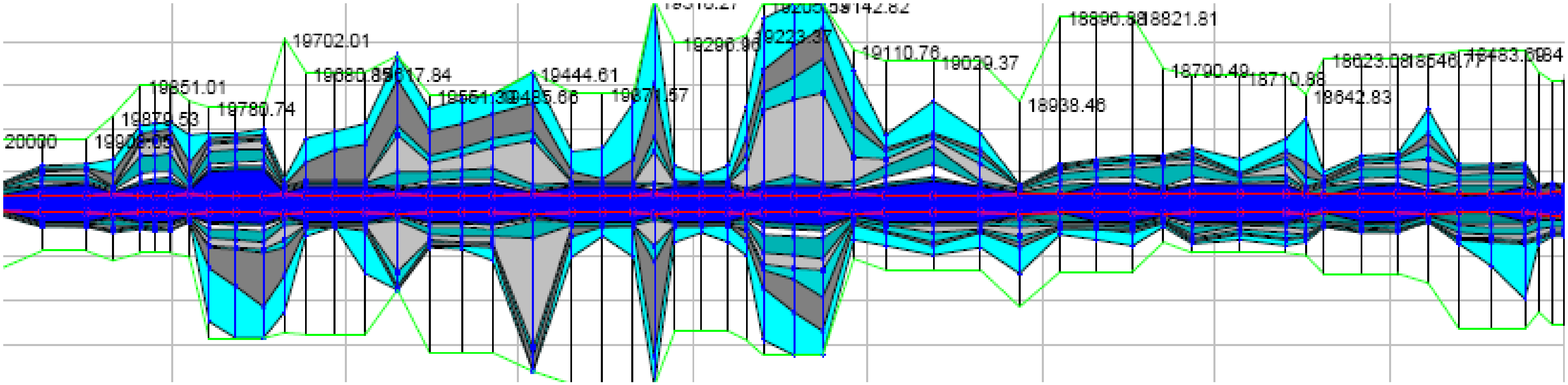
Guidance Exhibit 4

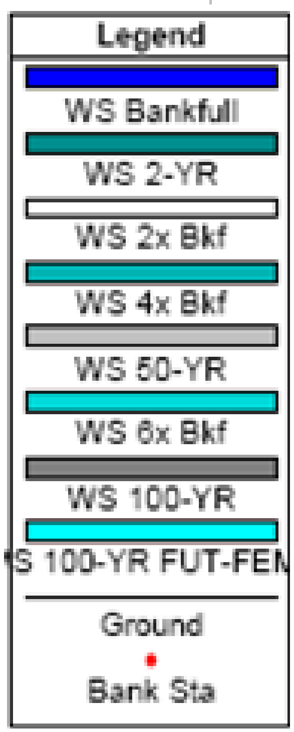
Example –Bank Condition Distributions

Water Quality and Habitat Potential



Guidance Exhibit 5





Example –

Flood contours > bankfull flows. Exhibit and stats are potential indicator of projects flood attenuation potential.

Guidance Exhibit 6

Example –

Pre-existing invasives mapping with threat levels, spatial distribution and opportunity to demonstrate extent of improvement.