WSDOT 2022 Fish Passage and Stream Restoration Design

12/19/22-12/21/22

Q&A for Progress Update (Julie Heilman, WSDOT)

- **Q: Is the 2023 exam available now or soon after this training or will we need to wait until a new exam is released later in 2023?**
    - A: It will be released in early 2023.
- **Q: How do we get involved in the tidally influenced culvert research?**
    - A: WDFW is leading that research. With respect to where WSDOT is in the process of developing tidal guidance, contact Susan Kanzler. We hope to have some additional guidance in our Hydraulics Manual update in spring of 2023 or a supplement.
- **Q: What is being done with respect to incorporating organic [material]? Is it the slash and small woody materials, or smaller material?**
    - A: We've partnered with Washington State University, which previously did research on meander bars and is currently doing research on incorporating organics. This is everything from slash in the stream bed itself to the stream banks. It's typically smaller wood (4-inch diameter). The research focuses on using small wood to maintain stability and its effect on scour. There will be further research on how to better incorporate organics in our crossings.
- **Q: Have we had any improvements in fish populations and returns in the areas that have already been improved?**
    - A: Yes, we've seen a lot of improvements. I don't know any hard numbers, but our fish passage program team could provide more. There are some projects where we're seeing a ton of fish in areas that haven't seen fish in decades.
- **Q: Have there been any lessons learned from passages requiring performance repair that can be used to inform design during PHD development and prior to commitment with comanagers?**
    - A: Yes, with every project we build and monitor we gain valuable data on the performance of complexity features. We make adjustments to design guidance as we go so the next project can benefit from those lessons learned. Meander bars are a good example. That's something we've been incorporating in some of our Performance Management Repairs where we've seen the bed go plane bed. We had projects that didn't have that complexity feature incorporated at the beginning, and so a lot of those decisions are being incorporated in the PHDs now. This whole program is a learn-as-we-go, and as soon as we know how to improve upon our designs and methods, we incorporate that int the next PHD and even in some FHDs. For projects that go Design-Build, we try to coordinate

with the design-builder and share the real-time updates for whatever current guidance we have. So we're constantly learning and evolving.

- **Q: Are the corrected barriers performing as expected?**
    - A: Most of the crossings are performing as expected. However, there are a lot of experimental features being implemented and at times we must make adjustments to those features. All crossings are monitored to make sure fish passage is achieved. If, through the monitoring, it is determined that a crossing has adjusted and a barrier is formed, WSDOT conducts Performance Management Repairs to maintain fish passage.
- **Q: How do railroads fit into the injunction?**
    - A: The injunction itself was for state agencies, including WSDOT, WDFW, DNR, and state parks. Local agencies and other entities are being very proactive in wanting to correct their barriers, but they're not part of the injunction.
- **Q: This year, the water in the streams was very low. How are design criteria being updated to address low-flow conditions in the fall, which are being exacerbated by climate change?**
    - A: Current climate change guidance is focusing on the areas of larger flows, particularly with respect to structure size and scour using the predicted 2080 100-year flows. We do address low flow through design and construction methods that prevent subsurface flow, but more research is needed to determine how to address those areas with lower flows expected through climate change.
- **Q: Fish passage has been around for a while... RMAP started early 2000's so how can WSDOT learn from lessons learned in RMAP? A lot of that work was on steeper areas w sites up to 20% gradient... I permitted several over 15% that have been highly successful. And that was mostly all based on Stream Sim to the environment in which the structure was being built.**
    - A: We do plan to collect information from previously constructed steep crossings and how they are functioning. We have already determined that stream sim is likely not enough for steep system.

Q&A for Module 4: Hydraulic Design Process (Heather Pittman, WSDOT; Julie Heilman, WSDOT)

- **Q: What is the most challenging [kind] of fish passage barrier, and why?**
    - A: We have a few that go through urban areas and those are some of the most challenging because we have to balance infrastructure impacts and stream design. It tends to push the limits of structures, alignments, etc.
- **Q: Are zero slope culverts a thing of the past?**
    - A: Effectively, yes. WSDOT no longer uses the zero-slope design option in the injunction area. The culverts may sometimes be placed at zero slope for constructability reasons, but that is not a zero-slope design because the gradient of the stream through the structure will match the prevailing gradient of the system and the design follows either stream simulation or one of the bridge design methodologies. Outside of the injunction area, it may be an option.
- **Q: When will guidance be released regarding placement of LWM within structures?**
    - A: Specific design guidance for wood inside structures is likely a ways out. However, the research WSU is conducting on incorporating organic material is expected to be completed by the end of 2023. WSDOT is also working on specific policy regarding wood inside structures and will be released in 2023.
- **Q: Who has the final say on stream alignment, especially in urbanized areas?**
    - A: WSDOT determines the stream alignment. The PEO or Pre-Design team should evaluate the impacts of alternatives and work with all specialty groups (including Bridge, Geotech, Hydraulics, Environmental, Utilities, etc.) and include co-managers in discussions to balance everything. As long as the alternative meets all the design elements of fish passage, it should be permittable.
- **Q: The creek can change on a yearly basis. Is the field report completed after site visit #2 updated each time you do a site visit?**
    - A: We don't produce a new site visit 2 form each time we go out. If there are design changing elements that are seen, depending on where we are in the design process, consideration should be given to updating it, but some of that documentation can also be added to the PHD or FHD itself if it's already been produced.
- **Q: Why is there not a construction cost/feasibility alternatives analysis step at the PHD level?**
    - A: We are currently working on a predesign process at the regional level that does a cost/feasibility analysis. Some projects go through a more in-depth process depending on the complicating factors i.e., adjacent infrastructure, constructability, meeting guidance, etc.
- **Q: Who prepares the FHD on a design-bid-build project?**
    - A: Typically, the PHD author if they are still under contract.
- **Q: Who is the PHD author on progressive design-build projects?**

    - A: For progressive design-build, the PHD authors are the pre-design stream design team. Then, the PHD is handed to the design-build team and their stream design team takes over the authorship of the PHD and the FHD. PHDs may need to be updated at that stage to reflect the updated design, similar to design-build.
- **Q: How frequently do you do design-bid-build projects? Are they bundled together like the design-build ones?**
    - A: We have a few out there. They are not as prevalent as design-build and progressive design-build now because of the volume and trying to meet 2030 deadline. They're sometimes bundled together, but it really depends.
- **Q: Will any more pre-NEPA design-build jobs be issued, or has WSDOT completely move to post-NEPA for design-build?**
    - A: It varies by region.
- **Q: What is the difference between design-bid-build and other methods?**
    - A: Design-bid-build is when WSDOT is the engineer of record. Both design-build and progressive design-build have the contractor as the engineer of record.
- **Q: How does the design-builder use the PHD if commitments have been made which might eliminate innovations?**
    - A: The PHD provides the starting point for the design. We try to not make too many commitments that will completely eliminate innovation, but sometimes we have to. It depends on the complexity of the site and what constraints we're looking at. Innovations in design build aren't limited to the stream components either. Often the roadway geometrics or traffic management can be innovative, even if the stream design is limited.
- **Q: Does bundling sites together eliminate opportunities for small firms?**
    - A: Not necessarily. We include small business goals in contracts tied to bundling, and these often invoke partnerships and the involvement of smaller firms.

Q&A for Module 5: Survey (Julie Heilman, WSDOT; Kevin Carlascio, WSDOT)

- **Q: How does WSDOT collect ordinary high water data?**
  - A: Ordinary high water is usually flagged by the environmental team and picked up by the survey team.
- **Q: What is sounding?**
  - A: It is the water depth resulting from the survey collection of the bottom of the channel.
- **Q: How many sounding data points are needed? Are the locations arbitrary?**
  - A: It depends on the stream. Locations aren't necessarily arbitrary. It's kind of a trained eye thing.
- **Q: How does the survey team locate "right" and left"? Are they relative to the thalweg?**
  - A: We only use left or right in relation to the instrument. Terms like "left bank" and "right bank" aren't used in survey.
- **Q: Right of way boundaries have sometimes not been included in survey used on PHDs, but it often comes up during the review process and discussions. Is that something that should typically be included?**
  - A: That is not something that is initially included in survey for the PHD. Region survey will identify RW in future phases of the project.
- **Q: The example cross section in the module says survey needs to pick up top of bank, water's edge, and thalweg. Isn't there risk of creating erroneous channel geometry if water's edge and toe of bank are not coincident? Why no toe of bank?**
  - A: At a minimum the top of bank, water's edge, soundings, and thalweg will be collected. Depending on stream geometry additional features may be collected to properly depict the section. Points are collected perpendicular from each other to eliminate crossing features and a vector changes. Additionally, the stream team – that is, the hydraulics engineers, geomorphologists, and biologists – have to go out on site and are still documenting their observations. The toe of bank can be identified through their field data and the pictures they've taken, which should be used in conjunction with the survey data.
- **Q: How can the water's edge survey location be used to inform design? I assume dates of survey shots and flow rates will not be provided as a means of calibrating models.**
  - A: Dates can be tied to survey. A vast majority of our streams are not gaged, which means the models cannot be calibrated. However, they are validated by comparing model results to observations made out in the field.

- **Q: Is invert elevation not included when there is sediment in the culvert?**

- A: No, survey does not collect invert elevation if there is material in the pipe. An elevation shot is taken at the top of the culvert and at the flowline, which is the top of the sediment or material in the culvert.

Q&A for Module: Modeling with SRH-2D (Ryan Barkie, WSDOT)

- **Q: What advantage does SRH-2D have over HEC-RAS2D?**
    - A: SRH-2D is designed specifically for transportation projects and has some tools that are more suitable for our projects.
- **Q: Is it possible to use the 2D model for no-rise certification?**
    - A: Generally, yes. We have done both 2D and 1D modeling, and we encourage 2D, but it really depends on the local community and whether they are comfortable with using a 2D model. However, the flood risk assessment (FRA) uses 2D modeling.
- **Q: How can we calibrate a 2D model? Can we bring in information from the reference reach?**
    - A: Calibration requires gage data that we typically don't have. However, we do validate them based on field observations.
- **Q: HEC-RAS does not have a monitor point and monitor line function. Is that something that only SRH-2D has?**
    - A: HEC-RAS calls them "profile lines," but they serve the same purpose.
- **Q: We've recently been asked to include meander bars in the model surface at the PHD level rather than use composite roughness. Is that the current requirement for WSDOT?**
    - A: That is a site or project-specific issue. It is acceptable to use composite roughness at the PHD level. Models may need to incorporate meander bars into the geometry at the PHD level if the site and design complexity call for it, but that is not typically the case. Usually, composite roughness is sufficient at the PHD level and then they are incorporated in the surface at the FHD level.
- **Q: Almost all Manning's n values references are for 1D calculations. Does WSDOT have any guidance for what Manning's n to use in 2D modeling since they're applied differently?**
    - A: WSDOT does not have guidance for this. The U.S. Forest Service National Stream and Aquatic Ecology Center has a stream channel flow resistance coefficient computation spreadsheet that does a decent job of estimating roughness values. They are more appropriate for 1D modeling but are generally sufficient for SRH-2D models. All models will undergo some degree of validation and fine-tuning during development and adjusting those Manning's n values is part of the process.
- **Q: How should wetlands be modeled, particularly with respect to model domain extent, assumptions for the Manning's n, and routing?**
    - A: Wetlands are kind of tricky, especially since survey often isn't able to pick up the thalweg at a lot of wetland sites and elevation differences can be minimal, and wetlands effectively function as ponds at greater-than-bankfull events. So,

for domain extent, we have to think about what's going on. We're probably looking at an unconfined stream, so at a minimum, you have to ensure that your domain extents are sufficiently large that the domain limits aren't affecting hydraulics at the crossing. You'll also probably end up modeling a variety of structure sizes to find a point of diminishing returns with respect to velocity ratio and WSE. For roughness values, I'd refer to the aforementioned tool from USFS. But, ultimately, a lot of this is going to rely on engineering judgement and doing your best to create a model that can be validated based on field observations and any historical records that might be available.

- **Q: Is there any guidance for using depth-varied Manning's roughness values, especially for floodplains?**
    - A: SRH-2D allows the Manning's n to vary with depth, but the engine assumes a linear variability. This is a limitation with current versions of SRH-2D since we know roughness variation is nonlinear. However, it's generally not an issue in a majority of our projects because our streams are usually relatively small and applied factors of safety ensure that that variable roughness with respect to depth doesn't typically have a significant impact on our designs. Thus, applying depth-varied roughness isn't very common in models used on WSDOT fish passage projects.
- **Q: Does WSDOT ever have to consider building physical hydraulic models rather than relying on mathematical modeling (especially when turbulence is hard to properly mathematically simulate)?**
    - A: WSDOT does not have the resources to build physical models for individual projects. Physical models would be needed for policy or design guidance changes, so that would be program-wide and not project-specific.
- **Q: Given the survey data resolution, would a 1D model be more suitable? The higher resolution of the 2D model is effectively illusory in terms of having greater accuracy. In addition, the shear stress calculation equation in SRH-2D is fundamentally flawed in many cases – if not most cases for the size of streams these projects focus on. A 1D model can give just as meaningful and sufficient results for design as a 2D model, so why not just go with the cheaper modeling alternative?**
    - A: There are multiple reasons why using 2D models is worth the extra effort and expense. For one, 2D models really do give more accurate, detailed hydraulic results even if we account for the limitations of 2D modeling. For example, 1D models only give you the magnitude of velocity across a cross-section while 2D modeling provides a velocity vector at each individual element in the stream. This is important for modeling the hydraulics at confluences, the effects of diversity features in the stream, and so on. If you have a confluence with a tributary near the crossing, for instance, a 2D model is going to give a much better representation of the hydraulic effects of the confluence on the structure

than what you could get from a 1D model. Another example would be an unconfined stream. 1D models frequently underestimate floodplain WSE by up to 2 to 4 times the actual WSE. Ultimately, the cost of modeling is a drop in the bucket compared to overall project costs, and it's well worth the effort to build a 2D model.

Q&A Module 8: Geomorphic Assessment for Stream Crossings (Cygnia Rapp, WSDOT)

- **Q: Would you consider The North Fork Toutle River more of a braided or anastomosing system?**
    - A: Upstream of the sediment barrier dam, I'd call it braided. Downstream of the dam, near the confluence with the SF, it appears to be in transition between braided and anastomosing, possibly leaning toward the latter. Wandering may be an appropriate intermediate classification. Either way, I'd wager the system is still adjusting to the Mt. St. Helens eruption (5/18/80) and affected by management at the barrier dam. Interesting system!
- **Q: Based on the sources cited in the presentation, it sounds like the channel-forming flows are often less than the 2-year flow. If this is the case, then why are we using the 2-year flow as the bankfull flow?**
    - A: During the design process the 2-year is used as a conservative estimate for "bankfull" for minimum structure sizing. The 2-year is used in this case because the regression equations/MGS Flood spit this number out and it's likely going to be conservative in most cases. The 2-year is not supposed to be at the edge of the floodplain on every system. The hydrology needs to make sense for the river or stream you are working on. If you are in a wetland, for example, and your 2-year is not spilling out of the banks, you've likely underestimated the hydrology. USGS is not the only gage source out there either; many counties have an extensive stream gage network that can help teams better verify the hydrology of a system.
- **Q: Are there some equations/models that you can suggest for estimating watershed sediment load in different parts of Western Washington? For people with less experience in geomorphology, is there anything that can be used to check if our estimates are within appropriate range?**
    - A: Geology is too variable in Washington state to have a reliable model for sediment yield. It comes down to the availability of pre-existing studies of individual basins.
- **Q: Could you please share your experience dealing with sudden channel incision and bank erosion that is located at the vicinity of highway?**
    - A: There are examples within our CED program that have been analyzed. Not all have been addressed, however. You could look up the finished reports here: https://wsdot.wa.gov/construction-planning/protecting-environment/chronic-environmental-deficiencies-ceds

- **Q: We make a lot of decisions on design based on the existing conditions we see in the site. However, it seems that the channel can change quite differently in the future from the same storm event based on what the initial conditions are. There were**

streams which did not have any flow in one site visit vs. larger than bank full flow in another site visit. Are there any suggestions on what we can do to avoid missing how the stream might change based on these initial conditions?

  - A: Careful examination of the project reach and watershed by a qualified geomorphologist.

- **Q: Do you make long term geomorphic changes predictions by ranking forces for erosion versus aggradation and then ignore the lowest ranking forces? For instance, factors at a large watershed scale may be considered to be a larger force than vegetation survey immediately at the project site.**
  - A: You can only bracket the potential effects at the watershed scale. However, by understanding the nature of the watershed and its potential for change, you can at least narrow the brackets a bit.

Q&A Module 9: Site and Reach Assessments, and Reference Reaches (Cygnia Rapp, WSDOT; Garrett Jackson, WSDOT)

- **Q: Why not simplify things and assume that the channel migration zone (CMZ) is the entire floodplain?**
    - A: This depends on the system. Olsen et al (2014) may be in line with what you are referring to, but in the cases where the Holocene River is underfit within a legacy glacial valley, more in-depth analysis is appropriate.
- **Q: If you are adding an extra count of gravel for each time that you record sand aren't you introducing significant bias towards gravel? I can imagine that leading to questionable results for streams with highly bi-modal distributions, in that the gravel portion of the distribution would be overrepresented. But I guess that's where the visual estimate of sand quantity comes in.**
    - A: That is the point of a pebble count. It was developed to capture particles larger than sand. The extra counts are to ensure a more statistically valid sample. When I consider bi-modal systems, cascade and step pool channels come to mind and there's not a lot of sand in those systems. Same with armored channels. The Wolman pebble count was developed for gravel/cobble bed systems for a qualitative snapshot of bedload transport. The sand content is important for indicating a potential increase in sediment transport of bedload (Wilcock and Crowe, 2003). Beyond a certain content of sand (35%? not sure), Wolman pebble counts are no longer appropriate.
- **Q: Has the current permitting changed? Or are we still limited on the time frame within which we can collect grab samples from below the water line on a creek?**
    - A: It is still limited due to the presence of redds.
- **Q: What is the alternative to the classic zip-zag pebble count method??**
    - A: The tape method, which is described in the module.
- **Q: What type of analysis should be performed on the subsurface grab sample? Qualitative visual analysis, pebble count, sieve analysis?**
    - A: Ideally sieve analysis, to properly represent the gradation. To be clear, the grab sample is not statistically valid but it’s better than nothing. It’s sieved.
- **Q: Does WSDOT have a preferred protocol for subsurface samples?**
    - A: As of now, no.
- **Q: Is the reference to "in the present climate" distinguishing from past climates, future foreseeable climates, or both?**
    - A: It distinguishes from past climates in the geologic sense.
- **Q: Can you expand on the reason for why the purpose for the reference reach is to match channel geometry rather than channel function?**
    - A: We use channel geometry, features, and LWM as a proxy for function. We are trying to maintain continuity, and the best way to currently do that is by analogy.

We can mimic the functions (and I assume you mean biological functions) of an adjacent, relatively stable reference reach, by mimicking its geometry.

- **Q: Are there any permitting or erosion control aspects to collecting grab sediment samples? Within OHWM okay?**
    - A: WSDOT has a general HPA for collecting McNeil samples, this contains timing requirements and minimization measures https://wsdot.wa.gov/sites/default/files/2021-10/Env-perm-HPASedimentSample.pdf.
- **Q: Are there any recommendations/guidance on how to measure water surface slope out in the field for the reference reach data collection-item?**
    - A: Self-leveling level and a stadia rod. If not that, two people can approximate the slope with tape and clinometer.
- **Q: Do we normally do the field surveying after determining the reference reach, so the surveyors know how far upstream and downstream from the roadway crossing they should have data collection? Is survey data needed for the entire stretch of the reference reach?**
    - A: Yes, we do need to have that data for the channel geometry of the reference reach.
- **Q: If survey data is collected prior to determining a reference reach (which seems to normally happen on these sites), is WSDOT sending survey crews out to collect additional data on the reference reach as needed?**
    - A: Yes, we often send out crews to capture additional data; however, it is something that we want to avoid, and therefore it is preferable to have the design team understand where the reference reach is likely to be prior to survey and be on site with the survey team if possible.
- **Q: Should we be considering precipitation levels within the watershed for our reference reach as well? I know in more mountainous areas precipitation levels can rapidly change.**
    - A: Yes, you should. But that should be taken care of generally by looking to adjacent watersheds. Shouldn't be so far away that the precipitation might be different.
- **Q: What is the approach to assessments in more urban settings when it's difficult or impossible to find a reach outside of anthropogenic impacts?**
    - A: We must do our due diligence to find a reasonable reference reach, as outlined in the presentation. When one can't be found, we use a design reference reach and hydraulic modeling to simulate a stable channel design for the project reach.

Q&A Module 11: Large Woody Material and Other Habitat Features (Garrett Jackson, WSDOT)

- **Q: How long is the typical lifespan of LWM?**
    - A: It varies. Decades, at least. Fully submerged wood can remain intact for over 1000 years, but wood subjected to frequent drying and wetting will have a much shorter lifespan.
- **Q: One common issue with using the Fox and Bolton LWM metrics is that meeting the total volume requirement is often infeasible for smaller streams. The calculator uses the same volume for all waterways with a BFW less than 98 feet. Is there any chance that will be updated in the future to be more applicable to smaller streams?**
    - A: We would like more research to be done into smaller streams, not just for total volume. At the moment, the most refined data we have is from Fox and Bolton. However, the targets are just that - we recognize the inherits crudeness of the tool and can scale back if needed.
- **Q: Are these metrics calculated from survey data or from site visits?**
    - A: The source data from which the targets are derived are from the surveys done by Fox and Bolton; for use of the metrics calculator, you don't need survey data, but your entries into the spreadsheet could be informed by site visits. It is up to the designer to populate the spreadsheet with the numbers and dimensions of logs that not only aim to meet the targets, but also are suited to the project reach.
- **Q: What is the relative importance of the various requirements in the LWM calculator spreadsheet (i.e., key piece number vs. key piece total volume and total piece # vs total volume)? In my experience, meeting the total volume results in about 2-3 times larger amount of LWM even when meeting the other 3 metrics. Also do you have any recommendations for selecting the appropriate BFW for the calculator? There have been cases in my experience, where in wetland-type streams with large widths (e.g., a creek with 30ft width but a few inches of depth), the calculator requires key logs so large that do not replicate any natural LWM size.**
    - A: If there are no constraints on a site, all targets have the same priority. However, if there is a limitation on space, we recognize the volume targets are the most difficult to achieve, and that where the designer must provide justification if the targets cannot be met due to space constraints or other constraints. As for bankfull width/key piece size, we would review on a case-by-case basis; the stream categories do not take into account unique stream systems like wetland channels. However, keep in mind that the targets are based on actual data, so they do in fact represent natural LWM sizes. Also keep in mind that large wood can be simulated by bundling smaller logs together, so that size should not be prejudged as 'impractical.'
- **Q: What is WSDOT's position on LWM in culverts?**

    - A: Wood inside the structure is not recommended. WSDOT is working on specific policy regarding wood inside structures which will be released in 2023.
- **Q: Channel spanning wood is natural in a lot of environments and specifically in steeper systems. If channel spanning wood is identified in a reference reach that exceeds water surface drop WDFW barrier criteria, has WSDOT had any success getting agreement from WDFW/co-managers on simulating this scenario?**
    - A: Yes, we have, for non-key pieces.
- **Q: How does high groundwater (assumed to follow seasonal flows) impact ballast and buoyancy on logs relying solely on bank embedment for stability?**
    - A: It's difficult to predict the effect of groundwater. It could be more ballast weight, or it could make the bank unstable. If seepage areas are known, you should avoid placing LWM there unless it's mobile wood.
- **Q: When it is appropriate for root wads to be in contact with the stream? I have heard various direction from agencies, co-managers, and SMEs what amount of root wads should be in contact with the stream when most naturally occurring LWM falls into the stream bole end first with the root wad left on the slope.**
    - A: It depends. Root wads create scour pools and provide cover better than the bole end, and the goal is usually for stream habitat improvement. In short, the root wad end is a little better for habitat. It is somewhat at odds with the goal of simulating natural recruitment, but we are in a highly altered environment, so we encourage diversity in design of orientation, dip angles, LWM size, and so forth, to cover all bases.
- **Q: It looks like some of the examples place LWM in areas currently unforested. Have there been any unintended consequences from introducing that much organic material to systems like that?**
    - A: I don't know of any biological consequences. Usually though if we are adding LWM, it was part of the riparian corridor at some point, prior to clearing.
- **Q: Wouldn't mobile wood clog the culvert or stream crossing structure and become a maintenance problem?**
    - A: That is a risk with mobile wood and the design must account for that. There are some general rules in terms of wood size relative to structure size.
- **Q: Has WSDOT done any research into different scour estimation methods around LWM structures?**
    - A: Not yet. We've been trying to get funding.
- **Q: What is the oldest WSDOT design using wood in a channel?**
    - A: Probably in the 1990s, not sure. There were projects on the Nooksack and the Sauk Rivers.
- **Q: WSDOT has required applying Fox & Bolton criterion for natural wood loading based on entire length of constructed channel to placements just outside the structure. My experience has been that significantly increasing density of in-channel**

wood often leads to significant lateral and vertical channel changes, which can accentuate local aggradation and channel migration problems at a crossing. Over-loading can aggravate these situations?

- A: Fox & Bolton is a tool to establish wood targets, not requirements. Almost all the streams we work on are incised to some extent beyond pre-development conditions. Thus, adding wood may be helping to reverse degradation, reverting from Stage three to Stage two or 1. To date, we have not seen any deleterious consequences from meeting the LWM targets.

- **Q: Is there a reference for the length of MWM to be 2/3 length of structure MHO?**
  - A: Furniss, et. Al, 1998, Flanagan, 2005, and Flanagan, 2003. See Chapter 10 of the HM.

Q&A Module 12: Streambed Design (Channing Syms, WSDOT; Cygnia Rapp, WSDOT)

- **Q: To be clear, shear stress averages should be analyzed mainly through cross sectional areas, not the centerline profile?**
    - A: That depends on the assumptions in the empirical equations you are using. Typically, yes.
- **Q: What was that layer called to seal the bed material/clay?**
    - A: Streambed sand.
- **Q: For various project delivery methods (DBB/DB/PDB), who is performing the field inspections as these lifts are installed and what are they documenting??**
    - A: For DBB, WSDOT hydraulics staff oversees the bed material placement. DB and PDB is inspected by the SME. HQ Hydraulics conducts oversight of the stream construction even for DB; however, there are some differences between DB and DBB oversight.
- **Q: Is there a standard spec or GSP for "Streambed Sand" or is that forthcoming?**
    - A: This is forthcoming.
- **Q: Is the 2013 WDFW Water Crossing Guidelines in "step" with the WSDOT Hydraulics Manual?**
    - A: WCDG is the starting point, and the hydraulics manual meets or exceeds those requirements and fills in the gaps of the WCDG.
- **Q: Does step pool installation require full time on-site construction supervision by the design professional?**
    - A: Yes.
- **Q: Is there ever any concern about the fish expending their energy reserves if a stream system has a large number of required leaps to travel upstream?**
    - A: Yes, and that is why resting pools are so important. Fish need a pool with a low enough energy requirement to rebuild strength before attempting the next set of obstacles.
- **Q: Is there a construction work plan submittal/readiness review meeting (great opportunity for the sticks/pebble mockup) in advance of the construction?**
    - A: Yes, for the initial meeting. At that time, we also go through the need for Hydraulics staff to be on site for guidance on challenging sites.
- **Q: For construction contracts (bid-build and design-build, both) will WSDOT specify in RFP/Bid sets that two construction observation staff (designer/engineer) are required for step-pool and cascade sites?**
    - A: We do require a hydraulics representative for all stream placement currently. Having two will only be a requirement for challenging, complex projects.
- **Q: Does WSDOT have any preferences or recommendations for 3D models to represent these elements?**

    - A: We do not currently have 3D models, but OpenRoads will soon be implemented within WSDOT.
- **Q: How do you reconcile your streambed mix gradation with the fact that the acceptance action for streambed cobbles is, "visual" per the CM Chapter 9? It just seems that since the acceptance of the material doesn't fall under measured and tested you can get wide variations in the material.**
    - A: It is challenging and requires experience from the Engineer. The pits also tend toward the larger side of our specification. One method is to spread a known volume of sediment onto a table and bin all the material for a gradation if it is questionable.
- **Q: Are there full Contractibility reviews (like PS&E projects) conducted on the proposed fish barriers/passage in DB projects? If not, it should be part of the process to help minimize issues during construction.**
    - A: A constructability review should be completed as part of the RFP process.
- **Q: When Streambed material does not meet the specs, is there a way to get it accepted with justification without needing to get the entire batch replaced?**
    - A: The Engineer can work with the hydraulics engineer of record to determine if the material can be accepted or rejected.
- **Q: When does WSDOT recommend geotechnical assessment as a component of design?**
    - A: Every WSDOT project obtains a geotechnical assessment.
- **Q: Since step-pool designs so reliant on no channel adjustments to maintain fish passage, any thoughts on use of steeper roughened channels which can handle a level of channel adjustment and still maintain fish passage?**
    - A: Roughened channels are an option and, if designed well, can provide the needed resting areas for fish passage, but a steep chute can become a barrier. This must be done with careful consideration to fish passage and collaboratively with co-managers. Stream gradient must also be taken into consideration. The purpose of step pools is to create discrete sections of lower gradient stream for resting pools and passability. Perhaps the lower end of channel gradients could sustain a roughened channel and maintain fish passage (e.g., around 4%), but as the channel steepens, step pool structures become of greater necessity. As step pool morphology transitions to cascade morphology, porous steps may occur.
- **Q: Do you have a time frame before the large wood pieces have to be replaced? I am wondering if the wood is prone decay due to wet/dry cycle?**
    - A: No. At this time, we heavily plant the riparian to resupply LWM, but we understand that may not happen. If the “bones” of the structure are composed out of rock, then this is less of an issue. If the step is composed of wood, then it should be buried or submerged year-round (i.e., not used in ephemeral systems).

- **Q: Can you speak more to the stream bed sediment being within 20% of all the sizes (D50, D84, etc.) in the reference reach? Seems like there would be occasions where that kind of mix wouldn't be stable.**
    - A: This is a professional judgement call. Our goal is to provide continuity of stream processes. As discussed in the module, we need to look at whether the stream has a healthy sediment supply from upstream. If so, you can have a bed that is mobile because it will aggrade at the similar rate as it degrades for a system in quasi-equilibrium. This is where your geomorphologist should get involved. It's not something that should be over-engineered.
- **Q: Is there a protocol for making sure the streambed material used are invasive species free?**
    - A: Typically, our pit materials are dry and should be ok, but we do not test.
- **Q: Does WSDOT have a plan to implement other channel restoration option such as bendway weir?**
    - A: Bendway weirs are considered bank protection not restoration. They can be used, but do not necessarily provide the habitat connectivity that is our goal.
- **Q: Is upstream juvenile fish passage considered as part step-pool design? If so, how is it demonstrated?**
    - A: That is determined in negotiations with the co-managers. Every site is different.
- **Q: Are the terms "minimum hydraulic opening" and "minimum hydraulic width" interchangeable?**
    - A: No. Minimum hydraulic opening includes a height component in addition to the width. Minimum hydraulic width is just the width component.

Q&A Module 13: PHD & FHD Template (Shaun Bevan, HDR)

- **Q: There are several different scour equations. Do we need to select the deepest depth of scour after using different scour equations to account for worst case scenario?**
    - A: Authors should evaluate the applicability of each equation and select/document the most appropriate method for each applicable scour component. Each applicable scour component must be evaluated at all flows up to the scour design flood and scour check flood. The depth of scour for each scour component is included in the summary table and summed up to quantify worst case total scour for the scour design flood and scour check flood at a specific infrastructure element.
- **Q: When is the Scour Certification expected to come out?**
    - A: The training will be out Spring 2023. The certification will likely be later in 2023.
- **Q: Should a factor of safety be incorporated in the total potential scour depth? If so, what factor of safety does WSDOT typically use for a culvert?**
    - A: It depends on the equation being utilized; however, most HEC 18 equations do not have an additional factor of safety added after the calculation. The WSDOT Hydraulics Manual is being updated to have a minimum of 3 feet of scour for bridges and 3-sided structures. Per the WSDOT Hydraulics and Bridge Design Manuals, 4-sided structures shall be buried such that the invert is 2 feet below total scour at the scour design flood.
- **Q: Could you please explain the scour design flood and scour check flood? Looks like the description on the manual is not adequate to remove confusion.**
    - A: In some situations, scour may be larger at lower flows. Therefore, designers need to evaluate total scour at all flows up to the designated annual exceedance probability (AEP) for the scour design flood and scour check flood. The scour design flood is the discharge associated with the 1-percent annual exceedance probability (e.g., 100-year) flood or the 2080 100-year projected flood (whichever is greater). The scour check flood is the discharge associated with the 0.2-percent annual exceedance probability (e.g., 500-year) flood or the 2080 100-year projected flood (whichever is greater).
- **Q: Who needs to approve the upsizing of the width opening to accommodate wildlife connectivity?**
    - A: That comes from the Region in coordination with the HQ Fish Passage Delivery and Capital Program Development and Management offices.
- **Q: At what point is the wildlife corridor integrated into the crossing design?**
    - A: The decision comes at the type, size, and location determination, which is after the MHO is determined. Sometimes the MHO is large enough to

accommodate the expected wildlife at a crossing or may just need additional freeboard to accommodate. HQ Fish Passage Delivery and Capital Program Development and Management offices make the final call along with input from the Region on what adjustments are made for wildlife connectivity.

Q&A Module 15: Post-Project Monitoring and Lessons Learned for Successful Crossings
(Tammy Schmidt, WSDOT; Channing Syms, WSDOT)

- **Q: Do you define construction "techniques" different from construction mean and methods?**
    - A: These terms are used interchangeably.
- **Q: Are there different rules for plant establishment and survival within structures?**
    - A: It is something that should be discussed with the team doing the permitting, so it is clear to everyone what the expectations are. Module 15 does not cover landscape design.
- **Q: What is the minimum critical flow depth for salmon species? Does it depend on the species?**
    - A: For design and assessing adult fish passage, the minimum is 1 ft of depth at fish passage flow which can be anywhere from ½ to ¾ of the 2-year flow rate. Practically, 6-8" is sufficient for salmon species to spawn with deeper pools for holding/resting.
- **Q: If we're trying to emulate wind fall, should we be leaving branches intact on the trunks projecting into the stream?**
    - A: We try to leave branches if possible, especially on-site wood. Logistics of obtaining full trees is challenging. Slash is currently being used to simulate the branches.
- **Q: Has there been any discussion on mostly buried vertical installations of wood for stability and whether those should count towards the target wood volume and quantity totals?**
    - A: Module 11 discusses this.
- **Q: Has WSDOT had programmatic "lesson learned" in weighing WSDOT criteria of FEMA no-rise with effects of installing LWM?**
    - A: We are still learning and do not have enough data points for a programmatic yet.
- **Q: With meander bar design within a structure, are you concerned about flow directed away from a bar toward the inside wall of the culvert and the potential for scour along the wall?**
    - A: There may be some scour on the wall, but it should not be entrained for a long distance. The next meander bar or complexity feature should redirect flow away from the wall. Structures are designed to accommodate total scour and this minor scour should not pose a problem.
- **Q: Since density and subsequent stability of LWM depends on the species and the recent water crossings GSP is not written to limit to certain tree species, has there been considerations to add in a write-in to limit the type of wood if needed for stability?**

    - A: The current GSP for LWM calls out native coniferous species.
- **Q: Do you try to make sure that flow conditions are appropriate during the fish migration season?**
    - A: Yes.
- **Q: Any passage strategy or component that has a noticeable high need for long term maintenance/adaptive management/costs?**
    - A: Coarse bands have been shown to deform the channel into a plane bed condition and, depending on the severity, can require a retrofit. This is discussed in more detail in the presentation.
- **Q: Have any constructed WSDOT fish passage crossings that later became barriers have their conditions reversed by nature back to passable due to another storm event? Are there certain conditions when we can take nature take its course for a couple years while monitoring instead of attempting a correction?**
    - A: Seasonally, yes. Long term, no. This is discussed in more detail in the presentation.
- **Q: The HPA has been relatively streamlined for these fish passage projects. I am curious and would be interested in learning more about the permitting processes outside of the HPA. How has working through federal and local permits impacted the project schedule and design considerations? FEMA and how they treat LWM as an example?**
    - A: Please work with our environmental team in the regions. This is still a learning process as more projects are going to construction.
- **Q: Curious about incorporation of undercut banks IN the crossings. What function is trying to be added, and how does it foster fish passage through the structure?**
    - A: Undercut banks are difficult to simulate in a sustainable way within crossings. We have not had any installations. Undercut banks provide excellent margin habitat and refuge for juveniles and adults and is part of the natural stream morphology, but constructing them in the structure just isn't feasible.
- **Q: Any special construction approaches/success stories for naturally armored streams considering difficulty of creating such a surface layer artificially?**
    - A: We have not implemented any designs, but our hydraulics manual does layout some ideas for how to implement such a concept.
- **Q: Does WSDOT check for fish habitat health upstream of removed barriers or do you coordinate with WDFW?**
    - A: Not sure what is meant by fish habitat health. We monitor fish passage and channel performance long term, and for adult fish presence after construction.
- **Q: Is WSDOT monitoring salmonid populations within their project areas too, or just channel structure/performance??**
    - A: We contract with WDFW to conduct spawner surveys post-project 500 m upstream and downstream of the new crossing.

- **Q: How do you correct subsurface flow issues?**
    - A: Some examples were provided in the presentation. They have varying levels of success. First, the upstream end of the subsurface flow must be found. Commonly, we then either trench in a sealing mix at intervals or remove and rebuild a portion of streambed.
- **Q: What are the long-term plans to mitigate the 6PPD tire chemical in road runoff to streams?**
    - A: Our stormwater group is hard at work finding solutions for 6PPD.
- **Q: How is WSDOT encouraging design engineers to embrace innovative but potentially unproven designs? "Success is fickle" is not a motto that many engineers feel comfortable with.**
    - A: On sites that we deem experimental, we work with the engineers to lower the risk, but WSDOT takes on the most risk as the owner.
- **Q: Is manual and mechanical compaction of proposed channel banks considered an option for replicating existing banks with till or bedrock features?**
    - A: The streambed material can be difficult to compact using ordinary compaction techniques. We have tried, but we'll never be able to match the compaction forces of nature.
- **Q: Are the results from the WSDOT monitoring surveys for completed crossing projects available online?**
    - A: Yes, see slide 44 of Module 15.
- **Q: Has there been any consideration for habitat restoration for species that naturally prey on the fish in conjunction with these stream restoration projects?**
    - A: That is beyond the scope of work related to the injunction. The injunction requires WSDOT to restore habitat for fish.
- **Q: If the ground water level is higher, it will be very difficult to stop seepage even with fines and compaction. How about providing some drainage for the ground water and taking away from the crossing?**
    - A: We would prefer that the groundwater be allowed into the crossing. It is a natural process and will increase depth through the crossing and reduces surface water temperature.
- **Q: How are resource and permitting agencies responding to lessons learned and experimental designs across the injunction?**
    - A: We partner with agencies throughout the process to obtain concurrence before moving forward. As long as we are collaborative and doing what is best for the resource, typically we have had limited setbacks with experimental designs. We also monitor and maintain passage.
- **Q: Can you explain the difference between ordinary high watermark and bankfull width?**

- A: See Module 10. From the WAC (111) "Ordinary high water line" or "OHWL" means the mark on the shores of all water that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in ordinary years as to mark upon the soil or vegetation a character distinct from the abutting upland. Provided, that in any area where the ordinary high water line cannot be found, the ordinary high water line adjoining saltwater is the line of mean higher high water and the ordinary high water line adjoining freshwater is the elevation of the mean annual flood. (12) "Bankfull width" means the width of the surface of the water at the point where water just begins to overflow into the active flood plain. In streams where there is no flood plain it is often the width of a stream or river at the dominant channel forming flow that reoccurs every one to two years.

- **Q: How do we measure bankfull for incised channels?**
  - A: See Module 10 for the bankfull width training.