



SUSITNA-WATANA HYDRO

Meeting Notes IFS-TT: Riverine Modeling Technical Team meeting November 13, 14 and 15, 2013

LOCATION: Tetra Tech, Inc.
1420 5th Ave, Suite 3200
Seattle, Washington 98101

SUBJECT: Riverine Modeling & Study Integration

Goal: *This IFS-TT meeting is intended to provide a forum to review and discuss various riverine-related modeling and study integration efforts. The meeting is centered on the Middle River segment and focused on discussing how the various modeling efforts will be used to address biologically relevant questions related to Project operational effects on fish and fish habitats. The overall goal of the meeting is to seek input from participants regarding the models that are being developed and how these models will be used to address resource questions and issues pertaining to project operations. See Handout on Meeting Goals, Structure and Outcome.*

ATTENDEES: Laura Arendall R2, Greg Auble USGS, Kasey Clipperton Golder, Matt Cutlip FERC, Jeff Davis ARRI, Steve Ertman HDR|HydroQual, Kevin Fetherston R2, Bill Fullerton Tetra Tech, Mike Gagner R2, Harry Gibbons Tetra Tech, Dara Glass CIRI, Leanne Hansen USGS, Mike Harvey Tetra Tech, Jon Hamrick Tetra Tech, John Haapala MWH Dan Healy NHC (Day 1 and Day 2), Bob Henszey USFWS, Phil Hilgert R2, Melissa Hill ADNR, Chris Holmquist-Johnson USGS, Felix Kastanovich Environ, Colin Kikuchi USGS, Joe Klein ADF&G, Michael Lilly GW Scientific, Matt Love VNF, Betsy McGregor AEA, Bill Miller Miller Ecological, Bob Mussetter Tetra Tech, Sara Oneil Trout Unlimited, Cherise Oram Stoel Rives, Steve Padula McMillen, Kathryn Peltier McMillen, Dudley Reiser R2, Eric Rothwell NMFS, Alice Shelly R2, Sue Walker NMFS, Charlie Wisdom Environ, Ed Zapel NHC (Day 3), Lyle Zevenbergen Tetra Tech, John Zufelt HDR

ON PHONE: Kirby Gilbert MWH, Domini Glass Environ, Jan Konigsberg AK Hydro, Long CSDA, Tara Moberg Nature Conservancy, Doug Ott AEA, Hal Shephard Center for Water Advocacy

MODERATOR: Steve Padula McMillen

This three day modelers meeting provided a forum to discuss the riverine fish habitat modeling efforts and the integration of related models and study components. Licensing participants were encouraged to request clarification to the modeling approaches being pursued by AEA and its consultants. Clarification requests or suggested changes after this meeting are to be communicated to Betsy McGregor at BMcGregor@aidea.org. Modeling efforts to address other potentially affected resources may be discussed in future technical team communications. Future potential topics include riparian habitat, river productivity, fish barriers/access, reservoir, mercury, and fish habitat in the Lower River.

All data provided in the meeting materials and discussed throughout the meeting are preliminary and have not been fully QA/QC'd. This included the model results which were provided as examples only and were based on models that were in the initial stages of development. The model results should not be cited or used in any way to describe project effects. The following meeting notes are intended to capture major discussion points, and questions and comments raised, that are in addition to the materials provided on the Project website (<http://www.susitna->

watanahydro.org/). The meeting agenda and meeting materials including the presentations given by the different model leads are available under the “Past Meetings” tab (link provided under the “Meetings” tab) on the Project website.

DAY 1 – November 13, 2013

Review of Agenda and Meeting Objectives – Dudley Reiser

Dudley Reiser briefly reviewed the agenda for the three day meeting and referred participants to the Goals, Structure, and Outcome handouts that describe the overall purpose of the meetings. He mentioned that Day 1 would be focused on descriptions of each of the respective models (Fish Habitat, Geomorphology, Ice Processes, Water Quality, Groundwater) with time allotted for questions and comments on each; Day 2 would center on the listing of draft Biological Questions that was provided as a handout and would focus on demonstrating how different models and analysis of empirical data would be used in addressing a subset of the questions; Day 3 would provide a forum for follow-on discussions regarding the models and to identify action items. The following notes are presented by day. Annotations generally include brief descriptions of what was presented followed by bulleted (●) Discussion Points and (○) Comments/Questions (C/Q).

IFS Conceptual Framework Presentation – Phil Hilgert

Phil Hilgert then presented an updated slide that was originally shown as Figure 8.5-10 in the Study Plan that displayed the conceptual framework for the Instream Flow Studies (IFS), linkages of different models, and how project operations will be evaluated relative to different resource disciplines. This proceeds for a given flow regime (operational scenario) as determined from the Dam/Reservoir Operations Model through the different physical, biological, and water quality models to determine project effects related to fish habitat. The results of these analyses can then be linked with results from other resource models (e.g., wildlife, recreation, etc.) as a means to compare overall project effects across resource interests. This is depicted in the figure as “Integrated Resource Analysis” which in the Study Plan was also termed Decision Support System (DSS). The DSS is a topic for discussion on the third day of the meetings and is intended to help identify the overall operational effects on a particular resource in relationship to effects on other resources. Evaluation of the output from an operational scenario can then be used in a feedback loop to make refinements to that scenario and rerunning of the Dam/Reservoir Operations Model. The various model outputs can be evaluated by spatial reference (Focus Areas) or by habitat units. It was noted that if desired, particular locations or habitats can be weighted to give emphasis or reflect priority. Discussion points follow:

- Application of model results
 - C/Q - Phil Hilgert noted that rather than determining specific parameter thresholds, AEA will likely evaluate which operational scenarios provide desired power benefits while having low impacts on fish habitat. Once these are identified, wildlife, recreation, in-river transportation, and other criteria and resource interests can be factored into a multi-criteria optimization analysis that can be used for determining a range of candidate operational scenarios. The overall goal when determining an operational scenario will be to satisfy multiple interests including but not limited to fish, wildlife, and power.
 - C/Q - Chris Holmquist-Johnson suggested a comparative analysis between the operation scenarios to identify the best scenario relative to baseline. Common uncertainties would act as common denominators; comparative analyses help reduce the influence of such uncertainties.
- Adding operational scenarios/computational constraints
 - C/Q - Phil Hilgert agreed, and added that because of the data needs, time needs, and expense, the number of operational scenarios run by the 2-D model are limited. It was noted that agencies would have the opportunity for input to future operational scenarios as part of the Technical Work Group (TWG) meetings in 2014.

- C/Q - Chris Holmquist-Johnson suggested running the 2-D model with a fixed bed to alleviate some computational constraints, possibly allowing for more runs. Phil Hilgert noted that the effects of some operational scenarios may be readily apparent and that not all operational scenarios may need to be evaluated through the entire suite of integrated models.
- C/Q - Chris Holmquist-Johnson mentioned that there will be many assumptions and if the change in flow falls within confidence ranges then the need for re-running the full suite of integrated models may be reduced. Dudley Reiser said that if there were a way to streamline the integration of models which would eliminate the need to run them all, additional operational scenarios may be possible. Eric Rothwell suggested an approach where certain inputs are held constant and you attempt to optimize certain values. Joe Klein suggested the possibility of conducting sensitivity analyses to reduce the ultimate number of scenarios that need to be run.
- C/Q - Jeff Davis asked if there will be an analysis of the range of variation in physical characteristics among macrohabitat types. Phil Hilgert said that habitat mapping study will be looking into this.
- C/Q - Phil Hilgert noted that fish habitat models are focused on habitat and are not intended to be linked directly with fish abundance or population levels. However, the models allow inferences to be drawn regarding fish distribution and abundance. Documenting explicit assumptions regarding biological effects will be important.

2-D Fish Habitat Middle River Focus Areas Presentation – Bill Miller

Bill Miller led off the discussion with a description of the habitat modeling approach that will be completed in the Middle River segment, specifically within Focus Areas (FAs). Bill Miller noted that the slides and data shown in his presentation are examples and are intended to illustrate the modeling process; he emphasized that the data presented are not final. Some of the major points from the presentation and discussion:

- Effective spawning/incubation analyses will provide an index of survival from egg deposition through incubation, but will not quantify the percent emergence of fry.
- 2-D modeling of Focus Areas will be conducted over a range of flows to determine effective usable area (the area that is sustained over changing flow conditions) for each operation scenario in lateral and mainstem habitats.
- Relative importance/weighting of dependencies will be determined by HSC/HSI, literature review, and excluding certain parameters to understand drivers.
- Focus Areas will have fine and coarse mesh although there will also be areas of transitions.
- Groundwater will be considered for each area rather than a single node. Slide 16 of the presentation provides an example of the groundwater component.
- Currently, the water quality parameters being considered in determining suitable spawning/incubation habitat are dissolved oxygen and temperature although it is possible to add more parameters.
 - C/Q - Chris Holmquist-Johnson asked if it is assumed that an area is still suitable if upwelling remains present without decreasing. Phil Hilgert said that it is, but suitability may be refined with more groundwater data. This is assuming that upwelling is a driving factor for spawning/incubation suitability. Chris Holmquist-Johnson suggested looking at other factors such as scouring.
 - C/Q - Dara Glass asked if sediment characteristics are being considered as a driving factor. Bill Miller explained that sediment is a consideration for determining cells with potential spawning habitat. This is expressed in the top square of the diagram on Slide 17. Bill Fullerton explained that the sediment transport model will provide sediment percent fines at a grid coarser than 2 meters. He added that he has observed salmon “digging” through a layer of fine sediment in areas of upwelling to spawn.

- C/Q - Jeff Davis asked if/how AEA is considering cases that a flood event deposits fine sediment during incubation, decreasing the percent emergence. Bill Miller said that the model will provide an hourly look up table providing estimates of spatial deposition and scour.
- C/Q - Chris Holmquist-Johnson mentioned that shear stress had been proven as a good predictor (in association with depth and velocity) when determining suitable spawning habitat in another project he was involved in and suggested that Froude number be included as one of the metrics. Bill Miller indicated this would be considered.
- C/Q - Tara Moberg asked if a metric will be used to evaluate habitat persistence and track a particular habitat throughout a scenario. Bill Miller said that it will be possible to look at the changes in spawning habitat at a particular timeframe.
- C/Q - Leanne Hansen asked if AEA is looking at neighboring habitats that are suitable for alevin development. Bill Miller said that post emergence is not addressed in the models, but is being considered.

Fluvial Geomorphology Modeling Presentation – Bill Fullerton

Bill Fullerton presented an overview of the 1-D and 2-D geomorphology models. He noted that in addition to the Middle River and Lower River, 1-D fluvial geomorphology modeling will be applied to the downstream portions of the Talkeetna and Chulitna rivers. Presentation/discussion points:

- 2-D geomorphology modeling will provide substrate deposition/degradation (scouring) in the Focus Areas for wet, average, and dry years per each operational scenario that undergoes evaluation by the 2-D model. Sedimentation cannot be solely linked to a flow magnitude, because it is also influenced by the duration of the flow and previous flows. The wet, average and dry years will be selected from the 61 year extended record developed by the USGS.
- 1-D geomorphology modeling will provide estimates of channel bed aggradation/degradation on a reach scale along with changes in bed material (substrate) size. The 1-D model will be executed for a 50 year hydrograph for the open-water portion of each year. The hydrograph will be developed from the USGS 61 year extended record.
- The sediment transport model provides an indication of areas that may be vulnerable to general aggradation and degradation as well as local scour and deposition; inferences can be drawn from this information regarding changes in substrate composition. This will involve both a qualitative and quantitative analysis.
 - C/Q - Jeff Davis asked if storm events will be identified that would result in deposition. Bill Fullerton explained that it should be possible to identify the effects of these types of events in the historical record from the modeling, since the 50 year record will include many actual hydrologic events. Bill Fullerton explained that for each wet, dry and average model run it may be possible to run warm and cold Pacific Decadal Oscillation (PDO) patterns. Bill Fullerton indicated that the preliminary selection of wet, average and dry years would be presented at the upcoming TWG meeting and will be included in the ISR. This will include a consideration of the need to consider warm and cool PDO in the fluvial geomorphology modeling of wet, average and dry years.
- The 25 and 50 year time steps applied to the 2-D geomorphology model are typical increments for FERC licensing and is a reasonable timeframe for executing models.
 - C/Q - Colin Kikuchi asked if the 1-D model showed a significant change after 10 years, would the 2-D be applied sooner. Bill Fullerton said that if there were large changes seen in the 1-D model in less than 25 years, the 2-D time steps could be reassessed.
 - C/Q - Jeff Davis asked if the 1-D model would need to be rerun for each new operational alternative. Bill Fullerton responded that some screening analysis could possibly be done.

- C/Q - Colin Kikuchi asked how uncertainties in the geomorphology models will be translated to the fish habitat model. Bill Fullerton indicated that one way uncertainty will be evaluated will be through sensitivity analysis conducted on key model input parameters such as sediment supply, flow resistance and bed material composition. Additionally, comparison of relative magnitude of potential changes for various operational scenarios could provide a means of ranking scenarios as to their influence on a particular aspect of the system's morphology that is important to fish habitat.

Ice Processes Model Presentation – Jon Zufelt and Steve Ertman

Jon Zufelt provided an overview of key ice questions that will be addressed by the Ice Processes models and also described some of the basic stages in ice development and breakup that occur on river systems. He also described stage – discharge dynamics during the ice development process and noted that dramatic changes in stage often occur in conjunction with ice formation. Steve Ertman described the ice processes models and depicted model dependencies and linkages with other resource models. He noted that River1D ice-processes model will be run for wet, dry, and average years for each operational scenario at 0, 25, and 50 years post project. However, he also noted that River1D is not as computer intensive as the River2D model and could be run for all years. The River2D model will be used for the Focus Areas but it is not dynamic and will need to have a specified ice cover defined; the 2-D model will be used to model ice cover and under ice conditions (e.g., water velocity, depth, and water surface elevation). Presentation/discussion points and questions

- C/Q - Mike Harvey explained that the Susitna River is not typical of a fluvial system. Ice plays a significant role in both flows and sediment deposition, and the persistent ice jam locations are downstream of fish habitats (such as the Focus Areas). Overtopping, if based solely on open-water hydrology, seems infrequent which indicates ice processes play an important role in the building of floodplain surfaces. Backwater and breakout effects of ice jams and possibly surge effects of releases from ice jam failures result in more frequent inundation of floodplain surfaces that would be achieved by open-water conditions alone.
- Ice-bridging locations will be specified in the River1D and River2D models based on observational data and professional judgment.
- River1D determines dynamic boundary conditions for River2D, while River2D considers ice in lateral habitats.
- Jon Zufelt noted that winter data will be collected at three primary Focus Areas (FA-104 [Whiskers Slough]; FA-128 [Slough 8A]; and FA-138 [Gold Creek]) to understand the open-water area influence. The data will be extrapolated outside the Focus Area. Additional information are being obtained via time lapse cameras that have been installed in FA-113 (Oxbow 1), and FA-115 (Slough 6A).
 - C/Q - Dan Healy asked what approach is being taken to inform what is happening with parameters not addressed in the model, such as border ice. Jon Zufelt said that calibration of empirical equations will analyze border ice. Dan Healy asked how frazil ice and anchor ice will be considered. Jon indicated that anchor ice is a challenge to model, but frazil ice transport is a key component of River1D.
- Steve Ertman noted that the River1D ice model will start as an open flow model until 0 °C water temperature is reached, then it will transition to ice-covered conditions (ice production, transport, and deposition).
- Frazil ice production will be included in the River1D model based on open-water area and air and water temperatures.
- Ice modeling is not explicitly considering climate change. The operation model will provide outflow temperatures which will be used in the modeling. It is envisioned that the choice of representative years would encompass the effects of climate change. If additional conditions (climate change) are desired to be run, they can easily be accommodated in the River1D modeling.

- Steve Ertman and Jon Zufelt noted that the ice models will provide output that will address various questions such as where ice formation may block fish access to habitats, and how ice formation may affect overwintering habitat.
 - C/Q - Greg Auble asked how AEA plans to determine an accurate net sediment balance if suspended sediment is not being accounted for during the seven winter months. Steve Ertman said that the ice model can be adapted to include changes in bed morphology due to sediment transport during winter. Bill Fullerton said that the winter flows are generally low so that sediment movement is also generally low; turbidity is likewise low in the winter. Bill Fullerton indicated that the Fluvial Geomorphology Modeling Study will use hydraulic conditions from the 1-D and 2-D ice model to determine what sizes of sediments mobilized during winter flow conditions.

Groundwater Study Modeling and Analysis Presentation – Michael Lilly

Michael Lilly provided an overview of the groundwater program and the types of information that will be provided to address resource questions primarily targeting Riparian and Fish and Aquatics studies. He mentioned that although earlier discussions focused on describing specific models that would be applied to address resource issues (e.g., geomorphology, ice, etc.) the groundwater studies include a combination of empirical data analysis as well as groundwater numerical modeling and other forms of groundwater analysis and characterization. In combination, the studies are designed to provide an understanding of the effects of Project operations on surface flows and how changes in surface flow may influence groundwater processes. He described the overall program and noted locations of groundwater wells (located in FA-104 [Whiskers Slough]; FA-113 [Oxbow 1]; FA-115 [Slough 6A]; FA-128 [Slough 8A]; and FA-138 [Gold Creek]) designed to address questions related to Riparian and Fish and Aquatics instream flow issues. He noted that the most intensely monitored site was in FA-128 (Slough 8A) in which detailed 3D groundwater modeling will be completed. The locations of the groundwater wells in the Focus Areas were determined collaboratively with the Study Leads of those three programs (Groundwater, Riparian, and Fish and Aquatics) and were also coordinated with the Water Quality team for chemistry sampling design in the Focus Areas.

Presentation/Discussion points and questions: Michael Lilly noted that temperature is being used as one indicator of upwelling or downwelling. A gradient is apparent at the interaction between groundwater and surface water.

- Michael Lilly noted that the groundwater modeling approaches will consider precipitation as a recharge source, which will include snowmelt.
- Michael Lilly noted that a table is being developed to include all parameters being used in the groundwater modeling and analysis.
 - C/Q - Jeff Davis asked if AEA planned to model residual flows in lateral habitats dependent on groundwater inflow, in relation to the fish barriers study. Michael Lilly responded noting it wasn't being modeled, but observations of flows are being documented.
 - C/Q - Colin Kikuchi said that it is good for models to include springs. Michael Lilly indicated that some springs are present within the Focus Areas and therefore will be considered in the analysis. The surface-water springs are locations where groundwater intersects land surface and are being used to collect empirical data to help characterize the groundwater system in Focus Areas and other select locations. The Thermal Infrared Imagery (TIR) will provide supplemental spatial information on areas directly influenced by springs and areas of groundwater upwelling. Michael Lilly described the process that would be used to provide groundwater inputs into the fish habitat models. He provided an example matrix table for FA-104 (Whiskers Slough) in which input parameters would consist of a two variable index that considers both whether there is upwelling or downwelling and associated with each, whether the upwelling/downwelling is increasing, decreasing, or reversing.
 - C/Q - Joe Klein acknowledged this approach but suggested it would be important to define how the values are determined including when "reversing" of groundwater upwelling is triggered.

Michael Lilly indicated that the inputs presented were those being considered at this time and that the actual parameters used would be presented as part of the proof of concept analysis that would be presented in April 2014.

- Michael Lilly discussed the application of temperature measurements and the importance for both habitat assessment and using as a tracer for groundwater and surface-water interactions. He also explained that this was not going to be simulated with MODFLOW, but would be analyzed with other analysis methods.
 - C/Q - someone asked about the measurement of upward groundwater fluxes in lateral habitats and whether combinations of surface-water inflow and groundwater recharge to lateral habitats, along with the potential use of well clusters (shallow and deep well combinations), could be used for this? Michael Lilly described the measurement of surface-water discharge at various reaches to describe the change in groundwater inflow/outflow as a method to measure contributing groundwater inflow.
 - C/Q - Melissa Hill mentioned this was a useful approach for measuring the groundwater fluxes.

Water Quality Modeling Presentation – John Hamrick

The water quality presentation provided an overview of the water quality modeling efforts for both the reservoir and Susitna River. John Hamrick explained the overall objectives of the reservoir and riverine water quality modeling efforts and listed major components of the Environmental Fluid Dynamics Code (EFDC) modeling framework. He also explained the reservoir and riverine hydrodynamics models that will be used for water quality modeling. The 2-D riverine hydrodynamics model is one of five hydrodynamic models developed for the river including three 1D models (open-water flow hydraulic routing model, geomorphology sediment routing model, and ice cover flow hydraulic routing model) and the 2-D hydraulic models that are being developed to evaluate sediment deposition and fish habitats in Focus Areas. John also described the reservoir and riverine temperature models that will be used for defining temperature effects of project operations. He provided a brief overview of different models associated with the reservoir modeling including the nutrient cycling model, solids and contaminant transport and fate model, and mercury cycling model. He also described the domain, spatial resolution, performance, and simulation capability of both the reservoir and riverine models. He noted that there would be enhanced resolution for the Focus Areas and provided an example in FA-115 (Slough 6A) and FA-104 (Whiskers Slough) that was approximately 100 m longitudinally and 30 m laterally. He acknowledged that the final resolution would be based on sensitivity to water quality gradients of different constituents in the Focus Areas.

- C/Q - Charlie Wisdom asked if the reservoir is considered to be thermally stratified. John Hamrick explained that there may be some stratification, but details regarding stratification are being refined.
- Although the Study Plan claims 22 variables will be applied to the nutrient cycling models, John Hamrick explained that those represent the maximum number of variables and many for coastal systems, some of which don't apply to riverine systems. Also, organic and refractory variables can be combined.
 - C/Q - Mellissa Hill asked how groundwater will be incorporated in the water quality modeling quantitatively. John Hamrick explained that it may be incorporated in higher resolution areas within the Focus Areas. Data for this would come from targeted grab samples that were collected at sample points along longitudinal transects centered on the groundwater wells at aquatic transects for the Groundwater Study and at a few other select locations.
- If there are large discrepancies in the water quality parameters between surface vs groundwater, therefore indicating influence of groundwater, then consideration would be given to adjusting the sampling during the next year.

- C/Q - Charlie Wisdom asked how mercury, post methylation, will be considered downstream of the reservoir. John explained that once the pathways analysis is available in the spring of 2014, mercury can be discussed further.

This completed the detailed presentations and Dudley Reiser then briefly summarized the first day session and reviewed plans for the next day. The meeting was then adjourned.

DAY 2 – Addressing Biological Questions – November 14, 2013

Dudley Reiser provided an overview of day two activities and introduced and reviewed a table containing a list of biological questions pertaining to anadromous salmonids in the Middle River of the Susitna River. He noted the list was by design limited to the Middle River Segment since it represents the area that will be influenced the greatest by the Project Operations and has received the greatest amount of study, especially within the Focus Areas. The list was organized by life stage and included a set of draft metrics that could be used to address each question as well as a list of models and analysis that could be used to derive the specific metrics. He then presented a list of key biological questions that were to serve as the focus of more detailed discussions and to demonstrate how the models are integrated to address specific questions. A companion set of flow charts aligned with the questions was also introduced.

Participants generally agreed with the questions but noted there were likely others that warranted consideration. Dudley Reiser stressed that the list of questions was not all inclusive but was intended to provide relevant examples of questions, identify candidate metrics for addressing the questions, and then highlighting the different models and analysis that would be used in deriving the metrics. Participants were asked to provide additional questions to the list but it was noted that AEA is working on the ISR and that input would be needed as soon as possible. A tentative date for providing this material was set for the end of November 2013; additional questions are to be provided to Betsy McGregor at BMcGregor@aidea.org. Dudley Reiser noted there are a large number of individual metrics listed in the table and there can be many more depending on specific resource issue. However, the challenge then is in the interpretation of the collective set of metrics and how to compare project operational effects between metrics. He noted this relates to Decision Support Systems which are discussed on Day 3. He indicated that from a practicality standpoint, it will be important to reduce the overall number of metrics being applied and that the selection of those metrics will be worked out with the TWG. For example, he noted that a number of the questions posed in the list can be addressed using a common metric, such as Effective Spawning/Incubation habitat or Effective Juvenile Rearing Habitat. These metrics address several life history stage questions together and reduce the need for individual metrics. Phil Hilgert noted that for the Baker River Project, the working group distilled the number of metrics evaluated down to 8-10 which they considered the most important for evaluating project effects. Participants acknowledged the challenges associated with evaluating multiple metrics and provided comments.

- C/Q - Sue Walker requested that effects on the migration of fish (specifically juveniles) between habitats be included in the biological questions. Dudley Reiser suggested that participants provide a list of additional questions as noted above.
- C/Q - Chris Holmquist-Johnson asked if major computational metrics will be grouped for the assessment and requested that they be made available. Phil Hilgert said that this will be discussed in Q4 2014 when a deeper understanding of the metrics is achieved.
- C/Q - Eric Rothwell noted that different licensing participants may have different interests in the grouping of metrics and suggested there should be a way for metric groupings to be deconstructed and recombined to address different interests.
- C/Q - Eric Rothwell noted that in terms of the biological questions the Services would need time to compare their list of biological questions (once it has been developed) with those provided by AEA. He said that, so far, it seems most of his questions could be nested within the broader questions included in AEA's current table.

- C/Q - Greg Auble listed five areas of analysis that he considered potential weaknesses in understanding the drivers of habitat suitability in the river:
 - (1) how will groundwater effects be evaluated and integrated into the analysis?
 - (2) how will off channel WQ associated with ground water be evaluated?
 - (3) how will alternate geometries/bed elevations be considered – i.e., aggradation/degradation?
 - (4) how will habitat usability relative to overall distribution of fish, (including access/passage to the habitats) be evaluated?
 - (5) how will results from the Focus Areas be extrapolated throughout the reach?

Dudley Reiser noted that many of the answers to these questions should become more apparent by the end of the meeting.

- C/Q - Joe Klein requested a plan for extrapolating data from Focus Areas to other locations in the Middle River. This would include temporal and spatial analysis. Dudley Reiser indicated that the Study Plan contained some initial thoughts on this and that further discussion would occur on Day 3. He noted that applying Focus Area data to other areas of Susitna River may also be influenced by Fish Distribution and Abundance studies that will provide an understanding of the use of different macrohabitats by fish.
- C/Q - Jeff Davis requested the ranking/weighting of different parameters be considered in determining suitable habitat. Dudley Reiser acknowledged that this would be considered.
- C/Q - Colin Kikuchi requested that AEA provide specifics on how each of the metrics would be calculated and how they would be combined in calculating, for example effective spawning/incubation area. Dudley Reiser noted that this will be explained during following discussion that is specific to the spawning/incubation metric.

Dudley Reiser then introduced the first flow chart which focused on Effective Spawning/Incubation Habitat. This was intended to illustrate the various model inputs that would be used to calculate effective spawning/incubation habitat computed as area (ft²). This can be done for different species and different spatial (e.g., by Focus Area; combined, etc.) and temporal scales (based on life stage periodicities). Bill Miller led off the discussion of Effective Spawning/Incubation and stepped through the various dependencies from other models or analysis including inputs from the operations model, open-water flow routing model, 1-D and 2-D sediment transport model, 1-D ice model, groundwater analysis, and the HSC/HSI models. He noted that changes in bed topography would be addressed by the 1-D and 2-D sediment transport models. Bill Miller noted that the details of inputs from the groundwater model/analysis are being developed with the goal of having that integrated as an HSI component. He referred to Slide 16 of his presentation and Slide 40 of Michael Lilly's presentation that demonstrated how groundwater upwelling and downwelling may be considered in the modeling. This stimulated substantial discussion regarding different model inputs used in the determination of the effective spawning/incubation metric. Major comments and questions are listed below.

Questions Related To Fish Habitat Models

- C/Q - Greg Auble asked how the accessibility of habitats will be integrated into weighted usable area. Dudley Reiser noted the issue of accessibility is being addressed under a specific study on fish barriers and passage analysis that will utilize in part the results of the bed topography and the 2-D hydraulic models that will allow for a determination of depth conditions at inlet/outlet locations of each Focus Area.
- C/Q - Dan Healy asked how undercut banks and vegetation overhang is being addressed. Phil explained that these are not common features in the system but can be included as a structure

(such as large woody debris). HSC is including these features when analyzing habitat relationships with fish.

- C/Q - Joe Klein requested that model diagnostics be provided once models are developed.
- C/Q - Eric Rothwell asked about decision points relative to different models and linkages and whether this was going to be discussed in the ISR. Phil Hilgert explained that details of how models fit together will be presented in Proof of Concept in April, which will also identify data gaps. The Proof of Concept will analyze 2-3 key metrics and will run through 1 Focus Area with at least 2 operational scenarios. This will help identify flaws.
- C/Q - Greg Auble commented that the Proof of Concept approach is a positive step to complete in 2014 and should help in identifying any flaws in the analysis and potential fixes.
- C/Q - Joe Klein requested that a plan be provided that explains how the extrapolation of results from the Focus Areas will be made to other portions of the Middle River Segment. Dudley indicated this will be discussed during Day 3 of the meeting with further information provided in the ISR.
- C/Q - Colin Kikuchi suggested that specific calculations made in determining effective spawning and incubation habitats be provided and discussed. Greg Auble indicated this might be more than is needed at this time. Bill Miller noted that the actual calculations that go into an effective habitat calculation can be provided if needed.

Questions Related to Winter/Ice Processes

- C/Q - Dan Healy asked if the addition of ice related episodic events are being considered as having effects on fish (multiple freeze ups and frazil events). Dudley Reiser acknowledged this and indicated this would be addressed as part of the modeling and time series.
- C/Q - Eric Rothwell asked how winter habitat quality will be affected by load following and the persistence of that quality. He also asked that the effects of winter daily fluctuations on juvenile fish be considered. Phil Hilgert described how flow changes in the winter may influence lateral habitats in terms of high water surface elevations, breaching conditions, and water temperature changes. These potential effects will be addressed as part of modeling.
- C/Q - Eric Rothwell voiced concern about the level of understanding of load following effects on juvenile fish in off channel habitats during the winter. This concern is based on uncertainties pertaining to water quality and groundwater during the winter. His comment was acknowledged.
- C/Q - Jan Konigsberg asked if the winter studies would sufficiently characterize the movement of fish and the range of parameters that would support survival. Dudley Reiser noted that the winter studies are designed to collect information and data concerning winter-time fish distribution and behavior and habitat use. The HSC and HSI studies will be collecting information on habitat utilization as well as some water quality parameters (temperature and dissolved oxygen). In addition, there are radiotagged resident species that will be monitor for movements in the winter.
- C/Q - Jeff Davis asked how effective spawning incubation will be determined throughout the year if the 2-D modeling will only be looking at discrete times. Also - how will dewatering over winter be considered? Jon Zufelt explained that the 1-D ice model can be run unsteady but the 2-D model is run with static conditions. Inferences concerning ice conditions within the Focus Areas throughout the winter period will be drawn from observations of ice thicknesses and dewatering (as determined from stage recorders). He noted that ice cover in the 2-D model can be tweaked when applying to lateral habitat to adjust for differential ice thickness from the main channel.

- C/Q - Dan Healy asked how the transition from open flow to ice cover will be handled with respect to restricting/ increasing fish access to lateral habitats. Jon Zufelt explained that the barriers study will evaluate blocking/access and will rely on ice model outputs as well as inputs from other models and data from cameras. Also, running the unsteady 1-D ice model with no ice cover could determine velocity to help evaluate ice flow into side channels.
- C/Q - Eric Rothwell suggested running a sensitivity analysis on the 1-D and 2-D models to see how ice thickness influences depth and velocity. Jon Zufelt explained that the thickness and roughness are both characterized so it would be difficult to single out the influencing factor. The 1-D ice model will be calibrated with Manning's n . Station gauge data will be used to calibrate bed roughness. Ice-front progression data will come from recon flights. Field data will be used to calibrate ice thickness and frazil concentrations. Bridging location characteristics are being noted during freeze-up recon flights. Similar conditions in models will be looked at to predict future bridging locations.
- C/Q - Dan Healy asked if the ice models are looking at cold, warm and moderate years, and if so, how will these carry over to models that are only considering wet, dry and average years? Dudley Reiser, Phil Hilgert, Bill Fullerton, Lyle Zevenbergen and others commented that the whole issue of representative years is being considered across the different models and will be discussed further in the ISR.
- C/Q - Sue Walker mentioned she had heard Wayne Dyok state the possibility of operating the dam during freeze up to create a stable ice cover while the river was relatively high. Load following flow fluctuations may thus remain under the ice cover. Sue Walker asked if this would cause adverse effects on the environment or ice stability. Jon Zufelt said that it may be possible to achieve such ice cover and it will be investigated.
- C/Q - Dan Healy asked how frazzle and anchor ice are considered in the modeling; and how episodic events related to frazzle ice formation affect fish and would changes in frazzle regime affect fish? Dudley Reiser indicated there is literature regarding fish-ice interactions that would be used to address biological questions. Dan Healy also brought up questions of how would the 1-D and 2-D ice models be brought together. Jon Zufelt and Steve Ertman noted this would be discussed in the ISR.
- C/Q - Dan Healy asked about representative years and combinations of these, such as warm/average/cold year versus wet/average/dry year? Lyle Zevenbergen noted that representative years are being evaluated. Phil Hilgert noted that representative years are being considered from several different aspects including geomorphology, fish habitat and ice processes. More information on this will be discussed during the Proof of Concept.

Questions related to Geomorphology

- C/Q - Felix Kastanovich asked if landslide or bank failure is being included in the sediment transport model. Bill explained that all contributing factors are being looked at.
- C/Q - questions arose regarding undercut banks and overhanging vegetation. Bill Fullerton explained the approach that is being followed relative to large woody debris. It was noted by several participants that there are few undercut banks in habitats within the Middle River Segment and what does exist is associated with a few of the lateral habitats.

Questions related to Groundwater

- C/Q - Melissa Hill raised the concern that the measurement of upwelling was qualitative and not quantitative.

- C/Q - Jeff Davis requested that the source of mixing water be analyzed with percent surface breach water and percent groundwater contribution. To do this Eric Rothwell requested that groundwater discharge be measured.
- C/Q - Eric Rothwell said that the relationship between temperature and groundwater discharge needs to be understood. Michael Lilly said that MODFLOW is not modeling temperature but the relationship will be understood when looking at multiple modeling efforts and measurements being collected. Bill Miller noted that if discharge measurements are being taken at different locations within an area, it may be possible to get some idea of groundwater inflow.
- C/Q - Melissa Hill commented on the importance of taking repeated measurements of flow, temperature flux, etc. as a means to get a better understanding of groundwater/surface water interactions. Michael Lilly concurred and indicated there is an extensive network of continuous recording temperature and stage gages associated with Focus Areas as well as other areas in association with water quality sites.
- C/Q - there was discussion regarding the groundwater component of the flow chart and the question was posed as to whether lateral habitats would get colder with higher flows provided by project? Michael Lilly indicated this can't be answered directly today but is a question that will be addressed via combination of modeling and data collection. It is not a simple question to address since groundwater/surface water interactions will vary depending on diurnal effects, air temperatures and climatic conditions (rain, snow, clear).

Questions related to Water Quality

- C/Q - Charlie Wisdom commented that based on his review of the WQ modeling and the HSC work that it would be unlikely that WQ resolution would be at the same level as the microhabitat scale measurements provided in HSC and HSI. Bill Fullerton commented that if the WQ is shown to be relatively homogeneous, than can simply expand via grid points to the more local areas.

The participants suggested that breakout sessions would be good to extend the discussions.

Break-Out Sessions

Attendees broke out into two groups; "groundwater and water quality", and "geomorphology and ice". Modeling experts attended their respective topic to discuss details of the modeling efforts. After the allotted time, the groups reconvened and updated each other of the key points discussed.

Groundwater and Water Quality

- Ensure appropriate methods are used to couple data from models.
- Address uncertainties in model data.
- Coordination is important among modelers.
- Include empirical data to support assumptions used in evaluating baseline and operational alternatives.
- It may be necessary to modify the water quality model for selective areas by increasing the resolution in lateral habitats.
- Address mercury and its linkage from the reservoir to downstream biota.
- The integration between water quality and groundwater should be quantitative.
- Schedule further discussions on how water quality, groundwater, and ice will affect water temperature changes.

Geomorphology and Ice

- It will be important to understand main channel – off channel flow interactions under ice conditions to evaluate Project effects on fish habitats (both incubation and juvenile rearing).
- Need to understand and consider how hydrostatic pressure influences fish habitats under ice.

- Important to understand what are anticipated Project operations in the winter; what are maximum load following characteristics?
- Questions raised: is evolution of ice cover important in side channels; is ice being characterized as both constructional and destructional?
- Understanding fish behavior under ice is important, which is reason for winter studies and radiotagging and tracking; existing literature also important.
- Need to understand why aggradation and degradation are not being considered in geomorphology modeling during winter periods.

Plans for the next day session were briefly discussed and then the meeting was adjourned.

Day 3 – Tying It All Together

Dudley Reiser briefly reviewed the meeting schedule and the topics for discussion.

Reservoir Operations Modeling Presentation – John Haapala

John Haapala provided an update on the reservoir operations modeling. He noted that two models are being applied including HEC-ResSim and MWH-ROM. HEC-ResSim is publically available and is a standard program, whereas MWH-ROM model can be programmed to handle complex operations. John Haapala explained model inputs and outputs and the output interface with other models. He also briefly discussed other model considerations including calibration (he noted that because the reservoir does not exist that model calibration data are unavailable), model verification, dependencies and schedule. John explained the current operations based on water outlets that include:

- Turbines (total ~15K cfs)
- 6 fixed cone valves (total ~24K cfs) – can take in water through entire reservoir operating range
- Spillway (~280K cfs) – only for 50 year flood or more severe
- Emergency discharge (~30K cfs) – through the construction diversion tunnel

Comments and questions included:

- Q/C - Joe Klein asked about the release of channel maintenance flows. John Haapala indicated that channel maintenance flows could be released through a combination of turbines and cone valves. John Haapala also indicated that the lowest operating flows would likely be in the area of 2,000 cfs.
- Q/C - Melissa Hill asked if sediment accretion behind the dam is being considered. Bill Fullerton indicated that the water quality model is considering this.
- Q/C - Dara Glass raised the concern regarding additional land inundation due to an increase in water surface elevation above elevation 2050 ft in the reservoir due to high flow events. Betsy McGregor acknowledged this comment.

Decision Support System Options Presentation – Alice Shelly

Alice Shelly then described several options related to Decision Support Systems (DSS) for the Project. She noted that the DSS is scheduled to be complete in Q4 2014. Because of licensing participants showing interest, the DSS planning process is starting early. Alice Shelly first defined what DSS and described its goal and objectives for the Project. She also listed some of the important considerations of DSS systems and considerations relative to evaluation metrics. She then briefly described three approaches that have been considered by AEA – manual matrix method, USGS DSS approach, and decision analysis and Bayesian belief networks. Based on that evaluation, AEA noted that the Matrix method is proposed for application on the Project. The method may include an approach for addressing some explicit uncertainties.

- Comments and questions included:

- C/Q - Joe Klein asked whether stakeholders will be able to game with the DSS. Alice Shelly noted that licensing participants will be able to manipulate the DSS with their own weighting of metrics. Joe Klein thought it would be a good idea to look at the DSS relative to one Focus Area to see how it would work.
- C/Q - Ed Zapel requested that relationships of parameters be understood before applying DSS. Alice Shelly explained that co-dependences will be considered at the model level.
- C/Q - Colin Kikuchi suggested adding a column to the table in Slide 17 indicating the “environmental cost” to account for particular areas of high importance to fish.
- C/Q - Melissa Hill suggested that for transparency actual modeling files should ultimately be made available by AEA. Betsy McGregor replied that all QA/QC’d data and models will be shared.
- C/Q - Greg Auble expressed concern with being able to integrate results from seven Focus Areas to provide a “Project effect” assessment over 50 years.
- C/Q - Bob Henszey asked what the units would be in the DSS. Alice Shelly indicated the units would be spatially and temporally explicit.
- C/Q - Sue Walker noted that NOAA/NMFS will be holding a training session on structured decision making.
- C/Q - Joe Klein expressed concern with the ability to extrapolate from data and analysis in the Middle River to the Lower River. Dudley Reiser noted that in general, at least from a habitat perspective, this would not be the case and that extrapolation within the Middle River Segment would be limited to other areas in the Middle River, not to the Lower River.
- C/Q - Colin Kikuchi suggested including particularly important areas in the decision analysis; if one area goes dry, make note of it in coefficient column. Bill Miller noted this would occur in the habitat analysis and that important areas would be noted in the spatial analysis.
- C/Q - Eric Rothwell asked about the ability to weight different variables, and Mike Gagner and Alice Shelly responded that this would be possible.

The USGS then presented an update of their DSS work completed on the Delaware River. This presentation was led by Chris-Holmquist-Johnson and included a PowerPoint presentation (Development and Application of Riverine Environmental Flow Decision Support Systems (REFDSS) for Water Management Investigations) that illustrated the interactive nature of the system they had developed. The REFDSS was created for the Delaware River and may, over time, be able to be applied to other river systems such as the Susitna. The beta version will be released in January 2014. Although much work would be needed to adapt the REFDSS to the Susitna some aspects may be useful for this Project. As an example, Chris demonstrated how changes in HSC values could be made and results immediately displayed. Questions remain however, regarding whether the software is proprietary since it was paid for by another entity. The USGS has been working on the Delaware River DSS for 4-5 years.

Other Topics Discussed and Comments/Questions Raised During the End of the Day

Proof of Concept (POC) – Phil Hilgert provided overview

- The POC will be available in the spring of 2014 in time for the April TWGs.
- The POC will provide a run of all models related to a particular Focus Area to confirm the successful integration of models and associated metrics.
- The POC will examine the modeling process rather than focus on the actual POC results. Feedback will be welcomed once the POC is available to licensing participants.
- The POC will clarify many questions related to the integration of multiple models.

Model Integration – All Participants

- Charlie Wisdom presented a “strawman” Model Integration Graphic as a means to help illustrate relationships visually. He noted that when overlaying multiple model outputs, identifying data gaps and redundancy may determine where added data collection is needed or efficiency can be added.
- Models do not receive duplication of parameters from multiple models (e.g., water temperature).
- Dudley Reiser noted that ongoing communication among modelers is occurring to ensure consistent units and to QA/QC data. This is particularly important for models using the same scenario parameters such as from the ice model and the open-water flow routing model.

Other Studies – Dudley Reiser and Betsy McGregor provided update

- AEA is considering the link between flow habitat relationships and eulachon.
- Consultation to discuss modeling of other resources will be scheduled at a later date. These resources include:
 - Riparian habitat
 - River Productivity
 - Fish barriers/access
 - Reservoir – including wildlife, recreation and riparian
 - Mercury – in respect to pathways and the direct effects on fish
 - Lower River
- Dara Glass recommended that AEA access local knowledge regarding hunting and fishing activity in developing important questions regarding reservoir operations.

Uncertainties – All Participants

- Eric Rothwell felt that of the resources models discussed, more certainty was needed with groundwater and its associated water quality, and under ice hydrology.
- Eric Rothwell requested that all assumptions be stated when presenting data. Some examples include:
 - The studies consider the Focus Areas to be representative to the respective reach. Predictive modeling would assume that the same areas are representative in the future.
 - Because the models are habitat specific, they rely on an understanding of biological utilization. Eric Rothwell said that he was concerned with the level of understanding that the studies will achieve. Dudley Reiser feels that the 1980s data and data from the current studies will help everyone achieve a sufficient understanding.
 - The same tributary inflows for existing conditions are being applied to predictive modeling assuming the next 61 years is similar to the previous. Joe Klein requested that extreme flood and drought years be accounted for; more so than is in the period of record in case they did not occur in the last 61 years. Melissa Hill suggested using tree ring data to understand extreme floods and droughts occurring earlier than the historic record. Kevin Fetherston indicated they are looking at tree borings for this.

Engagement with Licensing Participants – Steve Padula and Betsy McGregor led discussion

- The modeling efforts are currently on schedule according to the timeline proposed in the approved study plans.
- The ISRs will provide updates to the detailed methods included in the study plans, extensive data will be made available online and summaries will be included within the ISR. Modeling results will not be available for the ISR. If licensing participants would like to suggest specific information that should be included in the ISR, they may communicate this to Betsy McGregor at BMcGregor@aidea.org and if possible, AEA will address the request.
- Proof of Concept will be the next major engagement related to model integration and will help to identify potential areas of modeling uncertainty.
- Licensing participants will be involved in the determination of operational scenarios throughout TWG and technical team interaction.
- If changes to the 2014 study plans are recognized as necessary through the POC (available after the ISR), then changes can be made to the studies and listed as a variance in the USR.
- Licensing participants will have access to the models and be provided QA/QC'd input/output when available.
- Licensing participants requested that the format of TWGs include more time for discussion and shorter updates.

Action Item

Responsibility

Provide any additional biological questions or input by the end of November 2013 to Betsy McGregor at BMcGregor@aidea.org .	TWG
If licensing participants would like to suggest specific information that should be included in the ISRs, they may communicate this to Betsy McGregor at BMcGregor@aidea.org .	TWG