APPENDIX H

Summary Notes from Key Observation Discussions
Key Observations: Modeling
Day One - July 17, 2005

After the first afternoon of the workshop, participants were asked to provide their initial key observations. The following points were made by the group:

- Different disciplines are speaking different “languages”
- Models should have “appropriate” complexity
- Most model combinations seem to be one-way; is there a need for two-way models? Some model approaches could be cyclical
- Scale issues came up for a lot of the combinations:
  - Need to choose an appropriate scale
  - Boundaries for models might not match
- Conceptual models are important
- Need to define who does what
- More models (and/or team members) might be important
- Models need to incorporate social issues and stakeholders
- Testing models is important
  - How will this be done?
  - Ability to calibrate becomes more difficult when combining models

The initial ice-breaker and model exercise provide a great opener for this workshop and would be recommended for future workshops or adapted for a semester-long course.
Key Observations: Modeling
Day Two - July 18, 2005

- Need to first identify purpose/objective of modeling
- Will need to stay focused so that projects do not head off into tangential and unmanageable projects
- Each discipline has similar problems, but different approaches for dealing with uncertainty, lack of data, data problems such as data at wrong scale, and choosing the appropriate scale.
- Modeling is heuristic
- Need to look at models to determine most sensitive processes, fringe areas
- To build and run a model you have to organize the data in a certain way. In designing the model, you realize what data you will need. Therefore, model design should determine measurement strategy.
- It is not efficient to separate data needs from the models, but often what happens is the data collection is determined separately from the model planning and therefore you can end up with data that is not useful or missing data that would be useful.
- Challenge: Engineered urban stormwater systems are often built to handle large 25-year or 100-year storms. An unfortunate result is that detention basins are built and the smaller storms are captured needlessly. We need to design systems for various large and small “design storms” in order to allow some of the water to re-hydrate wetlands and not end up captured in the detention basins.
- We build huge safety factors into the designs because modeling is a tool with such large uncertainty and no one wants to under-engineer a system.
- There is not a common standard of model accuracy across disciplines.
- We should be talking about the appropriate “currency” within a range of scales
- The purpose/objective of the modeling project will influence what is the appropriate “currency.”
- It is useful to understand processes and what the model does (underlying mathematical formulas, assumptions, etc.) at a very general level.
- We should consider the model first before the data collection plan is determined.
- The importance of leadership (by modelers and those presenting model output to stakeholders) cannot be understated, working with egos sometimes makes it difficult
Key Observations – Curriculum
Day 2: July 18, 2005

- We want people to talk about the difficulty of collection “good” data
- It is important for students to get exposure to field data collection so that they have a sense of how difficult it is to collect “good” data and learn about issues of accuracy, etc.
- Students should understand the basic processes being modeled and then learn how the model works.
- A course should include activities, team teaching, some equations…
- Would like to see description of what a model is, definitions, reduce redundancy
- A prerequisite for the course should be at least one modeling course (in any discipline) so that students have a basic understanding of modeling issues, assumptions, uncertainties, etc. Another prerequisite would be a statistics course.
- The Interdisciplinary Modeling course should be an upper level graduate course.
- Early in the course, the basics should be covered (for example, scale, uncertainty, lack of data, etc.).
- What department should the course be offered in? Possibly a cross-listed course.
- The course would need to be described in such a way as to attract various students with various backgrounds (i.e. both engineering students and ecology students).
- Link equations across disciplines (i.e. a transport is a transport equation no matter what the constant is, j or k).
- Multiple instructors, co-teach
- Because the goal is experience in multiple disciplines, the course should have experts from various fields presenting. The experts will do a better job of presenting the information they are comfortable with.
- A common language (or in some cases, the lack of a common language) will become apparent with multiple instructors presenting.
- Should start with some basics such as uncertainty, scale, etc. before going into the specific disciplines.
- What do we want students to get out of the course? Do we want them to have some familiarity only, or learn how to actually combine multiple models?
- Should provide students an opportunity to see the actual models in use. This will demystify the various models and show the simplicity or complexity of the various options available. Students need the opportunity to get into the meat of the models.
- Be explicit about assumptions within each discipline.
- Could encourage students to participate by having an accompanying seminar series/discussion session.
- Should there be a programming language component?
- This course would not supplant traditional disciplinary modeling courses.
- Students should understand the complexity of various models, but they may not learn how to run specific models, such as a specific fish model, for example.
- The course will need a local campus leader to coordinate various lecturers so that expertise can be drawn from the larger community. It may be possible to connect electronically through access nodes across campuses.
- The course would require a lot of coordination.
- First step would be to have a good book available.
- First principles, history of model development, how models evolved within each discipline
- Probably need a semester course (on uncertainty alone!)
How do you determine what language you will be working in (i.e. Matlab versus R) since different students will have different backgrounds and experience with different programs?

- Students will have varying levels of knowledge.
- Could use packaged models.
- Develop computational examples
- Use open source models that students can have access to without paying huge costs
- Provide a list of various open source software that is available and the web sites that can be used to download these models. Students can download various models and work with them.
Key Observations: Curriculum
Day Three - July 19, 2005

- A benefit of the class is just being introduced to the people that work in the field
- Providing good references during the lectures is very useful
- What is the right amount to present in a discipline?
  - As much as is feasible
  - Knowledge can be very useful, but it is impossible for us to know everything
  - Lecturers must know that topics are foreign to many students
  - The challenge is to find the balance between wanting to know everything and reality
  - Lecturers should present enough but not too much
- Objectives for the course are to make students aware of models in different disciplines and the importance of working in interdisciplinary teams
- The course should enable students to gain experience about what you need to know
- There should have been a common thread through the 3 ‘sub-lectures’ for the combined scale issues lecture
- The team-taught class on scale was nice because it started off with definitions, then talked about more details, then had an example
- It would be nice to have a common example that could tie talks together; have one issue or one scale that is applied throughout all disciplines (for example, Tahoe sediment issues)
  - A virtual textbook could focus on Tahoe
  - Available to all on the web
- Clean off the details (??)
- It is more important to show how the models work than the details of what's in them
- Keep in mind that this is a special course setting, and the course would be different in a classroom setting -- in a regular course, there would be several lectures on each topic
- It is intimidating for those less familiar with differential equations to see lots of equations
- It was nice to see some of the workings of the model
- Didn’t deter from subject (??)
- It is satisfying to learn differential equation inputs
- Coming from a very different field, students don’t need to know equations, just what are inputs, outputs, uncertainty, assumptions
- Would like to learn what questions to ask to do interdisciplinary modeling from this class
- Would like to learn how to network well from this class
- It would be good to include discussion of how one science can further another science
- We enjoyed the first exercise – the process of having different disciplines get together to discuss; good way to start off the course
When models are introduced, include not only the main concepts, but also specific models and references (especially websites for freeware)

A few talks had a take-home message that “things are way too complex.” Some speakers went more in-depth on uncertainty and complexity issues. Should try to end each module/lecture on a positive note, realizing that there are limitations, but also opportunities.

When using models, should be aware that a certain level of expertise is necessary so that the models are not abused or results taken as the ultimate truth

Mathematics is key to the models and should be used to explain the models.

Statistics should be a pre-requisite for this course.

Interactions with mathematicians and statisticians add confidence in the results of model output and ultimately provide a better understanding of the results

**Model exercise #3**

- Students were not exactly sure what they were doing with the exercise. Usually this MMS model is taught over 3 days.
- Should have loaded software and files on computers in advance so that so much time was not needed for the set-up of individual laptops.
- The Model Exercise #3 wrap-up exercise was useful.
- In a classroom setting, the computer lab could have all the computers loaded, running and would save time for setting up the exercise.
- The exercise was very “canned”
- Exercise illustrates how models can be just a black box. Don’t forget that when you put garbage in, you get garbage out.
- There may possibly be a more simple exercise that could be effective.
- Could build up to this #3 exercise so that students understand as they go. This wasn’t really something that could be demonstrated in 2-3 hours. The lab should take a couple classes to lead into the exercise.
- Just having a step-by-step exercise doesn’t make you think. Could possibly show conceptual flowchart, source code, etc.
- Learning was more on the computer side compared to the science side. The struggling was computer-related struggling not really related to conceptual issues.
- The exercise provided a reality-check on how much time it is going to take to work with the various models
- Future models are moving towards plug-and-play modules. There is a concern that individual models will disappear into larger over-arching ones. Modelers should still be able to compare the different conceptual models for better understanding.

**Future Exercises**

- Several STELLA modules are uploaded (dynamic equilibrium) to the Aquamod website showing systems reaching steady-state and other systems-level type concepts (Fritsen).
- Could also work with a bucket of water to look at water-in/water-out for basic systems-level understanding
- Should learn mechanical side of the models and take some time to fumble through the code
Course Development

- Do we want students to go into a specific model, such as HSPF or WASP, and require them to dive into models at depth or just understand the concepts?
- OR, should students learn one particular model? Or possibly divide into groups to learn various models?
- For models with lots of uncertainty, the fact that they have uncertainty, we can quantify, and deal with it, use tools in adaptive management context… (need to expand)
- Might be better to have courses at the general, conceptual level. By learning about the models available, students may apply new information in their own disciplines and think about their own disciplines in a new way.
- We probably should not teach one over-arching model, but provide a flavor of the various models available.
- The course can be a “shopping trip” into the world of modeling. What are the various model capabilities? Is linking models worth the effort? What is available?
- Course should provide a visual demonstration and demystification of models available. Should not be hands-on.
- Can learn from what doesn’t work
Key Observations
Day Six - July 21, 2005

- We need all scientists to know the capabilities of interdisciplinary options
- Would rather take a more general seminar
- Don’t need to know other specialties
- Do not think a seminar series would help. In a semester long course, the greatest benefit would be putting a project together.

Other Questions/Issues/Discussions
- Topics/ideas to include for each lecture:
  - Potential research questions from multiple fields
  - Stability (numerical) issues
- Ideally each discipline provides examples and hands-on with a model in their discipline and an example into/across another discipline