Agency Advisory Board Meeting
Ramada Plaza Suites, Fargo, North Dakota
January 11, 2005

Agency Advisory Board (AAB) Members Present:
Paul Benedict
Doug VanDaalen
Ruth Lewis
Randy Gjestvang
Gary Thompson
Jim Sols tad
Bill Schuh
Mike Sauer
Esther Vogel
Troy Gilbertson

Energy & Environmental Research Center (EERC):
Beth Bolles
Doug Davidson
Lynette de Silva
Kim Dickman
Heith Dokken
Sheila Hanson
Jim Johnson
Marc Kurz
Corey Maki
Santa Pachhai
Wes Peck
Xixi Wang
Kirk Williams

Beth called the meeting to order. This was followed by brief introductions and Beth extending gratitude on behalf of the Waffle® staff for the time and effort the board has put forth to provide constructive criticism on the Waffle study. She gave an overview of this meeting's agenda — it consisted of updates, Wes talking about the light detection and ranging (Lidar) data that we've collected this past spring; followed by him discussing the identification of storage areas and storage volumes. Doug will speak about our modeling progress; Marc, about our field trial results from last year and will give an update on this year's progress; and Corey, the road stability evaluations. After that, we will open the floor for further discussions and wrap up the meeting. Board members were encouraged to comment throughout the presentations.

Update

This is our 7th meeting. We are nearing the final stretch of the Waffle project. Our last round of funding is set to come in June of this year, with the project completion date in June 2006. We will plan on having the last AAB meeting in the spring of 2006. At that meeting, we will provide documents, along with input we have received from the boards. All of your comments will be

incorporated into this research. We will need your concluding comments which we will incorporate into our final report.

We are talking about possibly pursuing funding for Phase II — Implementation, which would focus on a subwatershed. We would work toward Waffle implementation, work with the county water boards and the Soil and Water Conservation Districts, and work with the local entities to pursue future sources of funding for implementation of the Waffle. Our role would be to actually establish landowners who would like to implement the Waffle on their land and work with county authorities to establish the Waffle approach. We are looking right now at Antelope Creek, which is southwest of Fargo, North Dakota. There have been some studies done, and it does not appear to have much in the way of conventional storage. Topographically, it looks like an ideal place to do Waffle implementation. It has also been mentioned that since we have the Lidar and elevation data collected for the Forest River Watershed, maybe we should consider doing it there. Another potential watershed is Roseau, Minnesota; it has recently been associated with lots of flooding problems. In upcoming meetings, we hope to have more information on this topic.

Our key focus for 2005 is going to be modeling Waffle storage sections. The last 2 years have been focused on developing the base hydrological models that will allow us to evaluate Waffle storage, and now it is time to do it. Another vital component is going to be the economic evaluation effort. We just received a proposal from North Dakota State University (NDSU) to do the entire economic evaluation. Andy Manale has been doing some economic work and also researching existing policies we could use to implement the Waffle. He sent some preliminary economic analyses, but we are going to have NDSU complete this. Also for 2005, additional field trials are going to be a focus, as well as conducting a basinwide landowner survey. We did one previously in the Minnesota Wild Rice Watershed. This time, the landowner survey will be extended to the entire Red River Basin.

Another focus will be to develop a strategic document that can be used for implementation; among its contents will be the information that we collected from the advisory boards and agencies that we have met with. It will have the key recommendations; among them, what needs to be addressed to implement the Waffle, the laws that need to be changed, and other issues of concern.

All of the proposed hydrologic models for the Red River Basin are developed, and most are calibrated. The next step is to work on the mainstem model; toward this end, we have been working on coordinating our efforts with the U.S. Army Corps of Engineers (USACE). USACE will be developing the mainstem model from upstream, and we will be developing it downstream, of Halstad, Minnesota. We will be working with USACE to ensure that we are using the same approach in addressing some of the issues such as breakout flows. There were some areas in 1997 where the flow was quite wide. How do you address those issues in the mainstem model? Also how do you deal with ungauged flow areas? There are a couple of techniques we are using. One is to use nonboundary conditions; the other approach is to add the ungauged flow areas.

The model will be hydrodynamic, and will incorporate key bridges, culverts, major breakout flows and tributaries. Initially, we will use the geometric data from the USACE steady-state

Hydrologic Engineering Centers River Analysis System (HEC—RAS) model. Cross sections will be extended if necessary.

In the past 6 months, our outreach has focused on meeting with county commissions; this is now complete. An interesting meeting occurred when we approached the Minnesota Farm Service Agency's (FSA's) head office to get state approval to conduct field trials on Conservation Reserve Program (CRP) land later this year. The county initially gave us approval and suggested we get approval at the state level. We got approval for the field trials, and the Executive Director of the state FSA office was excited about coupling the Waffle with CRP. Jim Johnson has been giving presentations to Future Farmers of America groups at different high schools. This was a recommendation from our Citizens' Advisory Board (CAB) members. Our next focus is going to be on meeting with city councils and revisiting water boards and Soil and Water Conservation Districts.

Lidar

Wes explained that at our last meeting, we touched on some of the approaches we used in the determination of basinwide storage. One of the biggest challenges was trying to determine what the potential storage would be across the basin. We used the best available data sets that cover the whole basin. The 30-meter-resolution National Elevation Dataset was integrated with scanned quadrangle maps and a digital version of the public land survey system. These were the key pieces used in the method to look at storage. Each watershed was analyzed individually. Twenty random sections on a watershed basis were evaluated to determine the variation of storage across the watershed. A statistical formula was used to determine how many additional sections should be evaluated. Based on those results, we estimated total volume for that watershed.

Wes mentioned that the Forest River Watershed was split up a little differently since we are collecting Lidar data for that region. We also wanted to look at the topographic expression from the old lake bottom up through the intermediate and upland areas.

Randy Gjestvang added that in reality there might be much less storage available during a flood because some of the available storage will already be in use. He stated that our analysis uses the supposition that the section is dry. Wes agreed with this statement, and answered that this methodology is based solely on the topographic expression.

Bill Schuh added that for prevention of a 1997-type flood, you will have to incorporate the events that occurred in 1997. You basically had the roads holding back water. Bill added that you are going to have to include that into your data. Bill asked if this information would be fed into the model.

Wes responded that we are starting with empty sections of land. In the model, we will apply precipitation events based on the past snowfall from 1997, etc., and make it worse, increase it by 1%. In a worst-case scenario, we will have a beautiful, sunny, warm spring with rain. Turn all of that accumulated snowfall into a liquid for the model: some of it will have to stay in these pools and the rest will cascade down the landscape towards the mainstem. These are all modeled as empty pools right now. Bill asked if we will be able to look at this with and without retention.

Wes answered yes. Beth added that our approach is already conservative by reducing storage volumes by 50% to account for freeboard.

Wes commented on the Lidar data delivery. The contractor, Sandborn Mapping, has been responsive to all of our questions. Sandborn is well-known and respected in the industry. This is the largest area that they have done. We are getting the data in areas equivalent to 1/16th of a quarter section. These smaller file sizes make the data more manageable. Sandborn delivered close to 300 gigabytes of data for this analysis.

Wes stated that Kirk Williams collected 105 QA/QC GPS (quality assurance/quality control global positioning system) points across the landscape in different land use categories. The Lidar contract specifies an overall accuracy of 18 cm. This accuracy was confirmed through the QA/QC check. We are also using 2003 USDA photography for QA/QC. Dense cattail, CRP, and wetlands contributed to the largest differences between the Lidar data and the GPS data. Bill asked if this leads you to consider what time of year you want the contractors to start collecting Lidar. Wes said a phase in the spring and phase in the fall would be ideal. The leaves were just coming out when they were flying. The CRP grasses were waist tall. It's better to have done it when the leaves were off the trees. Beth added that we were about 3 weeks later from when we originally wanted this flown.

Bill asked about the expense. Wes indicated that the price has come down from May—September. Beth added the Lidar was $100 per sq mi. It would have cost $500—600 per/sq mi to have photography flown at the same time. Beth added that before we distribute the data, we have to provide it to the NRCS and they'll do their own QA/QC.

Modeling with Soil and Water Assessment Tool 2000 (SWAT2000

Doug Davidson discussed utilization of SWAT2000 and model simulations. In some detail he discussed the collection of available data necessary to run model simulations; the preparation and assimilation of data for model inputs; the running of simulations and display outputs; the calibration against known flow data, when available; and the validation with other similar flow data.

During discussions, Doug explained that the SWAT model is developed by Agricultural Research Service (ARS). Doug indicated that we have been collecting data to put into the model, run simulations to display the output and then calibrate the data for the model. We also validate the data for single flow areas. The data we collected includes the U.S. Geological Survey Hydrologic Unit Codes (USGS HUC5), with National Hydrology Dataset (NHD) DEMs, land use coverages, and soil data—the State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) data sets. SSURGO is available for most of the counties in North Dakota. USGS gauging stations use climatic data, which include the temperature and precipitation in each watershed. Doug was asked about the contribution of water from Minnesota to the Red River Basin; he said that he believed about 70% of the water comes from the Minnesota side.

Doug explained that the model calculates output for each single subbasin for a watershed. There are two different outputs that the model gives you: one is the basin output where each subbasin

has its own separate output; the other is a reach output which is an accumulative output for each subbasin as it goes down the streams.

Doug indicated that there are a lot of parameters that you can adjust for each subbasin, e.g., soil, land use type, subbasin data, specific parameters to a river, temperature of the snow, etc. After we input the data and run the model, we will proceed to the calibration and validation stage. We use five different methods for curve-fitting.

Paul Benedict asked if we look at the equal snow levels across the watershed or when the snow accumulates. Doug answered that the model allows one to choose snow coverage. You can set it to have even snow coverage across the valley, if it is completely covered 100%, it melts evenly. It can handle both fully covered and partially covered snow patterns.

Randy asked whether we are going to have to recalibrate the models after adding these storage scenarios. Doug answered we should not have to, if we have them set the way they are now, they should respond pretty much the same way.

Randy added that Wes has some detailed storage calculations and you are going to use that in the SWAT model. Wes added there is no way of knowing what the current conditions for storage are. You are saying that some storage is already in effect. There is no way of knowing exactly how much storage is already in place.

Bill indicated that he suspects that with groundwater, you might be able to back into some known areas, and there may also be some areas that you may be able to observe. Jim commented that it's not that you're making extra storage. It is that you're holding water for 2 weeks. Bill speculated whether it would be possible to put the ponds in the calibration and just leave it the way it is without trying to hold back the water for long periods of time. That way, you compare apples to apples.

Jim Solstad wanted to know how the model handled existing floodplain storage in the rivers, streams and ditches. Once you start storing water on the land, then that reduces the amount of storage that is occurring on the rivers, streams and, the ditches in the floodplain. You would almost need that much more on the land. He hoped the model also takes into account the impact of floodplain storage. Xixi Wang added this is not simulated for single reservoirs, but that is how you separate additional storage from natural storage.

Bill added that you might be able to find a statistical approach in the summer, and then make an assumption of where to calibrate it. Beth added if it was available, we could look at satellite imagery for various periods during that melt to determine where water tends to drain. Heith Dokken said that there is some satellite imagery available, but there is a lot of cloud cover. There is radar satellite imagery available with varying accuracies.

Wes added that the storage was the natural storage, built into the volume calculations. Xixi explained that the calibrated models already consider the natural storage areas, but another model can be used to change alterations/simulations. However, setting up separate range-based values so that the model can search for combinations in the natural storage areas is a challenge.

Randy asked about the effects downstream. Doug Davidson answered that he was still working on this model for the watershed.

Bill asked whether the numbers for total acre feet of storage for flood reduction for the whole valley applied all the way to Lake Traverse. Wes answered, yes, except for the Devils Lake and Red Lakes area and the southeastern portion of the basin.

Bill added that one might be able to infer something from hydrographs. With frozen ground, you might assume that you would get a fast runoff and the preexisting storage is full. There may be some portion of the hydro graphs you can consider as natural storage, and then subtract and calibrate from that point on. The hydrographs might be telling you something. When you are starting to see the flood, signifying a fast rise in the river; at that point there are some general assumptions that can be made. There might be something that you can infer from that that may be reasonable. Take a high-frequency flood and anything of this frequency or more, consider this as base, then subtract that from your total storage and work backwards. There is information that may be useful.

Doug added that there is not a lot of baseflow going on this time of year. Bill commented there is baseflow, but a lot of it is coming out of groundwater. Doug confirmed this, but he indicated that it is not a significant factor. He assumed that it would contribute little to this hydrograph.

Bill added that you view your sum as a stage factor. You have soil storage and surface storage. Those two factors will determine the nature of the hydrograph. It is possible to separate the various contributing flow factors.

Doug added that in the SWAT model, total stream flow consists of overland runoff, lateral flow from shallow aquifer, and baseflow from groundwater or deep aquifers. Surface storage directly affects the overland runoff, whereas soil storage directly affects the lateral flow. Of course, water retained in the surface storage and soil storage is connected through hydrologic processes of infiltration, re-evaporation, and seepage. The three sources to the total stream flow are reported separately in the SWAT simulation results.

Doug added that there is a parameter in there for fractional soil storage. He indicated that the SWAT model uses a set of parameters to mimic the affects of soil storage on the simulated flows. For snowmelt simulation, the SWAT model also estimates daily soil temperature, thaw depth, and hydraulic conductivity adjusted based on current soil moisture and temperature. Bill suggested that one could subtract the soil storage. Members of the Waffle team responded in the affirmative, indicating that for conservative purposes, we may just consider surface storage as natural storage. In terms of the modeling results and engineering judgment, the Waffle team thinks a natural storage of 1 inch (2.5 cm) runoff would be a good number to start with. Xixi added that there are several areas within watersheds where you can use peaks. In fact, generally we are just considering the surface storage because in the SWAT simulation results, baseflow and lateral flow are reported separately.

Field Trial Progress Update

Marc said that since the last meeting, we have done the crop estimation at the field trial site close to Shelly, Minnesota. Our newsletter has some of the results regarding the sunflower and corn

yields. The sunflowers showed identical yield estimates; the corn yields fall within the 5% potential error. There were no adverse effects to yields from the storage of water. However, we did have a very wet spring; therefore, in a year of drought or of average moisture content, the results might be different. The second-year field trial is going on, and we will have different weather conditions to work with.

Bill commented that sunflowers go in a little later. Your corn yields showed 134 bushels per acre on the nonflooded and 146 on the flooded. The numbers in the Waffle report were larger than that. Marc answered that we took an average. Within the field, there was no real good way to do a comparison between the flooded and the nonflooded areas based on the drainage ditches.

Bill added that he would suggest modifying the conclusion a little bit. He said that the Waffle team has a good grip on the variability. He disagreed with the expectation of a zero difference. With the additional 12 bushels, there are factors that had to do with the drainage setup that influenced the increase in yield. Bill thinks that the conclusion is that it is inconclusive. One really cannot infer anything from this. The real numbers tell you that there is a difference; the situation tells you that it is hard to interpret the results. You really cannot conclude that there is no difference.

Marc explained that there will be a draft summary of the field trial results mailed out by the end of next week. It will contain the details of every aspect of the field trial from testing of water quality, infiltration rates, evaporation, and crop yields. Also emphasized are the four other parcels of acquired land, three in Minnesota and one in North Dakota.

Marc said that we did not talk about the flood reduction potential at our last meeting. We measured water elevations in the judicial ditch adjacent to our field-trial site. Based on these data as well as the flow measurements that we collected throughout the spring thaw, Xixi estimated the reduction in water depth in the ditch as a result of storage. Coming up with an actual flow number was impeded because we had an ice jam in the ditch during the peak flow period, which interfered with our flow measurements. It was determined that there was 12% estimated reduction in the ditch-water elevations. Besides the flow, soil temperature and moisture data were used to determine what the frost depth was at each date. The frost came out significantly faster where there was water storage.

The 2005 field trial locations are near Shelly, Minnesota; Gilby, North Dakota; Lake Bronson, Minnesota; and Lake Agassiz, Minnesota. The Shelly, Minnesota, site is the same as last year. This will allow us to do extended monitoring and take a look at potentially different weather conditions this year to see if we get the same sort of results as we did this past year. We did some modifications on the trash racks. The Lake Bronson site is CRP land; it has a significant coulee running through it. There is a 52-inch culvert that we are modifying. It is surrounded by a larger county road that is paved that we will hold water up against. Corey Maki is doing a road stability evaluation. Also, we worked with the county to place instruments in the road, so we should be able to assess the impact of water storage on the road when the water is being stored up against it. The site storage is about 150 acre-feet; we will probably be flooding 60–70 acres.

Jim Solstad inquired about the size of the watershed. Marc said that we have not figured the size of the watershed yet. Marc responded that the Helman Swamp is a 2 × 6-mile area that has two or three coulees running through it and this is one of them.

Corey added that with the trash rack design, we are hoping that we will not experience any of the clogging problems that we had last year. The design is based on one that was provided by the Natural Resources Conservation Service.

Marc continued that the Agassiz site is in the U.S. Department of Agriculture (USDA) southwest corner of the Agassiz National Wildlife Refuge. This site includes about 400 acres of CRP, with the entire site contained within a constructed berm. In the past, the judicial ditch would flood every spring, so a berm was built up to keep the water from going into the section from the refuge. We are looking at 200 acre-feet of storage with about a 1.5 ft freeboard. The soil is tight clay that is underlaid by peat. There are four culverts that drain into the judicial ditch; two of the culverts will have standpipes on them and two will only have gates.

The site near Gilby is about 440 acres and is also contained within a berm. There is about 140 acre feet of potential storage; we estimate that we will be holding 60–70 acre-feet. This section is in the salt flats. We have taken extra soil samples so we can see how the water impacts soil concentrations. We will be looking at the flood reduction potential since we will have more sites for Xixi to model. We will also be evaluating the impact of water storage on CRP grasses. At the Shelly site, the Waffle team will be looking at crop yields, water quality, impact on the soils, infiltration, evaporation, and road stability.

Marc discussed the permitting issues that were encountered with the watershed districts, ditch authorities, county and state FSA offices, and also the county/state highway engineers. This was all documented as part of the implementation procedure. We are going to complete the instrumentation of these four field sites and anticipate storage in the March–April time frame. We will be preparing the summary and final report from these results.

Paul Benedict commented that it will be very interesting to see what happens to the soils, especially the ones with the salt. Much of the basin has soils where NRCS would not recommend irrigation because of the high concentrations salts and sodium. Something you should probably keep in mind is that the eligibility of certain programs could be affected by whether the land is being irrigated. The NRCS might consider this to be irrigation even though it is not.

Road Stability of Waffle Affected Sections

Corey touched on the primary and secondary factors of road stability. The primary concerns are washouts, where moisture content causes the road to fail on top or the whole road structure to shear off. There is also variable surface instability, that is, where the moisture content gets the road so wet that the road surface is affected when traffic drives over it.

The secondary concern is slope stability; once the water is contained in the ditch, the water could infiltrate the slope and weaken its shear strength. Because of the reduced strength, the water, once released, may actually cause the slope to slide off. The other secondary concern is wave action when water is in the ditch. If water were backed up across the entire section, the potential exists for waves to be transmitted across the surface of the water and interact with the slope of the road.

The reason why these are secondary concerns is that they are easier to cope with. With road stability, our contributing factors are steep slopes, moisture content, and proximity to the road.

The contributing factors for wave action are wind and moisture content. Wind is an obvious cause, otherwise waves would not exist. We had high moisture content in shoulder material and granular material along the shoulder slope. Prevention methods for wave action would be vegetative cover, geotextiles or fabrics—placing something down, such as riprap.

As for the primary concerns, one of the initial assumptions was that the road would be frozen. A frozen road would be expected to experience little or no weakening as a result of the retained water. To prove this hypothesis for the frozen road, we used data from the Shelly field trial site. These data provided us with frost and moisture information. Corey indicated that we were able to approximate a frost profile. Our region is in a relatively hard-frost area. We expect to see frost at least 4 ft deep. During our retention period, we saw the frost come out of the road from the asphalt surface down to a depth of approximately 14 in. The upper foot to 2 ft of soil can only actually absorb water during infiltration. It also means that while the road is being used as a retaining wall, the core area of the frozen ground itself will be hard. Since it will be frozen, the impact of the water there will be limited. To prove this, the Waffle team will record temperature and moisture throughout the frost zone from the surface to 6 ft deep.

Corey indicated that surface stability was one of the things we wanted to look at; asphalt roads have a tendency to be damaged more as a result of surface instability. The asphalt actually breaks up because the underlying layers are too soft to support the road. For that reason, we chose to monitor the asphalt road at Lake Bronson. We have two locations along County Road 19 which gave us an area to study and control area. To instrument the road, we used Yellow Springs thermistor probes, dielectric aquameter probes, and moisture sensors.

Eight probes were placed in a cross-sectional configuration at the test and control sites. The probes do not quite extend to the bottom of the ditch; they are actually a little further up on the slope because it is a paved, two-lane county road. This is carried out on both sides of the road. The temperature probes go 6 ft deep; the moisture sensors were set at 6-in. intervals.

Bill asked whether Corey was talking about dielectric probes, and whether they can tell the difference between ice and water. Corey answered affirmatively: it does read when it is frozen, and once it thaws, you will see a spike right away in the moisture content. As the moisture is reabsorbed in the soil, that spike will come down. You can definitely tell when it is frozen and when it is not.

Corey explained that the asphalt was cut to run the sensors below the road. We expect to get the temperature data, moisture data, and retention dates. Using those together, we can develop the actual frost profile. We then can show how far the frost has receded from the surface during our retention period; also, because we have moisture sensors in that range, we will be able to tell how much infiltrated. One will also be able to tell how deep the frost goes into the road. Corey indicated that the data will be available after the field trial runs next year.

Summary Comments

Beth stated that we will be sending the field trial results to the board. We would appreciate any input or comments on them, so we can address those before we distribute them to the general public. The methodology that Wes spoke of, conducted with Troy Simonsen, Santa Pachhai, and

others, has also been written up in some detail. This would also be good to provide to the advisory board for input, especially if there are any issues with the methodology.

Bill commented on the future direction. If this is ever going to become a practical thing, then this is something that is going to have to demonstrate itself. He suggests picking an area where it can have a considerable impact on flood reduction. Do the whole thing; if you can demonstrate the Waffle concept there and it looks like it is doing some good, and then maybe build two. He believes this is a really good concept, but that it is going to be a long curve if it is going to go at all.

Beth agreed. She believes the Antelope Creek subwatershed would be a good area, not just structurally, but also because it contributes significantly to flooding. One downside is that the Richland County Water board was one of the initial groups to write a resolution against the Waffle. They would be one of the key groups that we would have to interact with.

Bill added that you will want to get really good participation. Jim Solstad asked if we are strictly looking at spring, and if CRP land is being considered. Beth added that a Minnesota director was very interested in using CRP for summer flooding. However, we are not looking at summer flooding; we have always focused on spring. The effects of storage on CRP during the summer would have to be evaluated, to determine the cost of having to replant the CRP if it was washed out.

Jim commented that, in effect, you are talking about considerable infrastructure going out on that landscape with all these culvert modifications. Beth added that it all comes down to economics, whether or not it is feasible to flood an area. In a larger storage capacity, it might be more feasible. One would have to consider the types of CRP vegetation that would be most resilient to water storage during the summer or even during the spring. We do not think that our spring water detention is going to have any impact on CRP, but we do not know yet.

Beth asked whether there were any other questions or comments. She encouraged the board to contact us anytime, and thanked everyone for coming. Beth adjourned the meeting.