2.0 Detailed Work Plan

The plan for work can be split into four general tasks which are as follows:

Task 1 - Literature Review - The literature review will identify studies in which similar studies that may have been completed for other States. This search will also include gathering other background data/studies that would have applicability to this research.

Task 2 - Collection, Organization of Bridge Data, and Conducting Design Calculations - The Data Collection effort will require collecting project information for existing Wisconsin DOT CIP pile design and construction information. We will format and organize data on CIP supported bridges, and conduct design calculations for LFD and LRFD.

Task 3 - LFD and LRFD Analyses of CIP piles, effects of predictive method, soil, pile, geology, and geography - The third task requires analyses of the information

collected and interpreted in Task 2. Comparisons of pile length will be made for LFD and LRFD methodologies. Other metrics, such as Capacity Ratio and Load Demand will also be compared. Recommended changes will consider local and historic Wisconsin DOT experience.

Task 4 - Report Writing and Submission of Report - This includes writing and submitting the draft report presenting the data, findings, analyses and recommendations. After review by Wisconsin DOT, the report will address review comments, and the final report will be issued.

2.1 Task 1 - Literature Search and Background Study

The first task will be to conduct a thorough literature search of any similar-type studies that may have been completed for other States. This search will also include gathering other background data/studies that would have applicability to this research. I have already included a discussion pertinent to this task in the previous section (Background), and therefore in the interest of space, will not repeat the content.

A short interim report summarizing the results of the literature review and background study will be issued within four months after the beginning of the project. As part of this background, we will review the WHRP report on pile capacities (Long, 2009a) to ensure that the appropriate resistance factor specifically for CIP piles is being used. Also, we will define and discuss the metrics we plan to use for the project. If necessary, the report will refine the current plan to improve efforts for subsequent project work. It is anticipated that the principal investigator will travel to Madison and meet with members of the Technical Oversight Committee to discuss the results of the literature search, and establish a strategic cooperative workflow for Task 2.

2.2 Task 2 - Collection, Organization of Bridge Data, and Conducting Design Calculations

The second task will involve obtaining project information on existing Wisconsin DOT CIP pile design and construction information. It is anticipated that this information will be received in several formats including Excel spreadsheets, Access database, and a limited number of hardcopy files to retrieve specific project information. We will require the Wisconsin DOT to assist with coordinating and organizing this effort. I expect we will approach this task by spending at least two-to-three days at the Wisconsin DOT reviewing files and collecting/interpreting data to ensure we are able to interpret and calculate the necessary items for this task. This visit will occur after presentation of the interim report (Task 1).

Wisconsin DOT estimates there to be approximately 185 CIP-supported substructure units in its database, and approximately 40-50 more project records will be added during the 2009-2011 construction seasons. We will format and organize the data so it can be fully analyzed. We will complement existing designs so that both LFD and LRFD pile length designs are identified for each project. Driven pile records for all sites in which there is adequate information will be analyzed to determine modified ENR, modified Gates and/or Washington State DOT, and WAVE equation pile lengths/capacities for comparison. A limited number of Departmental PDA records will be used to analyze

similarly. These data will include sites from the Marquette Interchange project in Milwaukee. Task two will be conducted using the subtasks presented below.

Task 2a) Collect Information on the bridge abutment/pier to assess loads and to calculate loads - Information will be collected to allow the estimation of the dead and live loads to be applied to the bridge foundation necessary to identify the loading for both LFD and LRFD. This will require interaction with Wisconsin DOT engineers to confirm methodology for determining (or identifying) these loads. This information is necessary to identify, for a given structure, the difference in demand based on LFD and LRFD. Information for each bridge structure will identify bridge location (highway, county, structure number), support pier or abutment, original design (LFD or LRFD), type of crossing (water or grade separation). Calculations will be made to determine the DL and LL appropriate load factors and/or load combinations.

Task 2b) Collect Information on the CIP piles - Information will be collected to identify the pile foundation details. Items to record will be as follows: Number of piles, pile length, pile diameter, thickness of pile shell, strength of concrete, pile driving hammer, pile penetration resistance, hammer stroke, ram weight, soil profile, elevation profile for foundation and piles, location of groundwater table, pile driving record, design capacity.

Task 2c) Use Information in Task 2b to determine pile capacity versus depth with static and dynamic methods - Depending on the information available, his task can be problematic for comparing pile lengths based on different methodologies. For example, the length of pile may have been driven to satisfy LFD requirements. However, the driven length may be inadequate to satisfy LRFD capacity requirements. As a result, there could be no comparison of length based on dynamic formulae for this case. In addition, we may also run into the similar situation when comparing different dynamic methods (e.g. EN, versus modified Gates, versus WEAP, versus PDA). Rather than discarding this information, we will instead use a ratio of predicted capacity for each predictive method as the metric at the final depth of pile. Accordingly, this will allow us to obtain useful information in Task 3 from all foundations.

There will be a significant amount of work for this sub task. We will endeavor to identify capacity of the pile versus depth for all the methods possible to allow for the comparison of ratios of lengths and capacities for both LFD and LRFD designs. We will work with Wisconsin DOT to ensure our method for calculating static capacity and dynamic capacity is consistent with the Wisconsin Bridge Manual and Wisconsin DOT practice.

Task 2d) Organize the data in a form that is usable for Task 3 - While Tasks 2b and 2c will identify the basic data and calculations for each bridge support and foundation, Task 2d will combine the information generated in tasks 2b and 2c into a file that will allow comparisons of length, capacity, load demand, and capacity ratio for LFD and LRFD designs. The data will be organized to allow filtering based on pile size, soil type, location, and several other factors to assist in the analyses.

2.3 Task 3 - LFD and LRFD Analyses of CIP piles, effects of predictive method, soil, pile, geology, and geography

The third task will conduct analyses of the information collected, calculated, and filed as discussed in Task 2a-2d. We will provide length comparisons between LFD and LRFD. LFD is historically associated with using the EN dynamic formula, but estimates based on LRFD designs will be made using EN, modified Gates and/or Washington State DOT, and when possible WEAP and PDA will also be used. Length comparisons will also be made for the static method.

As mentioned in task 2c, length comparisons may not be possible for several bridge structures. Therefore, we will also compare ratios of predicted capacity at a given length (e.g. the final depth of pile). Accordingly, this will allow us to get some useful information in task 3 from all foundations.

We will look for trends in the data based on bridge details, soil type, geology, location, pile size, pile length, pile capacity, and other factors. These comparisons will be used as a basis for recommendations of changes to AASHTO LRFD design factors. Results will allow the Department to analyze the information and make an informed decision on any useful applications of the results.

2.4 Task 4 - Draft report and Final Report

The fourth task will present all data, findings, analyses and recommendations in a final report. A draft edition for the report will be provided to Wisconsin DOT three months before the end of the project, allowing two months for review. The final month will be used to revise the report and issue a final draft. Deliverables will include 36 printed copies of the final report.

3.0 Research Results and Implementation Plan

Results will provide needed data and analyses to help the Department determine the effects of changing to the AASHTO LRFD methodology and also changing from modified-ENR pile installation method to the modified Gates or Washington State method. Results will also provide data and recommendations on appropriate modifications to the AASHTO suggested design factors used in LRFD, based on local conditions and past experience. Furthermore, the results will allow the agreement between as-designed and as-driven pile lengths to be compared, quantified, and improved.

Specific locations of proposed Wisconsin DOT changes will be detailed in the final project report. Advantages and limitations of incorporating the results into Wisconsin DOT policy will also be provided. However, implementation of findings will be conducted by Wisconsin DOT, as appropriate.

3.1 Benefits

Since Wisconsin DOT has transitioned to the LRFD methodology, there has not been a significant effort to compare the design pile lengths to the previous LFD design lengths. A comparison also needs to me made between the modified ENR and modified Gates installation methods. Analyses of this data and comparisons will allow the Department to incorporate local and past experience into the current AASHTO design methodology. This refinement of the design method has been recommended by both AASHTO and

FHWA. Refinements may allow for the potential reduction in number of piles, or pile lengths, on transportation projects and the associated cost savings.

3.2 Implementation

Results from this study will provide the Department with necessary information to determine if revisions to the standard AASHTO code parameters are warranted. Provided information will detail the potential advantages, limitations and cost impacts of any proposed changes. These changes may require revisions to the Bridge Manual, Geotechnical design guidelines and/or the Facilities Development Manual. The researcher will help identify the location(s) of these changes and provide specific language, but the actual revisions will be the responsibility of the Department.

4.0 Work-Time Schedule

A table detailing the work schedule is given on page 9.

5.0 Reports and Meetings with Wisconsin DOT

Quarterly reports will be e-mailed to Mr. Andrew Hanz. In addition to the quarterly reports there will also be a short interim report issued within the fourth month of the project to summarize finding of Task 1 effort.

There are three additional meetings that will be scheduled with Wisconsin DOT personnel in which details of the project will be discussed and presented. The four meetings are as follows:

Meeting 1 - (month 4) Meeting to summarize the literature review and to start the process of collecting data from Wisconsin DOT. I may stay a couple of days to collect data and learn how to interpret the information provided by Wisconsin DOT.

Meeting 2 - (month 8) Meeting with WDOT personnel to update TOC members on progress and discuss issues. This meeting is optional, and will depend on the need to interact personally with the committee versus communicating with members by phone or e-mail.

Meeting 3 - (month 13) At this stage, a significant amount of data should have been interpreted and entered into the database and the character of the database should be presented and discussed with Wisconsin DOT. We will also discuss and restate our research plan for Phase 3 and solicit comments and suggestions from Wisconsin DOT personnel.

Meeting 4 - (month 24) The PI will make a presentation of the findings and submit the draft report. The summary presentation is suggested at month 24 (rather than month 27) to assist the reviewers in efficiently reviewing the report and clarifying any questions and concerns before the final review process begins.

Comparison of LRFD and LFD Cast-in-Place Pile Design and Construction Methods

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
		2009			2010												2010											
Task	Description	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Literature Search and Background Study																											
2	Collection, Organization of Bridge Data, and Conducting Design Calculations																											
2a	Collect Information on the bridge abutment/pier to assess loads and to calculate loads																											
2b	Collect Information on the CIP piles																											
2c	Use Information in Task 2b to determine pile capacity versus depth with static and dynamic methods																											
2d	Organize the data in a form that is usable for Task 3																											
3	LFD and LRFD Analyses of CIP piles, effects of predictive method, soil, pile, geology, and geography																											
4	Draft report and Final Report																											
	Meeting with TOC committee in Madison (* - means meeting may be necessary)				M				*M					M											M			