

DETAILED SPECIFICATIONS

VERTICAL CONTROL SURVEY AND HYDRAULIC STRUCTURE AND CHANNEL SURVEY AND MEASUREMENT

FLOOD HAZARD MAPPING SERVICES IN WISCONSIN

I. GENERAL

These specifications set forth the requirements of the Wisconsin Department of Natural Resources for surveying services, including vertical control surveys, vertical control survey monumentation, hydraulic structure and channel measurements, and photography of hydraulic structures for stormwater drainage and flood control planning and engineering purposes.

II. SURVEYS

A. General

The Consultant shall furnish all labor, materials, and equipment necessary to properly complete the necessary vertical control surveys, vertical control survey monumentation, hydraulic structure measurement, and photography as specified herein.

B. Vertical Control

1. General – The Consultant shall provide the vertical survey control necessary for the specified hydraulic structures along the streams outlined in their contract.

This work shall include the establishment of permanent third order bench marks on, or conveniently near, the dams, bridges, culverts, which have been identified by the responsible engineer as hydraulically significant.

The Consultant shall establish permanent bench marks on the structures and shown on a Map, and shall establish the elevation of these bench marks related to the National American Vertical Datum of 1988 (NAVD88). Vertical control may be established with automatic level circuit lines or global positioning system (GPS) methods that achieve the degree of accuracy specified below.

2. Datum and Order of Accuracy – The required vertical control survey shall be based upon NAVD88 as established by the National Geodetic Survey. Permanent bench marks in the project area shall be established to third order accuracy through closed level circuits or GPS methods. The error of closure in feet shall not exceed 0.05 times the square root of the total length of the level circuit expressed in miles. All level circuits shall be accurately adjusted for closure by the National Geodetic Survey methods.
3. Bench Mark Monumentation – When conducting the automatic level circuit or GPS survey, permanent bench marks shall be set wherever possible and as directed by the R.L.S. in charge on such objects as the exposed concrete bases of high-voltage electricity transmission towers, bridge abutments and wingwalls, headwalls of large culverts, foundations of large buildings, outcroppings of ledge rock or any other objects which are unlikely to be displaced vertically. The monuments marking such bench marks shall consist of a square chiseled into the horizontal surface of stable concrete and masonry structure, or ledge rock, used as base for the bench marks, or railroad or boat spikes driven into the vertical surface of

substantial, healthy trees or stable timber structure used as a base for the bench marks. In all cases, the monuments set shall be selected for their potential permanence and stability and shall preferably consist of squares cut into concrete bridge abutments, or culvert headwalls. Railroad spikes in trees and telephone or power poles may be acceptable.

At hydraulic structures, follow this order of where to set benchmarks. If the first location is unattainable, use the second, and so on.

- a. A square chiseled into the horizontal surface of the:
 - i. Upstream left headwall
 - ii. Upstream right headwall
 - iii. Downstream left headwall
 - iv. Downstream right headwall
- b. Spike in nearby power pole set towards the road and 0.5 feet above ground
- c. Top of the rim of a manhole (not in road)
- d. Flange bolt of a fire hydrant (not on top)
- e. Spike in nearby tree set towards road or creek and 0.5 feet above the ground

It is the intent of these specifications that in addition to each permanent bench mark established, one permanent reference bench mark shall be established. The permanent reference bench mark shall be set so that the elevation of the permanent bench mark may be readily verified from the reference bench mark from a single level position.

Care should be taken to conduct a thorough search of each structure to ensure that any existing chiseled squares or brass or aluminum caps are located and utilized in the level circuit.

C. Hydraulic Structure Measurement

1. General – The Consultant shall complete “as built” measurements on all structures that are determined to be hydraulically significant. Measurements shall be performed with sufficient precision and accuracy so that properly detailed and correct plan and cross-sectional views of the upstream side of the hydraulic structure and adjacent river channel can be drawn, all adequate for the correct establishment of the hydraulic capacity of the hydraulic structures for planning and engineering purposes.
2. Required Accuracy – All elevations for hydraulic structure measurements and profiles shall be based on NAVD88 and shall be determined to an accuracy of 0.1 foot plus or minus and recorded in feet and tenths of a foot. All horizontal measurements shall be determined to an accuracy of 0.1 foot plus or minus and recorded in feet and tenths of a foot.
3. Survey Sketches – A detailed plan and elevation sketch (looking downstream at upstream face of structure, sketched left to right) of the structure representing the structural geometry and the natural ground using standard survey codes must be provided.

Required details for a bridge include:

- a. Surveyors Name and Date
- b. Stream Name and flow direction
- c. Road Name
- d. Structure Number
- e. Survey Type (Differential GPS, Total Stations, ...) and Filename/Pages of Survey Notebook
- f. Photo Ids and location where taken
- g. Location of Permanent Benchmark(s) and Reference Mark(s), including elevations
- h. Location, Size, and type of:

- i. Rails
- ii. Piers (i.e. 3.0ft round or 2.5ft square)
- iii. Abutments (sloping or vertical)
- iv. Wingwalls - Flared 30 degrees from longitudinal axis of culvert, inlet top edge beveled approximately 45 degrees, etc....)
- i. General Channel and Overbank shape
- j. Clear Span Length
- k. Hydraulic Width – the distance that the stream flows through a structure
- l. Deck Thickness – distance from the Top of Road to the Low Chord (top of opening) of bridge
- m. Roadway Width
- n. Skew of Bridge with the River Channel

Required details for a culvert include:

- a. Surveyors Name and Date
- b. Stream Name and flow direction
- c. Road Name
- d. Structure Number
- e. Survey Type (Differential GPS, Total Stations, ...) and Filename/Pages of Survey Notebook
- f. Photo Ids and location where taken
- g. Location of Permanent Benchmark(s) and Reference Mark(s), including elevations
- h. Culvert Length (for each culvert) – the distance that the stream flows through a structure
- i. Culvert Type (for each culvert) – Reinforced Concrete Box [RCB], Reinforced Concrete Circular Pipe [RCP], Corrugated Metal Circular Pipe [CMP], Corrugated Metal Arch [CMArch]
- j. Culvert Size (for each culvert) – include height and width for non-circular culverts
- k. Culvert Entrance Conditions – The entrance conditions for culverts shall be recorded (e.g., square edge with headwall, groove end or socket entrance with headwall, projecting, wingwalls flared 30 degrees from longitudinal axis of culvert, inlet top edge beveled approximately 45 degrees, top edge rounded, etc.).
- l. Pipe Wall Corrugations - The spacing between corrugations and the height of corrugations should be recorded for corrugated metal or structural plate pipe (e.g., 6 inches by 2 inches, 2.67 inches by 0.5 inches, 3 inches by 1 inch).

Required details for a dam include:

- a. Surveyors Name and Date
- b. Stream Name and flow direction
- c. Dam Name
- d. Structure Number
- e. Survey Type (Differential GPS, Total Stations, ...) and Filename/Pages of Survey Notebook
- f. Photo Ids and location where taken
- g. Location of Permanent Benchmark(s) and Reference Mark(s), including elevations
- h. North Arrow, direction of flow
- i. Width of the top of the dam
- j. Side Slope – Embankment side slope of the dam
- k. Riser – size and material
- l. Principal Spillway –length and diameter
- m. Overflow Spillway – location, height and thickness
- n. Auxiliary Spillways – location, size, and type
- o. Gate sections – location, type, width, maximum opening height, and gate dimensions.
- p. Stoplog sections – location, width, and stoplog dimensions
- q. Type of construction, (earth fill or concrete)

4. Bridge Survey Data (See Exhibit E for example) – The following horizontal/vertical survey data must be collected and designated using the survey codes in parentheses. All locations where elevation data are collected should be located by station relative to the centerline of the bridge or culvert.
 - a. Top of Road (TR) – The highest-grade line of road, top of curb, or top of high rail for railway crossings along the structure extending 1000 feet laterally to each side from the center of the structure or to those points on each side at which the high point in the roadway or railway approach rises to and remains 3.0 feet above the top of road, top of curb, or top of high rail for railway crossings (TR) at the centerline of the waterway. At any given lateral distance from the waterway centerline, the profile should reflect the highest elevation of the bridge proper—excluding the handrail—or of the approach road, curb, or railway. Elevations shall be determined at a sufficient number of points so that an accurate profile of the roadway crown, top of curb, or railway rails can be drawn across the entire width of the floodplain. In addition to collecting elevations at sufficient locations to adequately define the profile, Top of Road (TR) shots must be taken at the following locations:
 - i. At the beginning and end of the hydraulic opening as defined by the abutment location.
 - ii. Above the centerline of the waterway
 - b. Low Chord (LC) – Low steel or concrete at top of waterway opening. Determine elevations at several locations if the elevation varies.
 - c. Hydraulic Width (HdW) – Measured along the center of the hydraulic opening from the upstream to the downstream face of bridge.
 - d. Rail (RAIL) – Must include shots where Rail (RAIL) begins and ends.
 - e. Toe of Abutment (TOE) – Necessary only for those bridges with sloped abutments
 - f. Piers (P#, #) – If there are piers, the center of each pier should be located on the upstream face. Piers should be numbered from left to right and include their width (i.e. 2nd pier from left with a 3' diameter would be labeled P2,3.0)
 - g. The Bottom of Stream Channel shall be surveyed at the upstream and downstream side of each structure in a location that represents the natural channel characteristics. This location is usually near the toe of the road embankment fill, or (on the downstream side) just downstream of any apparent scour holes. Elevations shall be determined at the following locations:
 - i. BK – Stream Bank: Top of Stream Channel
 - ii. EW – Edge of Water
 - iii. CH – channel (minimum 3 shots below the water line)
5. Culvert Survey Data (See Exhibit G for Example) – The following horizontal/vertical survey data must be provided using the survey codes in parentheses. All locations where elevation data are collected should be located by station relative to the centerline of the bridge or culvert:
 - a. Top of Road (TR) – The highest-grade line of road, top of curb, or top of high rail for railway crossings along the structure extending 1000 feet laterally to each side from the center of the structure or to those points on each side at which the high point in the roadway or railway approach rises to and remains 3.0 feet above the top of road (TR), top of curb, or top of high rail for railway crossings at the centerline of the waterway. At any given lateral distance from the waterway centerline, the profile should reflect the highest elevation of the bridge proper—excluding the handrail—or of the approach road, curb, or railway. Elevations shall be determined at a sufficient number of points so that an accurate profile of the roadway crown, top of curb, or railway rails can be drawn across the entire width of the floodplain. Top of Road (TR) shots must be taken at the following locations:
 - i. At the beginning and end of the hydraulic opening as defined by the culvert inverts.
 - ii. Above the estimated change in culvert direction beneath the roadway (if applicable).
 - b. Rail (RAIL) – Must include shots where Rail (RAIL) begins and ends.

- c. Culvert Inverts (UINV# or DINV#) – The upstream and downstream invert elevations must be taken at the center of the culvert opening. Culverts should be numbered from left to right (i.e. the upstream invert of the second culvert to the right would be UINV2).
 - d. Culvert Obverts (UOBV# or DOBV#) – The upstream and downstream obvort elevations must be taken at the center of the culvert opening on its crown (inside top of culvert). Culverts should be numbered from left to right (i.e. the upstream obvort of the second culvert to the right would be UOBV2).
 - e. The Bottom of Stream Channel shall be surveyed at the upstream and downstream side of each structure in a location that represents the natural channel characteristics. This location is usually near the toe of the road embankment fill, or (on the downstream side) just downstream of any apparent scour holes. Elevations shall be determined at the following locations:
 - i. BK – Stream Bank: Top of Stream Channel
 - ii. EW – Edge of Water
 - iii. CH – Channel (minimum 3 shots below the water surface)
6. Dam Measurements – (see Exhibit I for example). The following horizontal/vertical survey data must be provided using the survey codes in parentheses. All locations where elevation data are collected should be located by station relative to the centerline of the dam.
- a. Top of Dam (TR) – The highest-grade line of dam, (or embankment), along the structure extending 1000 feet laterally to each side from the center of the structure or to those points on each side at which the high point in the embankment. At any given lateral distance from the waterway centerline, the profile should reflect the highest elevation of the dam—excluding the handrail—. Elevations shall be determined at a sufficient number of points so that an accurate profile of the dam crown can be drawn across the entire width of the floodplain. Top of Dam (TR) shots must be taken at the following locations:
 - i. At the beginning and end of all Spillway sections.
 - ii. At the location where the dam meets natural grade.
 - b. Handrails (RAIL) – Must include shots where Rail (RAIL) begins and ends.
 - c. Spillway Inverts (UINV# or DINV#) – The upstream and downstream invert elevations must be taken at the center of the pipe opening. Each spillway should be numbered from left to right.
 - d. Spillway Obverts (UOBV# or DOBV#) – The upstream and downstream obvort elevations must be taken at the center of the pipe opening on its crown (inside top of pipe). Each spillway should be numbered from left to right.
 - e. Overflow and Auxiliary Spillways (TR TOP SPY1, 2) – The elevation of all weirs, numbered sequentially from left to right.
 - f. Gate sections (UINV#, UOBV#) – The sill elevations of each gate section, and the elevation of the bottom of each gate must be taken. Record the width and height dimensions of each gate, and if possible, the elevation of the bottom of the gate at its maximum open position.
 - g. Stoplog sections (UINV#, SPY#) – The elevations of the sill of each stoplog section and the top of each stoplog must be taken.
 - h. Staff gage (ex. GAGE 3.72) – Looks for any lake level staff gages and survey them in. Record a reading on the staff gage and survey that elevation.
 - i. The Bottom of Stream Channel shall be surveyed at the upstream and downstream side of each structure in a location that represents the natural channel characteristics. This location is usually near the toe of the road embankment fill, or (on the downstream side) just downstream of any apparent scour holes. Elevations shall be determined at the following location:
 - i. BK – Stream Bank: Top of Stream Channel
 - ii. EW – Edge of Water
 - iii. CH – Channel (minimum 3 shots below the water surface)

7. Photography of Waterway Openings – Five digital photographs must be taken at each structure and include (an example structure on Swift Creek identified as “SWI-100”):
 - a. Looking at the upstream face of the structure (SWI_100_USFACE.jpg)
 - b. Looking at the upstream channel from the top of the structure (SWI_100_USCH.jpg)
 - c. Looking at the downstream channel from the top of the structure (SWI_100_DSCH.jpg)
 - d. Looking at the downstream face of the structure (SWI_100_DSFACE.jpg)
 - e. Overtopping cross section looking left to right (SWI_100_OTXS.jpg)

D. Intermediate Channel Measurement between Structures

1. The Consultant shall measure the channel of the waterway as follows:
 - a. In rural areas, a minimum of one in channel cross section must be collected every 1000 ft.
 - b. In urban areas, a minimum of one in channel cross section must be collected every 500 ft.
 - c. There must be at least one channel cross section collected between road crossings in addition to the face sections.
2. The Consultant shall obtain enough information at each channel section to be surveyed and measured so that the shape and size of the channel may be reproduced adequately.
3. Elevation points shall be measured to represent the channel characteristics and they shall be determined at the following locations at a minimum (as shown on Exhibit A.):
 - a. BK – Stream Bank: Top of Stream Channel
 - b. EW – Edge of Water
 - c. CH – Channel (minimum 3 shots below the water surface including the lowest point in the channel)
4. Two digital photographs must be taken at each cross section:
 - a. Looking at the downstream channel (SWI_100_DSCH.jpg)
 - b. Looking at the upstream channel (SWI_100_USCH.jpg)

E. Field Notes and Office Computation Data and Flats

The Consultant shall keep all field notes and office computations in a neat and orderly manner, clearly indexed, and open for inspection and checking during the course of the work. Upon completion and acceptance, duplicate copies of all field notes and computations shall be furnished to the Department and shall become their property. The Consultant shall, on request before final acceptance of the work, furnish instruments and assistance to a duly authorized agent of the Department for such checking of field work and computations as may be deemed necessary by the Department.

1. The Consultant shall deliver to the Department for final acceptance, a diagram summarizing the location and orientation of the level circuits or of the GPS base stations and intermediate bench marks established under these specifications. Exhibit B attached hereto and made a part hereof, illustrates the required form and content of this diagram. This diagram shall be prepared on a base map (using either the USGS 7.5 Minute Quadrangle and/or suitable base map provided by the Department and shall include the following):
 - a. All bench marks erected and established in the field.
 - b. The identification number of each bench mark set.

- c. All basic U.S. Coastal and Geodetic Survey vertical control survey stations within and adjacent to the project area and to which the vertical control surveys are tied together with their bench mark elevation.
 - d. The “level net run” showing all the level circuits, if applicable.
2. The Consultant shall provide for each bench mark and its accompanying reference bench mark established a dossier on a form to be furnished by the Department. Exhibit C attached hereto and made a part hereof, illustrates the required form and content for these dossiers. The following information shall be included for each bench mark and reference bench mark on the dossiers:
 - a. Title giving the location of the bench mark by U.S. Public Land Survey section, town, and range, in which the bench mark is located.
 - b. A sketch showing the bench mark monument erected in relation to the salient features of the immediate vicinity. Any witness monuments set shall be shown together with their ties. A north point shall be shown properly located thereon. The names of adjoining streets, state and county trunk highways, railroads or public or quasi-public lands shall be indicated.
 - c. The bench mark elevation of the monument referred to NAVD88.
 - d. If necessary to supplement the sketch, a clear and concise description of each station so as to permit its ready recovery.
3. The Consultant shall provide the following data for each of the hydraulic structures measured:
 - a. A Field-book sketch, fully dimensioned, of each bridge, culvert, and dam. Each sketch shall clearly show a structure in both plan view and upstream elevation. When it is necessary, in order to fully describe a structure, a downstream elevation sketch shall also be included. An example of the detail required for this field sketch is attached hereto and made a part hereof as Exhibit D.
 - b. Field notes accompanying each field-book sketch with form and content adequate to enable verification and replication of each survey location.
 - c. Digital or 3-inch by 4-inch (or larger) photographs: Five for upstream, downstream, and top views of each hydraulic structure and two looking upstream and downstream of intermediate channel locations. Each photograph shall be identified by the structure numbers shown on Exhibit A. and the upstream and downstream views should also be identified.
4. The Consultant shall provide all digital output from the survey of all structures and intermediate channel sections recorded in x,y,z format to enable plotting exact locations and elevations of all survey points. In addition all data shall be projected to NAD83 HARN Wisconsin State Plane South Coordinate System (Exhibit K).
5. All structures and cross sections must have a unique alpha three-character ID as a feature name. A feature name (three-character ID) must have the abbreviated stream name followed by the number of the feature on that stream. All numbers must start from the downstream limit and increase upstream. Names must begin with an abbreviation consisting of the first three letters of the stream name. For example, Swift Creek would be SWI. In numbering structures and cross sections, it is suggested to use a numbering system that allows for intermediate numbers to be added later in cases where a structure or cross section is skipped or added (e.g., 100, 200, 300, etc.). Some variation is allowable if multiple streams in the same flood risk project area begin with the same three letters. The name and numbers must be separated by an underscore rather than space or dashes. An optional descriptor can be included at the beginning of the names to accommodate statewide programs (e.g., NC10_SWI_500_1).

III. SUMMARY OF ITEMS TO BE DELIVERED

Upon completion, the Consultant shall deliver to the Department the following items:

- A. One set of copies of the original field notes and computations as specified under Section II.E hereof.
- B. One diagram of the level circuit or of the GPS base stations and intermediate bench marks, specified under Section II.E.1 hereof. If digital, the diagram should be provided in ArcView shape file format or as an ArcInfo coverage.
- C. One set of bench mark dossier sheets specified under Section II.E.2 hereof.
- D. One set of copies of the plan and profile sketches as specified in Section II.E3a hereof.
- E. One set of copies of the field notes and computations as specified in Section II.E3b hereof.
- F. One set of photographs as specified in Section II.E3c hereof.
- G. One set of digital files containing all survey points collected for all structures and intermediate channel sections as specified in Section II.E.4.
- H. Certification that all work was done under the direct supervision of a Registered Land Surveyor or Professional Engineer in Wisconsin.

LIST OF EXHIBITS

Exhibit A

Exhibit A present listings of all hydraulically significant structures to be surveyed and measured. (provided per project)

Exhibit B

Exhibit B presents an illustration of the required form and content of the diagram to be delivered by the consultant in summarizing the level circuit layout and related data.

Exhibit C

Exhibit C presents an illustration of the required form and content of dossier sheets to be provided by the consultant for each bench mark and it's accompanying established referenced bench mark.

Exhibit D

Exhibit D presents an illustration of the required sketch for all structures to be surveyed and measured.

Exhibit E

Exhibit E presents an illustration of required bridge survey and measurements.

Exhibit F

Exhibit F presents an illustration of typical required bridge survey codes.

Exhibit G

Exhibit G presents an illustration of required culvert survey and measurements.

Exhibit H

Exhibit H presents an illustration of required culvert survey codes.

Exhibit I

Exhibit I presents an illustration of required dam survey and measurements.

Exhibit J

Exhibit J presents an illustration of required dam survey codes.

Exhibit K

Exhibit K presents the parameters for the WTM83 HARN projection.

Exhibit L

Exhibit L presents the specifications for the Full Valley Section Surveys

EXHIBIT A

n/a

EXHIBIT B

MAP SHOWING VERTICAL CONTROL SURVEY STATION LOCATION FOR MENOMONEE RIVER & TRIBUTARIES

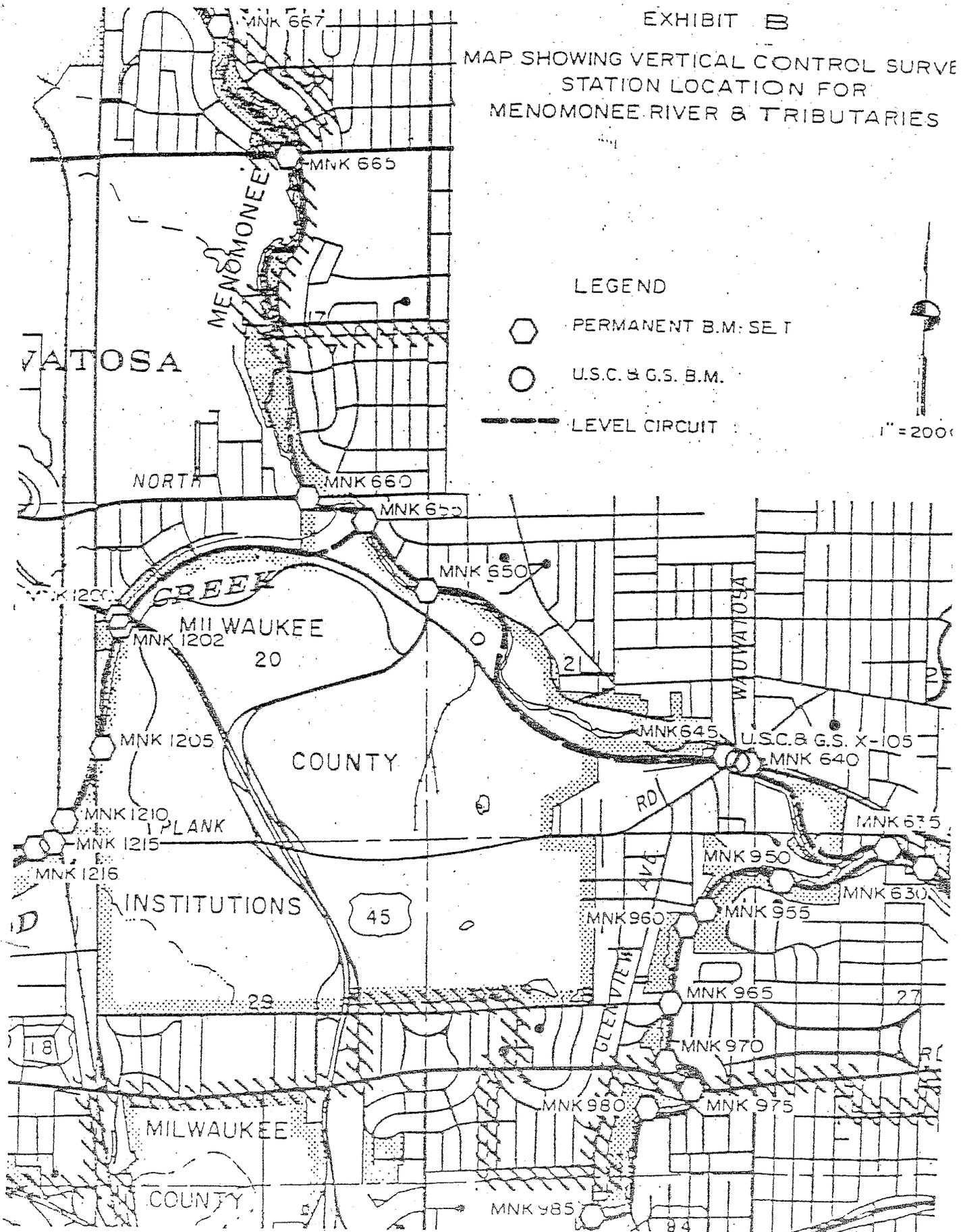


Exhibit C

RECORD OF VERTICAL CONTROL STATION

SECTION 14 T. 9 N. R. 20 E. WASHINGTON COUNTY, WISCONSIN

BENCH MARK NO. MN-45 ELEVATION 853.592'

REFERENCE BENCH MARK NO. RL-45 ELEVATION 853.814'

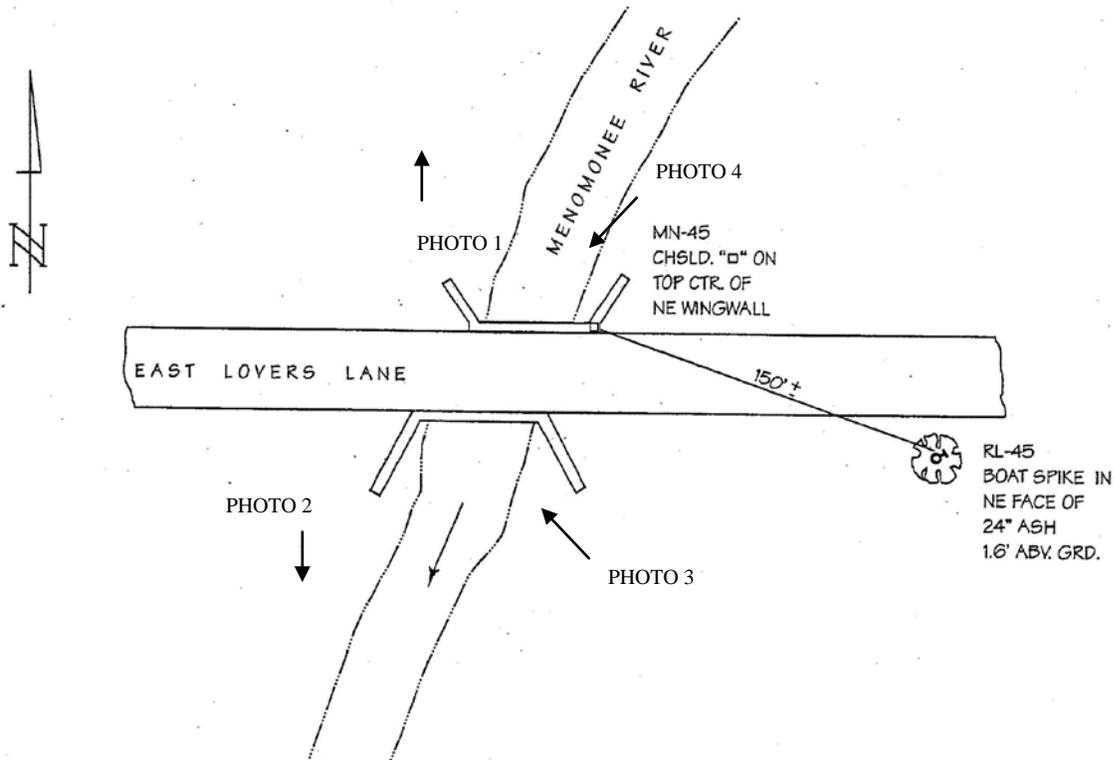
BM/RBM SET BY: ALSTER & ASSOC., INC. YEAR: 1973

BM/RBM CONTROL SURVEY BY: ALSTER & ASSOC., INC. YEAR: 1973

DATUM: NATIONAL GEODETIC VERTICAL DATUM OF 1929

CONTROL ACCURACY: SECOND ORDER, CLASS II

LOCATION SKETCH:



DETAILED DESCRIPTION:

Structure No. 900 is located about 0.1 mile E of the center of Section 14, T 9 N, R 20 E.

RECOVERED BY: SEWRPC DATE: 1 NOVEMBER 1996

FORM PREPARED BY SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

EXHIBIT D: TYPICAL SKETCH REQUIRED WITH STRUCTURE SURVEY

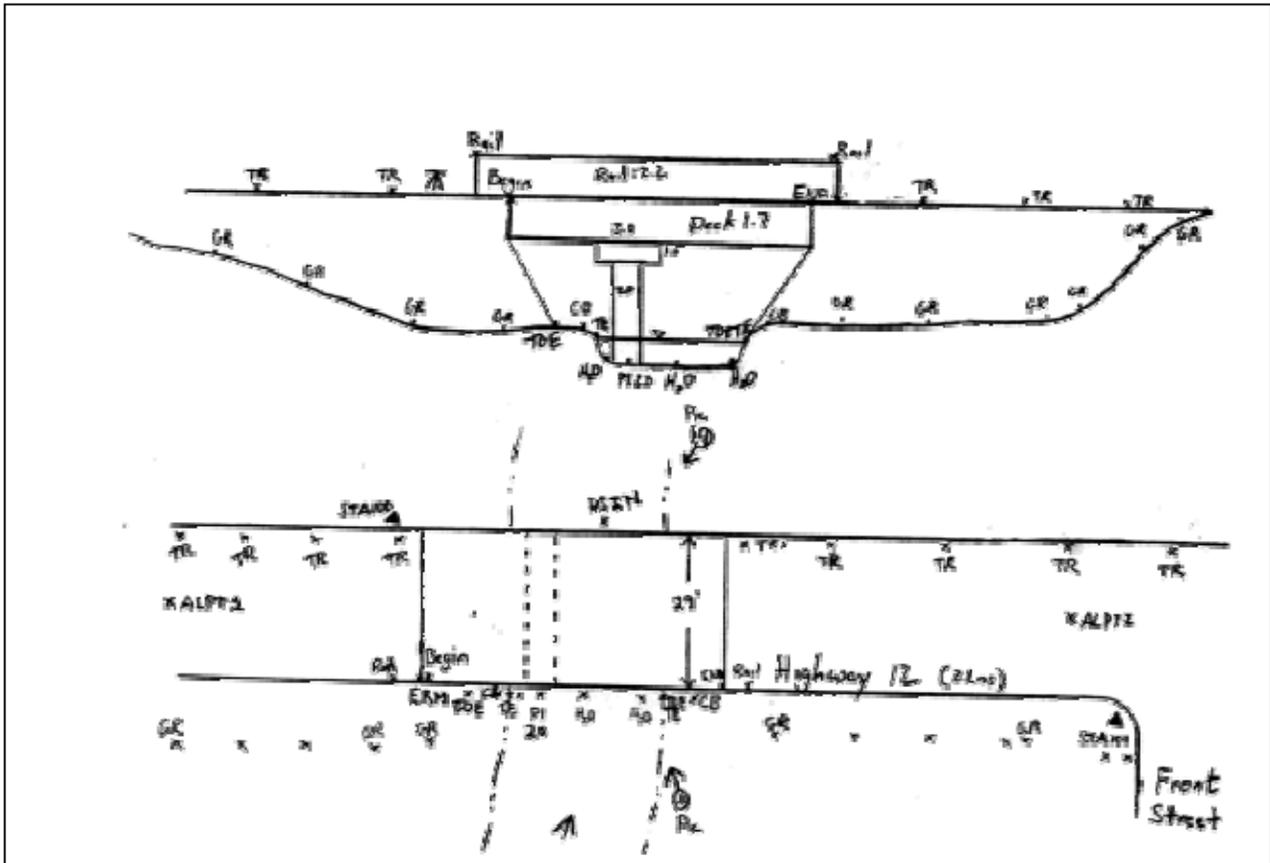


EXHIBIT E: EXAMPLE ILLUSTRATION OF TYPICAL REQUIRED BRIDGE SURVEY MEASUREMENTS

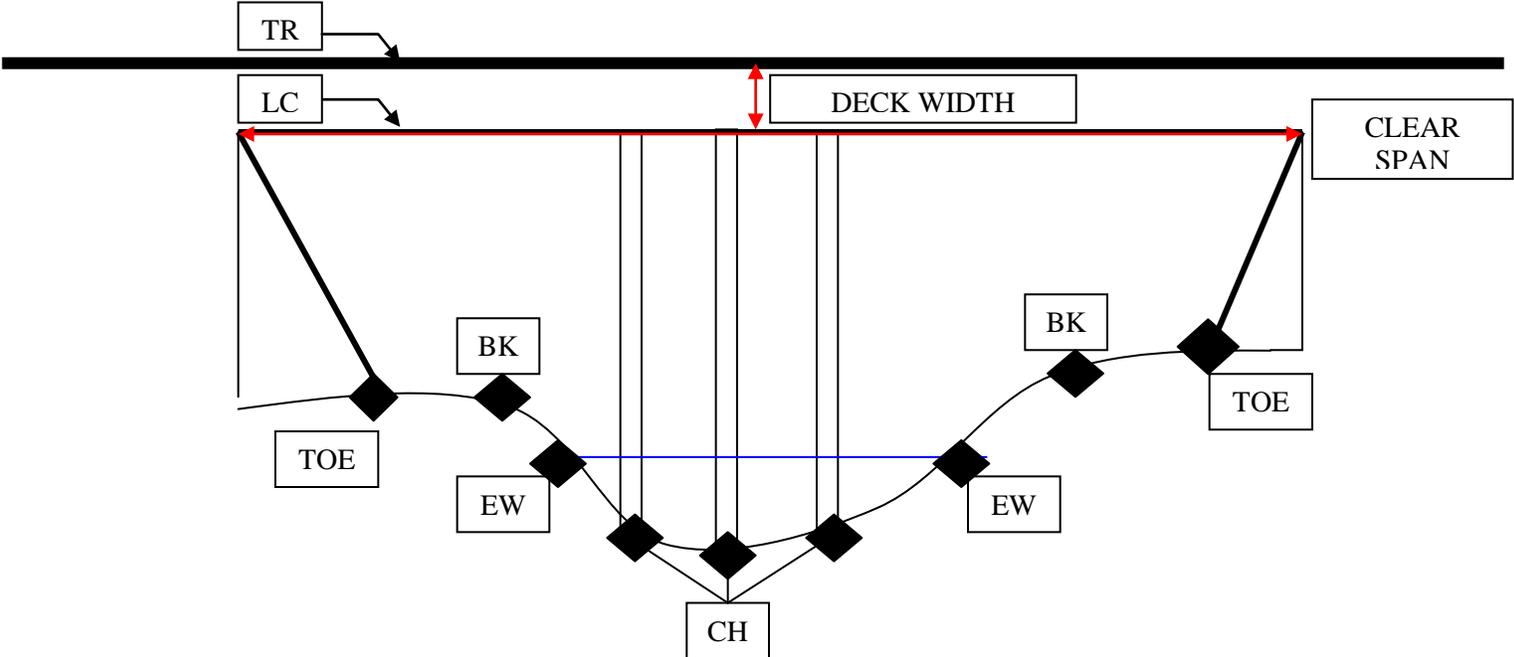
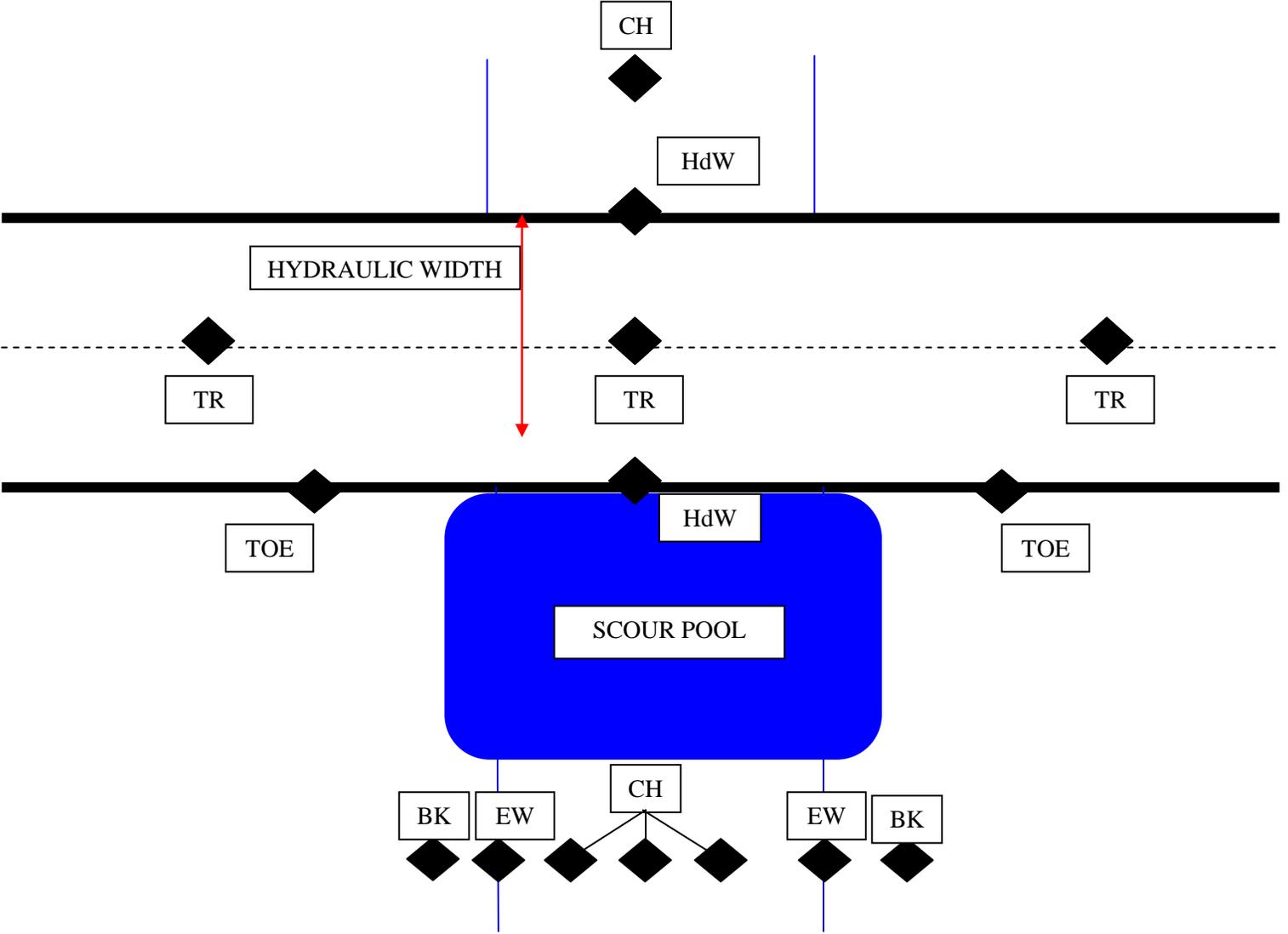
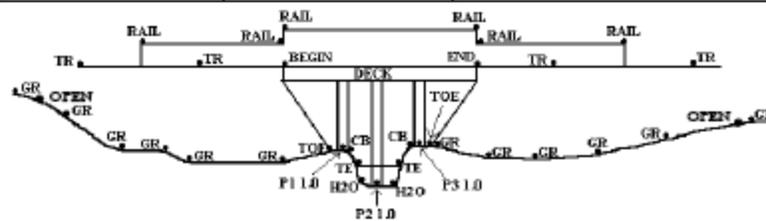


EXHIBIT F: EXAMPLE ILLUSTRATION OF TYPICAL REQUIRED BRIDGE SURVEY CODES

Survey Codes for a Bridge		
Valid Codes	Example	Notes for use
HEADER		
Structure Type ERM Length Deck	BR SF4 24 3.0	Shot 1 only. Bridge with ERM ID, Length and Deck Thickness. If Deck Thickness is supplied, it is not necessary to use LOW CHORD.
Road Name	Mountain Road, Interstate 85	Shot 2 only.
FIELD SHOTS (Bridge)		
ERM	ERM SF4, ERM N_TAR-4	Elevation reference mark
TR	TR	Top of Crown Data
BEGIN	BEGIN	Top of Crown at Begin Abutment
END	END	Top of Crown at End Abutment
RAIL	RAIL	Top of Rail. Must be inside TR.
GR	GR	Ground Field Data
CB	CB	Channelbank
P? Width	P1 3.0, P4 2.3	Pier #1 and Width
TOE	TOE	Toe of Fill Station
TOE TE	TOE TE	Toe of Fill Station and Edge H2O
TE	TE	Edge H2O
H2O	H2O	Underwater Field Data Shot
HIS	HIS	Historical Shot
DS IN	DS IN	Downstream Invert for Bridge
OPEN	OPEN	Open Area Field Shot
BRUSH	BRUSH	High Brush Field Shot
WOOD	WOOD	Wooded Canopy Field Shot
ALPT	ALPT1, ALPT2	Alignment points (left, right)
LC or LOW CHORD	LC	Bottom of suspension structure. Must be inside of TR. If LC is used, it is not necessary to supply Deck Thickness.



EXHIBITG: EXAMPLE ILLUSTRATION OF TYPICAL REQUIRED CULVERT SURVEY MEASUREMENTS

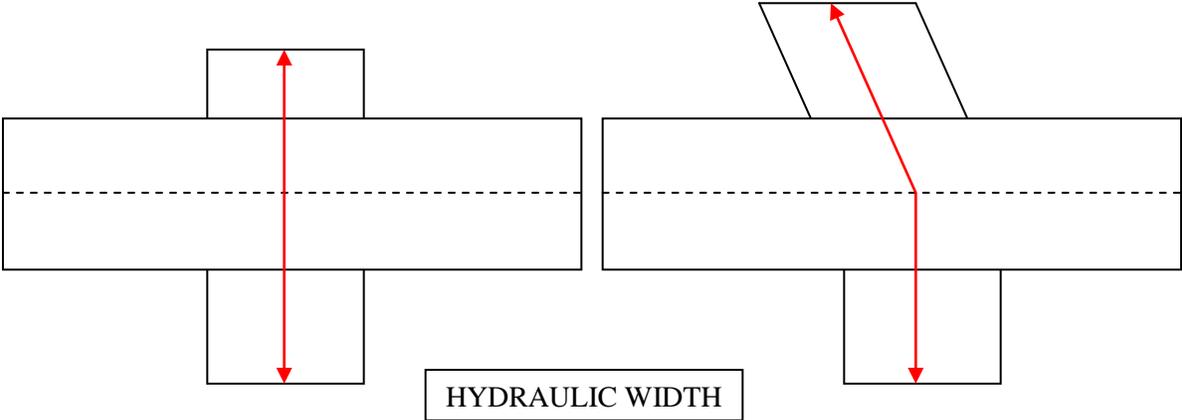
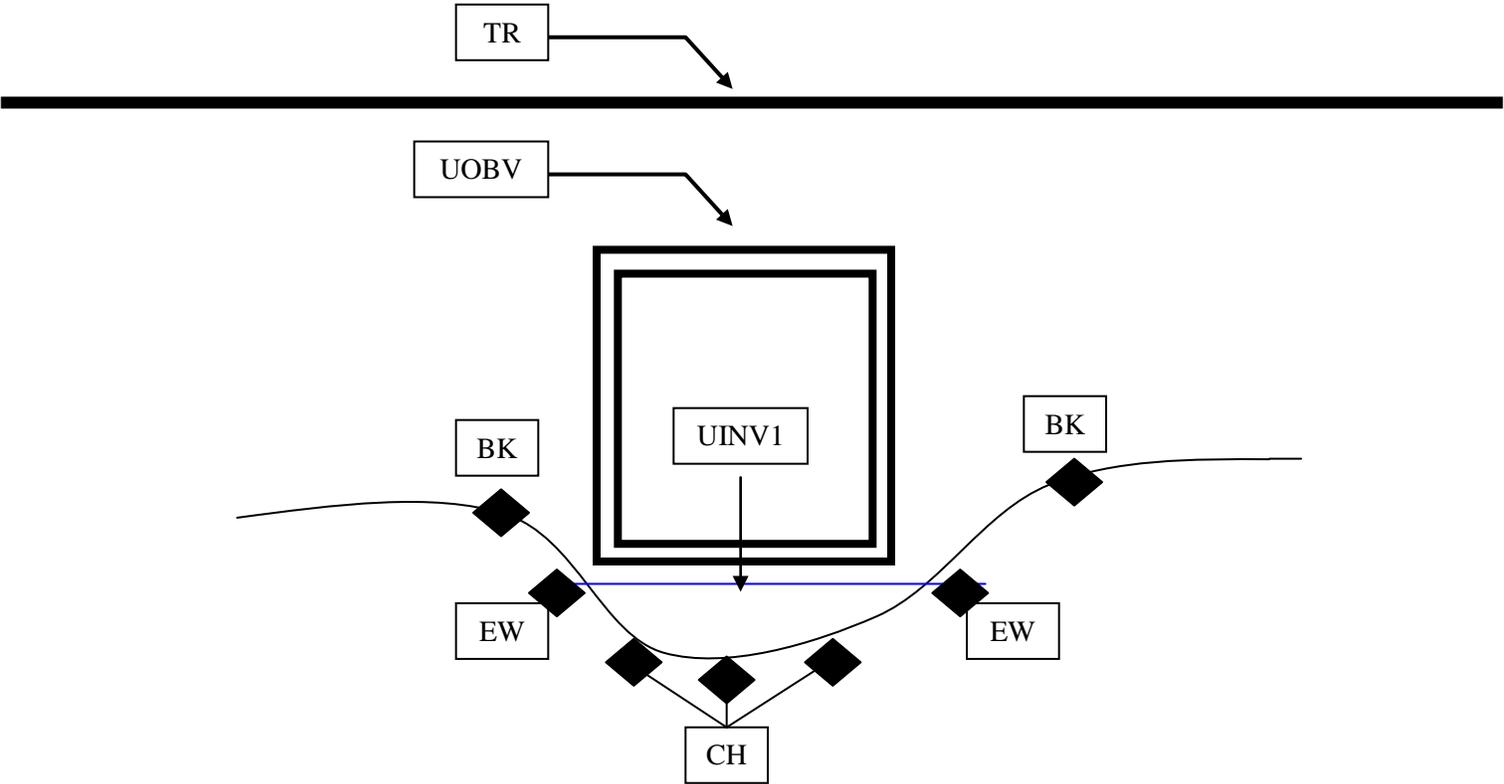
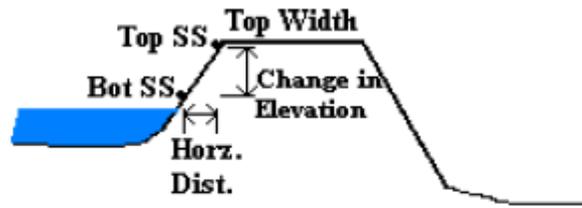


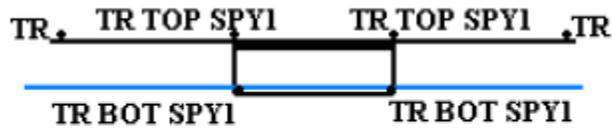
EXHIBIT H: EXAMPLE ILLUSTRATION OF TYPICAL REQUIRED CULVERTSURVEY CODES

Survey Codes for a Culvert		
Valid Codes	Example	Notes for use
HEADER		
Structure Type BM Length	CUL AC2 99	Shot 1 only. Culvert with Benchmark and Length of the Culvert.
Road Name	Garrison Boulevard	Shot 2 only.
FIELD SHOTS (Culvert)		
ERM	ERM AC2, ERM N_TAR-4	Elevation reference mark
TR	TR	Top of Crown Data
RAIL	RAIL	Top of Rail
GR	GR	Ground Field Data
TE	TE	Edge H2O
H2O	H2O	Underwater Field Data Shot
CB	CB	Channelbank
DS IN	DS IN	Downstream Invert for Culvert
OPEN	OPEN	Open Area Field Shot
BRUSH	BRUSH	High Brush Field Shot
WOOD	WOOD	Wooded Canopy Field Shot
ALPT	ALPT1, ALPT2	Alignment points (left, right)
UIB# Height Width	UIB2 10.1 10.8	Upstream Invert Box 2
DTE# Height Width Thick	DTE3 5.6 7.9 0.5	DS Top Ellipse 3
DTP# DIA Thick	DTP1 7.0 0.3	DS Top Pipe 1
DS = Downstream US = Upstream	I = Culvert Invert @ Centerline T = Top of Culvert @ Centerline	B = Box, P = Pipe E = Elliptical Culvert

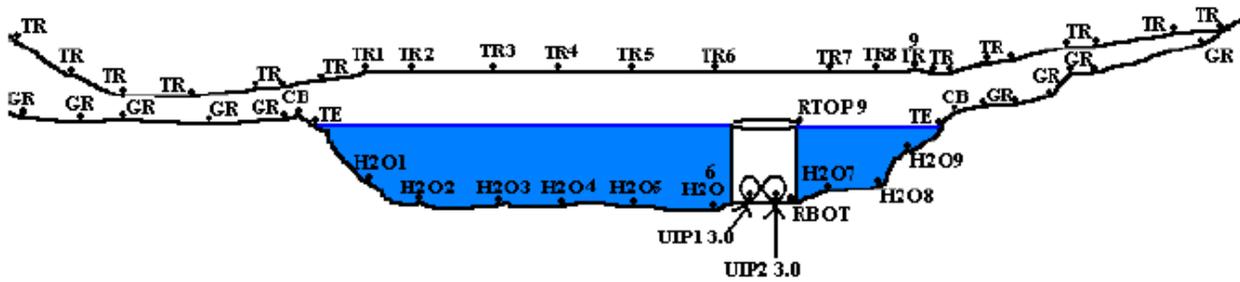
EXHIBIT I: EXAMPLE ILLUSTRATION OF TYPICAL REQUIRED DAM AND CHANNEL SURVEY MEASUREMENTS



Embankment and Top of Dam Shots



Spillway Shots



Shots Downstream of Dam

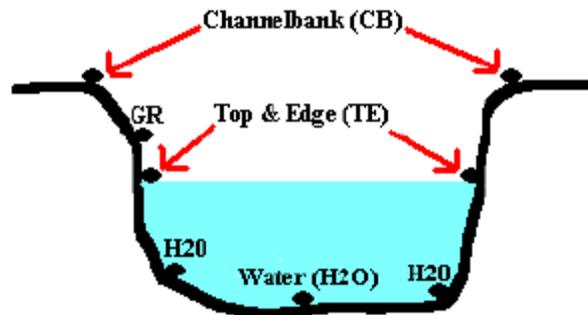


EXHIBIT J: EXAMPLE ILLUSTRATION OF TYPICAL REQUIRED DAM SURVEY CODES

Survey Codes for a Dam		
Valid Codes	Example	Note
HEADER		
DAM ERM Top width SS	DAM SC-3 20.0 2.5	Shot 1 only. Dam with ERM ID, Top Width and embankment side slope (x.x: 1)
Road Name	SR 2210, US220, Main Street	Shot 2 only.
FIELD SHOTS (Dam)		
ERM	SF4, N_TAR-4	Elevation reference mark
TR	TR	Top of Dam
GR [DS]	GR, GR DS	Ground Field Data
TE [DS]	TE, TE DS	Edge H2O
H2O [DS]	H2O, H2O DS	Underwater Field Data Shot
CB [DS]	CB, CB DS	Channel bank
OPEN	OPEN	Open Area Field Shot
BRUSH	BRUSH	High Brush Field Shot
WOOD	WOOD	Wooded Canopy Field Shot
ALPT	ALPT1, ALPT2	Alignment points (left, right)
FIELD SHOTS (Spillway)		
TR TOP SPY#	TR TOP SPY1	Top of Spillway 1 (2 shots req.)
TR BOT SPY#	TR BOT SPY2	Bottom of Spillway 2 (2 shot min.)
FIELD SHOTS (Outlet Pipes)		
UIB# Height Width	UIB2 10.1 10.8	Upstream Invert Box 2
DTE# Height Width Thick	DTE3 5.6 7.9 0.5	D/S Top Ellipse 3
DTP# DIA Thick	DTP1 7.0 0.3	D/S Top Pipe 1
D = Downstream U = Upstream	I = Culvert Invert @ Centerline T = Top of Culvert @ Centerline	B = Box, P = Pipe E = Elliptical Culvert
FIELD SHOTS (Riser Barrel)		
RTOP DIA/Width [Length]	RTOP 2.5, RTOP 3.7 6.1	Top of Riser Barrel (not trash rack)
RBOT	RBOT	Bottom of riser
ORIF DIA/Height Width	ORIF 0.7 2.0, ORIF 0.5 0.0	Centerline elevation of orifice
TRK DIA/Width Length Height	TRK 5.1 8.1 2.0, TRK 4.5 0.0 1.5	Top of Trash Rack
VALVE	VALVE	Location of drainage valve

EXHIBIT K: NAD 83 HARN STATE PLANE SOUTH FEET PROJECTION PARAMETERS

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PROJCS["NAD_1983_StatePlane_Wisconsin_South_FIPS_4803_Feet",GEOGCS["GCS_North_American_1983_HARN",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137,298.257222101]],PRIMEM["Greenwich",0],UNIT["Degree",0.0174532925199432955]],PROJECTION["Lambert_Conformal_Conic"],PARAMETER["False_Easting",1968500],PARAMETER["False_Northing",0],PARAMETER["Central_Meridian",-90],PARAMETER["Standard_Parallel_1",42.73333333333333],PARAMETER["Standard_Parallel_2",44.06666666666667],PARAMETER["Latitude_Of_Origin",42],UNIT["Foot_US",0.304800609601219241]]
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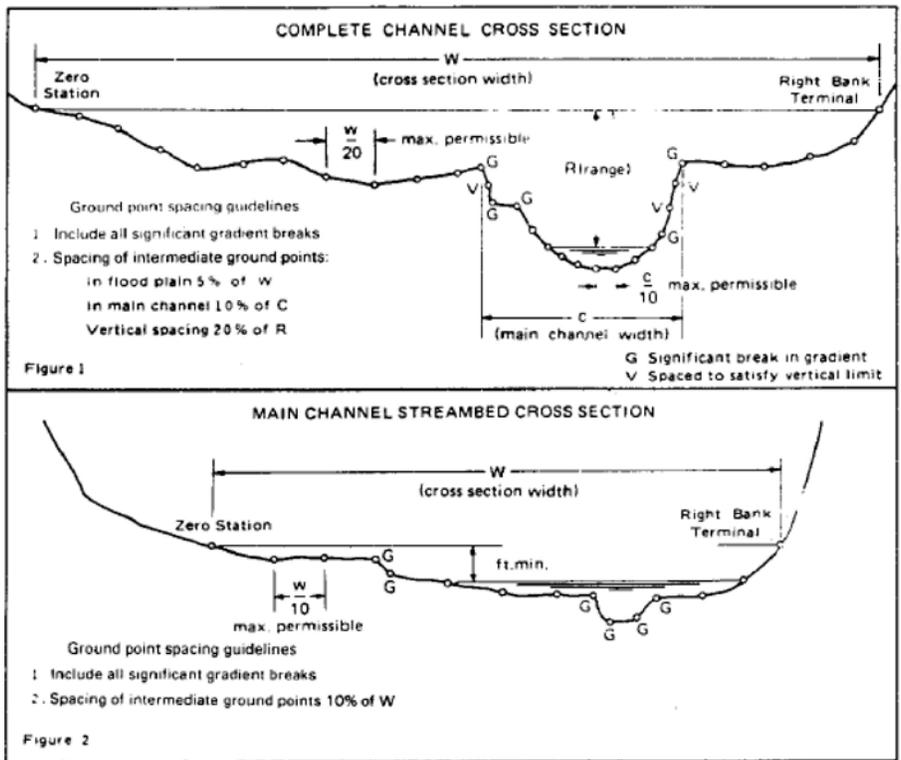
EXHIBIT L: FULL VALLEY CROSS SECTION SPECIFICATION

Extracted from FEMA Guidelines and Specifications, Appendix 'A' (April, 2003):

When the Mapping Partner compiles elevation data by traditional survey techniques, the elevations shall be taken to the nearest 0.5 foot at the three most significant gradient breaks on each bank and at enough intermediate points to satisfy the following three criteria:

1. No adjacent points separated vertically by more than 20 percent of range ('R');
2. No adjacent points separated horizontally by more than 5 percent of the complete channel cross section width ('W'); and
3. No adjacent points in the main channel separated by more than 10 percent of main channel width or 2 feet, whichever is greater.

Specified spacing is illustrated in Figure 1&2. Channel survey will follow the specifications in Figure 2. The Zero Station (initial point) for each cross section must be the finally adopted terminus on the left bank (looking downstream). Stations must be the distance to the nearest foot measured along the straight, curved, or zigzag alignment of the cross section. 'W' (from Figure 1&2) is equal to the total distance of the line indicating the location of the full valley section in the bid document materials. 'R' (from Figure 1) is equal to the greatest total vertical distance from either end of the 'Full Valley Section' to the bottom of the channel.



REFERENCES

1. FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) – www.FEMA.gov/fhm/dl_cgs.shtm
2. WISCONSIN DEPARTMENT OF NATURAL RESOURCES – BUREAU OF WATERSHED MANAGEMENT (WIDNR) – www.dnr.state.wi.us