DEPARTMENT OF ADMINISTRATIVE SERVICES
DIVISION OF ECONOMIC DEVELOPMENT
MILWAUKEE COUNTY LAND INFORMATION OFFICE
2711 West Wells Street, Rm 426, Milwaukee, WI 53208 (414) 278-2176

MEMORANDUM

TO: «prefix» «first_name» «middle_intial» «last_name» «LnameSuffix» «Suffix»
«title»
«organization»
«address1»
«address2»
«city», «state». «zipcode»

FROM: William C. Shaw, MCAMLIS Project Manager

DATE: November 30, 2012

SUBJECT: MCAMLIS 90th Steering Committee Meeting Materials

Enclosed please find a set of materials that the steering committee will take up at its scheduled December 4th Meeting.

I. Meeting Agenda

II. Meeting Minutes of the 89th Steering Committee meeting held March 20th, 2012

III. Reports

A. **Maintain Core Foundational Elements**

1. Report materials related to the status of the 2012 Orthophotography/Oblique Imagery Program
2. Report materials related to the status of the 2010 Planimetric Update Program

B. **Promote the Integration of Parcel Based Land Information**

1. Report materials related to the status of MCAMLIS street address and Cadastral map maintenance operations.

C. **Educational Outreach**

1. Report materials related to the status of work performed on behalf of MCAMLIS in support of local community GIS efforts

D. **Countywide Initiatives**

1. Report materials related to the status of work performed regarding 2012 Countywide Program Initiatives

E. Report materials related to the 2012 Year to Date Program Fiscal status

IV. Old Business

A. NA

V. New Business

A. Materials regarding the MCAMLIS Business Needs Assessment Sub-Committee Vendor Selection required to conduct a Business Needs Assessment and Develop a Five Year Work Program Implementation Plan

B. Materials regarding a 2012 agreement for Milwaukee County Surveyor Services between MCAMLIS and SEWRPC;

C. Materials regarding a 2012 agreement for Map Maintenance Services between MCAMLIS and the City of Milwaukee

VII. Correspondence

A. Ltr Kenneth R. Yunker, Executive Director, SEWRPC to William Shaw, MCAMLIS Project Manager, Milwaukee County Division of Economic Development Re: Memorandum Report No. 206

B. Memorandum Report No. 206

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MILWAUKEE COUNTY AUTOMATED MAPPING AND LAND INFORMATION SYSTEM

Ninetieth Steering Committee Meeting

AGENDA

Date: December 4th, 2012
Time: 9:00 a.m.
Place: Milwaukee Metropolitan Sewerage District
MMSD Hdqtrs, Room 401
260 W Seeboth St.
Milwaukee, WI. 53204

I. Roll Call

II. Meeting Minutes

Consideration of the minutes of the 89th Steering Committee meeting held March 20th, 2012

III. Reports

A. **Maintain Core Foundational Elements**

1. Report by MCAMLIS staff on the status of the 2012 Orthophotography/Oblique Imagery Program
2. Report by MCAMLIS staff on the status of the 2010 Planimetric Update Program

B. **Promote the Integration of Parcel Based Land Information**

1. Report by Milwaukee County Register of Deeds staff on MCAMLIS street address and cadastral map maintenance operations; and
2. Report by City of Milwaukee staff on MCAMLIS street address and cadastral map maintenance operations.

C. **Educational Outreach**

1. Report by MCAMLIS Staff on the status of work performance on behalf of MCAMLIS in support of local community GIS efforts.

D. **Countywide Initiatives**

1. Report by MCAMLIS Staff on the status of work performance on behalf of MCAMLIS in support of Countywide GIS Initiatives.

E. **Financial**

Report by Milwaukee County DAS staff on MCAMLIS Fiscal status

IV. Old Business

A. NA

V. New Business

A. Consideration of recommendations by the MCAMLIS Business Needs Assessment Sub-Committee regarding RFP Vendor Selection required to conduct a Business Needs Assessment and Develop a Five Year Work Program Implementation Plan

B. Consideration of a 2013 agreement for Milwaukee County Surveyor Services between MCAMLIS and SEWRPC;

C. Consideration of a 2013 agreement for Map Maintenance Services between MCAMLIS and the City of Milwaukee, and;

D. Appointment of a Nomination Committee to recommend officers to be seated at the Steering Committee's next regular meeting.

VI. Correspondence

VII. Date, time, and place of next meeting

VIII. Adjournment

MINUTES OF THE 89th MEETING
Milwaukee County Automated Mapping and Land Information System
Steering Committee

Date:	March 20th 2012
Time:	9:00 a.m.
Place:	Milwaukee Metropolitan Sewerage District MMSD Hdqtrs, Room 401 260 W Seeboth St. Milwaukee, WI. 53204

Members Present

Kurt W. Bauer	Milwaukee County Surveyor
Donald R. Nehmer, Chairman	Capital Program Business Manager, Milwaukee Metropolitan Sewerage District
Nancy A. Olson, Vice Chair	Chief Information Officer, City of Milwaukee
Greg High	Director, Architecture, Engineering and Environmental Services Division, representing Frank Busalacchi, Director, Milwaukee County Department of Transportation and Public Works
Timothy Marquardt	Manager - EDAM Support, We Energies
Vince Masterson	Fiscal Mgt Analyst, representing Patrick Farley, Director of Milwaukee County Department of Administrative Services
Pamela Booth	GIS Developer - Project Leader City of Milwaukee, representing Nancy A. Olson Chief Information Officer, City of Milwaukee
John L. La Fave, LIO	Milwaukee County Register of Deeds
John M. Bennett	City Engineer, City of Franklin, representing the Intergovernmental Coordinating Council of Milwaukee County

Members Absent

Guest and Staff Present

Tammy Bronson	City of Milwaukee, Information and Technology Management Division
William C. Shaw	MCAMLIS Project Manager, Milwaukee County DTPW/AE&ES
Kathleen Bach	Milwaukee County Register of Deeds
Emily Champagne	GIS Analyst, MMSD
Phil Mroczkowski	Engineer Drafting Technician, City of Milwaukee Department of Public Works

Brian Taffora	Director, Milwaukee County Division of Economic Development
Hardy Meihsner	Consultant, Spatial Data Solutions

II. ROLL CALL

Chairman Nehmer called the Eighty-Ninth meeting of the Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Steering Committee to order at 9:00a.m. Roll Call was taken by circulating an attendance signature sheet and a quorum was declared present.

II. SPECIAL ORDER OF BUSINESS

Nehmer: directed the Committee to Mr. John Bennett, chair and Mr. Greg High, member of the MCAMLIS Election Nominating Committee

Bennett: stated that he and Mr. High had met and were hereby recommending that the current MCAMLIS Steering Committee officers – Don Nehmer, Chair and Nancy Olson, Vice Chair be nominated for the new term. Further stating that Milwaukee County continues in the un-elected capacity of Secretary

Motion: Bennett moved to nominate Don Nehmer, Chair and Nancy Olson Vice Chair

Second: La Fave, motion carried unanimously

III. MEETING MINUTES

CONSIDERATION OF THE MINUTES OF THE 88TH STEERING COMMITTEE MEETING HELD DECEMBER 13TH, 2011

Nehmer: stated that a copy of the minutes was provided with the meeting materials and asked if any corrections are required.

Motion: Bauer moved to accept minutes

Second: Olson, motion carried, Bennett abstain

IV. REPORTS

a. MAINTAIN CORE FOUNDATIONAL ELEMENTS

1. REPORT BY MCAMLIS STAFF ON THE STATUS OF THE 2012 ORTHOPHOTOGRAPHY/OBLIQUE IMAGERY PROGRAM

Shaw: directed the Committee to the report included with the meeting materials. Noting for the Committee that the Milwaukee County Board had approved the project funding on 3/15 and the flight is scheduled to be flown on 3/24-25.

Secretary's Note: Due to schedule commitments and logistical problems brought on by the unseasonably warm spring weather the flight was not conducted as planned on the weekend of 3/24-25. The flight was further delayed by consecutive days of cloudy and windy conditions and finally a decision was made to postpone the 2012 flight the week of 4/16. These flights will now be completed during the Spring 2013.

Shaw: further noted that the Planimetric mapping program update will proceed through the summer and into fall starting with a competitive bid process to begin later this summer.

Bennett: inquired about the cost of increasing the resolution of the planned imagery from 6″ ground resolution to a possible 3″ ground resolution.

Shaw: replied that he did not know the cost for 3″ resolution but that it would be available in the future and possibly could be included for the 2015 flight.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file

b. PROMOTE THE INTEGRATION OF PARCEL BASED LAND INFORMATION

1. REPORT BY MILWAUKEE COUNTY REGISTER OF DEEDS STAFF ON MCAMLIS STREET ADDRESS AND CADASTRAL MAP MAINTENANCE OPERATIONS

Bach: directed the Committee to the report included with the meeting materials. Noting the status on the maps included and that her contact in Cudahy responded to numerous inquiries for address update information.

Shaw: stated that he would make an inquiry through the Cudahy Engineering department and would work with Ms. Bach to try and resolve this issue.

Secretary's note: As yet Cudahy has been non-responsive to requests for address updates requiring additional follow-up by the MCAMLIS Project Manager.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file.

2. REPORT BY CITY OF MILWAUKEE STAFF ON MCAMLIS STREET ADDRESS AND CADASTRAL MAP MAINTENANCE OPERATIONS

Bronson: directed the Committee to the report included with the meeting materials. Noting the status on the maps included.

Nehmer: inquired regarding the delays in assigning taxkey's.

Bronson: stated that there can be a delay of between 6 months and a year or more.

Shaw: requested that a copy of the City's Master Address Index (MAI) be provided to MCAMLIS staff with updates through 2011.

Bronson: agreed to make available a copy of the MAI.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file.

c. EDUCATIONAL OUTREACH

REPORT BY MCAMLIS STAFF ON THE STATUS OF WORK PERFORMANCE ON BEHALF OF MCAMLIS IN SUPPORT OF LOCAL COMMUNITY GIS EFFORTS.

Shaw: directed the Committee to the report included with the meeting materials. Noting that 1/10 meeting held at MMSD had 35 participants. Further noting that the next meeting of the MMGUG is schedule for 4/10 at the West Allis City Hall and that Steering Committee Members are invited to attend the meeting where GIS Mobile applications is going to be discussed.

Nehmer: commented that there was a diverse group of attendees at the 1st meeting and that was encouraging.

Bennett: remarked that he faces a challenge with getting people to us GIS especially in his Police Department.

Nehmer: noted that discussion of the Strategic Plan initiatives later in the agenda under New Business would be a place to continue a discussion of local community participation with MCAMLIS.

Nehmer: noted that the status report showing MCLIO website utilization indicated that the City of Cudahy was a high volume user and that perhaps they should be reminded of this when they are asked for address information necessary to maintain the website.

Marquardt: inquired as to the update cycle for the community base map product available on the ESRI online.

Shaw: replied that there is not a scheduled update but that the base map has been refreshed three times since 2010. Further adding that more recent work is concentrated on adding detail to high use areas e.g., Summer Fest and County Grounds.

Marquardt: noted that he uses the map quite often and found it to be quite useful especially in the urban areas. Further noting that he would like to see this type of product available throughout Southeast Wisconsin.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file.

d. COUNTYWIDE INITIATIVES

1. REPORT BY MCAMLIS STAFF REGARDING 2011 COUNTYWIDE INITIATIVES AND PROGRAM ACTIVITY STATUS

Shaw: directed the Committee to the report included with the meeting materials. Noting the growing importance of address information supplied to the Village of Greendale and Milwaukee Sheriffs. Phoenix Dispatch Systems Further noting the related accomplishments e.g., Historical Aerial photo, street centerline, plat of survey and Community Basemap Projects among others.

Discussion followed regarding the lack of address integration across community police dispatch systems and the further need to find mechanisms to gain efficiencies through a more coordinated approach.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file.

2. REPORT BY THE MILWAUKEE COUNTY SURVEYOR ON THE STATUS OF 2011 SURVEYOR ACTIVITIES

Bauer: directed the Committee to the report included with the meeting materials.

High: inquired as to whether the County Surveyor Dossier sheets referring to PLSS corners could be made available on the MCLIO website.

Shaw: indicated that these were already available and could be retrieved via use of a document link between the PLSS corner on the website and the document located at the SEWRPC website.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file.

3. REPORT BY MCAMLIS STAFF REGARDING 2011 ACCOMPLISHMENTS

Shaw: directed the Committee to an exhibit included with the meeting materials. Noting that the exhibit includes a number of charts and graphs showing the volume and types of requests for MCAMLIS data by local, regional and private concerns.

Bauer: noted that in review of a chart depicting various types of data requests the top two data types requested included Cadastral and Topographic base map materials. Further noting that these base map data are essential in providing a fundamental requirement of municipal engineering.

Shaw: added that the third highest requested data type included aerial photography that has become a major base map component as well.

Bauer: inquired as to whether a nominal fee was charged for data distributed to License Agreement holders.

Shaw: replied that fees were not charged to local units of government or their agents. Further noting that fees continued to be charged with regard to non-commercial use requests that are not related to government operations e.g., private site development, data used in map compilations by third parties etc.

Nehmer: stated for the minutes that the report(s) were accepted by consensus and are to be placed on file.

e. REPORT BY MILWAUKEE COUNTY DAS STAFF ON MCAMLIS FISCAL STATUS

Masterson: directed the Committee to the report included with the meeting materials.

Shaw: stated that a portion of the expenditures identified in the report included a number of projects that are shown to be charged to the $6 fee but are actually approved to be included with the $2 fee portion.

Masterson: agreed that he would arrange to have this corrected.

Bauer: inquired as to the fund balance at the close of year-end.

Masterson: stated that the year-end balance would be close to $845,000 less 10% hold back.

Nehmer: asked for an explanation of the $259,000 item drawn from reserves

Masterson: replied that this related to funds that were drawn from the MCAMLIS reserve account to offset the unbudgeted anticipated expenditures of the 2012 Orthophotography and Planimetric Mapping projects that were approved by the Steering Committee at its meeting in December 2011. Further adding that the MCAMLIS reserves held a balance of $1,264,000.

Discussion between Mr. Nehmer and Mr. Masterson followed regarding further clarification of how expenses for these two projects were originally not included in the 2012 Milwaukee County Budget and therefore resulted in a modified budget to account for the unbudgeted revenue transferred from the reserve account to offset project expenditures.

Nehmer: noted that the fund balances shown reflect a point in time rather than an estimated year-end fund balance and therefore do not show a true picture regarding what funds may be available due to fluctuations in spending and revenue throughout the coming year.

Bauer: noted that there appeared to be sufficient funding available in both the $6 and $2 fund balances and that future projects presented by staff would require a fiscal note to be included with any approval to assure that funds would be available.

Shaw: inquired of Mr. La Fave as to the revenue balances shown to date and whether these where on target to reach the predicted revenue based on 125,000 recordings through 2012.

La Fave: indicated that he had confidence in the budget estimate based on 125,000 recordings

Discussion of revenue further expanded on Mr. Shaw's question noting that revenues required to meet a budgeted $1 million require an estimated cash flow of approximately $83,000 and whether there was enough information in the fiscal report to assess progress toward projected year-end balances. It was agreed that the current Fiscal Reporting methods do not help the Committee needs track revenue versus expenses as these relate to projected year-end balances.

La Fave: agreed to provide the committee a closer accounting of actual revenue versus estimated revenue for use at future meetings

Masterson: agreed to work with Mr. Shaw to include an 'Anticipated Year-End' column in future Fiscal reports to make it easier to track revenues related to the MCAMLIS projected balances.

Nehmer: stated for the minutes that the report was accepted by consensus and is to be placed on file.

V. OLD BUSINESS

a. MCAMLIS STAFF SUMMARY REGARDING ITEMS CURRENTLY UNDER CONSIDERATION BY THE STATE OF WISCONSIN LEGISLATURE

Shaw: provided an oral report regarding the status of the State of Wisconsin AB-303 and other pending and proposed legislation that may affect future WLIP action and funding.

Bauer: stated that his understanding of the original law creating the WLIP restricted the fees collected to be used solely for Land Records Modernization (LRM) purposes. Further inquiring as to if the law has changed such that this is no longer true?

Shaw: replied that the law has not been changed and that perhaps if the LRM legislative lobby were larger it's possible that there may be a different outcome.

Nehmer: stated for the minutes that the report was accepted by consensus

VI. NEW BUSINESS

a. MCAMLIS STAFF REPORT OF THE DRAFT 'MCAMLIS PROGRAM STRATEGIC ASSESSMENT FOR 2012-2015'

Shaw: directed the Committee to the report included with the meeting materials. Noting that there has been over $20 million invested in the MCAMLIS Program over more than 2 decades.

Shaw: continued with a discussion of various tables showing historic revenue cycles leading him to believe that by looking at cyclical troughs in revenue that there is a strong possibility that an annual trough will be followed by revenue stream increases on the order of 15% year over year. Suggesting that the 9% projected increase in recorded documents by Mr. La Fave can be viewed as consistent with past revenue and that by using this projection as a baseline into the out years of the plan is reasonable.

Shaw: continued to go through projected balances through the years 2015 and identified expected operational and project funding requirements.

Bennett: asked with regard to whether there was any anticipated cost sharing with other participants to obtain orthophotography in 2015 e.g., SEWRPC and USGS

Shaw: replied that the plan does not anticipate cost sharing with the SEWRPC but that historically up to 80% of the required funds where provided by a cooperative agreement with the RPC. Further stating that the plan includes a worst case scenario in this regard and includes 100% of the required funding from MCAMLIS

Shaw: continued describing the projected balances through 2015 and concluded that there would be approximately $1.4 million available through 2015 for the Steering Committee to consider allocating to new projects outside of operational and currently committed project allocations.

La Fave: commented that it was clear to him that allocation of the $1.4 million to projects should be spread out over the full timeframe and not be spent immediately

Shaw: agreed with Mr. La Fave adding that it was up to the Committee to determine how it wanted to proceed regarding future expenditures. Further highlighting ongoing projects and potential projects that had been suggested but as yet had not been fully considered and presented to the Committee

Shaw: proceeded to outlined a Business Needs Assessment Project that he and Mr. Nehmer had discussed. Recommending that this be considered by the Committee in order to gather and provide the Steering Committee with an assessment of what and where to invest MCAMLIS resources in the future

La Fave: asked if Mr. Shaw knew how other county land office plans throughout the state were perceived and if the LRM plans located on the WLIP website could be used to gather this information

Shaw: replied that the state plans were not really strategic documents but instead were plans describing how each LIO would meet the State's requirement for LRM. Adding that he would use the outcome of the Business Needs Assessment to gather input to update our County Plan but would not use the Needs Analysis as the LRM Plan alone.

La Fave: asked how MCAMLIS compares with other county programs

Shaw: replied that he thought that MCAMLIS compared favorably with most programs and thought that MCAMLIS exceeds many programs in its ability to provide service and value to the county. Adding that the Business Needs Assessment would be a vehicle to be used to direct MCAMLIS to do even better.

Nehmer: stated that MCAMLIS has done an extremely good job of assembling and distributing data. Adding that the Business Needs Plan would be helpful in setting MCAMLIS Program priorities such that we are assured of utilizing resources to address critical program elements that would be uncovered through the conduct of the proposed planning effort.

La Fave: asked if the MMGUG could be used to assist in gathering this information.

Shaw: replied that many of the MMGUG members would be able to assist but that MMGUG was an informal group and therefore not capable of fully engaging at a level necessary to base a complete strategy for providing MCAMLIS services.

Bennett: noted that the ICC was also a possible forum for this purpose. Adding that the Mayor of Franklin may be willing to move this forward since he is the Chairman of this group.

Nehmer: recommended that MCAMLIS form a subcommittee to meet and formulate an approach leading to an RFP and eventual purchase of Professional Services to assist MCAMLIS Staff in preparing a 'SWOT' analysis or Business Needs Assessment for MCAMLIS.

Bauer: stated that any initiative that is undertaken, in his opinion, must come from the Steering Committee. Adding that surveying the local communities may not be productive in that most will not know how to respond. Noting that it is already March and that for the rest of the year there will be nothing undertaken except for the continuation of the ongoing maintenance of the core elements. Further submitting that funding is available and projects can be undertaken with the available funding.

Nehmer: stated that he was comfortable with the option of not undertaking projects until a business plan was established. Continuing that the committee needs to speak up regarding the direction it wants to move and is it interested in developing a 'program plan' or similarly a 'business plan'. Adding that if this is the will of the Committee then that needs to be taken up here and now or otherwise finalize the current agenda. Further recommending that there be a motion placed before the Committee requesting the establishment of a MCAMLIS Business Plan.

Motion: Bennett, moved that the Chairman select members of the Steering Committee to form a subcommittee who would develop a 'Work Program' for MCAMLIS over the next 3-5 years and that the Chairmen appoint members of the subcommittee, call the subcommittee to meet and direct the subcommittee to report on their progress at the next Steering Committee meeting.

Second: Olson, motion carried unanimously

VII. CORRESPONDENCE

Shaw: stated that correspondence items included letters from John La Fave, Register of Deeds and Don Nehmer, MCAMLIS Steering Committee Chairman to various legislators regarding pending State Legislation.

VIII. DATE, TIME, AND PLACE OF NEXT MEETING

September 11th, 2012 @ 9:00am, MMSD (next regular meeting)

Secretary's note: meeting scheduled September 11th, 2012 rescheduled to December 4th, 2012 @ 9:00am, MMSD (next regular meeting)

IX. ADJOURNMENT

Motion: Olson, moved to adjourn

Second: Bauer, motion carried unanimously

Respectfully submitted,
William Shaw

DEPARTMENT OF ADMINISTRATIVE SERVICES

DIVISION OF ECONOMIC DEVELOPMENT

MILWAUKEE COUNTY LAND INFORMATION OFFICE

2711 West Wells Street, Rm 426, Milwaukee, WI 53208 (414) 278-2176

MEMORANDUM

TO: MCAMLIS Steering Committee

FROM: William C. Shaw, MCAMLIS Project Manager

DATE: November 20, 2012

SUBJECT: 2012 Milwaukee County Orthophotography Project

BACKGROUND

At its meeting held September 13th, 2011, the MCAMLIS Steering Committee approved a staff recommendation to proceed with the acquisition of Pictometry International Inc. AccuPLUS orthophotography. Beginning with the 2005 Regional Orthophotography Project, Milwaukee County has acquired spring digital orthophotography every two or three years e.g., 2005, 2007, 2010 with the spring of 2012 the next scheduled acquisition period requiring orthophotography covering Milwaukee County.

PROJECT

This project will complete the second flight of a three (3) flight six-year license agreement with Pictometry International Inc. The original contract entered into in spring of 2010 specified a six-year agreement for imagery to be acquired in years 2010, 2012 and 2014/15 assuming that funds are available and authorized for this purpose.

The project includes acquisition of Pictometry International AccuPlus 6-inch pixel, color, digital orthophotography and oblique image photography as a package costing a total of $134,495. Delivery of the data will be within 90 days of the flight, which is scheduled between mid-March, and mid-April depending on conditions.

ACTIVITIES THIS PERIOD: 3/12 – 12/12

- April 10, 2012 canceled spring 2012 flight due to earlier than expected leaf-on conditions
- June 2012 completed final contract, work authorization and encumbered funds for a 2013 flight
- September 2012 scheduled spring 2013 flight between snow melt and leaf-on

NEXT

- Monitor conditions as flight window approaches

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DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

MILWAUKEE COUNTY LAND INFORMATION OFFICE

2711 West Wells Street, Rm 426, Milwaukee, WI 53208 (414) 278-2176

MEMORANDUM

TO: MCAMLIS Steering Committee

FROM: William C. Shaw, MCAMLIS Project Manager

DATE: November 20, 2012

SUBJECT: REPLACEMENT PLANIMETRIC MAPPING

BACKGROUND

At its meeting held on September 13th, 2011, the MCAMLIS Steering Committee approved a staff recommendation to proceed with a Planimetric Map Replacement Project as specified in the staff recommendation. This project was regarded a priority in the MCAMLIS PROGRAM STRATEGIC ASSESSMENT FOR 2010-2013. As included in the strategic assessment the project is scoped to meet requirements for updating the 2004 - 2009 Topographic/Planimetric Map Series and maintaining this series going forward.

PLANIMETRIC FEATURE UPDATES

The aggregate total of identified change in square miles is estimated to be approximately 7% by area from 2005 through 2010, or 17 square miles.

PROJECT SPECIFICATIONS

MCAMLIS Staff prepared a set of detailed planimetric map maintenance specifications that address the planimetric mapping update process to be overseen by a certified photogrammetrist and managed by MCAMLIS staff.

ACTIVITIES THIS PERIOD: 12/11 – 12/12

9/18/2012 RFP issue date

11/16/2012 RFP Closing date

The following four (4) vendors submitted proposals:

- Aerometric, Inc.
- The GRW Team
- Graef
- Rolta

NEXT

- Complete vendor selection process by 12/4/2012
- Prepare contract approval materials and submit for County Board approvals for the January 2013 Board Agenda
- Prepare and execute contract

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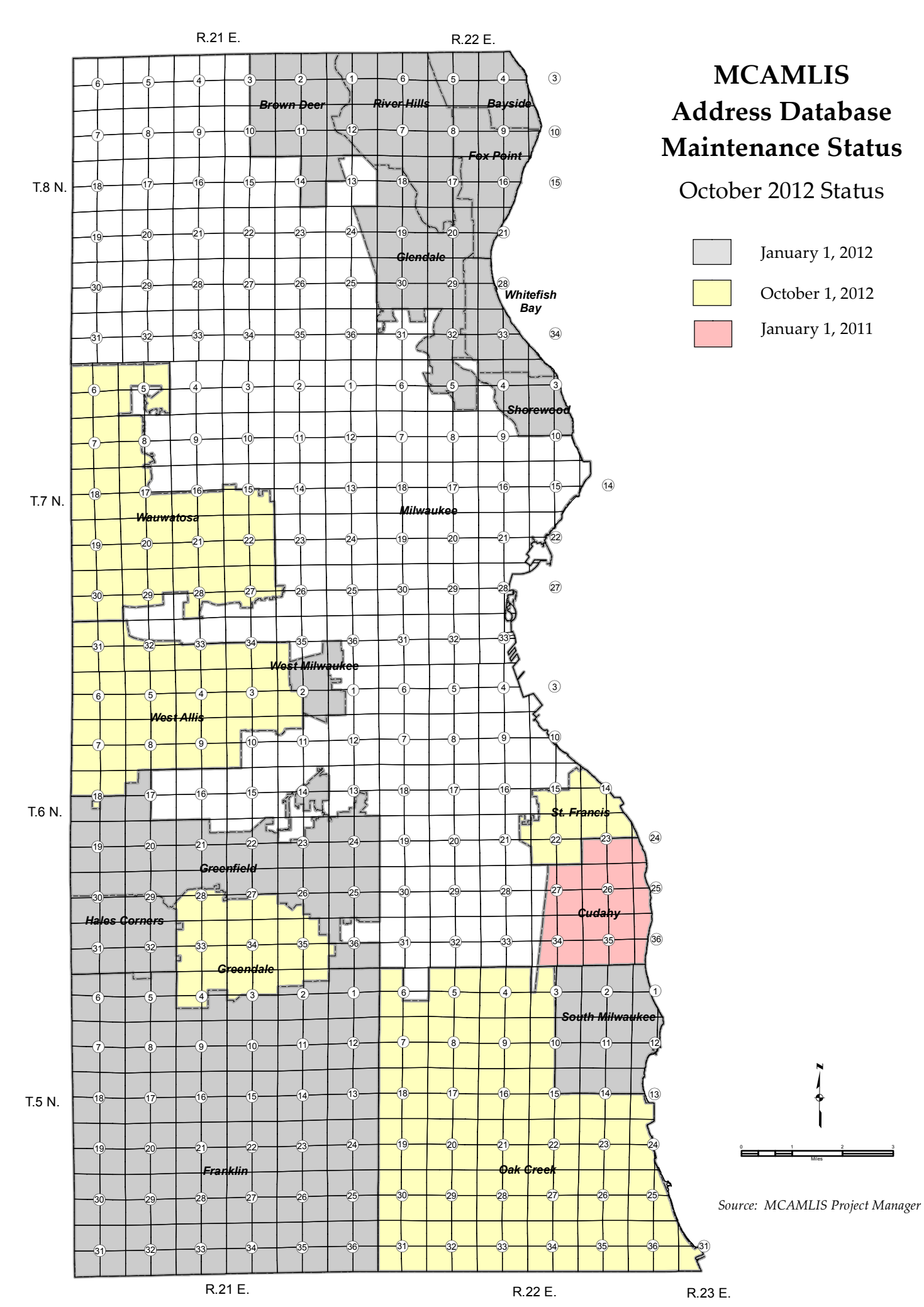
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West Milwaukee
West Allis
St. Francis
Cudahy
Greenfield
Hales Corners
Greendale
South Milwaukee
Oak Creek
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MCAMLIS
Address Database
Maintenance Status
October 2012 Status
January 1, 2012
October 1, 2012
January 1, 2011
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Source: MCAMLIS Project Manager

MCAMLIS
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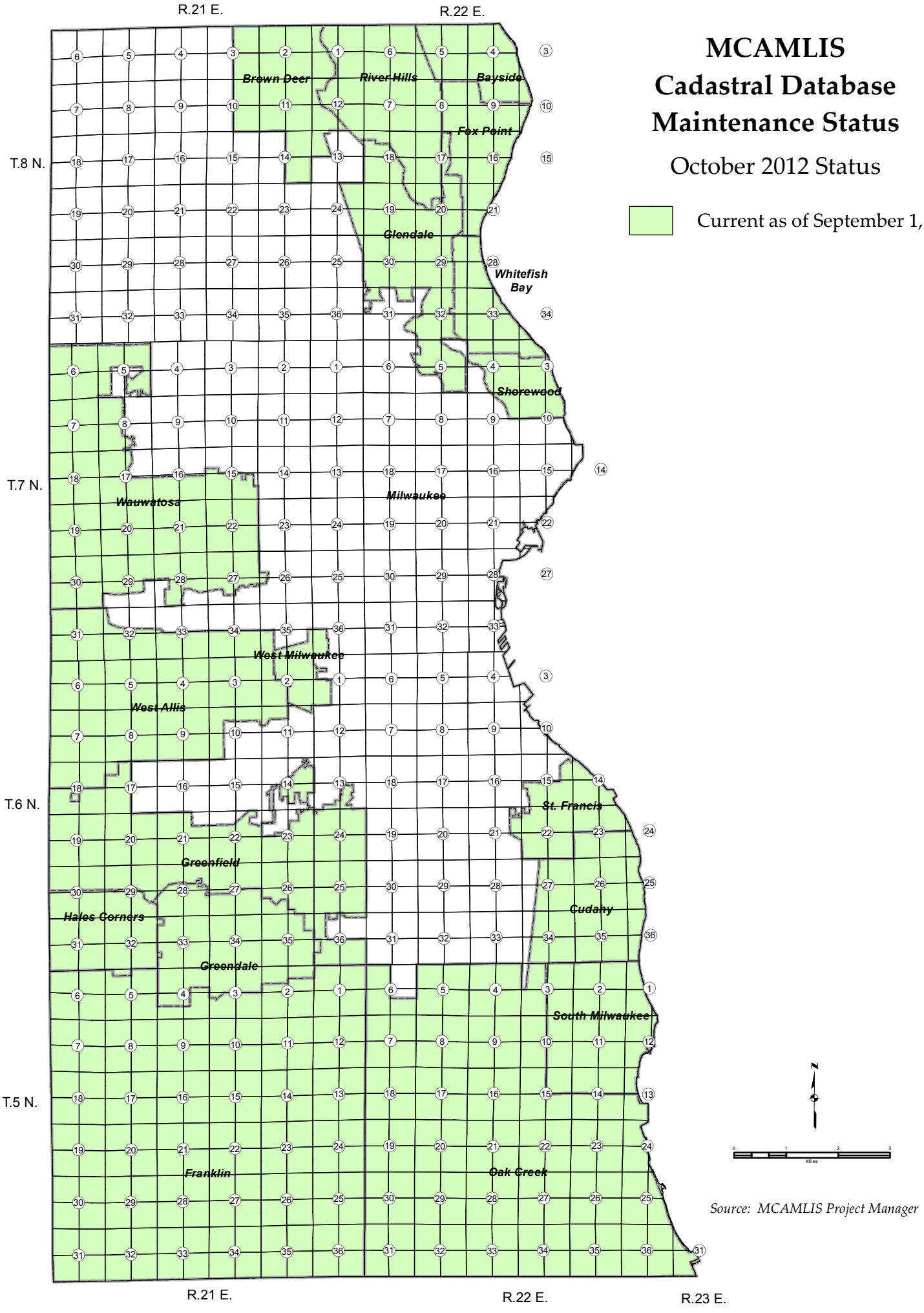
October 2012 Status

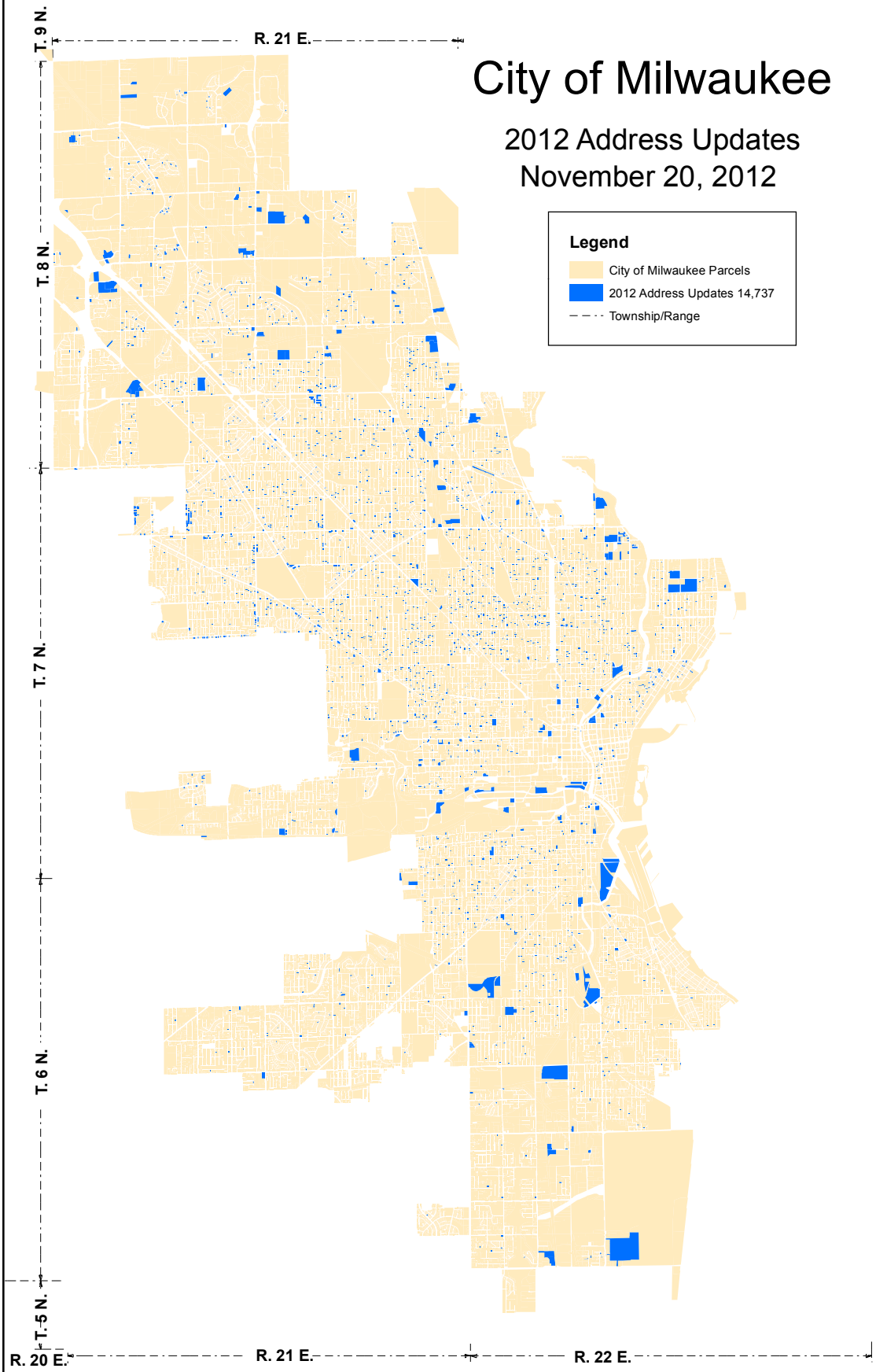
Current as of September 1, 2012



Source: MCAMLIS Project Manager

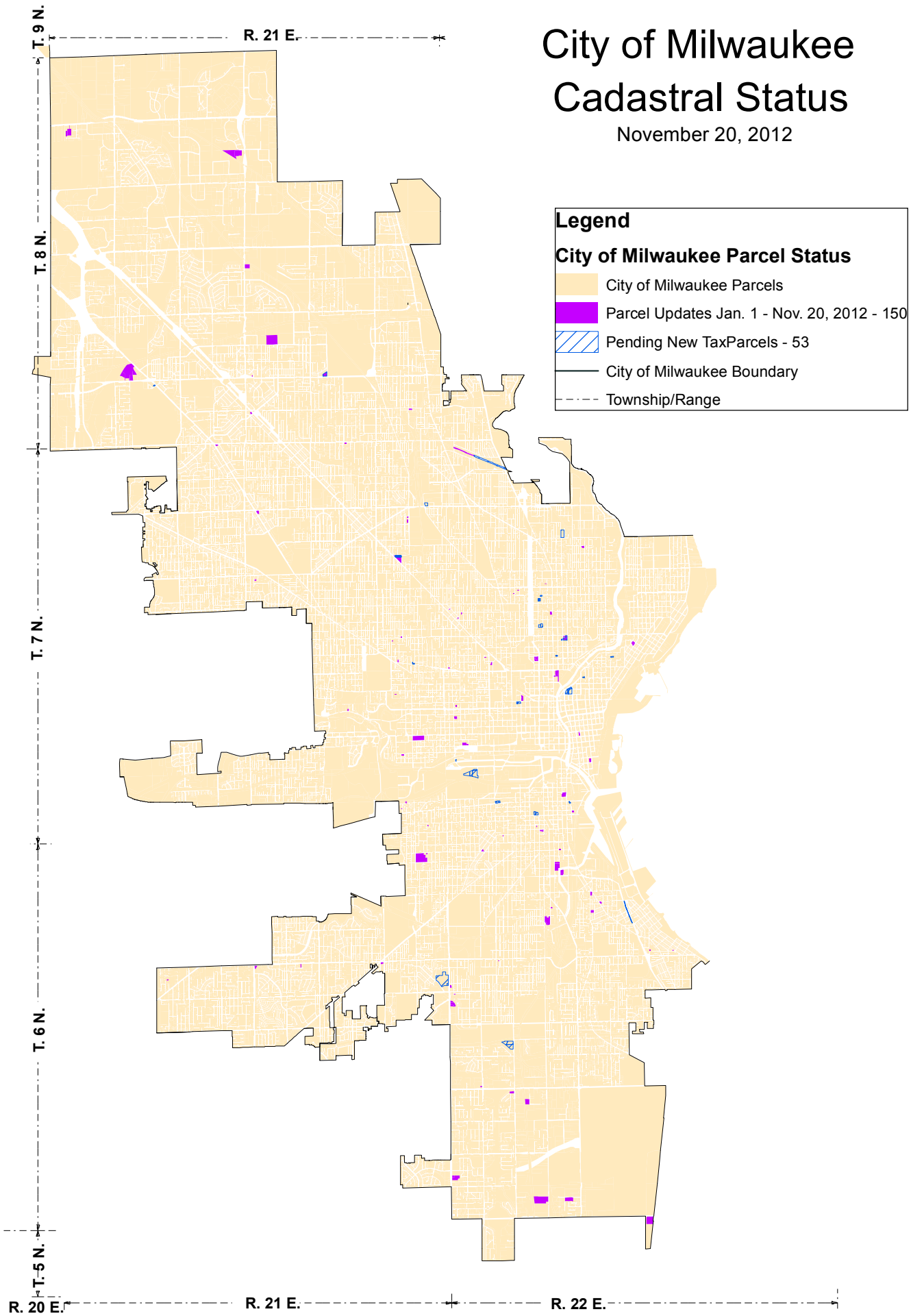
City of Milwaukee

2012 Address Updates
November 20, 2012



City of Milwaukee Cadastral Status

November 20, 2012



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2711 West Wells Street, Rm 426, Milwaukee, WI 53208 (414) 278-2176

MEMORANDUM

TO: MCAMLIS Steering Committee
FROM: William C. Shaw, MCAMLIS Project Manager
DATE: November 27, 2012

SUBJECT: Educational Outreach Activity Status

BACKGROUND

The MCAMLIS Program Goals and Objectives included in the 'Land Information Strategic Assessment for 2010 –2013' identified the need for MCAMLIS Staff to develop and promote MCAMLIS products and services to MCAMLIS Partners and especially to include contacts and assistance related to local municipalities. The following describes MCAMLIS Staff activities under this objective for the preceding period:

ACTIVITIES THIS PERIOD – 3/12 – 12/12

1. Organized and facilitated the third and fouth meeting of the Milwaukee Municipal GIS Users Group (MMGUG)
   - Meeting held on 4/10/2012 at the West Allis City Hall,
   - Meeting held on 11/13/2012 at the Wauwatosa City Hall,
   - Scheduled next meeting – 3/12/2013 @ Milwaukee County GMIA,
   - Continued support of a permanent MMGUG SharePoint page for purposes of communicating and networking with MMGUG participants,
2. Maintained production MCLIO web services (see attached Dashboard);
   - Initiated Secure Socket Layer (SSL) encryption certification for external use of MCLIO web services
3. Incorporated updated tutorial materials and announcements to users of the MCLIO Interactive Mapping Service website including:
   - Posting 1st, 2nd and 3rd Qtr 2012 foreclosure data
4. Maintained open channels of communication regarding web hosting data on the MCLIO SECURE website e.g., Glendale Planning and City of Cudahy Water
5. Coordinated Consolidated Boundary and Annexation Survey (C-BAS) participation. Eight (8) municipalities responded. Seven (7) agreed to participate (attached)

NEXT

1. Continue MCLIO website training, data distribution and product enhancements; and
2. Prepare for MMGUG Meeting – 3/12/2013
3. Continue to work with member participants to further their GIS goals

Attach: MCLIO Interactive Mapping Services Dashboard
CBAS Participation Agreement
Statewide CBAS Status Exhibit

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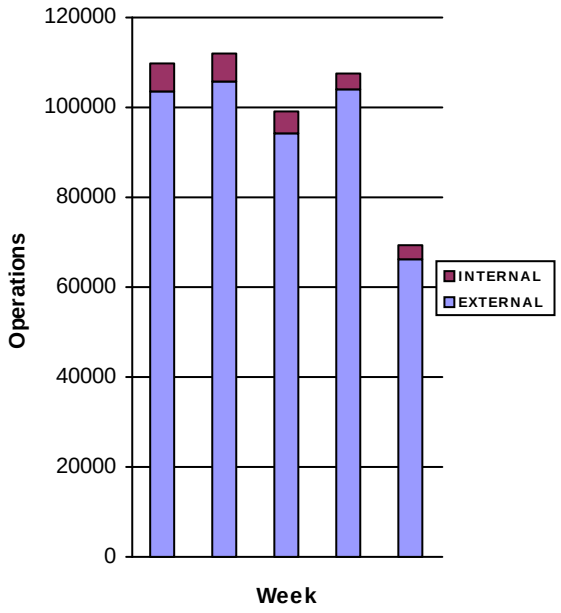
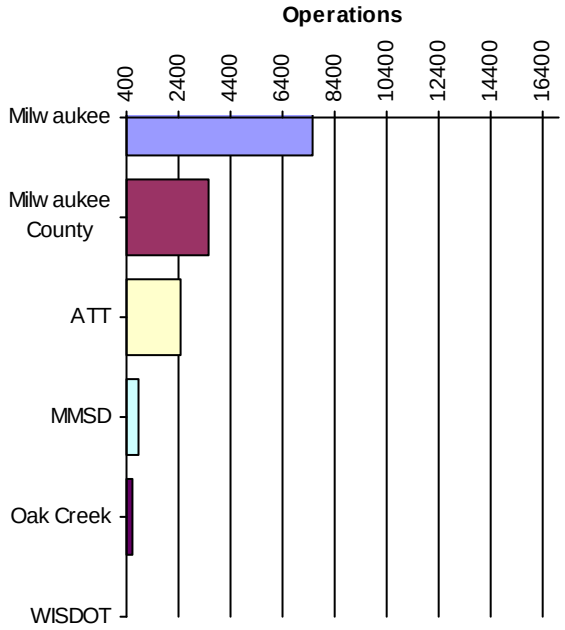
MCLIO Map Services Dashboard

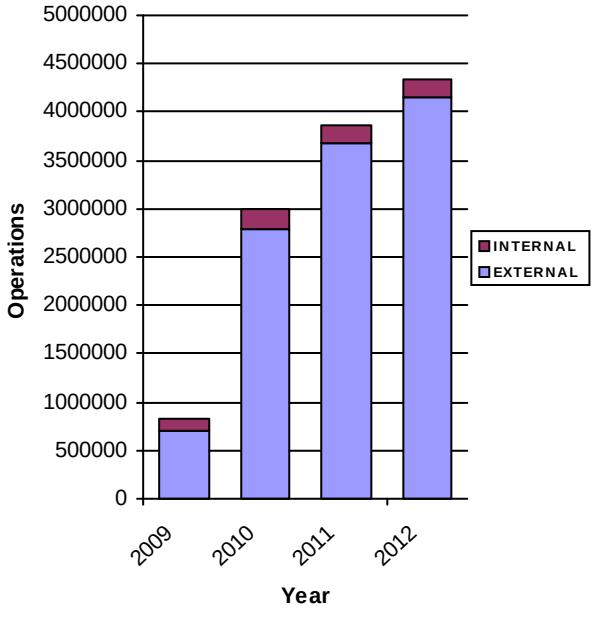
ACCESS



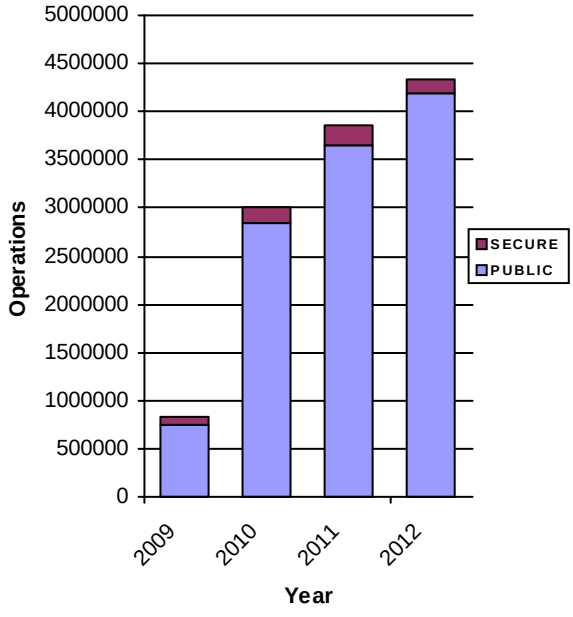
SECURE ACCESS



ACCESS METHOD



SITE SELECTION



FORM **BAS-6**
(10-18-2007)

BOUNDARY AND ANNEXATION SURVEY (BAS)
CONSOLIDATED BAS

U.S. DEPARTMENT OF COMMERCE
Economics and Statistics Administration
U.S. CENSUS BUREAU

GENERAL INSTRUCTIONS →

To sign up for the Consolidated BAS (C-BAS) program, please complete this form.
- It is important that all questions on the form are answered completely.
- Return the completed form(s) by August 1st for your county to be consolidated for next year's BAS.
- For further information, please contact the Legal Areas Team by calling (301) 763-1099 or emailing geo.bas@census.gov.

Name of county, parish, borough or equivalent area	State
Milwaukee	WI

BAS ID	25507900000	STATE CODE	55	COUNTY CODE	079

Section 1 **CONSOLIDATED BAS MAILING ADDRESS** (Address where Consolidated BAS materials should be sent) – *Please fill in contact information below.*

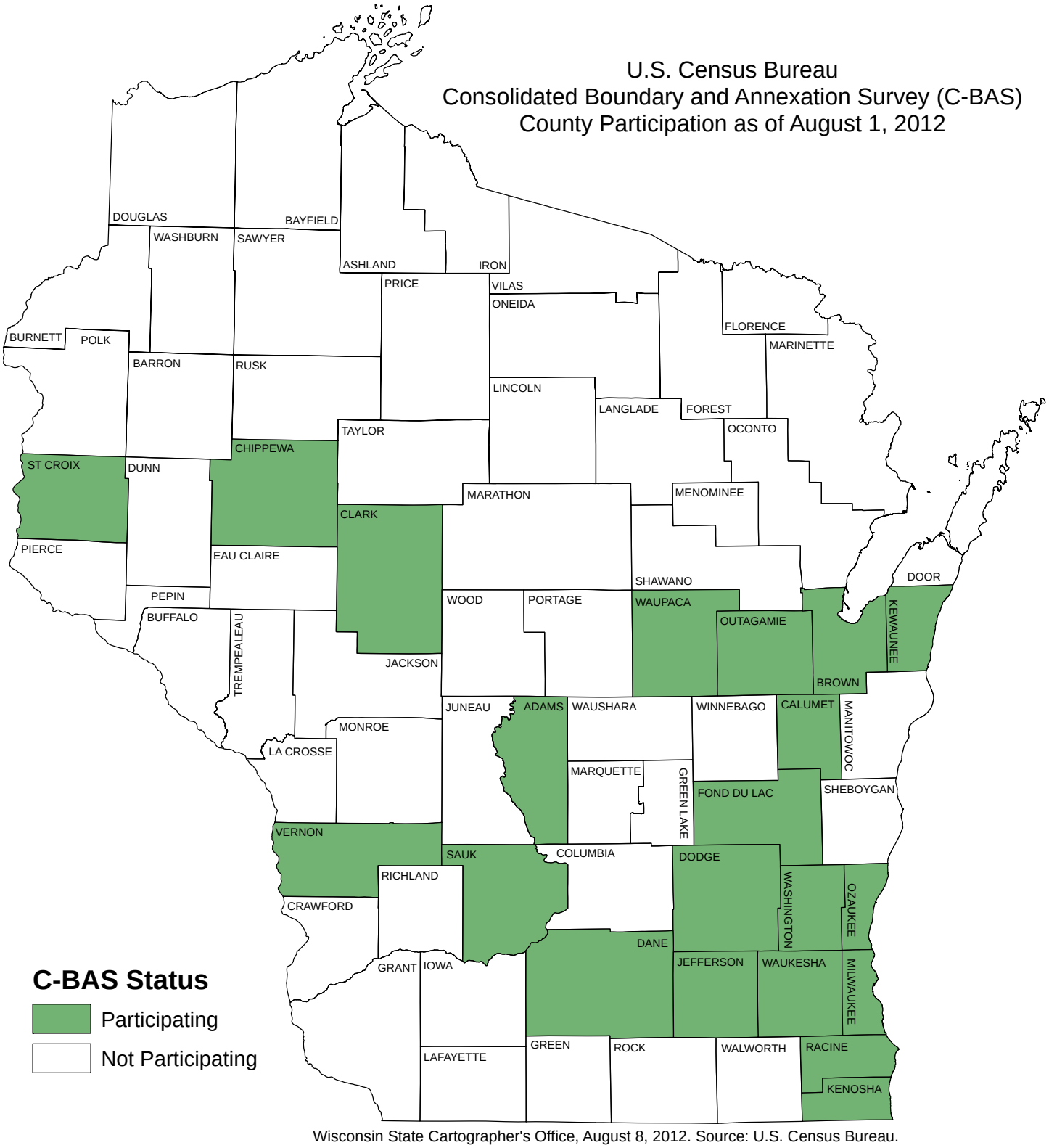
Name:	KATHLEEN BACH	Address:	901 N. 9TH ST.
Position:	GIS TECHNICIAN		COURTHOUSE Room G6
Department:	REGISTER OF DEEDS	City:	MILWAUKEE
Telephone:	(414) 278-3027 Ext:	State:	WISCONSIN ZIP code 53233
Fax:	( ) –	E-mail:	KBACH@MILWCNTY.COM

Instructions for filling out this form:
1) After contacting each of the entities listed below, enter a **Y** (Yes) or **N** (No) in the "Agreed" column to note each entity's response to participating in the Consolidated BAS program.
2) Fill in the name, position and phone number of the contact person you spoke with from each entity. Please provide this information for all entities listed below.
3) Enter the date that you spoke with each entity contact in the "Date of Contact" column.

Section 2 **PARTICIPATION ROSTER**

BAS ID	Entity Name	Agreed? Y/N	Contact Name	Position	Telephone Number	Date of Contact
15500005450	Bayside village		Ms. Lynn A Galyardt	Clerk treasurer, Dir of Fin and Admn		6/5/2012
15500010375	Brown Deer village	Y	Jim Buske	Engineering & GIS Services Manager	414-371-3060	6/12/2012
15500017975	Cudahy city		Mr. Alfred Podolak	Senior Engineering Technician		6/5/2012
49900741135	Forest County Potawatomi Community		Ms. Shari Alloway	GIS Specialist, GIS		6/5/2012
15500027075	Fox Point village	Y	Scott Brandmeier	Director, Public Works	414-351-8900	7/17/2012
15500027300	Franklin city		Sandra L Wesolowski	City clerk		6/5/2012
15500029400	Glendale city		Ms. Susanne M Hanaman	Clerk		6/5/2012

Section 2	PARTICIPATION ROSTER – Continued					
BAS ID	Entity Name	Agreed? Y/N	Contact Name	Position	Telephone Number	Date of Contact
15500031125	Greendale village		Mr. Todd K Michaels	Village Manager		6/5/2012
15500031175	Greenfield city	Y	Jeff Tamblyn	Senior GIS Technician	414-329-5323	7/13/2012
15500032075	Hales Corners village	Y	Michael F. Weber	Village Administrator/Clerk	414-529-6175	6/7/2012
15500053000	Milwaukee city		Ms. Nancy A Olson	Chief Information Officer, Administration		6/5/2012
15500058800	Oak Creek city		Mr. Douglas W Seymour	Director, Community Development		6/5/2012
15500068325	River Hills village					
15500073725	Shorewood village	Y	Ericka Lang	Planning & Zoning Administrator	414.847.2647	6/6/2012
15500075125	South Milwaukee city		Tiffany Laborde	GIS / Surveying Tech, Engineering		6/5/2012
15500070650	St. Francis city		Anne Uecker	City Clerk		6/5/2012
15500084675	Wauwatosa city	Y	Tammy Szudy	Principal Planner	414-479-3521	6/8/2012
15500085300	West Allis city	N	Patrick Walker	GIS Supervisor	414-302-8328	6/20/2012
15500085875	West Milwaukee village		Mr. Thomas Tollaksen	Village Administrator		6/5/2012
15500086700	Whitefish Bay village	Y	Jeff G. Jurgens	Engineer Technician II	(414) 962-6690	6/7/2012



Wisconsin State Cartographer's Office, August 8, 2012. Source: U.S. Census Bureau.

DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

MILWAUKEE COUNTY LAND INFORMATION OFFICE

2711 West Wells Street, Rm 426, Milwaukee, WI 53208 (414) 278-2176

TO: MCAMLIS Steering Committee

FROM: William C. Shaw, MCAMLIS Project Manager

DATE: November 26, 2012

SUBJECT: COUNTYWIDE PROGRAM INITIATIVES

BACKGROUND

This Goal states that - Where appropriate, identify, initiate, and complete projects proposed by Milwaukee County or its constituent municipalities, agencies of the federal, state or regional government, public utilities and by private entities, including, importantly, interested citizens which would, by understanding of the MCAMLIS Steering Committee, prepare information and maps useful for meeting the needs of the County and its local units of government and contributing toward the implementation of the Wisconsin Land Information Program.

CURRENT PROJECT STATUS SUMMARIES

1. **Address Database Maintenance**

   Activities this Period – 3/12 – 12/12
   - Deployed 1st, 2nd and 3rd qtr consolidated Milwaukee County and City of Milwaukee Cadastral Data;
   - Maintained address point "situs" relationship to structure location; and
   - Delivered countywide address and street centerline data to Milwaukee County Sheriff Office to be implemented as part of their ProPhoenix Dispatch System and to Milwaukee County Board of Supervisor District Finder.

   Next
   - Continuation of ongoing effort toward incorporating updated multiple address source information

2. **Plat-of-Survey Maintenance**

   Plat of Survey Documents received from the Milwaukee County Surveyors Office are scanned and indexed to their respective parcel(s). The public is able to access these as they are posted to the MCLIO Interactive Mapping website. In total, there are 92,497 parcel references to 81,179 documents. In 2012 a total of 791 documents have been scanned and indexed into the Plat of Survey scanned document library.

3. **Historical Aerial Photo Geo-rectification**

   1951 - MCAMLIS staff is currently in the process of geo-referencing section-centered black and white images. These images were taken by Abrams Aerial Survey

Corporation, Lansing Michigan for Milwaukee County, WI. Circa 1951-1952. There are eight books containing approximately 520 half-image prints that were scanned and will be geo-referenced. The images are generally in excellent condition and scanned such that they can be reasonably viewed at a scale of one-inch equals two hundred feet (1"= 200'). Staff has completed geo-referencing 95% of the county as shown in the (attached) status map.

Staff will complete the remaining 25 tiles through 2012 and post these on the website as they become available.

1928 – MCAMLIS Staff recently discovered a cache of what appears to be circa 1928 aerial imagery covering a portion of Milwaukee County (see attached exhibits). It is believed that there are possibly more photos from this series located throughout various Milwaukee County municipal archives. The State Cartographers Office has been consulted in this regard and has initially suggested that these photos may be among the oldest known to be available throughout the state.

Staff intends to pursue the process of geo-referencing the available photos and seeking further input from local communities to identify the availability of these and other photos needed to complete this series.

4. Routable Street Centerline

The structure of the MCAMLIS Street Centerline database allows for address geo-coding but does not allow for routing and other forms of network analysis e.g., emergency evacuation and turn by turn directions. An effort is underway to enhance the MCAMLIS Street Centerline to allow for the support of routing applications. Staff continues to complete the remaining portion of centerline segments as resources allow.

5. Non-project related activities

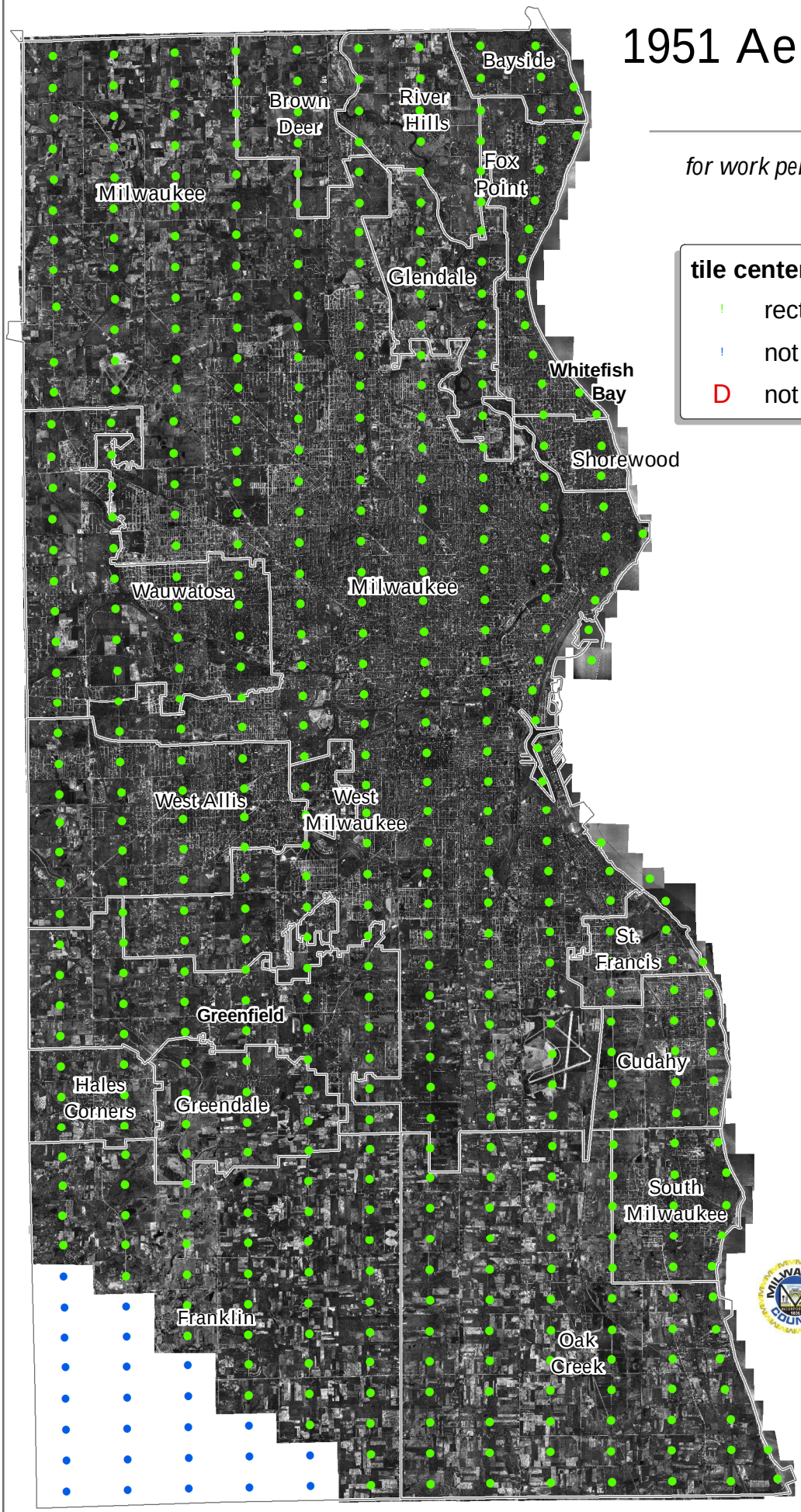
- Review and develop new technologies e.g., ESRI 10.1 and Latitude Geographics 'Silverlight' and 'HTML5' based viewers and opportunities to use cached services;
- Management and administration of Pictometry Connect services (see attached Exhibit) allowing MCAMLIS Partners to access Pictometry hosted services via a unique secure oblique image viewer.

Attach:

1951 Aerial Photo Status
1928 Aerial Photo Exhibit(s)
Pictometry Connect Exhibit

1951 Aerial Photo Project Status

for work performed through November 24, 2012



tile center points

- rectifed (483 of 508 tiles - 95%)
- not yet rectified
- D not available

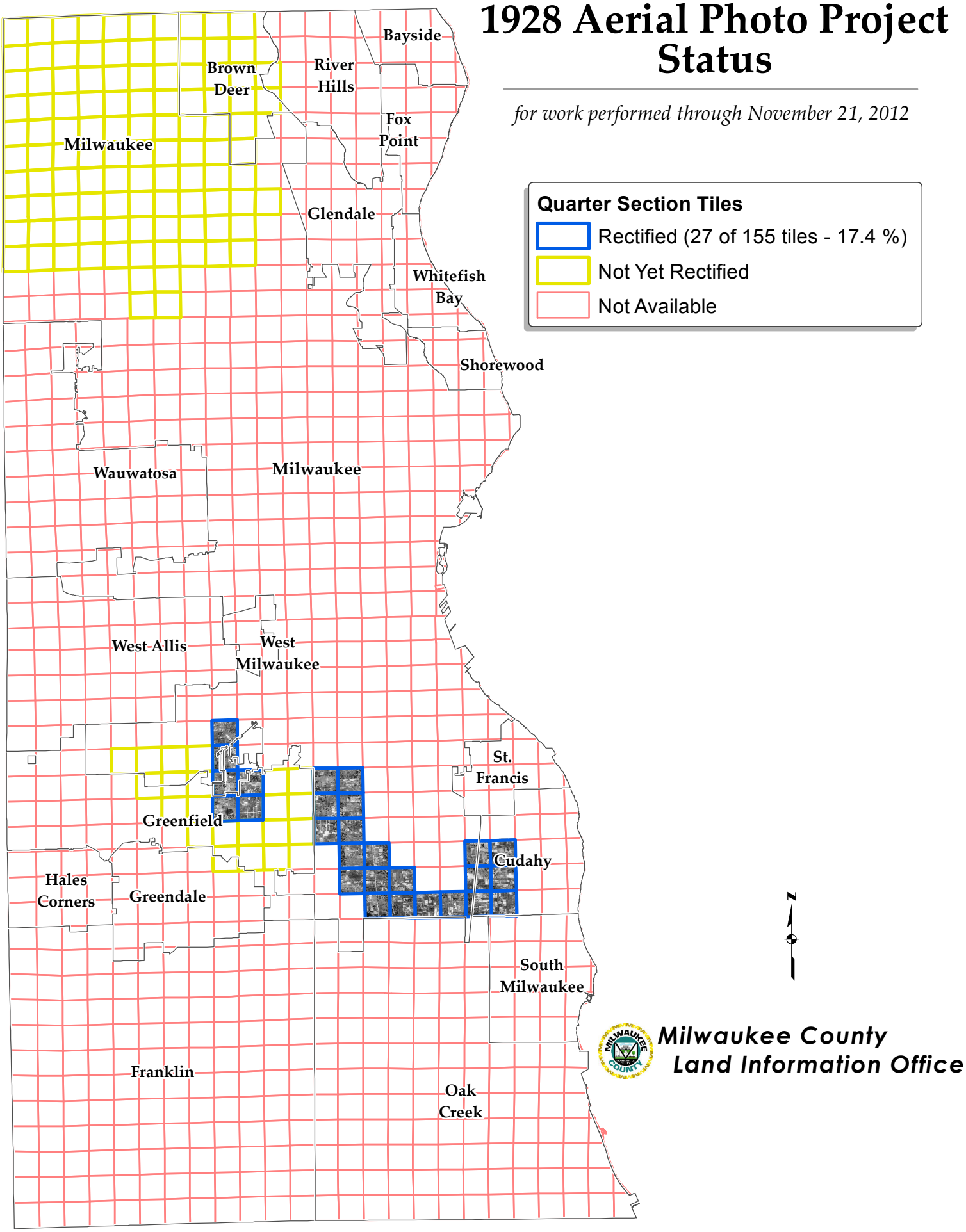
Milwaukee County Land Information Office

Comparison of Aerial Photos

1928 vs. 2010

1928 Aerial Photo Project Status

for work performed through November 21, 2012



Milwaukee County Land Information Office

PICTOMETRY® CONNECT

Don't Just See. See Answers.

Today, aerial images can instantly place a world of information at your fingertips. But only Pictometry's solutions can provide the unmatched precision and intelligence essential to making informed decisions and deliver them right to your desktop.

Pictometry®

The Most Accurate Data, Accessible Anywhere

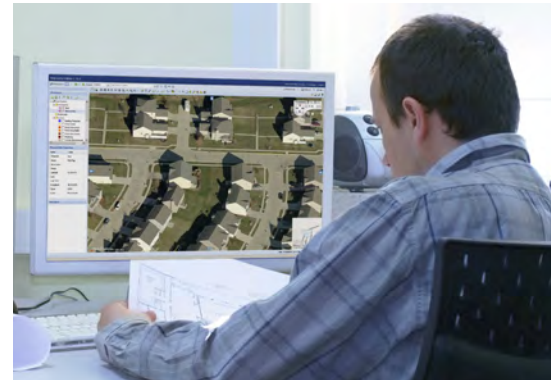
Imagine exploring a remote area, building, or asset; combining your existing data and knowledge of that environment with rich visual intelligence to validate and enhance your understanding, and providing an accurate representation of that location to others, helping them to comprehend the environment and solve related problems enterprise-wide.

All without leaving the office.

Pictometry Connect is an innovative service solution that can make it happen. Users can now affordably manage, deploy, and leverage powerful imagery, analytics, and GIS data across an entire organization, without the hassle of managing and storing massive amounts of data.

Security You Can Rely On, Experience You Can Trust

Pictometry uses its vast resources and expertise to capture, process, format, and store your imagery, because we understand spatial data and oblique imagery like no other company. Trust our state-of-the-art data center and extraordinary service and support to provide the security, backup, and performance you need and rely on.



What Is Pictometry® Connect?

Pictometry® Connect is a secure, web-based solution that combines high resolution aerial imagery with customer GIS data to create a powerful system that is easily accessible and interactive. Users can upload, view, and analyze their location-based data against the backdrop of the highest quality aerial imagery in the world. Since Pictometry® Connect is built on top of the Pictometry Analytics platform, this solution goes way beyond just visualization to provide the user with major benefits, including:

- Turnkey integration with leading GIS and CAD applications
- Access to Pictometry measurement and analytics tools
- Access to Pictometry image archive, featuring over 10 years of imagery
- Flexible deployment options including zero footprint installation
- Access to parcel boundaries and ownership information
- Reliable backup to onsite imagery and GIS data layers

Flexible Deployment Options

- Desktop – Esri® or Autodesk® turnkey integrations
- Server – Pictometry® for ArcGIS Server (Flex and Silverlight) and Pictometry Image Navigator™
- Web-based via Pictometry® Online
- Select 3rd Party Software Packages
- Directly embedded into customer software

How Pictometry® Connect Works

Imagery and spatial data is securely stored in a private library

WEB & BROWSER

Securely access content through an interactive web application

SERVER

Enhance existing server-based environments for enterprise-wide distribution

DESKTOP

Import high resolution imagery directly into existing GIS and CAD applications

Pictometry®

To learn more, contact your Pictometry representative:

100 Town Centre Drive
Rochester, NY 14623

888.771.9714
pictometry.com

2012 - Milwaukee County Documents Recorded
Monthly Totals & Daily Average

The 2012 Budget Estimates that there will be 125,000 documents recorded

Budget pace = 125,000 divided by 254 days = **492.1 per day**

Month	# of Recorded Documents	MORTGAGES	Percentage Mortgages	# of Days in Month	Daily Average	Month on Budget Pace ?	Y-T-D on Budget Pace ?
JAN	10,479	2,516	24.0	21	**499**	**Y**	**Y**
FEB	9,622	2,208	22.9	21	**458.2**	**N**	**N**
MAR	11,466	2,680	23.4	22	**521.18**	**Y**	**Y**
APRIL	10,276	2,552	24.8	21	**489.33**	**N**	**Y**
MAY	12,843	3,178	24.7	22	**583.77**	**Y**	**Y = 510.9**
JUNE	10,663	2,616	24.5	21	**507.76**	**Y**	**Y = 510.4**
JULY	11,021	2,807	25.5	21	**524.8**	**Y**	**Y = 512.4**
AUG	11,950	3,081	25.8	23	**569.05**	**Y**	**Y = 513.4**
SEPT	10,122	2,683	26.5	19	**532.74**	**Y**	**Y = 515.3**
OCT	12,506	3,063	24.5	23	**543.74**	**Y**	**Y = 518.4**

STATE OF WISCONSIN
DEPARTMENT OF ADMINISTRATION
DIVISION OF INTERGOVERNMENTAL RELATIONS
DOA-12020 (R 06/2011)
S. 16.967(7) WIS STATS
S. 59.72(2)(b) WIS STATS

RETURN COMPLETED FORM TO:
WISCONSIN LAND INFORMATION PROGRAM
PO BOX 8944, MADISON, WI 53708-8944
WLIP@wisconsin.gov
VOICE (608) 267-3369
FAX (608) 267-6917

County Retained Fee/Grant Report

Instructions:
If your county has accepted a grant under s. 16.967(7) WIS STATS or retained any fees under s.59.72 (5) WIS STATS, submission of this report to the State Department of Administration, Division of Intergovernmental Relations is required by June 30th of the following year in accordance with s. 59.72(2)(b) WIS STATS.

Wisconsin Land Information Program
Post Office Box 8944
Madison, WI 53708-8944

This Return address block is placed for use in a standard window envelope for your convenience.

Wisconsin Land Information Program County Retained Fee/Grant Report		
Name of Land Information Officer John L. LaFave	Recording Period: From Jan. 1, 2011 To Dec. 31, 2011	
County Milwaukee	Email Address jlafave@milwcnty.com	Phone Number (414) 278-3083

1. County has a land information council consistent with s. 59.72 (3m).	☒ Yes ☐ No
2. Amount of unspent funds carried over from grant under s. 16.967(7) or retains any fees under 59.72(5)(b) from before Jan. 1, 2011.	$1,278,142
3. Amount received in grants under s. 16.967(7), Wis. Stats. in the reporting period (Jan. 1 – Dec. 31st, 2011).	$300
4. Amount collected under s. 59.72(5), Wis. Stats. in the reporting period (Jan. 1 – Dec 31, 2011) ($8 – includes $2 for provision of land info on the Internet)	$909,185
5. Amount collected from other sources for land info activities (general county levy, interest earned, municipal projects, other revenue) during reporting period (Jan. 1 – Dec 31, 2011).	$0
6. Amount spent to develop, implement, and maintain the countywide plan for land records modernization in the reporting period AND provision of land info on Internet during reporting period (Jan. 1 – Dec 31, 2011) – *Should equal sum of individual items listed on back of form*	$923,458
7. Balance carried over into Calendar Year 2012. *(Should equal Line 2 + Line 3 + Line 4 + Line 5 – Line 6)*	$1,264,169

Wisconsin Land Information Program
County Retained Fee/Grant Reporting - continued.

	1. Project Description/Land Info Activities Area	2. Modernization Plan Citations	3. Budget - Provide Cost & Unit Cost for Specific Activities in Question 5:
a.	ROD 2009 – 2011 Improvements to Computer System VI	LRM: 2010, II.C.1	$58,484
b.	2011 Cadastral Address Maintenance – City of Milwaukee	LRM: 2010, II.G1.d, II.D, II.E.3, II.E.6	$90,010
c.	Milwaukee County Surveyor	LRM: 2010 II.B.G1.a, II.C.4, II.D, II.E.2.a, II.E.2.g	$78,719
d.	Staff Projects $2 Fee	LRM: 2010, II.2.C	$20,764
e.	Milwaukee County Project Management, Fiscal Management & Program Staff Milwaukee County Land Information Office (MCLIO) Operations	LRM: 2010, II.B.G1-G4, II.C.1-8	$675,481
f.			

4. Brief Narrative of Land Information Activities (include relevant web-links):

Property foreclosure data published quarterly to include information added though the year. Published training exercises designed to familiarize users with the Interactive Mapping Service's tools and features. Updates contributed to the Esri's World Topographic Map and is now available for viewing via ArcGIS Online. Published newer versions of THE INTERACTIVE MAPPING SERVICE, CADASTRAL UPDATES and DRAFT FLOODPLAIN MAPPING UPDATES. Completed CDBG Grants used to acquire 2010 LiDAR data

2012 MCAMLIS YTD

OPERATING REVENUE						
	Modified Budget	**Actual**	**Encumbered**	**YTD BAL**	**YE Projected**	**YE PROJ OVR/(UNDR) BUD**
OPERATING REVENUE	$1,000,780	$879,416		($121,364)	$1,048,000	$47,220

OPERATING EXPENDITURES						
	Modified Budget	**Actual**	**Encumbered**	**YTD BAL**	**YE Projected**	**YE PROJ OVR/(UNDR) BUD**
OPERATING EXPENSES						
$6 Project Expenditures	$935,834	$136,692	$454,200	$344,943	$777,273	($158,561)
All Other Expenditures	$601,738	$332,216	$238	$269,284	$536,738	($65,000)
Total	$1,537,572	$468,907	$454,437	$614,227	$1,314,011	($223,561)
					Net OVR/(UNDR) BUD	($270,781)

Fund Balance:	**YTD BAL**	**YE Projected**
2011 Year-End Fund Balance	**$1,264,169**	**$1,264,169**
- 2012 Resrv Draw-Down	$259,495	$259,495
+ 2012 EXP OVR / (UNDR) BUD	($923,345)	($223,561)
+ 2012 REV OVR / (UNDR) BUD	($121,364)	$47,220
= 2012 Fund Balance	**$1,806,655**	**$1,275,455**
2012 Reserve Revenue @ 10%	$100,078	$100,078
2012 Est Fund Balance- Unrestricted	$1,084,108	$597,913
2012 Est Fund Balance- Restricted	$622,469	$577,464

2012 MCAMLIS YTD

$6 Fee

OPERATING REVENUE						
	Modified Budget	**Actual**	**Encumbered**	**YTD BAL**	**YE Projected**	**YE PROJ OVR/(UNDR) BUD**
OPERATING REVENUE	$755,000	$661,496		($93,504)	$786,000	$31,000

OPERATING EXPENDITURES						
	Modified Budget	**Actual**	**Encumbered**	**YTD BAL**	**YE Projected**	**YE PROJ OVR/(UNDR) BUD**
OPERATING EXPENSES						
$6 Project Expenditures	$771,475	$78,720	$409,195	$283,561	$612,914	($158,561)
All Other Expenditures	$519,792	$294,484	$238	$225,070	$454,792	($65,000)
Total	$1,291,267	$373,204	$409,432	$508,631	$1,067,706	($223,561)
					Net OVR/(UNDR) BUD	($254,561)

Fund Balance:	**YTD BAL**	**YE Projected**
2011 Year-End Fund Balance	**$923,515**	**$923,515**
- 2012 Resrv Draw-Down (Topo Map, Orthophoto)	$259,495	$259,495
+ 2012 EXP OVR / (UNDR) BUD	($782,636)	($223,561)
+ 2012 REV OVR / (UNDR) BUD	($93,504)	$31,000
= 2012 Fund Balance	**$1,353,152**	**$918,581**
2012 Reserve Revenue @ 10%	$75,500	$75,500
2012 Est Fund Balance- Unrestricted	$743,457	$308,886
2012 Est Fund Balance- Restricted	$534,195	$534,195

$2 Fee

OPERATING REVENUE						
	Modified Budget	**Actual**	**Encumbered**	**YTD BAL**	**YE Projected**	**YE PROJ OVR/(UNDR) BUD**
OPERATING REVENUE	$245,780	$217,920		($27,860)	$262,000	$16,220

OPERATING EXPENDITURES						
	Modified Budget	**Actual**	**Encumbered**	**YTD BAL**	**YE Projected**	**YE PROJ OVR/(UNDR) BUD**
OPERATING EXPENSES						
$2 Project Expenditures	$164,359	$ 57,972	$45,005	$61,382	$164,359	$0
All Other Expenditures	$81,946	$ 37,732	$0	$44,214	$81,946	$0
Total	$246,305	$95,704	$45,005	$105,596	$246,305	$0
					Net OVR/(UNDR) BUD	($16,220)

Fund Balance:	**YTD BAL**	**YE Projected**
2011 Year-End Fund Balance	**$340,654**	**$340,654**
- 2012 Resrv Draw-Down	$0	$0
+ 2012 EXP OVR / (UNDR) BUD	($140,709)	$0
+ 2012 REV OVR / (UNDR) BUD	($27,860)	$16,220
= 2012 Fund Balance	**$453,503**	**$356,874**
2012 Reserve Revenue @ 10%	$24,578	$24,578
2012 Est Fund Balance- Unrestricted	$340,651	$289,027
2012 Est Fund Balance- Restricted	$88,274	$43,269

2012 YTD Combined Fiscal Report - MCAMLIS ($2) - as of 10-31-2012

Year Authorized	Project Description	Amount Authorized	Amount Paid 2002-2011	Amount Paid 2012	Amount Encumbered 2012	2012 Total Amount Paid (Encumbrances + Actual)	Remaining Unpaid Balance	Complete
2002	Large Format Scanner	$13,090	$13,090	$0	$0	$ -	$ -	Yes
2003	Improvements to Computer System	$240,000	$240,000	$0	$0	$ -	$ -	Yes
2003	Electronic Recording	$45,000	$45,000	$0	$0	$ -	$ -	Yes
2003	External Hard Drive/Two SNAP Servers	$40,000	$40,000	$0	$0	$ -	$ -	Yes
2003/2005	Digital Images; Conversion of Microfiche	$400,000	$400,000	$0	$0	$ -	$ -	Yes
2005	Scanning A Card	$50,000	$50,000	$0	$0	$ -	$ -	Yes
2005	Improvements to Computer System II	$450,000	$450,000	$0	$0	$ -	$ -	Yes
2007	Improvements to Computer System III	$150,000	$150,000	$0	$0	$ -	$ -	Yes
2008	Improvements to Computer System IV	$150,000	$150,000	$0	$0	$ -	$ -	Yes
2009	Improvements to Computer System V	$120,000	$120,000	$0	$0	$ -	$ -	Yes
2009	Enterprise Address System*	$65,000	$65,000	$0	$0	$ -	$ -	Yes
2009	Improvements to Computer System VI +	$95,000	$94,436	$525	$0	$ 525	$ 39	Yes
2012	Cadastral Address Maintenance-2012	$90,010	$0	$45,005	$45,005	$ 90,010	$ -	Yes
2012	Staff Projects $2 Fee	$73,234	$20,764	$12,967	$0	$ 12,967	$ 39,503	No
2012	Strategic Plan	$40,000	$0	$0	$0	$ -	$ 40,000	No
Total		**$2,021,334**	**$1,838,290**	**$58,497**	**$45,005**	**$103,502**	**$ 79,542**	

Data from John La Fave, Register of Deeds as of 11/16/2012

NOTES

+ Project is substantially complete. $39 BAL to fall to Reserve's unrestricted balance.

2012 YTD Combined Fiscal Report - MCAMLIS ($6) - as of 10-31-2012

Vendor Name	Description	Amount Authorized	Amount Paid - Prior Years	2012 Amount Encumbered	Amount Paid 2012 YTD	Total Amount Paid 2012 (Encumbrances + Actual)	Remaining Unpaid Balance
SOUTHEASTERN WI REGIONAL	MCAMLIS Floodland Mapping Phase 2	$ 436,000	$ 161,300	$ 274,700	$ -	$ 274,700	$ -
SOUTHEASTERN WI REGIONAL	County Surveyor	$ 78,719	$ -	$ 78,719	$ -	$ 78,719	$ -
MILWAUKEE COUNTY*	Staff Projects $2 Fee	$ -	$ -	$ -	$ -	$ -	$ -
PICTOMETRY INTL	Orthophotography Acquisition	$ 134,495	$ -	$ 134,495	$ -	$ 134,495	$ -
PLANIMETRIC	Planimetric Map Replacement	$ 125,000	$ -	$ -	$ -	$ -	$ 125,000
	TOTAL	**$ 774,214**	**$ 161,300**	**$ 487,914**	**$ -**	**$ 487,914**	**$ 125,000**

MILWAUKEE COUNTY FISCAL NOTE FORM

DATE: 11/18/12

Original Fiscal Note ☒

Substitute Fiscal Note ☐

SUBJECT: MCAMLIS Business Needs Assesssmnet Professional Services Contract

FISCAL EFFECT:

☒ No Direct County Fiscal Impact

- ☒ Existing Staff Time Required

☐ Increase Operating Expenditures
(If checked, check one of two boxes below)

- ☒ Absorbed Within Agency's Budget
- ☐ Not Absorbed Within Agency's Budget

☐ Decrease Operating Expenditures

☐ Increase Operating Revenues

☐ Decrease Operating Revenues

☐ Increase Capital Expenditures

☐ Decrease Capital Expenditures

☐ Increase Capital Revenues

☐ Decrease Capital Revenues

☐ Use of contingent funds

Indicate below the dollar change from budget for any submission that is projected to result in increased/decreased expenditures or revenues in the current year.

	Expenditure or Revenue Category	Current Year	Subsequent Year
Operating Budget	Expenditure	$149,845	
	Revenue	0	
	Net Cost	$149,845	
Capital Improvement Budget	Expenditure		
	Revenue		
	Net Cost		

DESCRIPTION OF FISCAL EFFECT

In the space below, you must provide the following information. Attach additional pages if necessary.

A. Briefly describe the nature of the action that is being requested or proposed, and the new or changed conditions that would occur if the request or proposal were adopted.
B. State the direct costs, savings or anticipated revenues associated with the requested or proposed action in the current budget year and how those were calculated. [1] If annualized or subsequent year fiscal impacts are substantially different from current year impacts, then those shall be stated as well. In addition, cite any one-time costs associated with the action, the source of any new or additional revenues (e.g. State, Federal, user fee or private donation), the use of contingent funds, and/or the use of budgeted appropriations due to surpluses or change in purpose required to fund the requested action.
C. Discuss the budgetary impacts associated with the proposed action in the current year. A statement that sufficient funds are budgeted should be justified with information regarding the amount of budgeted appropriations in the relevant account and whether that amount is sufficient to offset the cost of the requested action. If relevant, discussion of budgetary impacts in subsequent years also shall be discussed. Subsequent year fiscal impacts shall be noted for the entire period in which the requested or proposed action would be implemented when it is reasonable to do so (i.e. a five-year lease agreement shall specify the costs/savings for each of the five years in question). Otherwise, impacts associated with the existing and subsequent budget years should be cited.
D. Describe any assumptions or interpretations that were utilized to provide the information on this form.

A. The Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Steering committee recommends approval of a Professional Consultant Services contract with an experienced GIS consulting firm to conduct a 'location- based data and technologies' (LBDT) Business Needs Assessment leading to the development of a (Five Year Work Program) LBDT Implementation Plan. The Consultant developed Business Needs Assessment and Implementation Plan will capitalize on Milwaukee County Automated Mapping and Land Information System (MCAMLIS) ongoing GIS investments and resources. The development of a LBDT Implementation Plan is intended to guide the MCAMLIS Steering Committee decision making related to the support and use of location- based data and technologies into the future and is expected to result in enhanced and sustained local community operations and services as may be aided by MCAMLIS throughout Milwaukee County over a five year period.
B & C. The proposed professional services contract costs are included in the 2013 Adopted MCAMLIS Budget. Therefore there are no additional costs of funds required at this time.
D.MCAMLIS has approx. $207k budgeted for non-recurring professional services contracts in 2013 (account 6149) and would be able to cover the cost of this contract in 2013. This action would leave the Steering Committee with about $58k for any other projects for the rest of 2013 unless approval for a fund transfer from the MCAMLIS Reserve is granted

[1] If it is assumed that there is no fiscal impact associated with the requested action, then an explanatory statement that justifies that conclusion shall be provided. If precise impacts cannot be calculated, then an estimate or range should be provided.

Department/Prepared By Department of Administrative Services by William Shaw, MCAMLIS Project Manager

Authorized Signature _____

Did DAS-Fiscal Staff Review? ☒ Yes ☐ No

DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

MILWAUKEE COUNTY LAND INFORMATION OFFICE

2711 West Wells Street, Rm 426, Milwaukee, WI 53208 (414) 278-2176

MEMORANDUM

TO: MCAMLIS Steering Committee

FROM: William Shaw, MCAMLIS Project Manager

DATE: November 27, 2012

SUBJECT: MCAMLIS BUSINESS NEEDS ASSESSMENT STATUS AND RECOMMENDATION

BACKGROUND

At its meeting held on March 20th, 2012, the MCAMLIS Steering Committee considered a MCAMLIS staff report regarding the 'MCAMLIS Program Strategic Assessment for 2012 – 2015' wherein MCAMLIS Staff recommended that a formal Business Planning effort be conducted wherein to assess:

- Where MCAMLIS can (in the future) best align itself with local community interests and requirements?
- How MCAMLIS current performance is perceived?
- How MCAMLIS can provide improved value in the future?

Whereby in consideration of the staff recommendations the MCAMLIS Steering Committee directed the Committee Chairman to select a Sub-committee whose charge is to develop a 'Work Program' for MCAMLIS to be conducted over the next 3-5 years. Wherein the Chairmen is to call the sub-committee to meet and report on progress toward formulation of a MCAMLIS Business Needs Assessment including any recommendations at future Steering Committee meetings.

SUB-COMMITTEE MEMBERSHIP

The chairman selected MCAMLIS Steering Committee members (M), MCAMLIS Staff (S) and alternates (A) to the full sub-committee. In addition, a subset of the sub-committee members was identified to form a workgroup (W). The Sub-Committee and workgroup membership includes:

- Don Nehmer (M, W) – MCAMLIS Steering Committee Chair, Capital Program Manager, MMSD
- Nancy A. Olson (M) – MCAMLIS Steering Committee Vice-chair, Chief Information Officer, City of Milwaukee
- John Bennett (M) – Inter-governmental Coordinating Council (ICC) member representative to the MCAMLIS Steering Committee, City Engineer, City of Franklin

- Greg High (M) – DAS/Facilities Management - Director, AE & ES Division
- Emily Champagne (M, W) – Senior GIS Analyst, MMSD
- Kevin Bruhn (A, S)– representing Greg High, GIS Specialist, MCAMLIS Staff, Milwaukee County
- Todd Niedermeyer (A) – representing John Bennett, City of Franklin, GIS Consultant
- William Shaw (M, W, S) – MCAMLIS Project Manager, Milwaukee County

SUB-COMMITTEE MEETINGS

The Sub-Committee workgroup was formed to draft a mission and objectives statement and present the draft to the full sub-committee for comment and approval. The workgroup met three (3) times at MMSD Offices on 6/21, 7/13 & 8/17/2012. The sub-committee members via email commented and approved the draft mission and objectives document and the contents therein were then incorporated within the MCAMLIS Business Needs Assessment RFP.

An RFP was published on 8/17/2012 and responses were closed on 9/21/2012. The full 'MCAMLIS Steering Business Plan Sub-Committee' met three (3) times in October and November 2012 to conduct the RFP review and final vendor selection. The meetings were held at MMSD Offices on 10/3, 10/16 & 11/2/2012.

SUB-COMMITTEE MISSION AND OBJECTIVES

Mission:

To leverage MCAMLIS's investment and ongoing resources to better serve the applied use of spatial/location data and technologies resulting in enhanced and sustained local community operations and services.

Objectives:

- Use of Web and mobile technologies software/hardware to address local community operational and service delivery objectives
- Promote and facilitate core applications and services such that enable local communities to engage in nimble and effective service delivery solutions.
- Provide hosted solutions, by MCAMLIS, that incorporate common seamless feature rich data and services that can be further enhanced to meet a wide ranging set of unique situations and community demands.
- Provide resources to local municipalities to minimize their capital investments in using and implementing spatial/location data.
- Promote data sharing among MCAMLIS Stakeholders (such as utility data) with MCAMLIS being a clearing house.

SUB-COMMITTEE RFP EVALUATION PROCESS

Requests for proposals were sent to 15 firms. These firms were identified through a list compiled by MCAMLIS Steering Committee Members, the Wisconsin State Cartographers Office, and through the advertisement process.

Six proposals were received in the Milwaukee County Land Information Office by the deadline of 2:00 PM, September 21, 2012.

The following firms submitted proposals:

1. Sanborn
2. GeoPlanning Services LLC
3. PlanGraphics, Inc.
4. BLACK & VEATCH CORP
5. GEODECISIONS
6. Graef

The Sub-Committee evaluated and scored each of the submitted proposals based on but not limited to the following factors:

1. Experience of Firm in related projects
2. Response to overall Scope of Work
3. Cost

Each of the six (6) proposals were initially rated by MCAMLIS Staff and uniformly scored based on the proposed 'Experience and Scope of Work' using a form designed to rate each proposal.

MCAMLIS Staff considered four (4) proposals as meeting a minimum requirement of a 50% score or higher rating. A packet of rating forms was provided to each member of the sub-committee to score and tabulate the remaining four (4) proposals. These packets were completed through the period of September 26, 2012 to October 3, 2012, prior to the sub-committee meeting on 10/3.

On October 3, 2012, members and alternates of the consultant selection committee met for about 2 hours to review the proposals. By consensus the selection committee members (comprised of four (4) appointed and two (2) alternates) decided to short-list all four firms for interviews. The four short-listed firms were Sanborn, PlanGraphics, Inc., BLACK & VEATCH CORP and GEODECISIONS.

On October 16, 2012, interviews with the four short-listed firms were conducted in the MMSD offices at 260 W Seeboth Street. The sub-committee could not reach consensus on the final selection at this meeting because one (1) member who attended the interviews could not be present for the follow-up discussion. The selection committee was then evenly split between GEODECISIONS and PlanGraphics. The selection committee members present elected that a final decision could be made by four (4) Sub-Committee members at a meeting to be scheduled.

A final meeting on November 2, 2012 was held at MMSD offices and the consensus of the Sub-committee members (Don Nehmer, Emily Champagne, Nancy Olson and William Shaw) present elected to recommend award of the contract to GEODECISIONS.

SUB-COMMITTEE RECOMMENDATION

The MCAMLIS Business Needs Assessment Sub- committee recommends MCAMLIS Steering Committee approval of this recommendation and to direct MCAMLIS Staff to affect the execution of a Professional Services Standard Agreement to be entered into with:

GEODECISIONS
1515 Market Street, Suite 2020
Philadelphia, PA 19102

Estimated Lump Sum Fee $149,845.00

The GEODECISIONS project approach/scope of services, schedule, and consultant effort breakdown by task (attached). The consultants approach and scope closely match with the MCAMLIS Business Needs Assessment Sub-Committee's desired work effort. A firm scope and price will be clarified when the selection of GEODECISIONS is confirmed.

* * * * *

Section	MCAMLIS Business NeedsAssessment Proposal RFP 1199-12002 Evaluation	B&V	GEODECISIONS	PlanGraphics	Sanborn
Tab 1-4 Total Score	Possible Score of 190	148.3	153.8	141.3	126.5
Experience of the firm in related projects, including unique approaches 20%	Weighted % Section Score out of 20% possible	12.0%	12.6%	11.6%	10.7%
Tab 5-6 Total Score	Possible Score of 140	80.8	96.0	95.6	73.2
Response to Scope of Service 55%	Weighted % Section Score out of 55% possible	31.7%	37.7%	37.6%	28.8%
Total Technical Combined Experience & Scope	Possible Score 330	229.1	249.8	236.9	199.7
Total Technical Score %	Weighted Total Score 75% possible	43.7%	50.3%	49.2%	39.5%
Technical Rank	1 through 4	3	1	2	4
Total Cost Score	Weighted Total Score 25% possible	12.6%	6.3%	5.1%	25.0%
Cost Rank	1 through 4	2	3	4	1
Total Combined Score %	Possible 100%	56.4%	56.6%	54.3%	64.5%
Combined Rank	1 through 4	3	2	4	1

MCAMLIS Business Needs Assessment RFP 1199-12002

Section	Description		B & V	GEODECISIONS V1	GEODECISIONS V2	PlanGraphics	SANBORN
RFP Cost Criteria: 1	Scope of Consultant Services		$75,000	$94,602	$145,410	$169,800	$31,710
RFP Cost Criteria: 2	Other Costs		$0	$1,658	$4,435	$14,100	$6,147
	Total Cost		$75,000	$96,260	$149,845	$183,900	$37,856
A) Raw rank			2.0	3.0	4.0	5.0	1.0
B) $ Compared to Mean		$96,260	($21,260)	$0	$53,585	$87,640	($58,404)
C) $ Compared to Average		$108,572	($33,572)	($12,312)	$41,273	$75,328	($70,716)
D) $ Compared to Lowest			$37,144	$58,404	$111,989	$146,044	$0
E) % Compared to Mean			78%	100%	156%	191%	39%
F) % Variation to Mean			22%	0%	56%	91%	61%
Response to Cost 25%			12.6%	9.8%	6.3%	5.1%	25.0%

GEODECISIONS
710 Plankinton Avenue, Suite 340
Milwaukee, WI 53203

Office: (608) 836-1500
Toll Free: (800) 899-3337
Fax: (608) 831-3337
www.geodecisions.com

October 30, 2012

Mr. William Shaw, Project Manager
City Campus
2711 W. Wells Street, 2nd Floor
Milwaukee, WI 53208

Re: MCAMLIS Business Needs Assessment
RFP 1199-12002 (Revised)

Dear Mr. Shaw:

GeoDecisions appreciates the opportunity to submit a revised response to Milwaukee County for the MCAMLIS Business Needs Assessment (BNA). We have updated our Scope of Consultant Services to clarify our original proposal and take a more comprehensive approach that we believe will increase project participation by MCMALIS stakeholders.

Our adjusted approach is comprehensive and inclusive. This plan puts a greater emphasis on education, promotion, and awareness to receive buy-in and participation from MCAMLIS stakeholders. We have added a number of touch points with MCAMLIS stakeholders to take a more organic approach to obtaining participation in the BNA. This includes more on-site interviews, more phone interaction, and mailings. We have also included a separate task for communication needs that will strive to enhance the interaction with project participants, derive the most effective communication mechanisms for MCAMLIS stakeholders throughout the course of the BNA, and sustain momentum for the Five-Year Business Plan.

The table on the subsequent page includes the key alterations that were made to the GeoDecisions Scope of Consultant Services.

GeoDecisions is excited about the prospect of working with MCAMLIS on the Business Needs Assessment. Should you require any additional information, please contact David Mockert, the project manager, at (608) 836-1500 ext. 34 or via email at dmockert@geodecisions.com.

Sincerely,
GEODECISIONS
A Division of Gannett Fleming, Inc.

Kevin J. Switala, GISP
Vice President

– Generating Intelligent Solutions –

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Original Tasks	Adjusted Tasks	Primary Differences
Task 1 (Initiation)	Task 1 (Initiation)	Stakeholder awareness, education, and engagement were moved from this task to the new Task 2. This task is now devoted to packaging the current value of MCAMLIS and the initiation of project roles and project management.
	Task 2 (Education/ Awareness / Stakeholder Kick-off)	The awareness effort separated from original Task 1; this task also includes the following: (a) 3 days of on-site time to directly engage key organization decision-makers, (b) obtaining specific target area testimonials of LBDT from MCAMLIS stakeholder champions, and (c) non-electronic distribution of education materials and awareness communications to selected stakeholders.
	Task 3 (Communication)	This is a new task that was not included in our original proposal. This task determines communication expectations from stakeholders and implements the communication mediums that will guide the project. It also will help determine future communications and MCAMLIS outreach mechanisms. Stakeholder input will include on-line surveys, phone surveys (24 hours), and on-site visits (2 days).
Task 2 (Needs Identification)	Task 4 (Needs Identification)	This task now includes additional activities: on-site time (5 days) and phone time (32 hours) with selected stakeholders.
Task 3 (Task Analysis)	Task 5 (Task Analysis)	This task has increased development of work plan tasks and task costs.
Task 4 (Work Plan)	Task 6 (Work Plan)	This task now includes increased engagements with stakeholders from 1 stakeholder online meeting and 1 stakeholder document review to 1 stakeholder online meeting, 2 days on-site engagement with key stakeholders, and 1 on-site presentation to the MCAMLIS Steering Committee and Organizational Decision-Makers.
Project Management	Project Management	Differences are as follows: (a) an increase of 32 hours in incidental but direct collaboration with organization representatives and stakeholders, (b) increased effort to maintain communication mechanisms determined in Task 3, and (c) increased Project Management effort directly correlated to increased task effort.

Tab 5 (Scope of Consultant Services)

The following strategy provides a revised Scope of Consultant Services for the GeoDecisions proposal for developing the Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Business Needs Assessment (BNA). In undertaking the MCAMLIS Business Needs Assessment (BNA), GeoDecisions understands that MCAMLIS is looking to develop a strategy to be more responsive to its constituents in becoming a more active service-based organization. The BNA Plan proposed by GeoDecisions will leverage the investment that has been made to date in developing a spatial data repository for Milwaukee County, propose mechanisms to increase and sustain communications with and between MCAMLIS participants, and identify priorities for providing improved services to the stakeholders.

The GeoDecisions project approach will make certain that the most effective five-year work program is established for both MCAMLIS and its stakeholders. The BNA Plan will strive to engage project participants through a number of mechanisms, including face-to-face interviews, online surveys, meetings, phone calls, and project collaboration forums.

GeoDecisions will take an approach that sustains the momentum from this planning and implementation effort to allow MCAMLIS to remain responsive to the needs of its members. The following Scope of Consultant Services provides a detailed list of tasks included in GeoDecisions' updated Scope of Consultant Services for the needs analysis and planning program for MCAMLIS.

Task 1: Project Initiation

The goal of the Project Initiation task is to start the project by holding a kick-off meeting with the MCAMLIS core team to review the project objectives, timelines, and execution plan and develop an internal project communications plan. The meeting will provide the necessary groundwork for the project.

In this task, GeoDecisions will work with the MCAMLIS Project Manager and Project Core Team to establish the targeted audiences and organizational units. It is anticipated that as many as 10 target areas (i.e. Public Safety, Public Works, Planning, Education, etc.) will be designated for the MCAMLIS stakeholders.

GeoDecisions also proposes that an organizational representative be appointed on the MCAMLIS team to assist the project team in obtaining project information efficiently and on-time. In this role, the representative would determine who will provide the information for each targeted audience and help encourage timely responses with the information. Additionally, the representative will help identify key decision makers and "champions" from each target area.

Project team roles and number of participants anticipated for each role are as follows:

- **MCAMLIS Core Team (6)**
- **MCAMLIS PM (1)**
- **Organizational Representatives (24)**
- **Target Area Representatives (1 Decision Maker, 1 staff person) (360)**
- **1 champion per target area for success story content (~8-10 champions; 20-30 min of their effort per champion)**

The outcome of the initiation task is to establish the final BNA work plan and schedule.

It is anticipated that the following scope will be covered during the one-day project kick-off meeting held on site at the MCAMLIS facilities:

- Introduce respective MCAMLIS staff members to the GeoDecisions Project Manager and other key members of the GeoDecisions team.
- Establish the key elements (scheduling, methodology, scope management, communications protocols, resources, staffing, etc.) that will be incorporated into the project.
- Determine the list of project participants for target area and organizational representatives.
- Establish Champion List.

Deliverables:

- Kick-off Meeting at MCAMLIS Facilities.
- Final work plan and schedule.

Task 2: Awareness/Education/Stakeholder Kick-off

The purpose of this task is to create an awareness campaign for MCAMLIS and materials to promote the organization and the five-year program planning initiative. At the onset of this task, GeoDecisions will conduct phone interviews with select "Champions" from representative organizations to seek testimonials on the explicit value of MCAMLIS to their organizations and how they are using LBDT in their business. GeoDecisions will work with the champions to create success story content.

To provide project awareness, GeoDecisions will prepare for and facilitate a stakeholder kick-off summit. This will be a half-day, on-site summit to include all MCAMLIS stakeholders with the intent of providing education, setting expectations for involvement, and initiating the communications needs gathering process. This

meeting will provide a consistent message on project objectives and expectations and allow stakeholders to ask questions about the project. GeoDecisions will provide an overview of LBDT best practices, include common examples of GIS use associated with the targeted audiences, and present testimonials from MCAMLIS stakeholders at this summit. This meeting can be recorded and subsequently provided to stakeholders that cannot attend the actual meeting.

Additionally, GeoDecisions will spend 3 days onsite meeting with the appropriate decision makers to educate them and seek their engagement on the project. GeoDecisions understands that key decision makers may not be able to attend summits but it will be crucial that their organizations are involved and that they stay informed and have a means to communicate with the project team throughout the duration of the project and beyond.

The LBDT best practices education will be provided through various means. Materials such as an educational brochure will be developed to provide general information about current trends in the Geospatial industry, as well as online links to various resources on the use of LBDT in various sectors such as emergency management, parks and recreation, water and wastewater management, and public works. Letters will also be sent to project participants to promote the BNA and raise awareness of the value MCAMLIS provides its member organizations.

Deliverables:

- Key stakeholder decision-maker engagement (3 days on-site, or ~6-12 sessions).
- Awareness and educational materials.
- Target Area Testimonial materials (8-10 target areas).
- Stakeholder Awareness/Engagement kick-off meeting (On-site and on-line).

Task 3: Communication Needs

The purpose of the Communications Needs task is first to assess the communication mechanisms that will be most effective in engaging participant involvement in the needs gathering process and secondly to develop a communication plan that will be used by MCAMLIS through the planning and implementation tasks. One primary goal of the communication plan is to offer participation in the MCAMLIS needs analysis and awareness campaign. The communication plan will also provide a sustainable forum for stakeholder involvement through the five-year plan implementation and into the future.

GeoDecisions would create a communication needs survey that supports the collection of information for each targeted audience within each municipality. The survey would seek to identify how MCAMLIS stakeholders would effectively

communicate both through the course of the BNA project and after the project is complete.

GeoDecisions will compile and process the communication survey results and formulate a communications plan for MCAMLIS. This plan will establish communication mechanisms geared towards the approach required to effectively solicit input from participants, promote MCAMLIS initiatives to stakeholders, and engage these stakeholders in the organization going forward.

The plan will be reviewed with the core team via a WebEx meeting. Upon approval, GeoDecisions will work with the MCAMLIS Project Manager to implement the communications mechanisms outlined in the plan.

Based on the results of the communications survey, GeoDecisions will implement a project management and collaboration website for project awareness and ongoing communication that will be available to stakeholders. This site would initially be set up specifically for this project with access provided to all invited stakeholders. As outlined in the proposal, the decision on this will be made with the approval of the MCAMLIS Project Manager. This site would allow for anytime access to the most up-to-date project information and documentation, as well as provide access to documents for review and surveys to complete. In addition, stakeholders can request to be informed of key upcoming project events and communications via email links.

In addition to the website, GeoDecisions recommends setting up an internal collaboration tool to keep stakeholders informed of the process and allow an open forum to comment and share information. Use of these tools would also prepare participants to stay engaged in MCAMLIS beyond the scope of this project.

Deliverables:

- Communication Needs Survey. (Assumptions are 75% online survey, 20% phone, and 5% on-site: 2 days on-site).
- Project Collaboration Site Established.
- Communications Plan.

Task 4: Business Needs Identification

The purpose of this task is to gather and assess information from of a number of groups, including core MCAMLIS team members and municipalities, and produce a comprehensive and prioritized set of needs of the MCAMLIS stakeholders. Initially, GeoDecisions would gather baseline information from existing source documentation on existing participant websites, services, data, and infrastructure.

To make sure all potential stakeholders are given an opportunity to participate in the needs identification process, GeoDecisions proposes this project use surveys, interviews, email, summits, and collaboration tools to offer the most efficient means of gathering and collaborating on a project with so many stakeholders. Face-to-face interviews and meetings will be used to make certain the project scope and priorities are aligned with MCAMLIS member stakeholder expectations and, in some instances, follow up with certain municipalities and project participants with phone calls or emails.

Both on-site interviews and online surveys with stakeholders will be used to gather factual information on current and planned LBDT investments among the municipalities and initiate what stakeholders find as the strengths, weaknesses, opportunities, and challenges with MCAMLIS current and proposed services as outlined in the project objectives. Online meeting tools and the summit will be used to efficiently bring large groups of stakeholders together to confirm needs and collaborate on priorities.

An initial set of on-site interviews will be held with primary stakeholders (MCAMLIS core team members) to determine the big picture needs for the future of the organization. Additionally, a larger group of participants will be given the opportunity to provide input on needs via an online survey and on-site interviews. This information will be compiled into a list of needs and categorized into areas such as data, technology (applications and technical support), and services. These lists will be vetted in a Summit Workshop meeting that can be attended both physically and virtually. The outcome of the summit will be a summary findings report that will identify the highest priority needs for MCAMLIS.

MCAMLIS and GeoDecisions cannot accurately predict the number of specific MCAMLIS steering member interviews and stakeholder interviews at this point in the project. GeoDecisions prefers to identify the particular interview needs by working with the MCMALIS Project Manager and Core Project Team to determine the specifics for these interviews based on what is learned as the project progresses. For example, interviews can vary by participant (e.g., group or individual), information needs (specific needs or visioning/goals), where they will be held based on who will attend, etc. Therefore, GeoDecisions proposes 2 days and 5 days of on-site time for the MCAMLIS member and stakeholder interviews, respectively. The specifics of the interviews will be determined during the project.

Results from the data gathering approaches will be compiled and entered into the collaboration site. Then a draft Needs Assessment summary will be developed and distributed via the collaboration site and through email, or regular mail, for a two-week stakeholder review. Contributions from stakeholders will be taken into consideration for input into the Needs Assessment. MCAMLIS will be given the opportunity to review the stakeholder comments and provide feedback prior to finalization.

Deliverables:

- Baseline Inventory of current websites, services, and GIS data at Municipalities delivered in Adobe PDF format and entered into collaboration site.
- Steering member interviews: 2 days on-site, or ~6-8 sessions.
- Stakeholder Online Survey Results: ~ 135 target areas (assumes 75% response rate).
- Stakeholder Phone Surveys: 24 hours of phone surveys and survey follow-ups.
- Stakeholder Interviews: 5 days on-site, or 15-25 sessions.
- Summit Workshop on Needs Prioritization.
- Draft Needs Assessment summary document delivered both in MS Word and made available as a Google Docs document.
- Final Needs Assessment results delivered as a PDF document and made available on collaboration site.

Task 5: Five-Year Work Program Task Analysis

This task includes the activities for defining the list of priority improvement tasks for the five-year work plan and providing high-level cost estimates for these tasks. GeoDecisions will use the results of Task 4 to develop the list of priority tasks, which have two perspectives: 1) results where all project stakeholders will have collectively ranked all needs from all stakeholders, which is a result of the Task 4 summit meeting, and 2) results where municipalities have provided their individual priorities of addressing their own needs as part of the interviews and survey.

First, in the Five-Year Program Task Analysis task, GeoDecisions will develop a list of improvement tasks to address the prioritized needs from the Needs Assessment task. GeoDecisions will take into consideration the overall project objectives and technology trends. These improvement tasks will include high-level cost estimates. Then the MCAMLIS Project Team will prioritize these tasks based on pre-determined ranking criteria (cost will be one, but not the only criteria) in a working session facilitated by GeoDecisions.

GeoDecisions will then produce an improvement task findings document. These findings are not a formal deliverable, but are a key artifact to the business Needs Assessment process. These findings will allow MCAMLIS and its stakeholders to understand the improvement priorities before constraints of resources and timelines are applied when the five-year improvement plan is developed. In addition, it effectively guides and validates the development of the improvement program. Because this is an informal deliverable, there is no formal stakeholder review of these findings. The findings will be posted as a document and available via the project collaboration site. GeoDecisions will respond to stakeholder feedback as part

of project management activities and will incorporate essential feedback into Task 6 activities as determined by GeoDecisions and the Project Core Team.

Deliverables:

- On-site Prioritization Session with Core Project Team.
- List of Prioritized Improvement Tasks.
- High-level Cost Estimates.
- Prioritized Improvement Task Findings entered into Collaboration Site.
- Prioritized Improvement Task Summary document delivered as a PDF document.

Task 6: Five-Year Work Plan Development

The goal of this task is to deliver a Five-Year Program Implementation Plan for MCAMLIS and present the plan to the MCAMLIS stakeholders, Steering Committee, and decision makers. In the Five-Year Program Plan Development task, GeoDecisions will develop the Five-Year Program Plan document, which includes creating projects packaged from the prioritized improvement tasks developed as part of the Task Analysis task. In the document, each project will include a project definition; what is in scope, including the project's relationship to the prioritized improvement tasks; on what other projects it is dependent and vice versa; project deliverables; and related high-level cost estimates. The projects are scheduled into a five-year, high-level plan based on several factors, including project inter-dependencies and budget constraints. As with previous tasks, stakeholders can then comment on this work plan before it is finalized.

Deliverables:

- Draft Five-Year Program Plan delivered as a Word or Google Docs document for project participants on the MCAMLIS collaboration site.
- Presentation of work plan for Stakeholder Comment at an on-site summit.
- Additional stakeholder feedback on work plan from 2 days of on-site sessions.
- Program Presentation to MCAMLIS Steering Committee and Decision Makers.
- Presentation Materials.
- Final Five-Year Program Plan delivered in PDF format and made available to project participants on the MCAMLIS collaboration site.

Below is a high-level listing of the proposed project tasks to which the Deliverable strategies refer. For a presentation of project tasks and timeline, please see Tab 6 (Schedule). Also included here is an estimated level of effort that GeoDecisions expects of the MCAMLIS Project Team. Note that GeoDecisions assumes the MCAMLIS Project Team is composed of approximately six people that are

representative of the MCAMLIS stakeholders. The assumed duties of MCAMLIS Project Team members include guiding project communication and participating in project management activities, encouraging stakeholder participation, participating in working sessions regarding task priorities and five-year program project definitions, and performing final review on deliverables. Additional effort will be required if a MCAMLIS Project Team member also fulfills the roles of the project manager for MCAMLIS and of a MCAMLIS stakeholder.

MCAMLIS Core Project Team Responsibilities

Task Name	Hours
Task 1: Project Initiation	
Project Kick-off Meeting (Onsite)	4
Compile Stakeholders and Champions List	4
Task 2: Awareness/Education/Stakeholder Kick-off	
Develop Project/Educational Brochure and Letters	2
Decision Maker Engagement/Champion Follow-up (Onsite)	4
Send Out Materials (Email/US Mail)	2
Hold Stakeholder Kickoff Summit (Onsite)	4
Task 3: Communication Needs	
Develop Communication Needs Survey	2
Obtain Plan Implementation Approval from Core Team (Online)	2
Task 4: Business Needs Identification	
Baseline Municipality Existing Reference Study	2
Prepare for Steering Committee Interviews/Survey	2
Perform Steering Committee Interviews (Onsite)	4
Prepare for Stakeholder Summit Workshop (Needs Prioritization)	2
Hold Summit Workshop (Onsite/Online)	4
Submit Summary Document for Stakeholder Review	4
Task 5: Five-Year Work Program Task Analysis	
Task Review with Project Core Team (Online)	2
Core Team Prioritization Meeting (Onsite)	4
Core Team Review of Draft Prioritized Results (Online)	2
Task 6: Five-Year Work Plan	
Present/Modify Plan per Project Core Team (Onsite)	4
Present Plan for Stakeholder Review (Onsite/Online, Onsite again)	6
Update Plan from Stakeholder Feedback	2
Present/Modify Plan per Steering Committee/Decision Makers (Onsite)	8
Core Team Review of Final Plan	2
Project Management	**24**
Total Approximate Hours	96

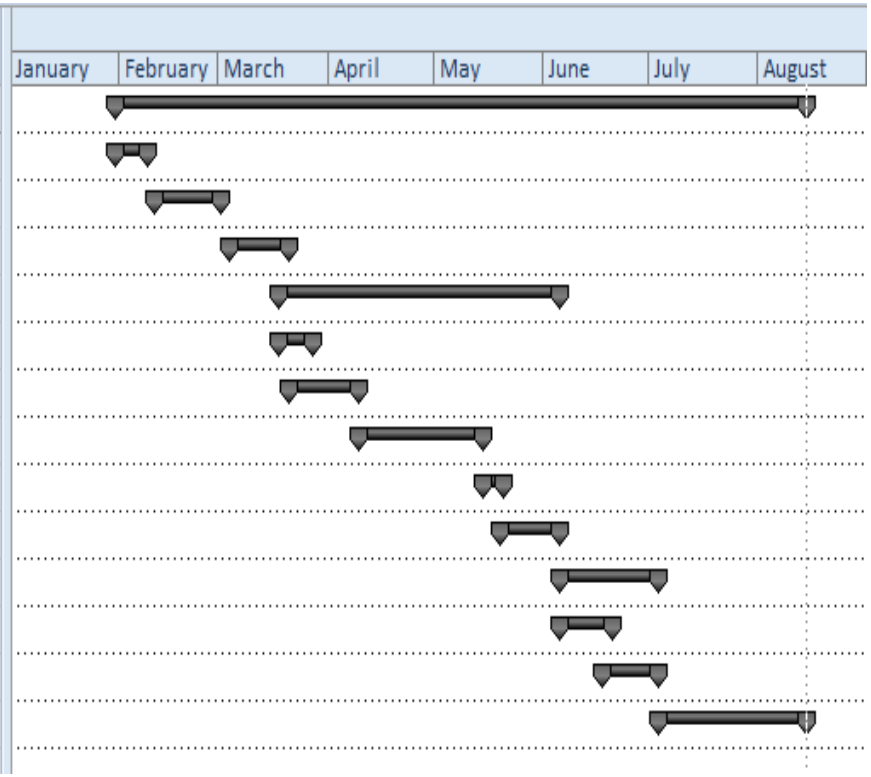
MCAMLIS is seeking to support the needs of local government and businesses in the Milwaukee County through reducing redundant investment, promoting wider data sharing resulting in improved government decision making, and developing a flexible infrastructure capable of supporting varied services delivery solutions. GeoDecisions appreciates the complexity of this effort and has put together a strategy for creating a collaborative Business Needs Assessment and promotional campaign for MCAMLIS towards development of the Five-Year Business Plan.

The adjusted BNA approach is comprehensive and inclusive. It places an emphasis on education, promotion, and awareness to receive buy-in and participation from MCAMLIS stakeholders. The strategy adds a number of touch points with MCAMLIS stakeholders to take a more organic approach to involving participation in the communication phase and needs identification process. This includes more on-site interviews, as well as phone interaction and mailings. The revised plan includes a separate task for communication needs that will enhance the interaction with project participants, derive the most effective communication mechanisms for MCAMLIS stakeholders throughout the course of the BNA, and sustain momentum for the Five-Year Business Plan. GeoDecisions welcomes the opportunity to collaborate with your team to chart a long-term, successful course for MCAMLIS into the future.

Tab 6 (Schedule)

GeoDecisions has developed a revised project plan for delivering the services and work products outlined in the RFP within six and a half months of contract execution.

Task Name	Start	Finish
MCAMLIS Business Needs Assessment	Thu 1/31/13	Wed 8/14/13
Task 1: Project Initiation	Thu 1/31/13	Fri 2/8/13
Task 2: Awareness/Education/Stakeholder Kick-off	Mon 2/11/13	Fri 3/1/13
Task 3: Communication Needs	Mon 3/4/13	Wed 3/20/13
Task 4: Business Needs Identification	Mon 3/18/13	Wed 6/5/13
Baseline Municipality Existing References	Mon 3/18/13	Wed 3/27/13
Obtain Steering Member Input	Thu 3/21/13	Tue 4/9/13
Obtain Participant Stakeholder Input (Issues and Opportunities)	Wed 4/10/13	Tue 5/14/13
Hold Summit Workshop - (Needs Prioritization)	Wed 5/15/13	Mon 5/20/13
Develop/Review Needs Assessment Result	Mon 5/20/13	Wed 6/5/13
Task 5: 5-Year Work Program Task Analysis	Thu 6/6/13	Wed 7/3/13
Draft Improvement Tasks	Thu 6/6/13	Thu 6/20/13
Task Prioritization	Tue 6/18/13	Wed 7/3/13
Task 6: 5-Year Work Plan	Thu 7/4/13	Wed 8/14/13



MCAMLIS
FISCAL NOTE
PROPOSED ACTION:_____

Financial Impact of Proposal		
Cadastral Address Maintenance - City of Milwaukee		$91,780
County Surveyor Services		$78,719
Annual Operating Costs		$0
Total Investment		$170,499
Identify Funding Source of Proposal	X $2.00 Fee	X $6.00 Fee

Fiscal Affair's Comments:

The 2013 Adopted Budget includes expenditure authority for the Cadastral services and County Surveyor Services. Therefore, there is no impact relating to un-restricted fund balance.

AGREEMENT

THIS AGREEMENT, entered into this ____ day of _____, 20__, by and between the Southeastern Wisconsin Regional Planning Commission (hereinafter referred to as the "Commission"); and the Milwaukee County Automated Mapping and Land Information System Steering Committee (hereinafter referred to as the "Steering Committee").

WITNESSETH:

WHEREAS, under Section 59.74 of the *Wisconsin Statutes*, the Commission serves as the County Surveyor for Milwaukee County; and

WHEREAS, under the requirements of this legislation, the Commission is responsible for receiving, indexing, and filing as a public record, a copy of each land survey plat prepared by a land surveyor registered in the State of Wisconsin; and

WHEREAS, under the further requirements of this legislation, the Commission is also made responsible for the perpetuation of the corners of the U.S. Public Land Survey which may be subject to destruction, removal, or burial through construction or other activities and for maintaining a record of the surveys for such perpetuation; and

WHEREAS, the activities of the Milwaukee County Surveyor are essential to the development and maintenance of the Milwaukee County Automated Mapping and Land Information System (MCAMLIS); and

WHEREAS, the Milwaukee County Board of Supervisors has determined that the expenses associated with the Milwaukee County Surveyor function should be paid from the annual operating budget of the MCAMLIS project; and

WHEREAS, Sections 66.0309 (12)(b) and 66.0301 of the *Wisconsin Statutes* authorize the Commission to enter into contracts with local units of government and their agents to make and implement studies and plans and to otherwise provide advice and services.

NOW, THEREFORE, in consideration of these premises and of their mutual and dependent promises and agreements, the parties hereto contract and agree as follows:

I. Scope of Work

The Commission will provide the professional staff services as necessary to act in the capacity of County Surveyor for Milwaukee County pursuant to the provisions of Section 59.635 of the *Wisconsin Statutes*. More specifically, under this agreement, the Commission, acting in the capacity of the Milwaukee County Surveyor, will perform the following functions:

A. In cooperation with the MCAMLIS project staff, record and maintain a file of all land survey plats prepared by land surveyors for parcels in Milwaukee County. An estimated 1,000 such land surveys are prepared and filed annually. Such surveys are essential to the maintenance effort required to keep the MCAMLIS cadastral maps up-to-date.

B. Perpetuate the corners of the U.S. Public Land Survey System throughout Milwaukee County. Such corners frequently are subject to destruction, removal, and burial through construction or other activities. The perpetuation work includes periodic inspection of the system of approximately 1,100 monuments and attendant reference benchmarks and witness marks, the removal and/or replacement of such monuments and reference benchmarks and witness marks either directly or through the supervision of others conducting such activities, and undertaking both horizontal and vertical control surveys to ensure the integrity of the reference framework that is critical to the automated mapping base established for Milwaukee County. An estimated 100 monuments and bench-marks are serviced annually.

C. Provide guidance and counsel to the Milwaukee County Automated Mapping and Land Information System Steering Committee through service on that committee.

D. Provide technical support and guidance to the staff assigned to develop and maintain the Milwaukee County automated mapping and land information system program.

II. Commission to Organize and Store Information Acquired by County Surveyor

In order to facilitate convenient use of the land survey records concerned by land surveyors, abstractors, assessors, appraisers, attorneys, engineers and other interested parties, the Commission agrees to maintain an orderly filing and retrieval capability for the land surveys by U.S. Public Land Survey township, range, section, and quarter section.

The Commission further agrees to maintain in an orderly manner, records of individual U.S. Public Land Survey Corners (dossier sheets), and records (control survey summary diagrams) of horizontal and vertical control surveys that have been run over the U.S. Public Land Survey corners.

III. Commission to Act as Custodian for all Milwaukee County Surveyor Records

The Commission agrees to maintain for inspection and copying as public documents, all records associated with its functions as the Milwaukee County Surveyor. The Commission further agrees to provide access to these data by U.S. Public Land Survey township, range, section, and quarter section.

IV. Steering Committee to Receive Copies of Records

The Commission shall furnish to the Steering Committee, as necessary for the pursuit of its responsibilities, copies of the records created and maintained by the Milwaukee County Surveyor.

V. Compensation

The Steering Committee through Milwaukee County shall pay to the Commission the sum of $78,719 as full payment for the services described herein.

VI. Method of Compensation

The Commission shall submit a single invoice in the amount of $78,719 to Milwaukee County. The County, on behalf of the Steering Committee, shall pay to the Commission the amount shown on the invoice upon receipt of said invoice.

VII. Timing

The work to be performed under this Agreement shall be carried out over the period from January 1, 2013, through December 31, 2013.

VIII. Indemnity

Except for acts done or taken at the direction of or pursuant to the Steering Committee policy or procedures, the Commission agrees to the fullest extent permitted by law, to indemnify, defend and hold harmless, the Steering Committee, and its agents, officers, and employees from and against all loss or expense including costs and attorney's fees by reason of statutory benefits under Worker Compensation Laws, and/or liability for damages including suits at law or in equity, caused by any wrongful, intentional, or negligent act or omission of the Commission, or its agents which may arise out of or are connected with the activities covered by this agreement.

IX. Insurance

The Commission, as an agency of the State, is self-funded for liability under Section 893.82 and Section 895.46(1) of the *Statutes*. As a result, such protection as is afforded under respective *Wisconsin Statutes*, is applicable to officers, employees, and agents while acting within the scope of their employment or agency. Since this is statutory indemnification, there is no liability policy as such that can extend protection to any other.

X. Records and Audits

The Commission shall allow Milwaukee County, the Milwaukee County Department of Audit, or any other party that Milwaukee County may name, when and as they demand, to audit, examine, and make copies of, excerpts or transcripts from, any records or other information directly relating to matters under this agreement. Any subcontracting by the Commission in performing the duties described under this contract shall subject the subcontractor and/or associates to the same audit terms and conditions as the Commission. The Commission (or any subcontractor) shall maintain and make available to Milwaukee County the aforementioned audit information for no less than three years after the conclusion of each contract term.

XI. Independent Contractor

Nothing contained in the Agreement shall constitute or be construed to create a partnership or joint venture between Milwaukee County or its successors or assigns; the Steering Committee or its successors or assigns; and the Commission or its successors or assigns. In entering into this Agreement, and in acting in compliance herewith, the

Commission is at all times acting and performing as an independent contractor, duly authorized to perform the acts required of it hereunder.

XII. Authorization

The Steering Committee approved the execution of this Agreement by action taken on December 4th, 2012.

IN WITNESS WHEREOF, the Commission and the Steering Committee have executed this Agreement, as of the date and year first above written.

ATTESTING WITNESS

By_____

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

By_____
David L. Stroik
Chairman

ATTESTING WITNESS

By_____
William C. Shaw
MCAMLIS Project Manager

MAPPING AND LAND INFORMATION SYSTEM STEERING COMMITTEE

By_____
Donald R. Nehmer (Date)
Chairman

ATTESTING WITNESS

By_____
William C. Shaw
MCAMLIS Project Manager

MILWAUKEE COUNTY

By_____
Brian Taffora, Director (Date)
Department of Administration Division
Of Economic Development

APPROVED AS TO FORM

By_____
Kimberly Walker (Date)
Milwaukee County Corporation Counsel

REVIEWED AS TO INDEMNIFICATION AND INSURANCE

By_____
Cindy VanPelt (Date)
Director Risk Management

APPROVED AS TO CHAPTER 42 DBE PROVISIONS

By_____
Nelson Soler, Interim Directorliance Manager (Date)
Milwaukee County Office of Community
Business Development Partners

AGREEMENT
Between
THE CITY OF MILWAUKEE DEPARTMENT OF ADMINISTRATION, INFORMATION AND TECHNOLOGY MANAGEMENT DIVISION AND THE MILWAUKEE COUNTY AUTOMATED MAPPING AND LAND INFORMATION SYSTEM STEERING COMMITTEE

THIS AGREEMENT, entered into this _____ day of _____, 20__, by and between the City of Milwaukee Department of Administration, Information and Technology Management Division (hereinafter referred to as the " City"); and the Milwaukee County Automated Mapping and Land Information System Steering Committee (hereinafter referred to as the "Steering Committee").

WITNESSETH:

WHEREAS, by Resolution No. 88-379, the Milwaukee County Board of Supervisors requested the Southeastern Wisconsin Regional Planning Commission to conduct a feasibility study pertaining to an automated mapping and land information system; and

WHEREAS, the requested feasibility study was completed and documented in SEWRPC Community Assistance Planning Report No. 177, “Feasibility Study for a Milwaukee County Automated Mapping and Land Information System,” published in October 1989; and

WHEREAS, by resolution adopted on November 8, 1990, the Milwaukee County Board of Supervisors, working in cooperation with the utilities concerned, created a public-private partnership to implement the proposed Milwaukee County automated mapping and land information system, including creation of a Steering Committee to provide oversight in the implementation of the system recommended in SEWRPC Community Assistance Planning Report No. 177; and

WHEREAS, the aforereferenced Milwaukee County resolution adopted on November 8, 1990, further authorized the execution of a Cooperative Agreement between Milwaukee County and the public and private utilities serving Milwaukee County, whereby the County and such utilities agreed to jointly fund the development of the Milwaukee County automated mapping and land information system), such Agreement delegating to the aforereferenced Steering Committee full responsibility for all policy matters relating to the conduct of the work program, including proposed contracts and specifications and the selection of contractors; and

WHEREAS, the City Chief Information Officer serves as a member of the aforereferenced Steering Committee and the City actively participates in implementation of the MCAMLIS; and

WHEREAS, the City desires the financial support of the MCAMLIS program to maintain the cadastral maps within the City of Milwaukee to ensure conformance with selected MCAMLIS standards; and

WHEREAS, on August 26, 1999, the City, the Steering Committee, and the Commission, through an assignment, entered into an Intergovernmental Cooperation Agreement (ICA) whereby the City would provide technical services to the Steering Committee; and

WHEREAS, the Steering Committee on September 14, 2004, formally authorized the County to accept the responsibilities of Project Manager for the implementation of the recommended automated mapping and land information system; and

NOW, THEREFORE, in consideration of the mutual promises of each agency made to the other, the fulfillment of the terms and conditions, agreements, and understandings hereinafter set forth,

I. Scope of Work

In general, the City agrees to perform all of the tasks specified herein. Other tasks to be completed by the City not covered herein will be carried out under separate agreements.

The City will provide professional and technical information technology services. This will include maintenance on cadastral maps and the street address database in the adopted Milwaukee County geodatabase format. Copies of the data will be delivered to the MCAMLIS project manager at a minimum bi-annually. This arrangement will allow data collected and housed at the City of Milwaukee to be maintained in the same format that the County of Milwaukee uses to store and retrieve the MCAMLIS cadastral data.

Should software data transfer protocols and standards be developed, the City will work with Milwaukee County staff to deliver the cadastral and street address data on a more frequent basis.

II. Timing

All services to be performed under this Agreement shall be carried out over the period beginning January 1, 2012, and ending on December 31, 2012.

III Compensation to City

The Steering Committee shall pay to the City the following amounts for those services described above:

SERVICES PROVIDED	AMOUNT
MCAMLIS Cadastral and Street Address Database Maintenance	$90,280
Annual software maintenance	1,500
Total	**$91,780**

IV Method of Compensation

Compensation is to be provided to the Department of Administration Information and Technology Management Division (ITMD) for services performed through the County Department of Transportation and Public Works Org. 5084. ITMD will request on a quarterly (March 31, June 30, September 30, December 31) basis reimbursement for said services provided.

If, during the course of carrying out the work elements identified herein, additional unanticipated work efforts not identified in the scope of work contained herein become necessary for successful project completion in the judgment of the City or in the judgment of the Steering Committee, then it is agreed that the City can request an amendment to the scope of work, with an attendant increase in the maximum amount payable to the City under this Agreement. Such an amendment would require the approval of both the City and the Steering Committee before becoming effective.

V. Support and Materials to be provided by others

It is assumed that the members of the Steering Committee, on behalf of their respective public agencies and private utilities, agree to make available without charge to the City all existing digital and hardcopy maps, documents, reports, legal records, and related materials deemed by the City to be needed to carry out its responsibilities under this Agreement. If this assumed level of cooperation does not materialize, then it is agreed that the City may, at its discretion, request payment from the Steering Committee for these costs above and beyond the total amount set forth in Section III of this Agreement.

VI. Ownership of Data

As the funds that are to be paid to the City for carrying out the herein described and required work are MCAMLIS project funds, the City agrees to share the data. The City, however, will retain sole ownership of all map files, as they exist in the City digital structure. As a condition of receiving payment from MCAMLIS, the City agrees that MCAMLIS will be free to use, reproduce, modify, display, and distribute the digital map files in the MCAMLIS digital structure.

The City will retain a nonexclusive, irrevocable and perpetual license to use and distribute the digital map files to any parties it desires.

VII. Subcontracts

Although the City does not anticipate use of subcontractors, the City agrees to bring any such subcontracts to the Steering Committee for its approval prior to execution.

VIII. Indemnity

Except for acts done or taken at the direction of or pursuant to the Steering Committee policy or procedures, the City agrees to the fullest extent permitted by law, to indemnify, defend and hold harmless, the Steering Committee, and its agents, officers and employees, from and against all loss or expense including costs and attorney's fees by reason of statutory benefits under Worker Compensation Laws, and/or liability for damages including suits at law or in equity, caused by any wrongful, intentional, or negligent act or omission of the City, or it's (their) agents which, may arise out of or are connected with the activities covered by this agreement.

IX. Authorization

The Steering Committee approved the execution of this Agreement by action taken on December 4th, 2012.

IN WITNESS WHEREOF, this Agreement executed the date and year first above written

ATTESTING WITNESS

By_____

By_____

CITY OF MILWAUKEE

By_____
Nancy A. Olson
Chief Information Officer

By_____
Martin Matson
Comptroller

ATTESTING WITNESS

By_____
William C. Shaw
MCAMLIS Project Manager

MAPPING AND LAND INFORMATION SYSTEM STEERING COMMITTEE

By_____
Donald R. Nehmer (Date)
Chairman

ATTESTING WITNESS

By_____
William C. Shaw
MCAMLIS Project Manager

MILWAUKEE COUNTY

By_____
Brian Taffora, Director (Date)
Department of Administration
Division Of Economic Development

APPROVED AS TO FORM

By_____
Kimberly Walker (Date)
Milwaukee County Corporation Counsel

REVIEWED AS TO INDEMNIFICATION AND INSURANCE

By_____
Cindy VanPelt (Date)
Director Risk Management

APPROVED AS TO CHAPTER 42 DBE PROVISIONS

By_____
Mark Phillips, Contract Compliance Manager (Date)
Milwaukee County Office of Community
Business Development Partners

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
W239 N1812 ROCKWOOD DRIVE • PO BOX 1607 • WAUKESHA, WI 53187-1607• TELEPHONE (262) 547-6721
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November 29, 2012

Mr. William C. Shaw
Milwaukee County Department of Transportation
and Public Works
City Campus -- Room 426
2711 W. Wells Street
Milwaukee, WI 53208

Dear Mr. Shaw

Since early 1964, the Regional Planning Commission has recommended the use of a unique system of survey control as a basis for the conduct of land and engineering surveys, and, since 1985, as a basis for the development of automated parcel-based, land information and public works management systems within the Region. The recommended survey control system provides two of the essential foundational elements for such systems namely: 1) a map projection and related horizontal and vertical geodetic datums; and 2) a survey control network that manifests the projection and datum on the surveys of the earth. These two elements, in turn, form the basis for the large-scale topographic and cadastral maps that comprise the third and fourth foundational elements of the land information and public works management systems. The datums used within the Region for the creation of these foundational elements and the attendant systems have, since 1964, been the North American Datum of 1927 and the National Geodetic Vertical Datum of 1929.

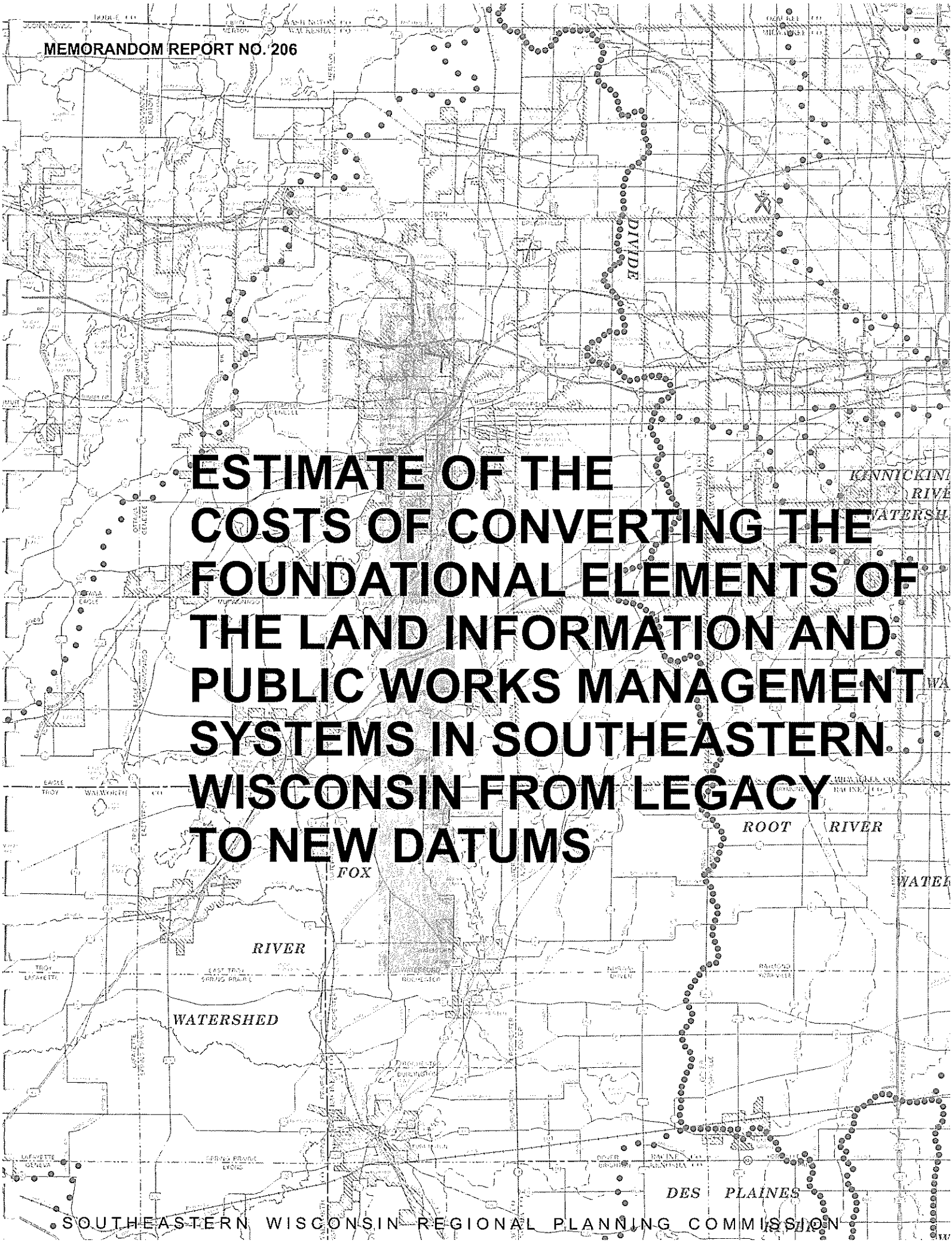
The Federal government in 1986, adopted a new horizontal datum: the North American Datum of 1983, a datum that has since experienced a number of realizations—refinements—within the Region, the latest being the North American Datum of 1983 (2007). In 1993 the Federal government also adopted a new vertical datum known as the North American Vertical Datum of 1988.

The Commission has a number of times considered the issues presented by the differences between the legacy and newer datums within the Region and has consistently recommended that the legacy datums continue to be used as a basis for the land information and public works management systems within the Region. The primary basis for this recommendation has been the findings that the costs of datum conversion would be very high and that there would be no significant benefit to conversion.

The Commission has recently been requested to provide an estimate of the costs of a datum conversion within the Region and has done so with the aid of a consulting engineering firm knowledgeable and experienced in both geodetic surveying and in topographic and cadastral mapping. The requested cost estimate is presented in SEWRPC Memorandum Report No. 206, *Estimate of the Costs of Converting the Foundational Elements of the Land Information and Public Works Management Systems in Southeastern Wisconsin from Legacy to New Datums, October 2012.*

MEMORANDOM REPORT NO. 206

ESTIMATE OF THE COSTS OF CONVERTING THE FOUNDATIONAL ELEMENTS OF THE LAND INFORMATION AND PUBLIC WORKS MANAGEMENT SYSTEMS IN SOUTHEASTERN WISCONSIN FROM LEGACY TO NEW DATUMS



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

MEMORANDUM REPORT
NUMBER 206

ESTIMATE OF THE COSTS OF CONVERTING THE FOUNDATIONAL ELEMENTS OF THE LAND INFORMATION AND PUBLIC WORKS MANAGEMENT SYSTEMS IN SOUTHEASTERN WISCONSIN FROM LEGACY TO NEW DATUMS

Prepared by the

Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P.O. Box 1607
Waukesha, Wisconsin 53187-1607
www.sewrpc.org

The preparation of this publication was financed in part through planning grants from the U.S. Department of Transportation and the Wisconsin Department of Transportation. The contents of this report do not necessarily reflect the official views or policy of the above agencies.

October 2012

Inside Region: $10.00
Outside Region: $20.00

Table of Contents

List of Tables

List of Figures

Appendices

ESTIMATE OF THE COSTS OF CONVERTING THE FOUNDATIONAL ELEMENTS OF THE LAND INFORMATION AND PUBLIC WORKS MANAGEMENT SYSTEMS IN SOUTHEASTERN WISCONSIN FROM LEGACY TO NEW DATUMS

INTRODUCTION AND BACKGROUND

Since early 1964, the Regional Planning Commission has recommended to the governmental agencies operating within the Southeastern Wisconsin Region the use of a unique system of survey control as a basis for the compilation of large-scale topographic and cadastral maps; as a basis for the conduct of land and engineering surveys; and, since 1985, as a basis for the development of automated, parcel-based, land information and public works management systems within the Region. The recommended survey control system involves the remonumentation of the U.S. Public Land Survey System corners within the Region and the establishment of State Plane Coordinates for those corners in order to provide a reliable horizontal survey control network. The system also includes the establishment of elevations for the remonumented corners and for related auxiliary bench marks to provide a reliable vertical survey control network fully integrated with the horizontal survey control network.

Through the cooperative efforts of the Commission and its constituent counties and municipalities, the recommended horizontal and vertical survey control system has been extended over the entire seven-county Region. All of the 11,985 U.S. Public Land Survey System corners and ancillary survey stations within the Region have been monumented, and the locations, coordinate positions, and elevations of the corners have been determined to a high level of accuracy. The resulting survey control network has been widely used in the preparation of large-scale topographic and cadastral maps, in the conduct of land and engineering surveys, and in the creation of parcel-based land information and public works management systems within the Region.

Legacy and New Datums

All of the horizontal control survey work within the Region has been referenced to the North American Datum of 1927 (NAD 27), a datum based upon the Clarke Spheroid of 1866, a spheroid which fits the North American Continent and the Southeastern Wisconsin Region well. All of the vertical survey control work within the Region has been referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29), a datum formerly known as the Sea Level Datum of 1929.

The Federal government in 1973 determined to undertake a readjustment of the national horizontal control survey network, and to adopt a new horizontal datum known as the North American Datum of 1983 (NAD 83), utilizing a new reference spheroid known as Geodetic Reference System of 1980 (GRS 80). In 1977 the Federal government further determined to undertake a readjustment of the national vertical control survey network and to adopt a new vertical datum, known as the North American Vertical Datum of 1988 (NAVD 88). The new horizontal datum was subsequently adjusted to create NAD 83 (1991), with further adjustments proposed by the National Geodetic Survey (NGS). The use of these new datums within the Region does not provide any significant advantages over the continued use of the old datums. Since no significant benefits can be shown to accrue from the use of the new datums, and since a change in datums would incur very high costs, the Commission has determined to continue to utilize the older datums as a basis for its surveying and mapping activities within Southeastern Wisconsin. To facilitate the use of the new datums within the Region by such agencies as may determine to do so, the Commission in 1993 and 1994 developed computational systems that would permit the ready bidirectional transformation of coordinates and elevations between the horizontal and

vertical datums concerned. These computational systems are described in SEWRPC Technical Report No. 34, *A Mathematical Relationship Between NAD 27 and NAD 83(91) State Plane Coordinates in Southeastern Wisconsin,* December 1994; and SEWRPC Technical Report No. 35, *Vertical Datum Differences in Southeastern Wisconsin,* December 1995.

Review and Reevaluation of Regional Control Survey Network

The aforereferenced changes in datums, the further adjustment of the "new" datums to create NAD 83 (2007) and NAVD 88 (2007), coupled with changes in surveying and mapping technology, however, caused the Commission to undertake in 2008 a review and evaluation of the regional control survey and mapping program and of the Commission role in that program. These changes included, in addition to the adjustments of the once "new" Federal datums, the increasingly widespread use of Global Positioning System (GPS) technology for both horizontal and vertical positioning, and the provision of a network of Continuously Operating Reference Stations (CORS) within the Region by the Wisconsin Department of Transportation to facilitate the use of GPS technology. Following its long-standing practice, the Commission created a Technical Advisory Committee of knowledgeable users of the regional control survey system and asked that Committee to: 1) critically review and evaluate the status and continued utility of the Commission survey network; 2) recommend any needed changes in the network and the means for its perpetuation, maintenance, and use; and 3) recommend the Commission's role, if any, in such perpetuation, maintenance, and use. The findings and recommendations of that Technical Advisory Committee are set forth in SEWRPC Technical Report No. 45, *Technical Review and Reevaluation of the Regional Control Survey Program in Southeastern Wisconsin*, March 2008. Those findings and recommendations may be summarized as:

1. The Commission should continue to utilize NAD 27 and NGVD 29 as the basis for its horizontal and vertical survey control network within the Region; as well as to recommend that county and local governments in the Region similarly continue such utilization.

2. The Commission, in cooperation with its constituent counties, should continue to maintain the monuments that perpetuate the U.S. Public Land Survey System within the Region and the network of bench marks that make available to users accurate State Plane Coordinate positions and elevations; and

3. The Commission should undertake the development of a new methodology for the bidirectional transformation of State Plane Coordinates between NAD 27 and NAD 83 (2007) and elevations between NGVD 29 and NAVD 88 (2007).

Commission Bidirectional Transformation Methodology

On May 8, 2008, the Commission retained Earl F. Burkholder, PS, PE, consulting geodetic survey engineer, to develop the new bidirectional transformation methodology called for in SEWRPC Technical Report No. 45. The results of Mr. Burkholder's work, carried out with the assistance of a Commission Task Force, are set forth in SEWRPC Technical Report No. 49, *Bidirectional Transformation of Legacy and Current Survey Control Data Within Southeastern Wisconsin,* May 2010.

Testing of the new three-dimensional, bidirectional transformation methodology developed by Mr. Burkholder indicated that the transformations provided are clearly reliable for parcel-based land information and public works management system applications; are clearly reliable for use in vertical surveys made for most routine land surveying and public works engineering purposes; and are generally reliable for use in most horizontal survey applications within the Region. The cited report indicated, however, that where higher-order survey accuracies are required, the conduct of field surveys referred to the NAD 27 and NGVD 29 datums were recommended. Importantly, the SEWRPC Technical Report No. 49 demonstrated that no conversion of these legacy datums to the newer NAD 83 (2007) and NAVD 88 (2007) was necessary because GPS positioning technology operating within the real-time network of Continuously Operating Reference Stations (CORS) established by the Wisconsin Department of Transportation within the Region could be readily used with the Commission recommended NAD 27 and NGVD 29 datums.

RESURVEY COSTS AND BENEFITS

The Commission determined to continue to utilize the legacy datums as a basis for its surveying and mapping activities, and to continue to recommend to its constituent counties and municipalities the continued use of those datums. That determination was based upon consideration of the costs and benefits of a conversion to the new datums of not only the extensive control survey network that has been established within the Region, but of other foundational elements of the parcel-based land information systems being created within the Region—the topographic and cadastral base maps—and of the vast amounts of data being accumulated in those information systems. For counties where substantial efforts have been made to develop high-order horizontal and vertical control survey networks, to prepare accurate topographic and cadastral maps, and to incorporate geospatial inventories of land use, soils, woodlands, wetlands, floodlands and environmental corridors, the Commission has, in the past, estimated the cost of datum conversion to approximate one to two million dollars per county. Proponents of conversion have yet to quantify and document the value of any substantial benefits that might offset these conversion costs.

The use of the new datums within the Region would provide no improvement over the continued use of the legacy datums for local area mapping. In this regard, it should be noted that the rationale for changing mapping datums at the Federal level relates largely to military considerations, such as missile guidance and satellite surveillance systems, to considerations of intercontinental navigation of both commercial and military aircraft and ocean vessels, and to consideration of scientific research needs where absolute positioning is essential. While these may be important considerations at the national level, they have little bearing on local area mapping or on land and engineering survey operations where relative—as opposed to absolute—positioning is important. Importantly, however, the use of a common datum and projection permits ready correlation of disparate surveying and mapping programs, minimizes the effort required for transformation of data from one datum to another, and reduces confusion in the use of both analog and digital spatial related data.

Certain arguments advanced in support of the conversion to the newer datums either have explicitly stated, or have implied, that the use of the newer datums will in some way result in the preparation of "more accurate" maps. This assertion is patently absurd to anyone knowledgeable about mapmaking. Map accuracy is determined by the specifications to which maps are prepared and by such factors as the scale of the map data compiled and of the map reproduction. Such factors are independent of the coordinate system utilized in the map production.

The quality of spatial information stored in a geographical information system is similarly determined specifically by the precision of the physical measurements added to the database. Deficiencies of any applied computational model, or the datum to which the data are attached, can result in the reduced spatial accuracy of defined points, but the act of expressing results in or attaching spatial measurements to a newer datum does not, in itself, imbue the results with increased accuracy or integrity.

Unless and until the quality of spatial data—both horizontal and vertical—in the existing Commission database is determined to be deficient for the purposes for which it was established—for large-scale topographic and cadastral mapping, the conduct of land and engineering surveys, and the development of parcel-based land information and public works management systems—the fact that more precise spatial data can now be collected and the fact that newer datums have been defined do not constitute compelling reasons to abandon use of the legacy datums in favor of the newer datums. With respect to the use of NAD 83 (2007) for data collection, the mathematical relationship between the two horizontal datums concerned has been determined and documented by the Commission, and users who wish to share compatible horizontal location data may do so efficiently and reliably using those procedures.

Any consideration of conversion is further negated by the frequent adjustment of the newer datums by the National Geodetic Survey (NGS) and by a proposal to adopt an entirely new national positioning datum. Adjustments of the NAD 83 and NAVD 88 datums have resulted in the creation of NAD 83 (1991), NAD 83 (2007), NAD 83 (2011), NAVD 88 (2007), and NAVD 88 (2012). NGS is presently in the process of creating

NAD 83 (2022)[1], and is considering adoption of an entirely new datum—the International Terrestrial Reference Framework datum of 2017 (ITRF-17). The adoption of ITRF-17 would bring with it the use of a new ellipsoid, and would result in a significant shift in horizontal positioning from NAD 83. The need for datum stability for local surveying and mapping application, where relative positioning is more important than absolute positioning, should be apparent.

ESTIMATE OF COSTS TO MIGRATE TO NEWER DATUMS

In spite of the reasons advanced by the Commission for the continued use of the legacy datums within the Region, questions continue to be raised by some but not all practicing surveyors and by some but not all land information system managers as to why the Commission continues to use, and recommends the continued use of, the legacy datums within the Region. Indeed, the Commission convened an interagency staff meeting to address these questions. The meeting was held on November 7, 2011. It was attended by Donald G. Dittmar, Land Information Division Manager, Waukesha County, William C. Shaw, Milwaukee County Automated Mapping and Land Information System Project Manager, Eric Damkot, Geographic Information System Manager, Washington County, Kenneth R. Yunker, Commission Executive Director, Philip C. Evenson, Commission Special Projects Advisor, John G. McDougall, Commission Geographic Information System Manager, and Kurt W. Bauer, Commission Executive Director Emeritus. The consensus reached in the meeting was that the day-to-day operational issues associated with the use of both the new and legacy datums within the Region were not insurmountable, and did not presently impose any significant demand and cost burden on the county and municipal geographic information system staffs. It was nevertheless agreed that it would be helpful to those staffs for the Commission to develop an estimate of the probable costs entailed in the transformation of the existing control survey network and attendant foundational mapping elements to the NAD 83 (2007) and NAVD 88 (2007) datums.

Accordingly, the Commission on December 16, 2011, engaged the firm of Aero-Metric, Inc. to prepare an estimate of the cost that reasonably may be expected to be incurred in a resurvey of the existing control survey network within the seven-county Southeastern Wisconsin Region. The requested cost estimate is presented in a report prepared by Aero-Metric, Inc., which report is provided in Appendix A.

Resurvey Cost Estimate

The estimate of a resurvey of the regional control survey network as provided in the appended report prepared by the firm of Aero-Metric, Inc. may be summarized as:

- Establishment of primary and secondary horizontal control survey network: $2,285,500
- Resurvey of vertical control survey network – Option 2:[2] $4,530,000
- Total: $6,815,500

These costs, expressed in year 2012 dollars, would be incurred over a minimum period of five years. Price inflation at a rate of 2.5 percent per year would bring this total cost to about $7,164,900 over a five-year period.

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[1]*The NGS does not regard the various versions of NAD 83 or NAVD 88 as "new datums." The "datum tag" used is considered by the NGS to identify differing "realizations"—that is, refinements or adjustments—of the datum concerned. From this viewpoint, the first new datum proposed to be introduced by the NGS since the introduction of NAD 83 datum would be the ITRF-17 datum. From the Commission standpoint, the various adjustments of the NAD 83 and NAVD 88 datums are, in effect, new datums since the coordinate position and orthometric height of a monumented survey station would have different values under each adjustment.*

[2]*See Appendix A for descriptions of the two options considered for the vertical control resurvey. Option 2 is the least costly option considered.*

Map Projection and Datums

A resurvey of the regional control survey network would provide, in effect, two of the four foundational elements of a good parcel-based land information or public works management system; namely: 1) a map projection and related datum; and 2) a survey control network that manifests the projection and datum on the surface of the earth. The map projection provided in the Southeastern Wisconsin Region is a Lambert Conformal Conic Projection based upon the Geodetic Reference System of 1980 (GRS 80). The spherical coordinates of this projection are reduced to plane coordinate values by the new State Plane Coordinate System created by the National Geodetic Survey (NGS) for use with the NAD 83 datum. The State Plane Coordinates on the new system are intended to be expressed in meters, while Coordinates on the original State Plane Coordinate System are expressed in U.S. Survey Feet. The map projection for the original system was also a Lambert Conformal Conic Projection based, however, upon the Clarke Spheroid of 1866. The geodetic coordinates of this projection are reduced to plane coordinates by the original State Plane Coordinate system developed by the then U.S. Coast and Geodetic Survey for use with the North American Datum of 1927.

Topographic Maps

A third foundational element of a good parcel-based land information or public works management system is a large-scale topographic map. Ideally, as the resurveys of the horizontal and vertical control survey networks within the Region are completed, new topographic maps would be prepared at a scale of one inch equals 100 feet with a vertical contour interval of two feet. An example of a portion of a topographic map at a scale of one inch equals 100 feet is provided in Figure 1. Examination of Figure 1 will indicate that such maps show such cultural planimetric features as existing buildings, roadway pavements and public sidewalks, driveway pavements and service walks, railway tracks, culverts, power poles, and fence lines; and such natural planimetric features as individual trees, wetlands, and woodlands. The maps show the hypsometry—the elevation and configuration of ground surface—by two foot vertical interval contour lines. These maps are adequate for use in the design of land subdivision plats, for the accurate delineation of drainage areas, for accurate flood hazard area delineation, and for use in the preliminary engineering of public works facilities including roads, sanitary trunk sewers, storm water drainage facilities, and water transmission lines.

These maps provide a good foundational element for the development of matching cadastral maps and for the creation of automated parcel-based land information and public works management systems, particularly in urban areas. These maps should be prepared to meet National Map Accuracy Standards and should be based upon the map projection and datum provided by the resurvey of the horizontal and vertical control survey networks. The maps should be prepared by U.S. Public Land Survey System one-quarter section and should show in their correct location and orientation the section and one-quarter section corners, the State Plane Coordinates of those corners, and the ground level lengths and grid bearings of the one-quarter section lines. The map projection should be shown by grid ticks at a five-inch spacing. These maps provide the essential "ground-truth" for the compilation of the fourth foundational element of good land information and public works management systems.

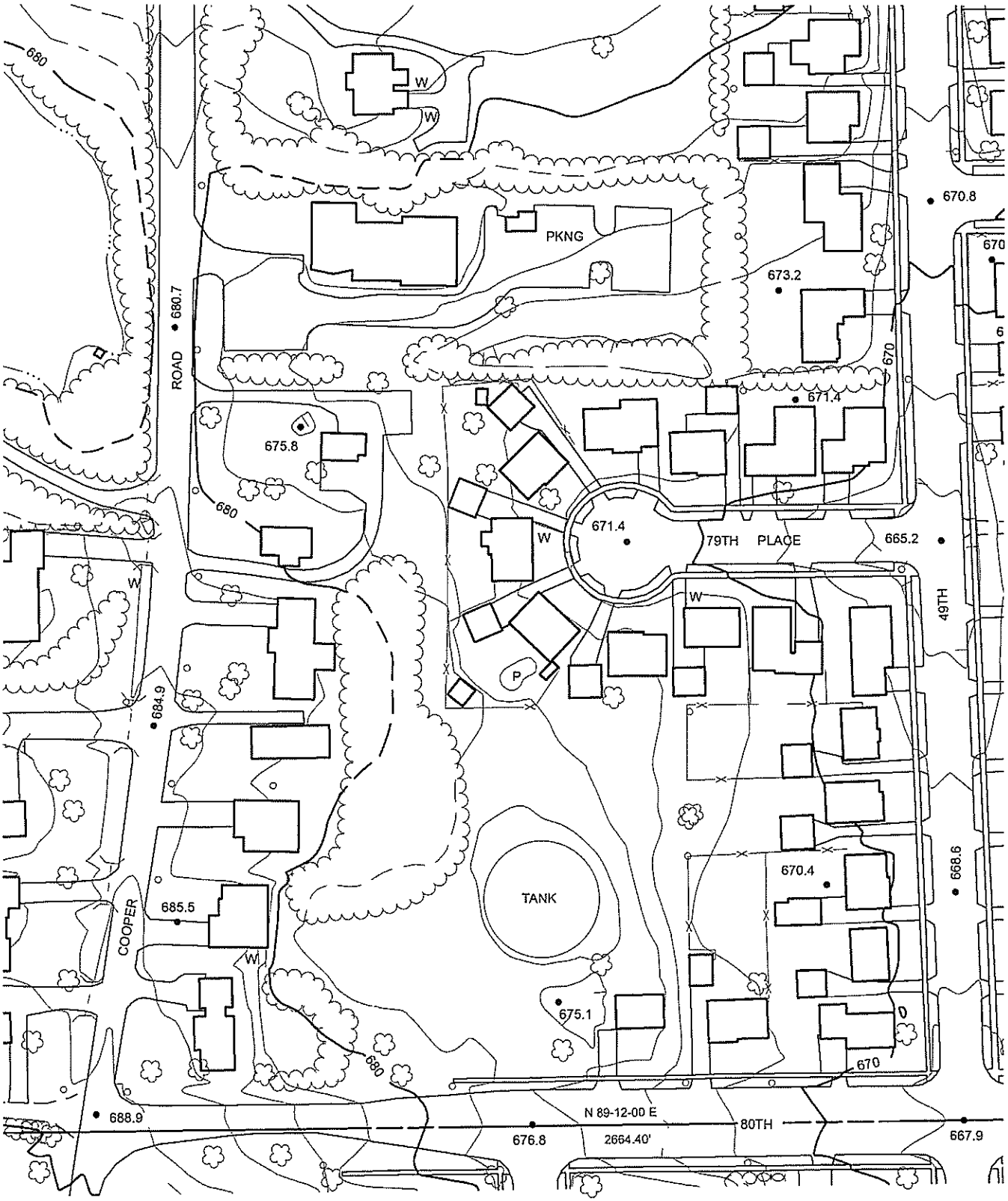
The cost of the preparation of the topographic maps would vary with the land use pattern of the area to be mapped—urban or rural. In the year 2000, there were, as given in Table 1, 761 square miles of urban development within the seven-county Region, and 1,928 square miles of still remaining rural area. At an estimated cost of $18,000 per square mile for areas in urban use, and $6,000 per square mile for areas in rural use, the cost of the preparation of the topographic maps would approximate $25,266,000. This cost expressed in year 2012 dollars would be incurred over a minimum period of five years. Price inflation at a rate of 2.5 percent per year would bring the total cost to approximately $26,561,300.

Cadastral Maps

The fourth foundational element of a good parcel-based land information or public works management system is a cadastral—real property boundary line—map matching the topographic maps. Like the topographic map, the cadastral map should be compiled by U.S. Public Land Survey System one-quarter section, at a scale of one-inch equals 100 feet, and should be based upon the map projection and datum provided by the resurvey of the control survey networks. The cadastral maps should show in their correct location and orientation the section and one-

Figure 1

PORTION OF TYPICAL LARGE-SCALE TOPOGRAPHIC MAP AT ONE INCH EQUALS 100 FEET



Source: Kenosha County and SEWRPC.

Table 1

LAND USE AREA AND NUMBER OF OWNERSHIP PARCELS
IN THE SOUTHEASTERN WISCONSIN REGION 2012[a]

County	Area Square Miles	Land Use Square Miles		Approximate Number of Parcels
		Urban	Rural	
Kenosha	278	64	214	69,670
Milwaukee	242	196	46	259,941
Ozaukee	234	56	178	36,385
Racine	340	79	261	78,680
Walworth	578	73	505	61,296
Washington	436	79	357	53,488
Waukesha	581	214	367	141,169
Total	2,689	761	1,928	700,629

[a]*Land Use Areas are Latest Available: Year 2000.*

Source: SEWRPC.

quarter section corners, the State Plane Coordinates of these corners, and the ground level lengths and grid bearings of the one-quarter section lines. The map projection should be shown by grid ticks at a five-inch spacing. The maps should show in their correct location and orientation the recorded real property boundary lines and the right-of-way lines of all public streets and highways, and of all railway lines. The property boundary corners should be plotted to within one-fortieth of an inch of the record position and any gaps or overlaps between adjoining property boundary lines of 2.5 feet or more and should be shown as mapped lines. The constructed location of the property boundary lines should be checked against the ground-truth provided by the matching topographic maps in the form of building outlines, pavement edges, railway tracks, fences, and stream and water course locations. Figure 2 shows a matching cadastral map for the topographic map provided in Figure 1. The constructed maps are transformed into digital form.

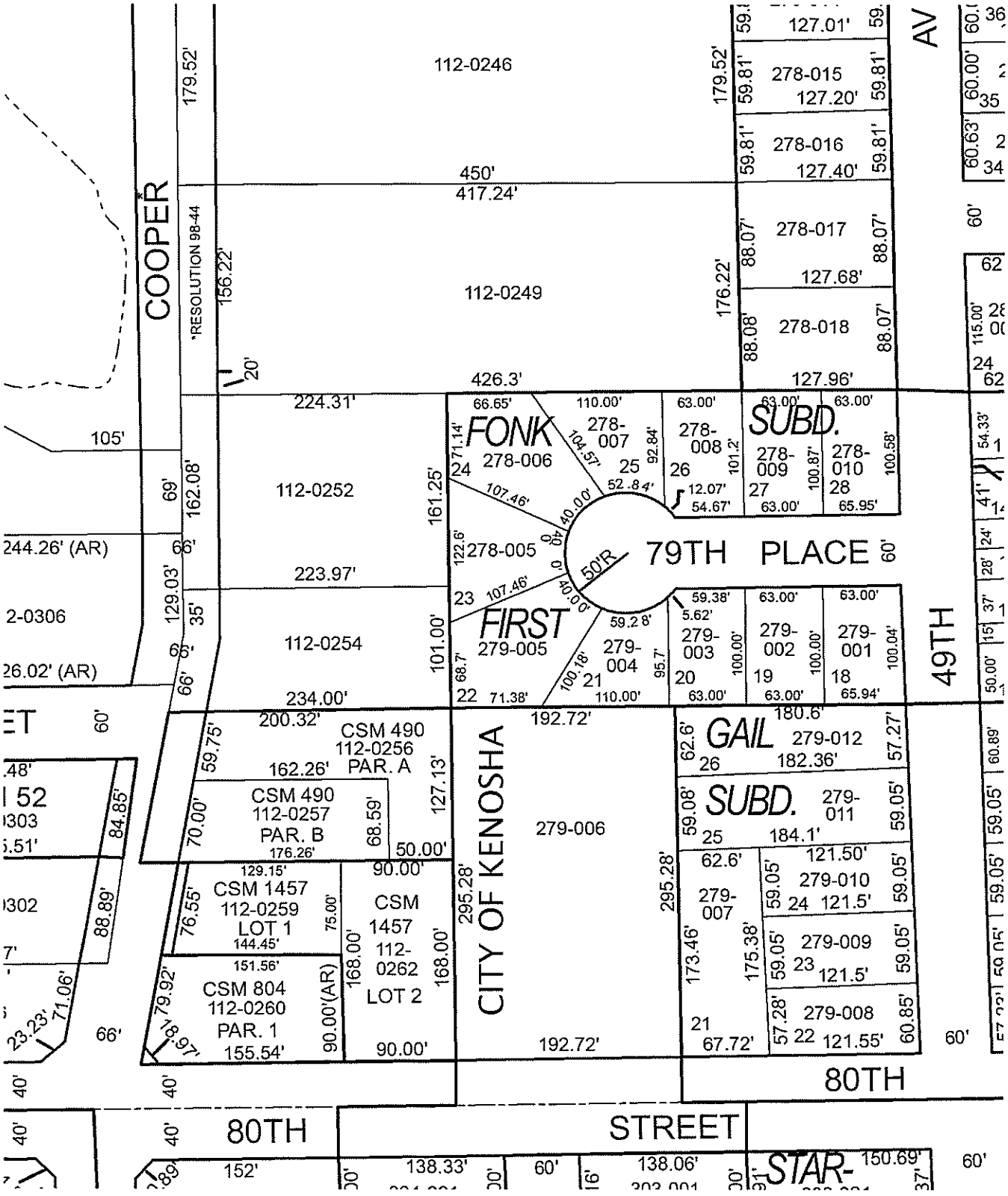
Importantly, the cadastral maps should contain parcel identification numbers which provide the link between digital information stored in the parcel-based land information or public works management system and the geographic location, configuration and areal extent of the attribute data concerned. The data that can be so linked are virtually infinite including, among many others, parcel ownership, assessed valuation, street address, existing and planned land use, soil type and properties, vegetative cover, flood hazard, and zoning. The cadastral maps also provide the basis for the preparation of sanitary sewerage, storm water management, water supply, and other utility system and facility maps, and the linkage of engineering data about these systems and facilities to maps for use in public works management.

It should be noted that a particular feature of the cadastral maps as proposed is not in accord with the basic definition of a map in that the dimensions of the real property boundary lines shown are ground level values, that is, they have not been reduced to grid values. This practice introduces a small difference that can be up to 0.01 foot per 100 feet in the values concerned.

The cost of preparing the new cadastral maps may be estimated at an average of approximately $12 per parcel. As given in Table 1, there were in the year 2012, approximately 700,629 parcels within the seven-county Region, and accordingly, the cost of preparing the new cadastral maps would approximate $8,407,500. This cost expressed in year 2012 dollars would be incurred over a minimum period of five years. Price inflation at a rate of 2.5 percent per year would bring the total cost to approximately $8,838,600.

Figure 2

PORTION OF TYPICAL LARGE-SCALE CADASTRAL MAP AT ONE INCH EQUALS 100 FEET



Source: Kenosha County and SEWRPC.

Summary of Migration Costs

The total cost of migrating the four foundational elements of a good parcel-based land information or public works management system from the legacy to the new datums may thus be expected to approximate $42.56 million, the work being conducted over a five-year period and assuming the production of conventional one-inch equals 100 feet, two foot vertical interval contour maps. The foundational elements provided for this large investment would be of the same, or higher, quality as the elements provided for the existing land information and public works management systems being developed within the Region.

In order to reduce the costs entailed, one-inch equal 100 feet scale orthophotographs could be substituted for the topographic line maps. Two feet vertical interval contour lines obtained by aerial remote imaging—Light Detection and Ranging (LiDAR)—survey could be superimposed upon the orthophotographs thus providing, as do topographic maps, both the hypsometry and the planimetry of an area. The orthophotographs should be prepared with a three-inch pixel size to ensure the sharpest practical delineation of the planimetric features of the area photographed. An example of a portion of a one-inch equals 100 feet scale orthophotograph utilizing a three-inch pixel size is provided in Figure 3. Examination of Figure 3 will indicate that orthophotographs show, in effect, all of the planimetric details of the area photographed, although some of the details may be obscured by shadows. In some areas the detailed configuration of such details as pavement edges may lack the definitive delineation shown on line maps. Moreover, the definitive identification of some features such as power and light poles, culverts, and fence lines—and even building outlines—may require substantial skills in aerial photo-interpretation. With the availability of such skills, however, these orthophotos may be put to the same, but not all, uses as the comparable line maps.

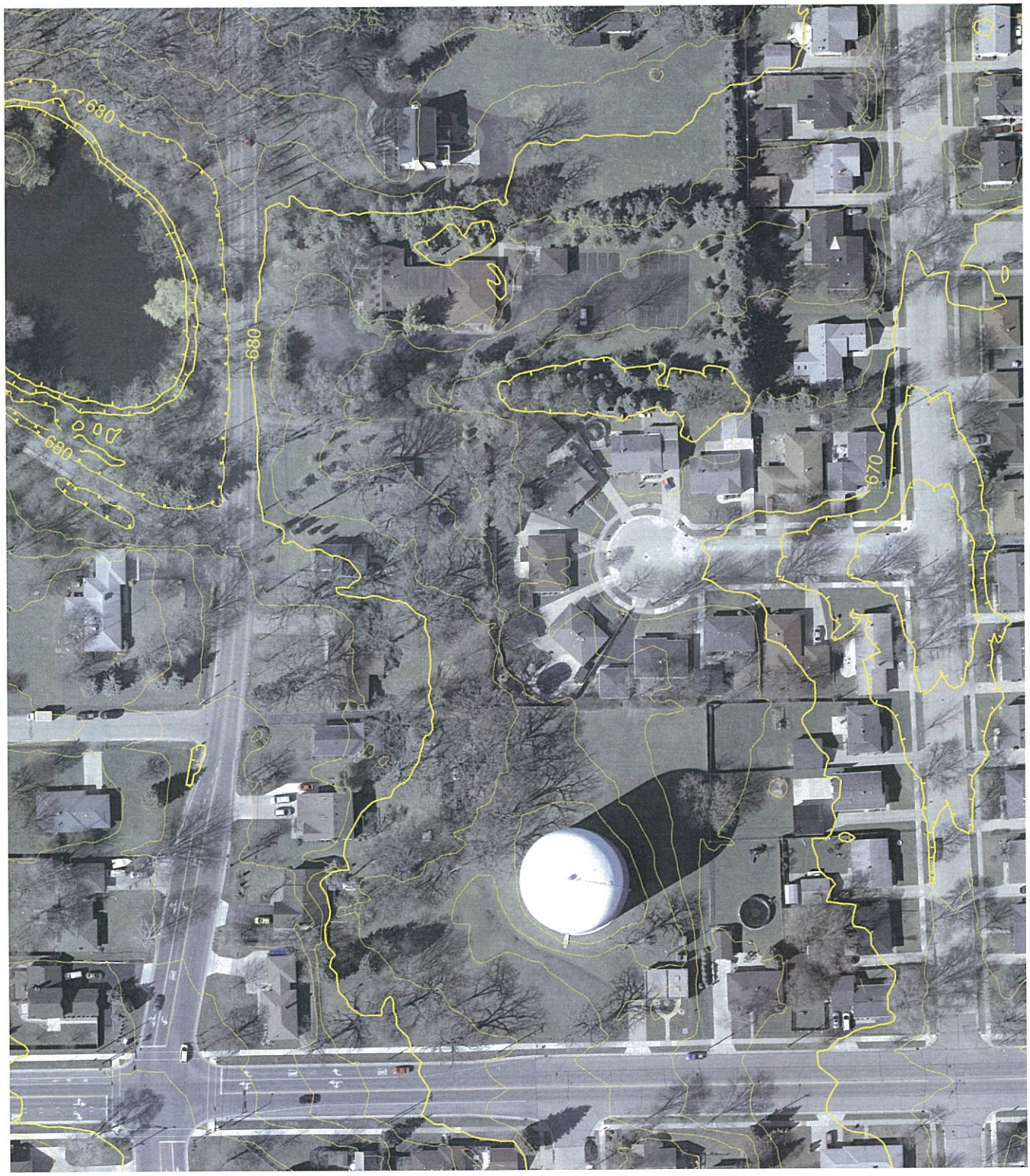
The cost of the type of orthophotographs recommended may be expected to approximate $1,795.00 per square mile, or $4,827,000 for the entire Region, expressed in 2012 dollars. The cost would be incurred over a minimum period of five years. Price inflation at a rate of 2.5 percent per year would bring the total cost to approximately $5,074,200. The cost of the third foundational element could thus be reduced from the approximately $26.56 million cost of new conventional topographic mapping, to approximately $5.07 million, a reduction of approximately 81 percent. The most readily quantifiable differences between the use of line maps and orthophotographs are related to post acquisition processing cost. Other differences, however while intangible may be more important, and relate to the cost effectiveness, as opposed to processing cost, of the products. These differences relate to the innate characteristics of the two types of products, and concern the usefulness of the products for some applications. These intangible differences have not been addressed, to date, in the professional literature concerning the use of maps and orthophotographs in the development of land information and public works management systems.

Properly prepared, orthophotographs can meet the same accuracy standards as line maps for features located at ground level. Features on orthophotographs such as the roof lines of buildings and bridges which are above ground level may be displaced. The identification of certain kinds of features such as power and light poles, fence lines, culverts, and even sometimes building outlines may, as already noted, be left to the user, but require the application of aerial photo-interpretation skills. Moreover, the plethora of detail on an orthophotograph may actually be a disadvantage for some uses since the features shown are not differentiated with respect to the importance of the features for an intended use. For this reason, the use of orthophotographs in the preparation of the plan portion of public works construction plans and profiles has been found by some engineers and agencies to be less satisfactory than the use of line maps.

In the preparation of the line maps the necessary aerial photo-interpretation is accomplished by experienced photogrammetrists, and the resulting product is not only more definitive than comparable orthophotography, but also more useful for some applications since the maps emphasize the features important to those applications. Moreover, the differing details shown on line maps may be maintained in a database in separate digital layers. Such differentiation may be useful for certain engineering applications, as for example, in the design of storm water management systems. In such design the proportion of a catchment area covered by impervious surfaces is an important consideration, and this proportion can be readily and accurately determined by computer

Figure 3

PORTION OF AN ORTHOPHOTOGRAPH UTILIZING A THREE-INCH PIXEL AT ONE INCH EQUALS 100 FEET WITH TWO-FOOT VERTICAL CONTOUR INTERVAL LINES



Source: Kenosha County.

manipulation of the digital data on a layered line map. Because of the definitive nature of line maps, such maps are also better suited as a foundational element for public works management systems than are orthophotographs.

Other Map Transformation Alternatives

The bidirectional transformation procedures and equations developed by the Commission permit the transformation of survey data collected using the newer horizontal and vertical datums such as NAD 83 (2007) and NAVD 88 (2007) to the legacy datums. Those procedures and equations also permit existing attribute data residing within the land information system to be transformed to the newer datums for use. Such transformation of attribute data is also possible utilizing a number of transformation programs currently available from both public and private sources. The commercially available software most commonly used within the Region for the transformation of spatial data between datums is that provided by Environmental Systems Research Institute, Inc. and known as ESRI ArcGIS. Other such software programs include Intergraph GeoMedia, Blue Marble Geographic Calculator, and FME Spatial Data Transformation. The software vendors indicate that transformations between NAD 27 and NAD 83 utilizing these programs may be expected to have mean errors of approximately 0.2 meter, adequate for land information system purposes, but not for land and engineering survey purposes. Software known as NADCON—available from the National Geodetic Survey (NGS) permits the conversion between the legacy and new horizontal datums at a mean error of approximately 0.15 meter. Software—known as VERTCON—available from the NGS permits the conversion between the new and legacy vertical datums at a mean error of approximately 0.02 meters, adequate for land information system purposes and for some land and engineering survey purposes. The Commission equations set forth in SEWRPC Technical Report No. 49 provide equivalent or better levels of accuracies in the transformations concerned.

EMERGING ISSUE

Technically, the legacy datums in use within the Region clearly can serve indefinitely as essential components of the foundational elements of the parcel-based land information systems that have been or are being developed within the Region. The ability to make bidirectional transformations between these legacy and the newer datums, combined with the ability of newer survey techniques to provide accurate State Plane Coordinate values referred to the legacy datum, permit the continued use of the legacy datums for both the collection and dissemination of attribute data for use in comprehensive physical planning and municipal engineering. Consequently, no compelling reasons exist to abandon these legacy datums for newer datums with respect to the relatively stable—or static—control survey, topographic and cadastral map, and related attribute data such as parcel street address location, ownership, assessed valuation, land use, zoning, soils, vegetation, floodland and wetland, and other similar types of planning and engineering data. These types of data usually change slowly over time. The data bases concerned are usually updated only periodically, and the procedures permit application of the available bidirectional transformation equations to effect any occasional needed shifts in the datums concerned.

There may be, however, an emerging need to provide spatial location information for virtually real-time applications. Such applications are beginning to be used by police, fire protection, emergency medical service, arterial street and highway traffic management, and transit service providers utilizing GPS technology. This technology permits the identification of the spatial location of conditions and incidents—such as an accident—and the location of service vehicles—such as police patrol cars and transit buses on a real-time basis. The various types of GPS equipment used provide geographic positions relative to the NAD 83 datum with the locations being displayed relative to some kind of map showing the public street and highway network and the street address data embedded in the map. The legacy foundational elements for the more stable, or static, parcel-based land information systems do not appear suitable for use with these emerging dynamic applications given the datum differences and the need for rapid transformations between datums.

There are a number of emergency management dispatch centers currently in operation within the Region. These centers utilize computer-aided dispatch (CAD) software which generally contains default base maps, including street centerlines and related reference features. Some CAD systems include address ranges whereby the location of specific incidents can be interpolated along street centerline segments. The default base maps generally do not

contain and display a high level of detail with respect to specific street address locations and specific building locations. Some dispatch centers have chosen to augment the default base map layers with large-scale digital maps—more accurate street centerlines, parcel lines, address points, and orthophotography—compiled on the NAD 27 datum. The most common CAD system in use in the Region—Phoenix CAD from ProPhoenix, Inc. headquartered in New Jersey—converts all data imported into the system to the World Geodetic System of 1984 (WGS 84) reference framework, the same system of reference used for global positioning systems. Data in this system uses a latitude and longitude coordinate system. Incorporating digital data into such systems involves a conversion effort, but often this is accomplished by software without operator interaction. Ultimately, data in the commercial systems and data in land information systems are not immediately integrated in real time. This lack of integration creates the need to find a way to utilize the land information system maps as the maps utilized by the emergency management systems.

Potential Resolution

If total conversion of the developing land information systems and the supporting control survey network within the Region from the legacy datums to the new datums is concluded to be impractical and unnecessary, a potential solution to the issue raised might be the creation of a new set of foundational elements supplementing the legacy foundational elements in use within the Region. The new set of foundational elements would be concerned only with horizontal positioning, and would be based upon NAD 83. This new set of foundational elements would be utilized for the spatial location and plotting of the types of dynamic real-time attribute data desired by the police, fire protection, emergency medical service, arterial street and highway traffic management, and transit service providers within the Region utilizing GPS technology to establish coordinate values for the phenomena concerned. This second "dynamic" system would be maintained and used in parallel with the "stable" existing systems intended to serve comprehensive planning and municipal engineering applications.

These "dynamic" systems should not require the same level of accuracy in horizontal and vertical positioning as do the "static" existing systems with their supporting control survey networks. Consequently, it should be possible to use either the Commission's equations, or one of the commercially available software programs, to create the new foundational elements for the "dynamic" systems. If it is assumed that cadastral maps and the street address data embedded in the maps would provide an adequate foundation for the "dynamic" systems, then only the cadastral maps residing in the existing legacy systems would need to be transformed to fit the new datum—NAD 83. Transformation of the topographic maps and control survey network data comprising two of the three foundational elements would not be necessary.

There appear to be at least two means of providing a foundational element for the dynamic systems. One of these involves the acquisition and use of one of the commercially available digital base maps specifically designed and provided for use by a dynamic real-time system. This means is apparently in wide-spread use within the Region by agencies such as police and fire departments and for navigational systems installed in vehicles. These systems rely upon the collection of attribute data by global positioning system technology and are, therefore, related to the newer datums.

The second means of providing the foundational element for a dynamic system would be transformation of the legacy cadastral maps from the legacy horizontal datum to the NAD 83 datum. This conversion could be done either by use of commercially available software such as ESRI ArcGIS, or by application of the Commission's equations. Conceptually, such transformation would be accomplished by the transformation of the property boundary corners plotted on the cadastral maps from one datum to the other, and then the completion of the map by an automated drafting program. Undertaking either of these transformations presumes that, for whatever reasons, the commercially available digital base maps are deficient for comprehensive public use.

The accuracy of the two transformed maps should be evaluated by field measurement in terms of the ability to meet the requirements of dynamic user applications. Computer software may have to be developed to facilitate the conversion using the Commission equations. The practicality of the application with respect to computer time and, therefore, cost required for the transformations would be determined as part of a pilot program. A pilot study would also formulate the positional accuracy standards to meet the transformed cadastral maps in order for such maps to be suitable as a foundation for a dynamic system.

SUMMARY AND CONCLUSIONS

The recommendations of the Commission with respect to the continued use of the NAD 27 and NGVD 29 datums within the Region have served well the land information system, land survey, and public works engineering communities within the Region from 1961 to the present. The control survey network based upon these datums, together with the attendant topographic and cadastral maps, have provided a sound foundation for the development of automated parcel-based land information and public works management systems within the Region by the Commission and its constituent counties and municipalities. The control survey network has also provided a sound basis for the conduct of land and engineering surveys within the Region, and for the periodic preparation of areawide aerial orthophotography. The integration of the control survey network and the topographic and cadastral maps achieved within the Region provides a unique and extraordinarily effective foundation for the parcel-based land information systems being developed and used within the Region. This integration permits the ready acquisition and incorporation of attribute data typically required for comprehensive physical planning and municipal engineering into the land information systems. It similarly provides for the update of the cadastral maps of such systems through the ready incorporation of new subdivision plats and certified survey maps. This integration also provides for the development, maintenance, and use of public works management systems within the Region, such systems being separate from, but complementary to the land information systems. The introduction of the newer survey technologies—specifically Global Positioning System (GPS) and Continuously Operating Reference Station (CORS) technology—present no problems for the continued use of the legacy datums within the Region.

The Commission staff has demonstrated that it is possible to utilize GPS technology cost-effectively and the existing CORS network established within the Region by the WisDOT to obtain accurate State Plane coordinate values in the NAD 27 datum. Moreover, the Commission has provided a detailed example of how GPS technology and the WisDOT CORS system can be used to obtain accurate coordinate values of survey points on the NAD 27 datum. This example is set forth in Appendix G of SEWRPC Technical Report No. 49, *Bidirectional Transformation of Legacy and Current Survey Control Data Within Southeastern Wisconsin,* May 2010.

In spite of the foregoing rationale advanced by the Commission for the continued use of the legacy datums within the Region, questions continued to be raised by some practicing surveyors and by some land information system managers as to why the Commission continues to use and recommends the continued use of the legacy datums within the Region. In response to these questions, the Commission engaged the firm of Aero-Metric, Inc. to prepare an estimate of the cost that may be reasonably expected to be incurred in a resurvey of the existing control survey network within the Region in order to base that network upon the new datums introduced by the Federal government. The cost estimate so prepared is presented in a report prepared by Aero-Metric, Inc., which report is provided in Appendix A. That report estimates the cost of such a resurvey, if carried out over a five-year period, at approximately $7.16 million, assuming that Option 2 of the resurvey of the vertical network is chosen for a vertical component.

The resurvey would provide only two of the four foundational elements of a good parcel-based land information or public works management system; namely: 1) a map projection and related datum; and 2) a survey control network that manifests the projection and datum on the surface of the earth. The resurvey would place these two elements on the new NAD 83 (2007) datum and would do so with as high, or higher an accuracy level, than the legacy control survey network within the Region.[3] Two additional foundational elements would, however, also

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[3]*The land information managers concerned specifically requested that the desired cost estimate be made for the migration of the existing control survey network within the Region from the legacy datums to the NAD 83 (2007) and NAVD 88 (2007) datums. The costs presented in this report are applicable to the migration of the legacy datums in use within the Region to any of the NAD 83 and NAVD 88 realizations. It is not known at this time if those costs would also apply to the proposed ITRF-17 datum. The different datum realizations and the new datum would provide different coordinate values and different elevations between the datum realizations and the new datum as well as between the various datum realizations and new and the legacy datums.*

Table 2

COST SUMMARY OF ALTERNATIVE APPROACHES TO PREPARING REPLACEMENT LAND INFORMATION SYSTEM (LIS) FOUNDATIONAL ELEMENTS FOR THE REGION UNDER NEW DATUMS[a]

LIS Foundational Elements	Conventional 1"= 100' Scale Topographic Mapping	3" Pixel Orthophotography With 2' Contour Intervals
Resurvey of Horizontal and Vertical Networks	$ 7,164,900	$ 7,164,900
Topographic Mapping	26,561,300	- -
Orthophotography With Contour Intervals	- -	5,074,200
Cadastral Mapping	8,838,600	8,838,600
Total	$42,564,700	$21,077,700

[a]*All costs based on 2012 unit costs inflated over a five-year production period.*

[b]*Cost for the Resurvey of the Vertical Network assumes the use of Option 2 of the vertical component.*

Source: SEWRPC.

have to be transformed to fit the new datum; namely: 1) large-scale topographic maps meeting National Map Accuracy Standards; and 2) matching large-scale cadastral maps meeting a comparable level of accuracy. The cost of preparing the new topographic maps over a five-year period is estimated at about $26.56 million. The cost of preparing the new cadastral maps over a five-year period is estimated at approximately $8.84 million, bringing the total cost of providing the four foundational elements, to the same or higher quality as the elements provided for the legacy systems, to approximately $42.56 million (see Table 2). By substituting less desirable orthophotographs for the topographic maps, this total cost could be reduced to about $27.08 million, or by about 50 percent.

This substantial cost entailed in providing new foundational elements, would not include the cost of transforming the attribute data presently contained within the land information and public works management systems being developed within the Region from the legacy to the new datums. Such transformations would be possible through application of the bidirectional transformation equations developed by the Commission, or by the application of commercially available software programs. The use of such transformation methodologies might also be considered to provide the two base map elements of the four foundational elements described above. The transformed base maps may not meet National Map Accuracy Standards for the topographic maps, nor the compatible accuracy standards for the cadastral maps, thus, destroying the integrity provided by the legacy systems.

It is highly unlikely at this time that funding of the very large costs associated with a datum transformation within the Region could be obtained. Even if such funding could be obtained, however, a transformation would not necessarily be in the public interest. Good public administration practice requires that it be shown that the benefits derived from a potential investment exceed the costs entailed. To date, none of the proponents of a datum transformation within the Region have provided evidence of any significant monetary benefits that might accrue from the transformation. The Commission decision to continue to use the legacy datums within the Region, and to recommend the continued use of those datums to the county, municipal and special purpose government agencies operating within the Region, is reaffirmed.

APPENDICES

Appendix A

AERO-METRIC REPORT ON COST OF RESURVEY OF SEWRPC CONTROL SURVEY NETWORK

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REPORT ON COST OF RESURVEY OF SEWRPC CONTROL SURVEY NETWORK

General

The Southeastern Wisconsin Regional Planning Commission has established an extensive and accurate network of horizontal and vertical control survey stations on 11,985 U.S. Public Land Survey System (USPLSS) corners throughout the seven-county Southeastern Wisconsin Region.

The State Plane Coordinates of the horizontal network are related to the North American Datum of 1927 (NAD 27) achieving Third-Order, Class I accuracy and specifications. The elevations of the vertical element which consists of a minimum of one reference bench mark for each USPLSS corner are based upon the National Geodetic Vertical Datum of 1929 (NGVD 29) achieving Second-Order, Class II accuracy.

The use of Global Positioning System (GPS) technology and new national datums have made the previously established control difficult to reference using current surveying procedures. Elaborate computations are required to relate the two horizontal and two vertical datums to one another. A local governmental agency has requested the Commission to investigate the cost associated with establishing North American Datum of 1983-2007 (NAD 83 (2007)) coordinates and North American Vertical Datum of 1988 (NAVD 88 (2007)) elevations for all 11,985 USPLSS corners and ancillary bench marks within the region. In response to this request, the Commission requested the firm of Aero-Metric, Inc. to prepare an estimate of the cost of a resurvey of the horizontal positions of all USPLSS corners based upon the NAD 83 (2007). The resurvey would at a minimum meet Order C (former First Order) standards and specifications. The resurvey would also determine orthometric heights – elevations – for at least one bench mark for each monumented USPLSS corner and the corner itself, based upon the NAVD 88 (2007) datum. The vertical control surveys would meet or exceed Second Order, Class II standards.

Primary Horizontal Control Network

The first phase of a proposed horizontal control resurvey would establish a Primary Network. The Primary Network would consist of the USPLSS Township Corners, including correction corners, throughout the region. If the USPLSS Township Corner cannot support a direct occupation a USPLSS corner nearest the Township Corner would be selected and observed.

This Primary Network would require the occupation of all 107 township corners. Observations at these corners would be made simultaneously in groups designed to achieve closed high order configurations, the groupings always including in addition to the township corners one or more of the Continuously Operating Reference Stations (CORS) of the Wisconsin Department of Transportation CORS network in the area. Thirty-minute simultaneous static observation sessions by the groups of township corners incorporating the CORS network in the processing would be required. The observations would provide coordinate positions for the occupied stations by reference to Global Positioning System (GPS) satellites. As observed, these positions would be expressed in terms of latitude and longitude, and would then be converted to State Plane Coordinates expressed in meters based upon the NAD 83 and the State Plane Coordinate system provided by the National Geodetic Survey. The coordinate positions would be further converted to feet based upon the U.S. Survey Foot. It should be noted that the differences between NAD 83 and NAD 83 (2007) would be considered insignificant for these purposes and therefore ignored in the computations. These positions would then be converted to vectors connecting the stations and forming a network amenable to adjustment by least squares computation. The basic control would be provided by the CORS network in the area, and the published coordinate values of the CORS stations would be held fixed in subsequent network adjustment computations. The resurvey would follow Wisconsin Department of Transportation (WisDOT) Standards and Specifications for Global Positioning System (GPS) Surveys in Support of Transportation Improvement Projects, as revised in 2005. These standards and specifications are appended to this report. The proposed accuracy would achieve 1:250,000 (Order B, Class III).

The purpose of the proposed Primary Network would be to support all the subsequent horizontal control surveys by minimizing any distortion errors in localized secondary control surveys. Exhibit A indicates the proposed groupings of the observation control survey sessions anticipated to establish the Primary Network within the region.

Secondary Horizontal Control Network

The second phase of the proposed horizontal control resurvey would establish a Secondary Network. This phase would include the recovery and use of USPLSS corners, including section, one-quarter section, center of section, meander, and witness corners as stations in the network. In total the Commission maintains 11,985 USPLSS corners. The secondary resurvey would be conducted by township blocks to ensure the timely completion and delivery of new horizontal control information over the course of the project. Priority of delivery would be based on the direction of the Commission.

All of the 11,985 USPLSS corners within the region would be recovered and surveys would be completed to determine the coordinates of the corners and the lengths and bearings of all the quarter-section lines. Using the positions of the township corners, a minimum of two base stations would also be established within each

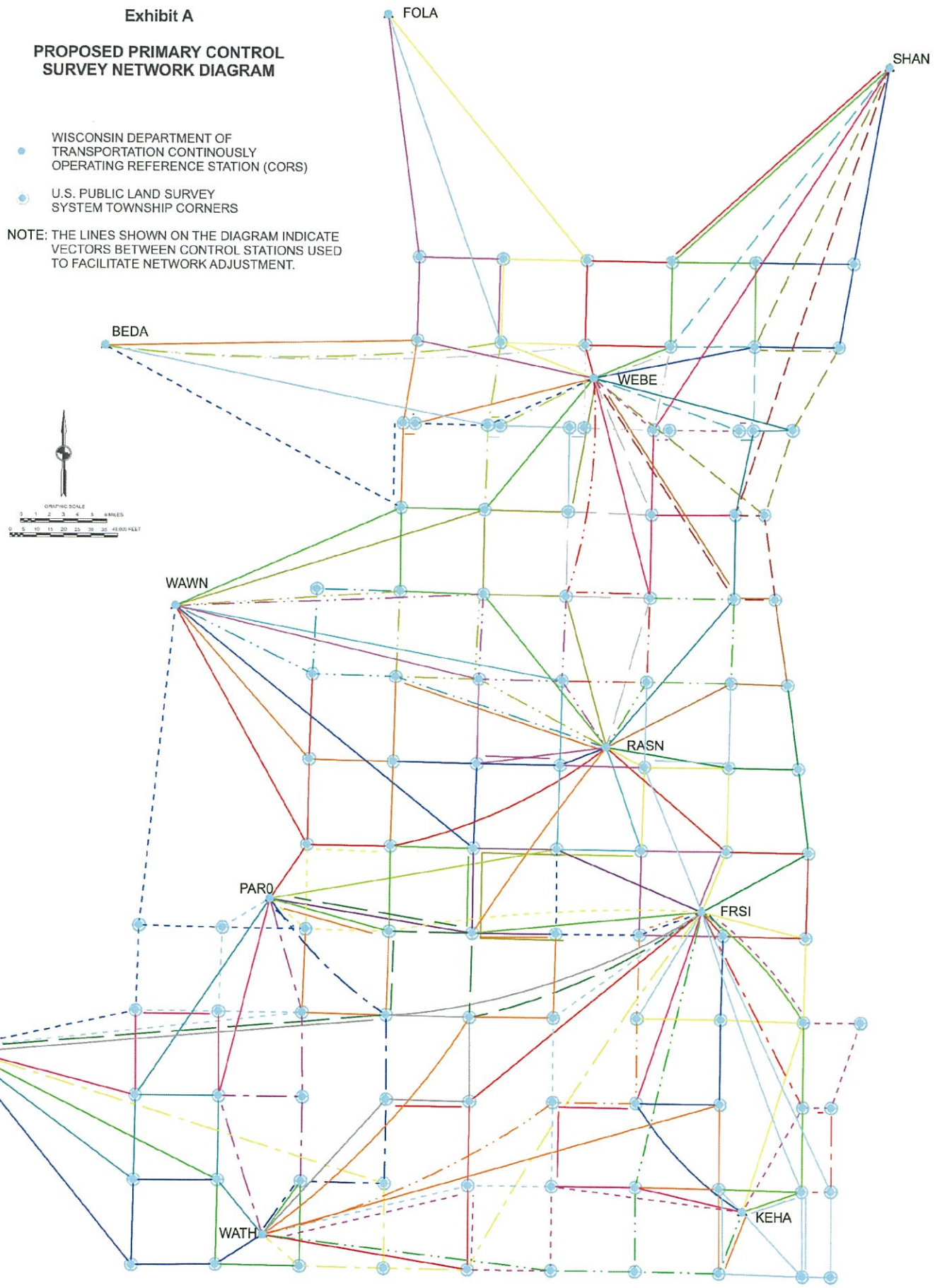
Exhibit A

PROPOSED PRIMARY CONTROL SURVEY NETWORK DIAGRAM

WISCONSIN DEPARTMENT OF TRANSPORTATION CONTINOUSLY OPERATING REFERENCE STATION (CORS)

U.S. PUBLIC LAND SURVEY SYSTEM TOWNSHIP CORNERS

NOTE: THE LINES SHOWN ON THE DIAGRAM INDICATE VECTORS BETWEEN CONTROL STATIONS USED TO FACILITATE NETWORK ADJUSTMENT.



Source: Aero-Metric, Inc. and SEWRPC.

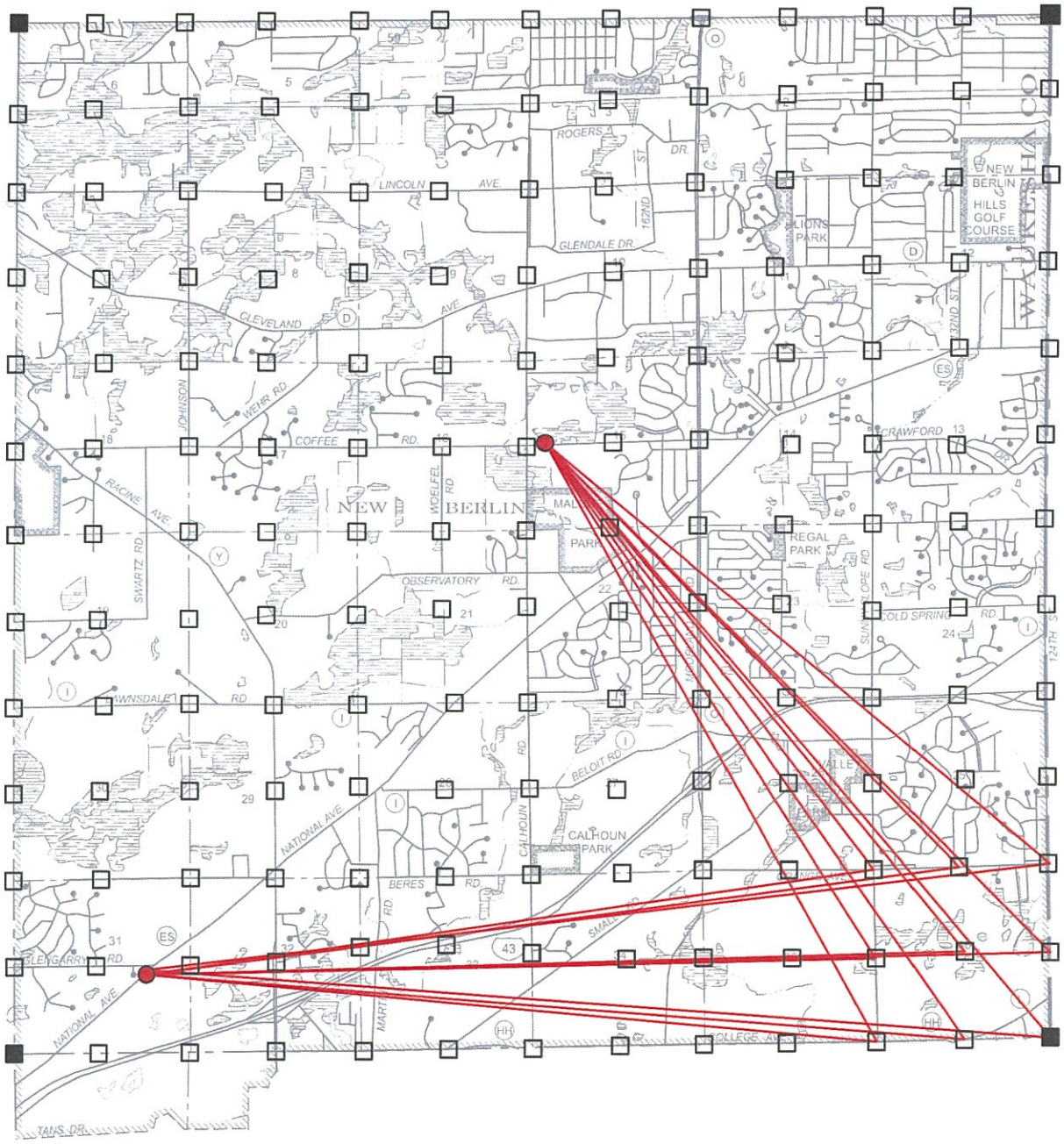
township. These base stations would be established to facilitate the observations that would be made simultaneously at the base stations and at each of the section, quarter-section, center of section, meander, and witness corner within the township. The observations would provide coordinate positions for the base stations and USPLSS corners by reference to the GPS satellites. As observed, these positions would be expressed in terms of latitude and longitude, and would then be converted to State Plane Coordinates expressed in meters based upon the NAD 83 and the State Plane Coordinate system based upon that datum provided by the National Geodetic Survey. The coordinate positions would be further converted to feet based upon the U.S. Survey Foot. It should be noted that the differences between NAD 83 and NAD 83 (2007) would be considered insignificant for these purposes and therefore ignored in the computations. These positions would then be converted to vectors connecting the township corners, base stations, and USPLSS corners for use in adjustment computations. All coordinates would be based upon the Wisconsin State Plane Coordinate System, South Zone, NAD 83; and sufficient survey connections would be made to the Primary Network—the township corners—to permit the proper checks and adjustments to be made as required to achieve the desired level of accuracy for each monumented USPLSS corner. The coordinates would be expressed in feet – not meters as envisioned by the National Geodetic Survey. The Secondary Horizontal Control surveys would utilize GPS technology to determine the coordinates of the monumented corners and the lengths and bearings of the quarter-section lines. This would require approximately 200 observations in a typical full township, consisting of the 169 section and quarter-section corners. Approximately 30 redundant observations would also be required to validate the desired accuracy. The observations at the corners would be made simultaneously with observations at the base stations and at the township corners, and would occupy about 10 minutes at each corner.

The accuracy of the horizontal control surveys would meet Order C (former 1st Order) accuracy as set forth in the WisDOT Standards and Specifications for Global Positioning System (GPS) Surveys in Support of Transportation Improvement Projects, 23 October 1996 (revised 4 January 2005). All field measurements would be adjusted by National Geodetic Survey (NGS) methods to provide closed traverses before traverse station and USPLSS corner coordinates are computed, and attendant lengths and bearings of the quarter-section lines are computed so as to form closed geometric figures for the quarter-sections.

Exhibit B indicates a sample baseline diagram to illustrate the second phase resurvey of the USPLSS corners within a typical Township.

Exhibit B

PORTION OF A GPS BASELINE SURVEY PROPOSED TO BE USED TO OBTAIN NAD 83 (2007) COORDINATE VALUES FOR USPLSS CORNERS WITHIN A TOWNSHIP



LEGEND

- BASE STATION
- PRIMARY CONTROL
- USPLS SECTION OR QUARTER SECTION CORNER
- LINE MEASURING BEARING AND DISTANCE FROM BASE STATION TO SECTION OR QUARTER SECTION CORNER

GRAPHIC SCALE

0 1/2 1 MILE

0 2,000 4,000 6,000 FEET

Source: SEWRPC.

Survey Computation Data and Plats

All field notes and office computations would be kept in a neat and orderly manner, clearly indexed, and open for inspection and checking during the course of the work. Upon completion and acceptance, all field notes and computations would be furnished to the Commission and become Commission property. Instruments and assistance would be provided to a duly authorized agent of the Commission for such checking of field work and computations as may be deemed necessary by the Commission.

1. A dossier would be prepared for each control survey station (USPLSS corner) on 8-1/2 inch by 11 inch stable base material. Exhibit "C" attached hereto illustrates the required form and content of these dossiers. The following information would be provided for each station on the dossiers:

    a. Title giving the description of the control survey stations (USPLSS corners). The stations would also be identified by assigned numbers.

    b. A sketch, showing the monumented control survey station in relation to the salient features of the immediate vicinity. Witness monuments and bench marks set would be shown together with their measured ties to the station. A north point properly positioned thereon. The names of adjoining streets, state trunk highways, or public land would be indicated. The bearing and distance to one other control station from the station would also be shown.

    c. The coordinates of the station.

    d. The Elevation of the USPLSS corner and at least one ancillary bench mark

    e. The angle between geodetic and grid bearing at the station (theta angle).

2. One azimuth mark would be set for each control survey station (USPLSS corner) surveyed. The azimuth mark could be an adjacent USPLSS corner, or some other well-defined, permanent, distant object of the landscape that can be clearly identified and described. Where it is not possible or practical to use such an object, a commercial survey monument of a design approved by the Commission would be substituted.

Exhibit C

EXAMPLE OF RECORD OF U.S. PUBLIC LAND SURVEY CONTROL STATION

RECORD OF U. S. PUBLIC LAND SURVEY CONTROL STATION

U. S. PUBLIC LAND SURVEY CORNER 24|24 / 25|25 T 5 N, R 21 E, MILWAUKEE COUNTY, WISCONSIN

HORIZONTAL CONTROL SURVEY BY: AERO-METRIC ENGINEERING, INC. YEAR: 1993
VERTICAL CONTROL SURVEY BY: SEWRPC YEAR: 2007

STATE PLANE COORDINATES OF: QUARTER SECTION CORNER
NORTH 324,725.89
EAST 2,546,528.32
ELEVATION OF STATION: 728.007

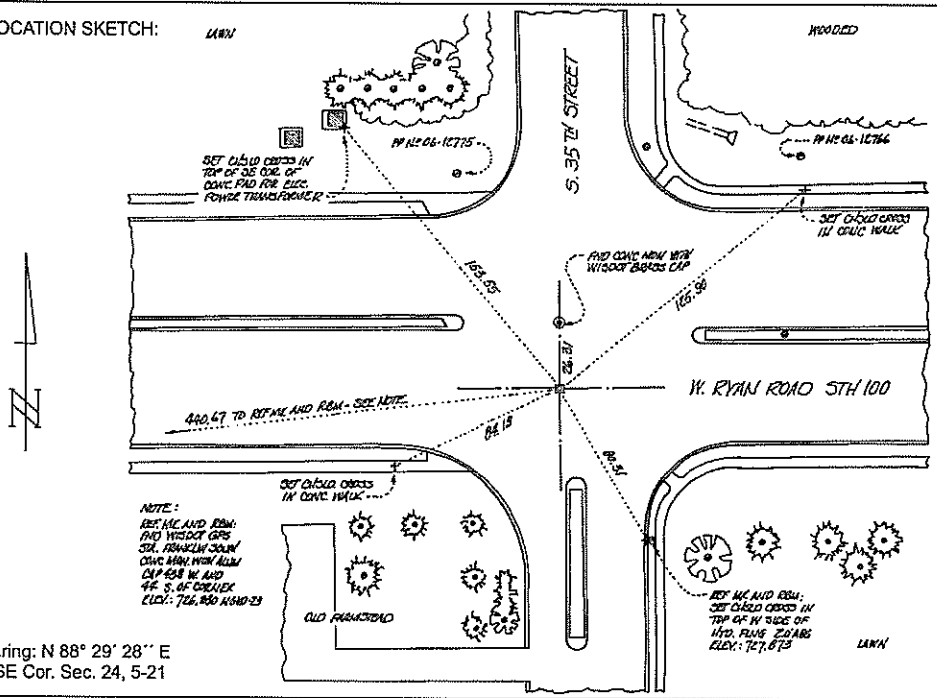
HORIZONTAL DATUM: WISCONSIN STATE PLANE COORDINATE SYSTEM, SOUTH ZONE
NORTH AMERICAN DATUM OF 1927

ALL MEASUREMENTS AND COORDINATES EXPRESSED IN U.S. SURVEY FEET

VERTICAL DATUM: NATIONAL GEODETIC VERTICAL DATUM OF 1929 THETA ANGLE: +1° 24' 03"

CONTROL ACCURACY:
HORIZONTAL: THIRD ORDER, CLASS I VERTICAL: SECOND ORDER, CLASS II

LOCATION SKETCH:



Bearing: N 88° 29' 28" E
To SE Cor. Sec. 24, 5-21

SURVEYOR'S AFFIDAVIT:

STATE OF WISCONSIN)
MILWAUKEE COUNTY) SS

As Milwaukee County Surveyor, I hereby certify that following highway reconstruction, I set a concrete monument with SEWRPC brass cap to mark the location of this corner; replacing a concrete monument with cast iron plug with cross found and referenced by me as Milwaukee County Surveyor on September 11, 1992; said concrete monument with cast iron plug having been set to mark the location of this corner in 1941 by E.G. Plautz, State Highway Commission of Wisconsin Project Engineer, following highway reconstruction; replacing a cast iron plug with cross set in the then existing concrete pavement to mark the location of this corner in 1916 by a Milwaukee County Highway Department Project Engineer, following highway reconstruction; replacing an old cut limestone monument set to mark the location of this corner in 1878 by Jonathan C. Crounse, Surveyor, in the conduct of the remonumentation of the Town of Franklin; replacing in turn a wood post set to mark this corner in May 1836 by Elisha Dwelle, Deputy United States Surveyor, in the conduct of the original United States Public Land Survey; that I have referenced the same as shown hereon; and that this record is correct and complete to the best of my knowledge and belief

WISCONSIN K. W. BAUER S-157 MILWAUKEE, WI LAND SURVEYOR

DATE OF SURVEY: 30 August 2007 Kurt W. Bauer S - 157
REGISTERED LAND SURVEYOR

FORM PREPARED BY SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

106

Vertical Control Surveys – Option 1

The vertical control survey would be based upon NAVD 88 (2007) as established by the NGS. As already noted, at least one ancillary bench mark has been established by the Commission for each monumented USPLSS corner. The Vertical Control resurvey would be completed by USPLSS Township blocks to ensure the completion and timely delivery of the vertical control information over the course of the project.

Closed digital bar coded spirit-level circuits would be run to the established bench mark in the project area. The spirit-level circuits would meet Second-Order Class II accuracy as set forth in "Standards and Specifications for Geodetic Control Networks" prepared by the Federal Geodetic Control Committee. A copy of these standards are appended to this report. All level circuits would be adjusted for closure by NGS methods. Elevations would be obtained for the 11,985 monuments marking USPLSS corners and for at least one ancillary bench mark for each corner as established by the Commission. In addition, elevations would be obtained for bench marks set along the spirit-level lines on such objects as bridge abutments and wing walls, headwalls of large culverts, water tables of large buildings, outcroppings of ledge rock, or other stable objects which are unlikely to be displaced vertically.

At least one bench mark would be established for, and tied horizontally to, each USPLSS corner monument and would be set so that the elevation of the corner monument may be readily verified from the additional permanent bench mark by a single spirit-level position.

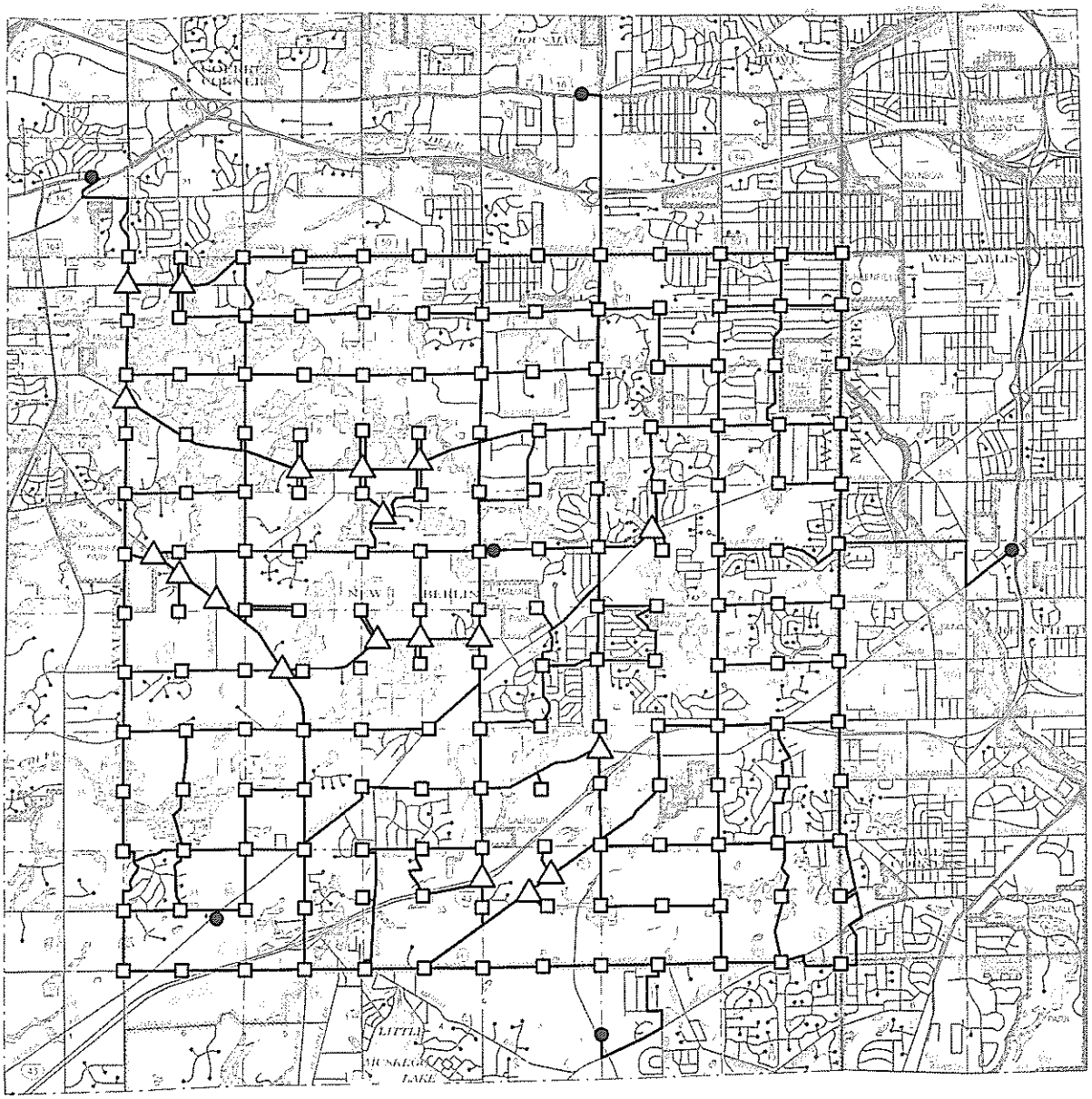
Survey Computation Data and Plats

All field notes and office computations would be kept in a neat and orderly manner, clearly indexed, and open for inspection and checking during the course of the work. Upon completion and acceptance, all field notes and computations would be furnished to the Commission and become Commission property. Before final acceptance of the work instruments and assistance would be provided to a duly authorized agent of the Commission for such checking of field work and computations as may be deemed necessary by the Commission.

Exhibit D shows, as an example, a proposed circuit within a survey township that would tie the elevations of the USPLSS corner monuments and ancillary bench marks to existing Wisconsin Height Modernization monuments that would be used as a basis of the vertical control surveys.

Exhibit D

EXAMPLE OF A VERTICAL CONTROL SURVEY LEVEL CIRCUIT TO OBTAIN NAVD 88 (2007) ELEVATIONS OF USPLSS CORNER AND ANCILLARY BENCH MARKS



LEGEND

- WISDOT HEIGHT MODERNIZATION STATION
- USPLSS SECTION OR QUARTER SECTION CORNER
- HIGH-ORDER SPIRIT LEVEL CIRCUIT LINE
- SUPPLEMENTARY BENCHMARK LOCATIONS

Source: SEWRPC.

Vertical Control Survey – Option 2

In the alternative to Option 1, GPS technology would be used to resurvey the vertical control survey network. The GPS measurements made for each USPLSS corner under the Horizontal Secondary Network resurvey would be used to determine orthometric height—elevations—for each control survey station (USPLSS corner). These ellipsoid height measurements together with an applied latest NGS geoid and the differences in elevations between neighboring USPLSS corners as determined by historic Commission spirit-level surveys would be used to determine an orthometric elevation vertical height—for each observed USPLSS corner. The differences found between adjacent USPLSS corners as determined from the GPS observations would be compared to the differences found between the existing spirit-leveled differences as determined by the original Commission control surveys, as published on the NGVD 29. If the GPS determined differences were found to meet Second-Order, Class II accuracy the NGVD 29 difference would be used as an additional constraint in a final least squares adjustment. If the difference were found to be outside of Second Order, Class II accuracy, the corner concerned would require a new digital bar-code spirit-level run to determine a new elevation and resultant difference. This would also be compared to the GPS measurement and if within acceptable tolerance used as part of the vertical constrained adjustment. If still outside of the limit, the GPS measurement would be ignored and the elevation for the corner accepted using the digital bar-code spirit-leveled solution.

Deliverables

Upon completion of the resurvey the Engineer would deliver to the Commission the following items:

- One control station dossier sheet for each of the 11,985 control survey stations (USPLSS corners) and ancillary bench marks.
- The original field notes and computations prepared under the resurvey.
- A summary of the findings of the resurvey documenting an approximately 469 control survey summary diagrams. Each diagram is to cover an area consisting of six USPLSS sections—and is to show the State Plane Coordinates of the monumented stations referred to the NAD 83 (2007), the grid and ground-level lengths and grid bearings of the one-quarter section lines, the elevations of the monumented stations referred to NAVD 88 (2007), the interior angles of the one-quarter Sections, the area of the one-quarter sections in ground-level acreage, the difference between grid and geodetic north, and the combination scale and sea level reduction factor applicable at the center of each six-section diagram. The Coordinates are to be expressed in U.S. Survey feet, not meters. A typical control survey summary diagram is provided in Exhibit E.

Cost Estimate

The anticipated cost of each phase of the resurvey work described above is estimated to be as follows:

- Establishment of Primary Horizontal Network - $55,500.00
- Establishment of Secondary Horizontal Network - $ 2,230,000.00
- Resurvey of Vertical Network—Option 1 – $ 6,772,000.00
- Resurvey of Vertical Network Option 2 - $ 4,530,000.00

The estimates provided are based upon average survey costs as of calendar year 2012. Table 1 provides a summary of the basis of the cost estimates set forth above.

The significance and complexity of this resurveying program would be enormous. The locations of these USPLSS Corners should be given special consideration and proper planning will be vitally necessary for a successful completion of this program. It would be the opinion of Aero-Metric that a minimum of 5 years based on the level of effort necessary to complete the field observation, the office reduction of the measurements, and finalization of all project deliverables.

Exhibit E

EXAMPLE OF CONTROL SURVEY SUMMARY DIAGRAM

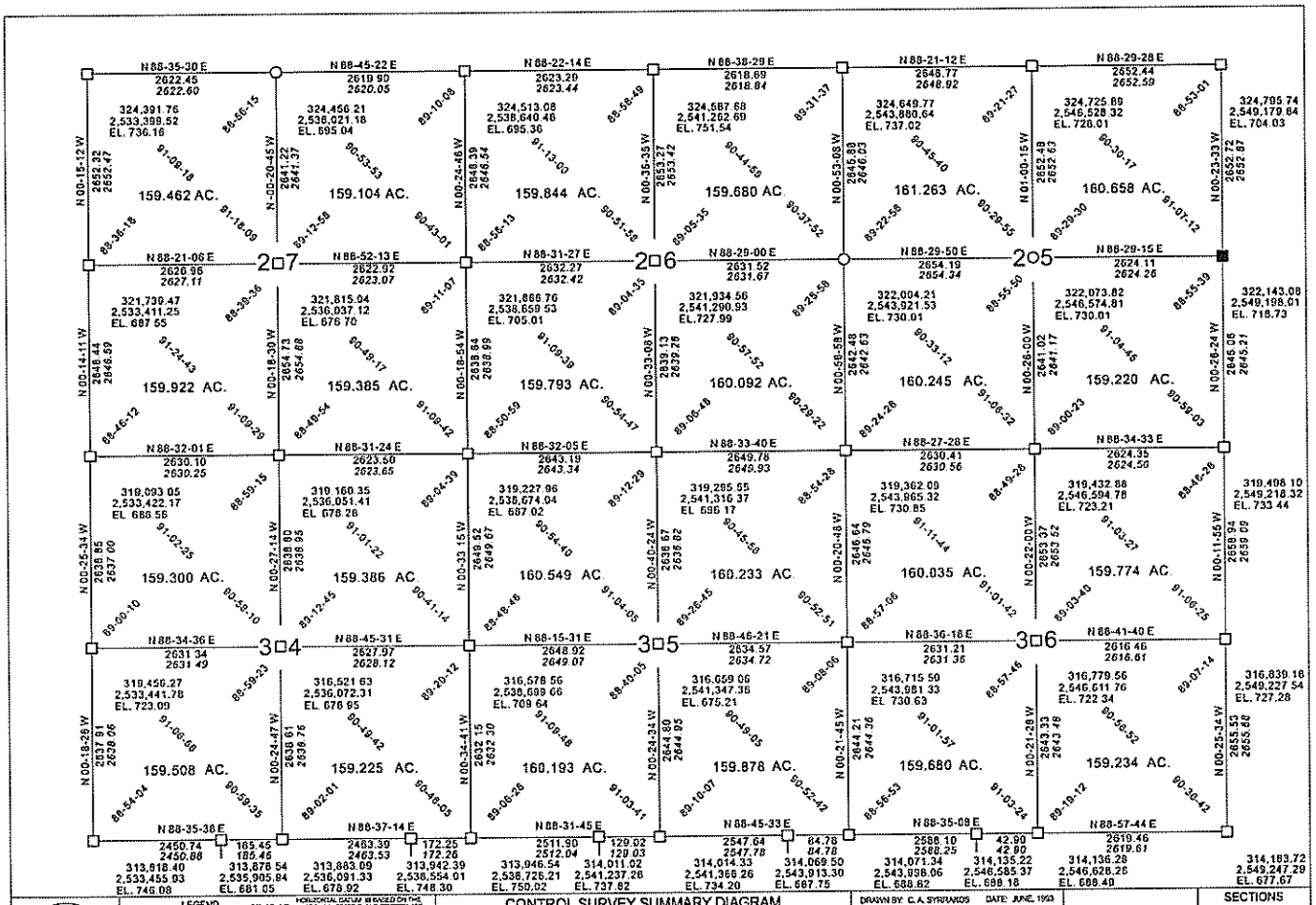


Table 1

BASIS OF COST ESTIMATES

Establishment of Primary Network

Description	Personnel Hours	Cost Breakdown
Field Work	420	$46,800.00
Office Reduction	64	$ 6,700.00
Project Management	16	$ 2,000.00
Total	--	$55,500.00

Establishment of Horizontal Secondary Network

Description	Personnel Hours	Cost Breakdown
Field Work	12,907	$1,651,500.00
Office Reduction	5,531	$442,500.00
Project Management	1,134	$136,000.00
Total	--	$2,230,000.00

Vertical Network (Option 1)

Description	Personnel Hours	Cost Breakdown
Field Work	52,690	$6,011,440.00
Office Reduction	7,380	$590,400.00
Project Management	1,418	$170,160.00
Total	--	$6,772,000.00

Vertical Network (Option 2)

Description	Personnel Hours	Cost Breakdown
Field Work	14,892	$1,721,680.00
Office Reduction	31,912	$2,552,960.00
Project Management	2,128	$255,360.00
Total	--	$4,530,000.00

The budgetary fee estimates indicated above are based upon average survey costs as of calendar year 2012.

Source: Aero-Metric, Inc.

FIRST APPENDIX TO AERO-METRIC, INC. REPORT
WISDOT HORIZONTAL SURVEY CONTROL SPECIFICATIONS

Wisconsin Department of Transportation
Guidelines on Standards and Specifications
For Global Positioning System (GPS) Surveys
in Support of Transportation Improvement Projects

DRAFT

23 October 1996 (revised 04 January 2005)

For Further Information Contact:

Wisconsin Department of Transportation
Surveying and Mapping Section
Geodetic Surveys Unit - Rm 5B
4802 Sheboygan Avenue
P.O. Box 7916
Madison, WI 53707

(608) 267-2462

Table of Contents

1. Purpose

This document provides technical standards, specifications, guidance, and quality control criteria for performing Global Positioning System (GPS) surveys in support of photogrammetric mapping and engineering activities.

2. Reference(s)

a. Challstrom, C. W., 1991: Federal Geodetic Control Classification Standards Revision for Network Upgrades, GIS/LIS 1991.

b. Hoyle, D., 1992: Unpublished Correspondence, St. Paul, MN.

c. Hull, W. V., (Federal Geodetic Control Subcommittee), 1988, (Reprinted 1989): Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, National Geodetic Information Center, NOAA, Silver Spring, MD.

d. Rapp, R. H., 1984: Geometric Geodesy Part 1, The Ohio State University, Department of Geodetic Science and Surveying, Columbus, OH.

e. Wisconsin Department of Transportation, 1992: Request For Proposal on Establishment of a High Precision Geodetic Network Using GPS Technology for Dodge, Jefferson, and Rock Counties, WI, Madison, WI.

3. Applicability

This document applies to all Bureau Offices, Districts, and consultants performing surveys with the Global Positioning System (GPS) in support of geodetic, engineering and photogrammetric mapping activities.

4. Reconnaissance

A number of factors affect the performance of GPS and the final coordinate position. These factors include the following:

- Setup errors (pole tips and level/data collector) bracket.
- Obstructions.
- Satellite geometry.
- Observation time.
- Resolution of correct set of integer ambiguities (initialization).
- Topography (range of communication link).
- Weather.
- Field survey procedures.
- Quality of control stations.
- Equipment configuration.
- Radio frequency interference.

Site selection is a key element in reducing the time required for planning GPS surveys and post-processing and analyzing GPS observational data. The following guidelines shall be used for determining the optimal location of newly established survey stations and the potential use of existing stations:

- At normal antenna height, having a clear view above 15 degrees above the horizon for 360 degrees in azimuth.
- Where not likely to be disturbed.
- On stable ground.
- Readily accessible by vehicle.
- Avoid tall artificial and natural reflective structure or surfaces that would project above the antenna ground plane.
- Anticipate future road construction and tree growth.
- Provide adequate site distances for conventional survey methods.
- Adhere to airport requirements.
- Ensure safety of surveyors and others.
- Avoid radio towers, high transmission lines, and other sources of radio frequency (RF) interference.
- Off of the traveled portion of a road but within highway right-of-way or other public property (e.g., parks).
- In the event power lines are not avoidable, place on the opposite side of the road from power lines such that the lines are below 15 degrees above the horizon.

5. Standards

Standards are utilized to classify the accuracy of the survey. Standards consist of position closure requirements and relative error ellipse values (line accuracies). Standards are driven by the project requirement and not the technology. Before a survey is certified it must satisfy the Relative Line Accuracy (RLA) requirements set forth in Table 1. B Order geometric accuracy standards were subdivided into three classes of 1, 2, and 4 ppm (Challstrom, 1991 and WIDOT, 1992) (Table 1). These additional orders of accuracies bridge the gap between the FGCS B and First Order accuracy standards. The survey control established under the guidance of these standards and specifications is not intended to be incorporated into the National Geodetic Reference System (NGRS).

Table 1 - Geometric Relative Positioning Accuracy Standards

Application	Conventional Accuracy Classification		Maximum Allowable Error (s)[a]		Proposed FGCS Accuracy Classification
	Order	Class	Base Error (m)	ppm	
Densification of HARN - Multi County	B	I	0.008	1	2 cm
Densification of HARN - County	B	II	0.008	2	2 cm
Densification of HARN - Township	B	III	0.008	4	2 cm
Geodetic Surveys (Engineering and Project)	First		0.010	10	5 cm
Section Corners	Second	I	0.010	20	1 dm
Section Corners and Photogrammetric Targets	Second	II	0.010	50	1 dm
Local Control	Third		0.010	100	2 dm

5.1. Table 1 - Legend

HARN: High Accuracy Reference Network
m: meters
ppm: parts per million (mm/km)
mm: millimeters
cm: centimeter
dm: decimeter
m: meter
km: kilometers

5.2. Table 1 - Footnotes

a: All connected and unconnected baselines (vectors) within the minimally constrained and constrained network adjustments shall comply with the 3-D relative positional error (s) required for the desired classification.

$$s = \sqrt{e^2 + (d * p * 10^{-6})^2}$$

s = Maximum allowable relative positional error (m) at the 95% (2σ) confidence level.
e = Base error in meters (m)
p = ppm for that classification (e.g. B Order, Class II, 2 ppm)
d = Distance in meters (m)

6. Specifications

Specifications are the procedures and processing guidelines that must be followed in order to satisfy a specific accuracy Classification. Specifications evolve with technology and the development of innovative techniques. The specifications were subdivided into data acquisition, data analysis, and data submittal sections.

6.1. Data Acquisition Specifications

Different GPS survey techniques (e.g. static, rapid/fast static, etc.) can be utilized with these specifications. Specifically, each technique is described as follows:

Static Relative Positioning Technique:

- Most reliable of all relative positioning techniques.
- Using dual-frequency receivers, the technique is applicable for A- through third-orders of accuracy.
- Using single-frequency receivers, the technique is applicable for first- through third-orders of accuracy.
- Consists of at least two receivers remaining stationary during the observation period.
- Requires simultaneous observation of a minimum of four common satellites at two or more stations to obtain reliable resolution of integer ambiguities.
- Occupation time at station(s) is dependent on distance between stations, ionospheric activity, and model of GPS receiver. An approximate guideline for occupation times for static positioning is approximately 60 minutes for every 10 km of distance separating the stations.

Rapid/Fast Static Relative Positioning Technique:

- This technique is applicable for first- through third-orders of accuracy.
- Consists of at least two receivers remaining stationary or one receiver remaining stationary and one (or more) receivers roving during the observation period.
- Requires simultaneous observation of a minimum of five common satellites at two or more stations to obtain reliable resolution of integer ambiguities.
- Occupation time at station(s) is dependent on distance between stations, and model of GPS receiver. Occupation times at station(s) may vary between 5 and 30 minutes.
- Generally is effective for baseline distances less than 25 km.

Kinematic Relative Positioning Technique:

- This technique is applicable for second- and third-orders of accuracy.
- Consists of one or more receivers remaining stationary and one or more receivers roving during the observation period.
- Requires lock on a minimum of five satellites.
- Depending on the GPS receiver hardware, firmware, and software, loss of lock can be tolerated since this technique is capable of determining the integer ambiguities instantaneously.
- Occupation time at remote station(s) is generally a few seconds to a few minutes.
- Generally is effective for areas with no visual obstructions projecting more than 15 degrees above the horizon.

Table 2 illustrates the suggested guideline for the order of accuracy and specification.

Table 2 - GPS Relative Positioning Data Acquisition Specifications

Specifications	B Order			First Order	Second Order		Third Order
	Class I	Class II	Class III		Class I	Class II	
Geometric Relative Accuracy Standard	1 ppm	2 ppm	4 ppm	10 ppm	20 ppm	50 ppm	100 ppm
1. Horizontal Control							
1. Minimum number of connections to known control	3[a]	3[a]	3[a]	3[a]	3[a]	3[a]	3[a]
2. Vertical Control							
1. Minimum number of connections to known control	5[b]	5[b]	5[b]	5[b]	4[b]	4[b]	4[b]
3. Station Spacing							
1. Minimum station spacing (km)	20[c]	10[c]	3[c]	0.4[c]	0.15[c]	0.15[c]	0.15[c]
2. Maximum station spacing (km)	50[c]	20[c]	10[c]	10[c]	5[c]	3[c]	1[c]
4. Location of Known Control							
1. Number of quadrants relative to the center of the project	4	4	4	3	3	3	3
5. Dual Frequency Observations (L1 and L2) Required	Y[d]	Y[d]	Y[d]	Y[d]	OP[d]	OP[d]	OP[d]
6. Required Number of Receivers Observing Simultaneously (not less than)	4	4	4	3[e]	2	2	2
7. Satellite Observations							
1. Geometric Dilution of Precision (GDOP)	MG[f]	MG[f]	MG[f]	MG[f]	MG[f]	MG[f]	MG[f]
2. Period of observation session required	MG[g]	MG[g]	MG[g]	MG[g]	MG[g]	MG[g]	MG[g]
3. Number of satellites tracking simultaneously continuously during entire session	5	5	5	5	5	5	5

Table 2 - GPS Relative Positioning Data Acquisition Specifications							
Specifications	**B Order**			**First Order**	**Second Order**		**Third Order**
	Class I	Class II	Class III		Class I	Class II	
Geometric Relative Accuracy Standard	1 ppm	2 ppm	4 ppm	10 ppm	20 ppm	50 ppm	100 ppm
4. Number of quadrants signals shall be available during entire observing session	3	3	3	3	3 or 2[h]	3 or 2[h]	3 or 2[h]
5. Maximum angle (degrees) above horizon for obstructions	20	20	20	20	20-40	20-40	20-40
6. Minimum observation angle (degrees)	15	15	15	15	15	15	15
7. Data sampling rate (sec)	MG[i]	MG[i]	MG[i]	MG[i]	MG[i]	MG[i]	MG[i]
8. Re-observation times must differ	Y[j]	Y[j]	Y[j]	Y[j]	Y/OP[j]	Y/OP[j]	Y/OP[j]
8. Independent Occupations per Station 1. Three or more (percent of all known and new stations, not less than)	20[k]	20[k]	20[k]	10[k]	0	0	0
2. Two or more (percent of new stations, not less than)	50[l]	50[l]	50[l]	30[l]	30[l]	30[l]	30[l]
3. Two or more (percent of known vertical control stations, not less than)	100[k]	100[k]	100[k]	100[k]	100[k]	100[k]	100[k]
4. Two or more (percent of known horizontal control stations, not less than)	50[m]	50[m]	50[m]	30[m]	30[m]	30[m]	30[m]
5. Between occupations, tripod must be removed and reset	Y	Y	Y	Y	Y	Y	Y
6. Two or more occupations on all stations (reference - azimuth stations or eccentric stations)	Y	Y	Y	Y[n]	Y[n]	Y[n]	Y[n]
7. At least two independent vectors required for each station	Y	Y	Y	Y	Y	Y	Y

Table 2 - GPS Relative Positioning Data Acquisition Specifications							
Specifications	**B Order**			**First Order**	**Second Order**		**Third Order**
	Class I	Class II	Class III		Class I	Class II	
Geometric Relative Accuracy Standard	1 ppm	2 ppm	4 ppm	10 ppm	20 ppm	50 ppm	100 ppm
9. Repeat Baselines 1. Approximate equal number in N-S and E-W directions, minimum not less than (percent of independent baselines)	5[o]	5[o]	5[o]	5[o]	OP[o]	OP[o]	OP[o]
2. Repeat baseline measurements for station pairs (reference-azimuth stations or eccentric stations)	Y	Y	Y	Y[n]	Y[n]	Y[n]	Y[n]
10. Antenna Set-up 1. Number of antenna phase center height measurements per session, not less than	2[p]	2[p]	2[p]	2[p]	2[p]	2[p]	2[p]
2. Tribrachs and/or other centering devices shall be checked and adjusted	Y[q]	Y[q]	Y[q]	Y[r]	Y[r]	Y[r]	Y[r]
3. Height of Instrument (HI) in metric and English	Y[s]	Y[s]	Y[s]	Y[s]	Y[s]	Y[s]	Y[s]
4. Independent plumb bob check required	Y[t]	Y[t]	Y[t]	Y[t]	OP	OP	OP
11. Photograph and Pencil Rubbing Required	Y[u]	Y[u]	Y[u]	Y[u]	OP	OP	OP
12. Meteorological Observations Required	Y[v]	Y[v]	Y[v]	Y[v]	Y[w]	Y[w]	Y[w]
13. Field Data Logs Required	Y[y]	Y[y]	Y[y]	Y[y]	Y[z]	Y[z]	Y[z]
14. Maximum Elevation Angle (degrees) Between Operator and/or Vehicle and Antenna	5	5	5	5	5	5	5

6.1.1. Table 2 - Legend

Y: Yes (required)
OP: Optional
MG: Manufacturers Guidelines
m: meters
km: kilometers
ppm: parts per million

6.1.2. Explanation of Table 2 (Specifications, Footnotes, Discussion and Examples)

Specification: *1. Horizontal Control.*

1. Minimum number of connections to known control.

Footnote: a: ***The minimum number of horizontal control connections is three (3) for all Orders of accuracies. The connections between the control stations and unknown stations shall be formed to ensure that all control stations influence (through direct or indirect observations) the unknown stations.*** Two survey techniques (network, traverse) are used to ensure redundancy and increase reliability of the survey. The network or traverse should consist of a minimum of three known horizontal control stations.

- *Network.* A network consists of a closed polygon where vectors (baselines) connect known and unknown stations. The known control stations should be situated in different quadrants (cardinal directions) relative to the center of the project. The network method is required for B and First Order surveys and optional for all other order surveys.
- *Traverse.* Traverses are an effective method of establishing engineering quality survey control for transportation projects. A minimum of three known stations is required when performing a traverse. Two of the known stations form the beginning and the terminus of the traverse line. The third known station should be located perpendicular to the traverse line and near the center of the project area. The traverse method is an optional approach to Second and Third Order surveys.

The known stations must be of equal or greater classification (B, First, Second, Third Order) than the control that is to be established. The known control stations can be "acceptable" Wisconsin Department of Transportation (WIDOT), National Geodetic Survey (NGS), County or United States Army Corps of Engineers (USACE) control.

Discussion: Depending upon the accuracy standard a minimum of three (3) control stations shall be used to control the network to be surveyed. When possible, other control stations should be used to assist in strengthening the network and isolating errors between control stations and observations. The known stations must be of equal or greater classification (B, First, Second, Third Order) than the control that is to be established. The known control stations can be "acceptable" WIDOT, NGS, County, or USACE control. Two survey techniques (network and traverse) are used to ensure redundancy and increase reliability of the survey. It is not advisable to use the "rover" survey technique where one (1) or more base stations are established and one (1) rovers are used to position section corners. This "rover" survey technique does not provide adequate connections between stations, which weakens network geometry and hence blunders and/or errors are not adequately detected.

Example: To be included at a later date.

Specification: 2. Vertical Control.

1. Minimum number of connections to known control.

Footnote: b: The vertical control must be distributed in a least three quadrants relative to the center of the project. ***The establishment of vertical control using GPS is currently a developmental effort and should be used with caution for production purposes.***

Discussion: Depending on the accuracy standard the specification requires a minimum of four (4) vertical control stations, which must be distributed in a least three quadrants relative to the center of the project. The accuracy of the orthometric heights established will be dependent upon the number of vertical control stations (i.e. benchmarks), accuracy of previously derived orthometric height, availability of an accurate geoid model, and size of project area in relation to existing vertical control.

Example: To be included at a later date.

Specification: 3. Station Spacing.

1. Minimum station spacing (km) and 2. Maximum station spacing (km).

Footnote: c: Depending on the application, the user may need to extend the distance to achieve required positional accuracy for Second and Third Order.

Discussion: The specification requires that stations be established at specific intervals to satisfy relative line accuracy requirements.

Example: To be included at a later date.

Specification: 4. Location of Known Control.

1. Number of quadrants relative to the center of the project.

Footnote: Not applicable.

Discussion: The specification requires known control to be equally distributed in three quadrants relative to the center of the project. This will ensure proper network geometry.

Example: To be included at a later date.

Specification: 5. Dual Frequency Observations (L1 and L2) Required.

Footnote: d: Dual frequency observations are required for all baselines in excess of 10 km. When performing surveys using the rapid/fast static technique the user must follow the equipment and software guidelines of the manufacturer.

Discussion: This specification is required to reduce the effect of error caused by ionospheric refraction.

Example: Not applicable.

Specification: *6. Required Number of Receivers Observing Simultaneously (not less than).*

Footnote: e: When reference - azimuth stations or eccentric stations are observed the requirement is two (2) receivers.

Discussion: The specification requires a minimum of four (4), three (3) and two (2) GPS receivers observing simultaneously for B Order, Class I through B Order Class III, First Order and Second Order through Third Order accuracies respectively. For Second and Third Order accuracies three (3) receivers is more practical and four (4) receivers is more efficient for production.

Example: Not applicable.

Specification: *7. Satellite Observations.*

1. Geometric Dilution of Precision (GDOP).

Footnote: f: The GDOP should follow manufacturer's guidelines.

Discussion: The specification suggests the user follow the manufacturer's guidelines for GDOP.

Example: Not applicable.

2. Period of observation session required.

Footnote: g: The period of the observation session is dependent upon the receiver manufacturer recommendations, distance (length) between stations and the user's experience with their hardware, firmware, and post-processing software.

Discussion: The specification does not require a specific amount of time over the mark for recording observations. The period of the observation session will be dependent upon the receiver manufacturer recommendations and the user's experience with their hardware, firmware, and post-processing software.

Example: Depending on the GPS hardware, firmware and software, and the distance between observing stations observation times can range from 2 minutes to several hours. For example, a 1 ppm survey with baselines up to 50 km should observe satellites for approximately 2.5 - 4 hrs or with baselines up to 2 km should observe up to 5 minutes.

3. Number of satellites tracking simultaneously continuously during entire observing session.

Footnote: Not applicable.

Discussion: This specification ensures an adequate number of satellites in the event signals are pre-empted because of blockage.

Example: Not applicable.

4. Number of quadrants signals shall be available during entire observing session.

Footnote: h: Satellites should pass through quadrants diagonally opposite each other (FGCC, 1988)

Discussion: To be completed at a later date.

Example: Not applicable.

5. Maximum angle (degrees) above horizon for obstructions.

Footnote: Not applicable.

Discussion: Depending on the accuracy standard the specification requires that obstructions be 20-40 degrees or less above the horizon. The specification ensures that the user does not observe in heavily obstructed areas however, judgment should be used in determining if quality data can be obtained. As an example, it might be permissible to observe a mark if no satellites are in the area of the obstruction.

Example: Not applicable.

6. Minimum observation angle (degrees).

Footnote: Not applicable.

Discussion: The specification requires a minimum observation angle of 15 degrees. Most manufacturers do not recommend tracking satellites below 15 degrees.

Example: Not applicable.

7. Data sampling rate (sec).

Footnote: i: The data sampling rate will be dependent on the manufacturer's guidelines.

Discussion: The specification requires the user to follow the recommendations of the manufacturers. This rate can be either 5, 10, 20, or 30 seconds depending upon the survey technique used.

Example: As an example, a 5 second recording interval is used for fast/rapid static positioning techniques.

8. Re-observation times must differ.

Footnote: j: Re-observation times must differ by tracking a constellation that includes a minimum of two (2) different satellites, which were not tracked in the previous occupation. In addition, the observation times between occupations must differ by at least one (1) hour. The processing of session observational data shall include all satellites with only satellites that present problems be deleted. For First Order, this requirement only applies to azimuth marks established with HARN densification stations.

This specification must be satisfied when kinematic relative positioning techniques are used for Second and Third Order surveys.

Discussion: The specifications do require a separation between the times of re-occupation of the stations. It is recommend in order to satisfy the Independent Occupations specification that the user occupy the mark approximately an hour or more later to ensure a change in the constellation.

Example: As an example, if stations 101, 102, 103 and 104 are occupied from 1000 - 1130 hours of Day 1 then each of those stations can be occupied after 1230 hours of Day 1 to satisfy this specification.

Specification: *8. Independent Occupations per Station.*

1. Three or more (percent of all known and new stations, not less than).

Footnote: k: The number (i.e. three or more and two or more) of independent occupations per stations shall be equally distributed throughout the project area.

Discussion: This specification ensures the survey network has adequate redundancy and uniformity, and with assisting in isolating blunders and/or errors.

Example: As an example, using B Order Class II (2 ppm), if a project has 5 known stations and 10 new (unknown) stations, then the percent of three or more occupations would equal (5 + 10) * .20 (i.e. 20%) = 3 stations. Therefore, 3 stations (known, new or combination thereof) shall be occupied at least three or more times and be equally distributed throughout the project area.

2. Two or more (percent of new stations, not less than).

Footnote: l: The number (i.e. two or more) of independent occupations per stations shall be equally distributed throughout the project area. For kinematic positioning techniques the requirement is 100%.

Discussion: This specification ensures the survey network has adequate redundancy and uniformity, and with assisting in isolating blunders and/or errors.

Example: As an example, using Second Order, Class II (50 ppm), if a project has 28 new (unknown) stations, then the percent of two or more occupations would equal (28) * .30 (i.e. 30%) = 8.4 or 9 stations. Therefore, 9 stations (new) shall be occupied at least two or more times and be equally distributed throughout the project area.

3. Two or more (percent of known vertical control stations, not less than).

Footnote: k: The number (i.e. two or more) of independent occupations per stations shall be equally distributed throughout the project area.

Discussion: This specification ensures the survey network has adequate redundancy and uniformity, and with assisting in isolating blunders and/or errors. In addition, the specification ensures that a higher order of accuracy can be achieved in elevation.

Example: For all Orders of accuracies each vertical station must be occupied at least two times.

4. Two or more (percent of known horizontal control stations, not less than).

Footnote: m: The number (i.e. two or more) of independent occupations per stations shall be equally distributed throughout the project area. For kinematic positioning techniques the requirement is 50%.

Discussion: This specification ensures the survey network has adequate redundancy and uniformity, and with assisting in isolating blunders and/or errors.

Example: As an example, using Second Order, Class II (50 ppm), if a project has 5 known stations, then the percent of two or more occupations would equal (5) * .30 (i.e. 30%) = 1.5 or 2 stations. Therefore, 2 stations (known) shall be occupied at least two or more times and be equally distributed throughout the project area.

5. Between occupations, tripod must be removed and reset.

Footnote: Not applicable.

Discussion: The specification requires the tripod (or similar device) to be removed and reset over the mark between occupations. This specification reduces the possibility of any errors in measuring height of instrument and centering over mark.

Example: Not applicable.

6. Two or more occupations on all stations (reference - azimuth stations or eccentric stations).

Footnote: n: Two or more occupations on all stations (reference - azimuth stations or eccentric stations) is not required when there are two independent vectors at each station with one vector observed between reference-azimuth stations.

Discussion: The specification requires two (2) or more occupations on all reference to azimuth stations or eccentric stations established. This requirement is waived if two or more independent vectors are at each station with one vector observed between reference-azimuth stations.

Example: Not applicable.

7. At least two independent vectors required for each station.

Footnote: Not applicable.

Discussion: The specification requires at least two (2) independent vectors connected to each station. This requirement will not allow "radial" type surveys to be performed.

Example: Not applicable.

Specification: 9. Repeat Baselines.

1. Approximate equal number in N-S and E-W directions, minimum not less than (percent of independent baselines).

Footnote: o: An equal number of the repeat baselines must be distributed in the cardinal directions (north-south and east-west). In addition to the aforementioned requirements, it is required that the repeat baselines be evenly distributed throughout the project area. For rapid/fast static or kinematic positioning techniques the requirement is 5%.

Discussion: To be completed at a later date.

Example: To be completed at a later date.

2. Repeat baseline measurements for station pairs (reference-azimuth stations or eccentric stations).

Footnote: n: Two or more occupations on all stations (reference - azimuth stations or eccentric stations) is not required when there are two independent vectors at each station with one vector observed between reference-azimuth stations.

Discussion: To be completed at a later date.

Example: To be completed at a later date.

Specification: 10. Antenna Set-up.

1. Number of antenna phase center height measurements per session, not less than.

Footnote: p: The required number of measurements shall be two (2); one set of measurements at the beginning and one set of measurements at the end of each occupation. A set shall include one measurement in Metric and one measurement in English. If a Constant Height GPS Pole is used the user shall check the levels at the beginning, middle, and end of the observing session.

Discussion: This specification will minimize the blunders resulting from improper height of instrument measurements.

Example: Not applicable.

2. Tribrachs and/or other centering devices shall be checked and adjusted.

Footnote: q: Tribrachs and/or other centering devices shall be checked and adjusted (if necessary) at least every day of observation for Order B surveys. In lieu of this calibration, a Constant Height GPS Pole can be used and shall be calibrated if all three (3) bubbles are not centered.

r: Tribrachs and/or other centering devices shall be checked and adjusted (if necessary) at the beginning and the end of the project. In lieu of this calibration, a Constant Height GPS Pole can be used and shall be calibrated if all three (3) bubbles are not centered.

Discussion: To be completed at a later date.

Example: Not applicable.

3. Height of Instrument (HI) in metric and English.

Footnote: s: Antenna phase center shall be measured from station mark in meters (to mm) and feet (to hundredths of ft) or inches (to tenths of in). HI shall be measured and indicated on log sheet as either slant or vertical distance. This requirement is waived if a Constant Height GPS Pole is used. If a fixed height tripod pole is used the following information must be recorded:

- Vertical height of antenna (pole height plus antenna phase center).
- Pole height.
- Phase center offset.
- Fixed height pole (tripod) manufacturer.

Discussion: To be completed at a later date.

Example: Not applicable.

4. Independent plumb bob check required.

Footnote: t: Independent check of tribrachs and/or other centering devices shall be performed before, during, and after each mark observation session using a heavy weight plumb bob.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *11. Photograph and Pencil Rubbing Required.*

Footnote: u: A photograph and pencil rubbing is only required when the monument is either in bedrock; or an approved concrete pedestal; or an approved 3-D drivable. The photograph shall illustrate the tripod in position over the mark and vehicle location (if used) during the observation period.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *12. Meteorological Observations Required.*

Footnote: v: Meteorological data gathered at each mark observation shall meet the following:

- Weather data (pressure, relative humidity and temperature) for each session shall be recorded at the beginning and at the end of each GPS session.
- Temperature shall be measured and recorded to the nearest ± 1 Centigrade (°C).
- Pressure shall measured and recorded to the nearest ± 1 millibar (mb).
- Relative humidity shall recorded to the nearest ± 5 percent (%). Relative humidity can be measured or obtained from another source for that specific day and general location of the GPS observation session.
- Note weather conditions (i.e. wind, clouds, rain, snow, etc.) and rate of occurrence (e.g. 15 mph, partly cloudy, light, heavy, etc.) respectively, if present during the GPS observation session.
- Note any unusual weather conditions (i.e. passing thunderstorms, lightning, etc.).

w: Visual recording of weather data during observation session.

Discussion: Visual recording of weather data could include the following: approximate temperature, wind conditions, visual observation (i.e. partly cloudy), precipitation conditions (i.e. rain), and storm activity. This information will assist the data processor in determining if weather had any effect on the resolution of the baseline processing.

Example: Not applicable.

Specification: *13. Field Data Logs Required.*

Footnote: y: Field data logs shall be maintained with, but not necessarily limited to, the following information for each master station occupation (see Attachment ***):

- Date.
- Station name.
- Session number.
- Start time and end time (UTC).
- Receiver and antenna make, model and serial numbers.
- Operator's name.

- Height of instrument as per these specifications.
- Meteorological measurements as per these specifications.
- Receiver calculated latitude, longitude and ellipsoidal height; satellites being tracked and their respective health status; and PDOP at the beginning and end of each GPS observation session.
- Note any unusual data while monitoring the receiver.

z: Field data logs shall be maintained with, but not necessarily limited to, the following information for each master station occupation (see Attachment ***):

- Date.
- Station name.
- Session number.
- Start time and end time (UTC).
- Receiver and antenna make, model and serial numbers.
- Operator's name.
- Height of instrument as per these specifications.
- Meteorological data as per these specifications.
- Note any unusual data while monitoring the receiver.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *14. Maximum Elevation Angle (degrees) Between Operator and/or Vehicle and Antenna.*

Footnote: Not applicable.

Discussion: The specification requires a maximum elevation of 5 degrees between operator and/or vehicle and the receiver's antenna to minimize signal blockage and multipath.

Example: Not applicable.

6.2. Data Analysis Specifications

Prior to performing a minimally constrained and constrained adjustment the network or traverse should be analyzed for possible outliers using loop closures, analysis of repeat baselines, and comparison of known and observed baselines. To facilitate in detecting the source of the blunder (height of instrument, centering errors, etc.), vectors should be displayed in northing, easting, upping (ΔN, ΔE, ΔU) or azimuth, distance and height ($\Delta\alpha$, Δs, Δh) or geodetic latitude, longitude, and height ($\Delta\phi$, $\Delta\lambda$, Δh).

Table 3 outlines the requirements for the post-processing, analyzing, and adjusting of GPS observational data relative to the HARN.

Table 3 - GPS Relative Positioning Data Analysis Specifications							
Specifications	**B Order**			**First Order**	**Second Order**		**Third Order**
	Class I	Class II	Class III		Class I	Class II	
Geometric Relative Accuracy Standard	1 ppm	2 ppm	4 ppm	10 ppm	20 ppm	50 ppm	100 ppm
1. Precise Ephemerides	Y	OP	OP	OP	NR		
2. Processing Requirements	MG[a]	MG[a]	MG[a]	MG[a]	MG[a]		
3. Loop Closure Requirements 1. Baselines from independent observing sessions, not less than	2[b]	2[b]	2[b]	2[b]	DES[o]		
2. Loop length, not to exceed (km)	400	100	50	50	DES[o]		
3. Loop length, minimum (km)	340	85	42	34	DES[o]		
4. Number of loop closures required per project	2[c]	2[c]	2[c]	2[c]	DES[o]		
5. Maximum misclosure for any single loop (ppm)	0.5[d]	1.0[d]	2.0[d]	5.0[d]	DES[o]		
6. Maximum average project loop misclosure (ppm)	0.3[d]	0.7[d]	1.3[d]	3.3[d]	DES[o]		
7. Maximum misclosure in any component, not to exceed (m)	.10	.10	.10	.10	DES[o]		
4. Baseline Closures 1. Differences between repeat unadjusted baselines computed and compared	Y[e]	Y[e]	Y[e]	Y[e]	Y[e]		
2. Differences between known and observed baselines computed and compared	Y[f]	Y[f]	Y[f]	Y[f]	Y[f]		
5. Relative Line Accuracy	F[g]	F[g]	F[g]	F[g]	F[g]		

Table 3 - GPS Relative Positioning Data Analysis Specifications							
Specifications	**B Order**			**First Order**	**Second Order**		**Third Order**
	Class I	Class II	Class III		Class I	Class II	
Geometric Relative Accuracy Standard	1 ppm	2 ppm	4 ppm	10 ppm	20 ppm	50 ppm	100 ppm
6. Blunder Detection Scheme	Y[h]	Y[h]	Y[h]	Y[h]	Y[h]		
7. Three Dimensional Adjustment	Y	Y	Y	Y	Y		
8. Absolute Residual in Minimally Constrained Adjustment	F[i]	F[i]	F[i]	F[i]	F[i]		
9. Control Position Closures	Y[j]	Y[j]	Y[j]	Y[j]	Y[j]		
10. Minimally Constrained Adjustment	Y[k]	Y[k]	Y[k]	Y[k]	Y[k]		
11. Constrained Adjustment	Y[l]	Y[l]	Y[l]	Y[l]	Y[l]		
12. Scalar (Covariance Matrix)	Y[m]	Y[m]	Y[m]	Y[m]	Y[m]		
13. Scale and Rotation (Control)	N	N	N	N	N[n]		

6.2.1. Table 3 - Legend

Y: Yes (required)
N: No (not required)
DES: Desirable
MG: Manufacturers Guidelines
F: Formula
m: meters
km: kilometers
ppm: parts per million

6.2.1. Explanation of Table 3 (Specifications, Footnotes, Discussion and Examples)

Specification: *1. Precise Ephemerides.*

Footnote: Not applicable.

Discussion: The precise ephemerides shall be used for A and B Order surveys and is optional for B Order, Class I and II and First Order surveys.

Example: Not applicable.

Specification: *2. Processing Requirements.*

Footnote: a: The consultant or agent of the State must present evidence that the guidelines published from the manufacturer provide adequate results. This evidence can be data from previous surveys or testing agencies such as the FGCS.

The consultant or agent of the State shall follow the guidelines published from the manufacturer in processing the observational data. ***Only non-trivial (independent) baselines shall be processed.*** Observation session shall be repeated if the percent of unacceptable baselines processed does not exceed 33 percent of the total number of baselines possible for each session.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *3. Loop Closure Requirements.*

1. Baselines from independent observing sessions, not less than

Footnote: b: Computational loops shall be composed of those baselines that close upon themselves in the shortest distance possible.

o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

2. Loop length, not to exceed (km)

Footnote: o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

3. Loop length, minimum (km)

Footnote: o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

4. Number of loop closures required per project

Footnote: c: At least two (2) loop closures for each survey project shall be performed to give a representative sample of the observations and data reductions performed. This requirement (of two loops) is waived if there are not enough stations to compute two loops. Loop closures shall be performed on those stations where the relative accuracy of the survey is questionable.

o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

5. Maximum misclosure for any single loop (ppm)

Footnote: d: The maximum misclosure for any loop and average misclosure for all loop closures performed for the project shall be computed as the sum of the squares of the misclosures in terms of loop length.

o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

6. Maximum average project loop misclosure (ppm)

Footnote: d: The maximum misclosure for any loop and average misclosure for all loop closures performed for the project shall be computed as the sum of the squares of the misclosures in terms of loop length.

o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

7. Maximum misclosure in any component, not to exceed (m)

Footnote: o: The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *4. Baseline Closures.*

1. Differences between repeat unadjusted baselines computed and compared

Footnote: e: Repeat baseline closures should be computed for each repeat baseline combination. The absolute value of the difference in each baseline component and the distance dependent error (part per million) are analyzed to determine if blunders exist. The difference in each vector component is compared to the rejection threshold (RT). The RT includes a base error and length dependent error that corresponds to the survey classification. In addition, the results of the repeat baseline measurements should be compared to the instrument specifications stated by the manufacturer.

$$RT_{ppm} = \frac{\sqrt{(e)^2 + (SC_{ppm} * d * 10^{-6})^2}}{d} * 10^6$$

e = Base error is 0.008 m for B Order and 0.010 m for First, Second, and Third Order.
SC_{ppm} = Survey Classification (i.e. B, First, Second, or Third Order).
d = Baseline distance in meters (m).

If the baseline component differences exceed the RT the baseline should be analyzed for possible blunders.

Discussion: This specification assists the user in identifying possible baseline outliers prior to an adjustment. Poor satellite geometry, insufficient occupation times, height of instrument and centering errors are possible sources that may cause outliers.

Example: As an example, a repeat baseline 804.674 m in length is surveyed at 20 ppm and has the following baseline component differences:

ΔX = -0.021 m
ΔY = -0.009 m
ΔZ = +0.011 m

The Rejection Threshold is as follows:

$$RT_{ppm} = \frac{\sqrt{(0.010)^2 + (20 * 804.674 * 10^{-6})^2}}{804.674} * 10^6 = 23.55\ ppm$$

The residual component differences in ppm is as follows:

ΔX = -0.021 m or $|\{(-0.021) \div (804.674)\} * 10^6| = 26.1$ ppm
ΔY = -0.009 m or $|\{(-0.009) \div (804.674)\} * 10^6| = 11.2$ ppm
ΔZ = +0.011 m or $|\{(+0.011) \div (804.674)\} * 10^6| = 13.7$ ppm

Therefore:

ΔX = 26.1 ppm > 23.6 ppm.....fails (possible blunder)
ΔY = 11.2 ppm < 23.6 ppm.....passes
ΔZ = 13.7 ppm < 23.6 ppm.....passes

2. Differences between known and observed baselines computed and compared

Footnote: f: Similar to the repeat baseline closures, known minus observed baseline closures provide insight on the location and possible cause of outliers. The differences between the known vector and observed vector components are compared to the same rejection threshold presented for repeat baseline closures.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *5. Relative Positioning Accuracy.*

Footnote: g: Relative Line Accuracy (RLA) (2σ) is computed by dividing the semi major axis (a) of the relative error ellipse by the spatial distance between the point (D). The RLA estimate can only be computed from performing a least squares adjustment or comparative estimation algorithm (Kalman filtering). A RLA must be computed and comply for all observed baselines.

Relative Line Accuracy

$$RLA_{ppm} = a/D_{AB}\ (10^6)$$

Symbol Definition

RLA_{ppm} = Relative Line Accuracy
a = Semi major axis of the relative error ellipse
D_{AB} = Distance between stations "A" and "B"

In order to satisfy the accuracy Standards outlined in Table 1, the line accuracy estimate for all lines must comply with the line accuracy listed in Table 1.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *6. Blunder Detection Scheme.*

Footnote: h: The adjustment software must perform the global variance test (Chi Square) and utilize a blunder detection scheme (i.e. Tau test) that tests the standardized (normalized) residuals. The global variance test and blunder detection scheme must be evaluated at a probability of 0.95 (95%).

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *7. Three Dimensional Adjustment.*

Footnote: Not applicable.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *8. Absolute Residual in a Minimally Constrained Adjustment.*

Footnote: i: The absolute value of the residual (v_o) and normalized residual (v_o/σ_v) for each vector component are analyzed for possible outliers. The absolute value of the residual ($|v_o|$) for each baseline component is compared to a defined threshold (v_c). The threshold equals an offset plus a length dependent error. The offset accounts for centering errors. The residual test provides the user a guideline of possible outliers.

Residual Test

$$v_c = \sqrt{(e)^2 + (SO_{ppm} * d * 10^{-6})^2}$$

SO_{ppm} = The lowest station order within the pair.
e = Base error is 0.010 m.
d = Baseline distance in meters (m).

Rejection Threshold

$$|v_o| \geq v_c$$

If the absolute residual computed in the minimally constrained adjustment (v_o) exceeds the threshold residual (v_c) the observation should be inspected for possible blunders and resolved.

In addition to the residual test, it is recommended that the normalized residuals be inspected for possible blunders using a blunder detection scheme (i.e. Tau Test).

Discussion: To be completed at a later date.

Example: As an example, a baseline 1340.560 m in length is surveyed between 4 ppm and 20 ppm stations and has the following residuals:

v_x = +0.003 m
v_y = -0.031 m
v_z = +0.017 m

The Residual Threshold is as follows:

$$v_c = \sqrt{(0.010)^2 + (20 * 1340.560 * 10^{-6})^2} = 0.029\,m$$

Therefore:

v_x = |+0.003 m| < 0.029.....passes
v_y = |-0.031 m| ≥ 0.029.....fails (possible outlier)
v_z = |+0.017 m| < 0.029.....passes

Specification: *9. Control Position Closures.*

Footnote: j: The Position Closure is computed by performing a minimally constrained adjustment and comparing the remaining known stations to their published values. A minimally (free) constrained adjustment consists of fixing the known latitude, longitude, and height of one station in the adjustment. Position Closure Estimates (PCE_{ppm}) provide the user an estimate of the quality of their known control. However, the user must realize that a "poor" PCE may also indicate an error in the GPS observations. Therefore, it is imperative that both the PCE and the Relative Line Accuracy (RLA) estimates are utilized to determine the quality of the survey. . A guideline for position closures was adopted to determine the integrity of the known survey control. The PCE includes a base error and the published Station Classification (SC_{ppm}).

Position Closure Estimate

$$PCE_{ppm} = \frac{\sqrt{(e)^2 + (SC_{ppm} * d * 10^{-6})^2}}{d} * 10^6$$

SC_{ppm} = Station Classification.
e = Base error is 0.010 m.
d = Distance between known stations in meters (m).

The PCE_{ppm} is compared to the computed Positional Errors (PE_{ppm}) for each known station in the minimally constrained adjustment.

Position Error***

$$PE_{ppm} = \frac{\sqrt{(\Delta\phi)^2 + (\Delta\lambda)^2 + (\Delta h)^2}}{d} * 10^6$$

$$\Delta\phi\,(m) = \frac{(a * (1 - e^2))}{\sqrt{(1 - e^2 * \sin^2\phi_m)^3}} * (\phi_c - \phi_p)_{rads} \quad (Rapp, 1984)$$

$$\Delta\lambda\,(m) = \frac{a * \cos\phi_m}{\sqrt{1 - e^2 * \sin^2\phi_m}} * (\lambda_c - \lambda_p)_{rads} \quad (Rapp, 1984)$$

d = Distance between known stations in meters (m).
Δh (m) = $h_c - h_p$
h_c = Computed ellipsoid height in meters (m).
h_p = Published ellipsoid height in meters (m).
a = Semi-major axis of the reference ellipsoid in meters (m).
e^2 = Square of the eccentricity of the reference ellipsoid in meters (m).
ϕ_c = Computed latitude for the minimally constrained adjustment in rads.
ϕ_p = Published latitude in rads.
λ_c = Computed longitude for the minimally constrained adjustment in rads.
λ_p = Published longitude in rads.

$$\phi_m = Mean\ latitude: \frac{(\phi_c + \phi_p)}{2} \quad (degrees)$$

Rejection Criteria

If the PE exceeds the PCE, the integrity of the known control should be verified and the results from the loop closures, repeat baseline analysis, known minus computed baselines, and residual test should be inspected for possible blunders.

$$PE_{ppm} \geq PCE_{ppm}$$

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *10. Minimally Constrained Adjustment.*

Footnote: k: Two (2) minimally constrained adjustments shall be performed which follows the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data". One adjustment shall be unscaled and the other scaled (scalar applied).

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *11. Constrained Adjustment.*

Footnote: l: A constrained scaled adjustment shall be supplied which follows the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data".

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *12. Scalar (Covariance Matrix).*

Footnote: m: Immediately following the blunder detection of the minimally constrained adjustment, a scalar is applied to reflect proper weighting and to evaluate the adequacy of the variance of unit weight. The estimated variance factor sought for each adjustment is a value close to unity with no flagged residuals. Obtaining a scalar can be an iterative process with selection of initial scalar values influenced by prior experience with the manufacturer's equipment and software.

Discussion: To be completed at a later date.

Example: Not applicable.

Specification: *13. Scale and Rotation (Control).*

Footnote: n: Scale and rotation may be required when establishing control relative to the North American Datum of 1927 (NAD 27) or on the North American Datum of 1983 (1991) if existing control does not fit with processed GPS vectors. The entity performing the adjustments shall contact the agency for instructions before scale and rotation is applied.

Discussion: To be completed at a later date.

Example: Not applicable.

6.3. Data Submittal Specifications

The submittal section was developed for those agencies that use contractual assistance to obtain surveying services (WIDOT, 1992).

Table 4 - GPS Relative Positioning Data Submittal Specifications

Specifications	B Order			First Order	Second Order		Third Order
	Class I	Class II	Class III		Class I	Class II	
Geometric Relative Accuracy Standard	1 ppm	2 ppm	4 ppm	10 ppm	20 ppm	50 ppm	100 ppm
1. Project Report	Y[a]	Y[a]	Y[a]	Y[a]	Y[a]	Y[a]	Y[a]
2. Project Diagram	Y[b]	Y[b]	Y[b]	Y[b]	Y[b]	Y[b]	Y[b]
3. Project Instructions or Contract Specifications	Y[c]	Y[c]	Y[c]	Y[c]	Y[c]	Y[c]	Y[c]
4. Final Station Coordinate List	Y[d]	Y[d]	Y[d]	Y[d]	Y[d]	Y[d]	Y[d]
5. Session Observing Schedules	Y[e]	Y[e]	Y[e]	Y[e]	Y[e]	Y[e]	Y[e]
6. Loop Closures	Y[f]	Y[f]	Y[f]	Y[f]	DES[f]	DES[f]	DES[f]
7. Baseline Closures	Y[g]	Y[g]	Y[g]	Y[g]	Y[g]	Y[g]	Y[g]
8. Control Position Closures	Y[h]	Y[h]	Y[h]	Y[h]	Y[h]	Y[h]	Y[h]
9. Minimally Constrained Adjustment	Y[i]	Y[i]	Y[i]	Y[i]	Y[i]	Y[i]	Y[i]
10. Constrained Adjustment	Y[j]	Y[j]	Y[j]	Y[j]	Y[j]	Y[j]	Y[j]
11. Baselines Removed From Adjustments	Y[k]	Y[k]	Y[k]	Y[k]	Y[k]	Y[k]	Y[k]
12. Observation Logs	Y[l]	Y[l]	Y[l]	Y[l]	Y[l]	Y[l]	Y[l]
13. Photographs and/or Pencil Rubbings	Y[m]	Y[m]	Y[m]	Y[m]	OP[m]	OP[m]	OP[m]
14. Raw Phase Observational Data (R-files)	Y/OP[n]	Y/OP[n]	Y/OP[n]	Y/OP[n]	OP[n]	OP[n]	OP[n]
15. Baseline Vectors (G-file)	Y/OP[o]	Y/OP[o]	Y/OP[o]	Y/OP[o]	OP[o]	OP[o]	OP[o]
16. Project and Station Occupation (B-file)	Y/OP[p]	Y/OP[p]	Y/OP[p]	Y/OP[p]	OP[p]	OP[p]	OP[p]
17. Descriptions or Recovery Notes (D-file)	Y[q]	Y[q]	Y[q]	Y/OP[q]	OP[q]	OP[q]	OP[q]

6.3.1. Table 4 - Legend

Y: Yes (required)
N: No (not required)
OP: Optional
DES: Desirable
ppm: parts per million

6.3.2. Explanation of Table 4 (Specifications, Footnotes, Discussion and Examples)

Specification: *1. Project Report.*

Footnote: a: A project report shall be supplied in a binder and shall include all of the Submittal Items in the order listed under Table 4. The report shall address the entire project and shall include all of the specified Submittal Items under Table 4 and include, but not necessarily be limited to, the following:

1. Introduction. The Introduction shall include, but not necessarily be limited to, the following:
   - The number and type of stations/marks established.
   - The accuracy standards of the project.
   - Timeframe of project (i.e. arrival and departure dates of field survey and start and ending dates of data processing, adjustment and analysis).
   - Location of project.
   - The name, mailing address and phone number of the point of contact for which the survey was performed and for the organization that performed the services.
2. Personnel. Personnel involved in the data acquisition; data processing, data adjustment and data analysis; and project report shall be supplied.
3. Instrumentation. Describe the make, model and serial number of each receiver used on the project.
4. Software. Describe the software used to post-process, analyze and adjust the GPS observational data for this project.
5. Project Diagram. A project diagram (sketch) shall be supplied and can be referred to as an Attachment.
6. Project Instructions or Contract Specifications. Project instructions or contract specifications shall be supplied and can be referred to as an Attachment.
7. Horizontal Control Stations. A description of the horizontal control stations used for the project shall be supplied.
8. Vertical Control Stations. A description of the vertical control stations used for the project shall be supplied.
9. Final Station Coordinate List. A final station coordinate listing shall be shall be supplied and can be referred to as an Attachment. A

brief description on the content of the data shall be supplied in the report.

10. Session Observing Schedules. A narrative discussing any field acquisition problems shall be supplied in the report. Session observing schedules shall be supplied and can be referred to as an Attachment.
11. Data Processing Results. A narrative discussing the results of the processed observational data shall be supplied.
12. Loop Closures. A narrative discussing the results of loop closures shall be supplied in the report. Loop closures shall be supplied and can be referred to as an Attachment.
13. Baseline Closures. A narrative discussing the results of baseline closures shall be supplied in the report. Baseline closures shall be supplied and can be referred to as an Attachment.
14. Control Position Closures. A narrative discussing the results of control position closures shall be supplied in the report. Control position closures shall be supplied and can be referred to as an Attachment.
15. Minimally Constrained Adjustment. A narrative discussing the results of the minimally constrained adjustments shall be supplied in the report. Minimally constrained adjustments shall be supplied and can be referred to as an Attachment.
16. Constrained Adjustment. A narrative discussing the results of the constrained adjustments shall be supplied in the report. Constrained adjustments shall be supplied and can be referred to as an Attachment.
17. Baselines Removed From Adjustments. The listing of baselines removed from the adjustments and the reasoning used shall be supplied.
18. Observation Logs. Observation logs shall be supplied as an Attachment.
19. Photographs and/or Pencil Rubbings. Photographs and/or pencil rubbings shall be supplied as an Attachment.
20. Raw Phase Observational Data (R-files).
21. Baseline Vectors (G-file).
22. Project and Station Occupation Data (B-file).
23. Descriptions or Recovery Notes (D-file).

Specification: *2. Project Diagram.*

Footnote: b: A project diagram (sketch) shall be supplied which follows the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data". The diagram shall depict non-trivial (independent) baselines observed and the final baseline vectors used. The observed baselines shall be delineated by solid lines and the baselines removed (or not used) in the final constrained adjustment shall delineated by dashed lines.

Specification: *3. Project Instructions or Contract Specifications.*

Footnote: c: Project instructions or contract specifications shall be supplied and can be referred to as an Attachment.

Specification: *4. Final Station Coordinate List.*

Footnote: d: A final adjusted coordinate list shall be supplied which follows the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data". In addition, the final adjusted coordinate list shall include following: station name; geodetic coordinates in latitude, longitude and ellipsoidal height; state plane coordinates in X and Y in both meters and feet (using the U.S. Survey Foot); and the appropriate standard errors for each dimension of position in meters based on the appropriate NAD 83 (1991) state plane zone (as defined by NGS publication) on hard copy as well as in ASCII format MS/DOS formatted 3 1/2" HD discs or CD ROM.

Specification: *5. Session Observing Schedules.*

Footnote: e: A narrative discussing any field acquisition problems shall be supplied in the report. Session observing schedules shall be supplied and can be referred to as an Attachment.

Specification: *6. Loop Closures.*

Footnote: f: A table indicating the loop closures shall be supplied. The table shall include the following: stations forming the loop; calculated misclosure (in meters); length of loop (in meters); required and calculated misclosure (in ppm); and vector information (i.e. session and day). A report discussing if the loop closures satisfied the specifications or not shall be supplied.

The specification is desirable for Second and Third Order surveys only if the user cannot automatically (through software routine) calculate the loop closures.

Specification: *7. Baseline Closures.*

Footnote: g: A table indicating the comparisons of the differences (ΔX, ΔY and ΔZ) between known and observed, and repeat unadjusted baselines shall be supplied. The table shall include the following: station to and from; vector components (ΔX, ΔY and ΔZ); distance between stations (in meters); required and calculated accuracy (Rejection Threshold - RT) in ppm; observation day and session time (UTC). A report discussing if the comparisons satisfied the specifications or not shall be supplied.

Specification: *8. Control Position Closures.*

Footnote: h: A table illustrating the position closures between computed coordinates and published/recently computed coordinates shall be supplied. The table shall include the following: station to and from; vector components ($\Delta\phi$, $\Delta\lambda$ and Δh) (in meters); distance between stations (in meters); Position Closure Estimate (PCE) and Positional Error (PE) (in ppm); and pass or fail indication.

A report discussing if the position closures satisfied the specifications or not shall be supplied.

Specification: *9. Minimally Constrained Adjustments.*

Footnote: i: Two (2) minimally constrained adjustments shall be supplied which follows the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data". One adjustment shall be unscaled and the other scaled. In addition, the minimally constrained adjustments shall include the following: input and output least squares adjustment files (in ASCII format on hard copy, MS/DOS formatted 3 1/2" HD disks and CD ROM) shall be supplied.

The scalar value (to modify the GPS error estimates) shall be noted on the scaled adjustments.

The report shall indicate if the absolute residuals in the minimally constrained adjustment were satisfied or not.

Specification: *10. Constrained Adjustment.*

Footnote: j: A constrained scaled adjustment shall be supplied which follows the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data". In addition, the constrained scaled adjustment shall include the following: input and output least squares adjustment files (in ASCII format on hard copy, MS/DOS formatted 3 1/2" HD disks and CD ROM) shall be supplied. The scalar value (to modify the GPS error estimates) shall be noted on the scaled adjustment.

Specification: *11. Baselines Removed From Adjustments.*

Footnote: k: A report shall indicate those baselines removed from the adjustments that are outliers or blunders and the justification or reasoning used shall be supplied.

Specification: *12. Observation Logs.*

Footnote: l: Observation logs shall be supplied as an Attachment.

Specification: *13. Photographs and/or Pencil Rubbings.*

Footnote: m: Photographs and/or pencil rubbings shall be supplied as an Attachment.

The specification is optional for Second and Third Order surveys if the user so desires.

Specification: *14. Raw Phase Observational Data (R-files).*

Footnote: n: The raw phase observational data shall be supplied and follow the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data" if the user chooses to submit the project to NGS otherwise, the specification is optional. At a minimum all raw GPS observational data from this project shall be made readily available to the client upon request from the entity that performs the GPS services if the client so desires this data. The client will retain ownership of this data. If the entity that performs the GPS services decides to no longer retain the data, the entity will supply the data to the client on the most efficient media available and agreeable with the client.

Specification: *15. Baseline Vectors (G-file).*

Footnote: o: The baseline vectors shall be supplied and follow the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data" if the user chooses to submit the project to NGS otherwise, all baseline vector solution files shall be supplied in ASCII format on MS/DOS formatted 3 1/2" HD disks or CD ROM.

Specification: *16. Project and Station Occupation Data (B-file).*

Footnote: p: The project and station occupation data shall be supplied and follow the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data" if the user chooses to submit the project to NGS otherwise, the specification is optional.

Specification: *17. Descriptions or Recovery Notes (D-file).*

Footnote: q: The descriptions or recovery notes shall be supplied and follow the recommended procedures under NOAA, "Input Formats and Specifications of the National Geodetic Survey Data Base, ANNEX L - Guidelines for Submitting GPS Relative Positioning Data".

The specification is optional for First (i.e. non-densification control, azimuth marks), Second and Third Order surveys.

SECOND APPENDIX TO AERO-METRIC, INC. REPORT
FEDERAL VERTICAL SURVEY CONTROL SPECIFICATIONS

2.2 Vertical Control Network Standards

When a vertical control point is classified with a particular order and class, NGS certifies that the orthometric elevation at that point bears a relation of specific accuracy to the elevations of all other points in the vertical control network. That relation is expressed as an elevation difference accuracy, b. An elevation difference accuracy is the relative elevation error between a pair of control points that is scaled by the square root of their horizontal separation traced along exiting level routes.

Table 2.2—Elevation accuracy standards

Classification	*Maximum elevation difference accuracy*
First-order, class I	0.5
First-order, class II	0.7
Second-order, class I	1.0
Second-order, class II	1.3
Third-order	2.0

An elevation difference accuracy, b, is computed from a minimally constrained, correctly weighted, least squares adjustment by

$$b = S/\sqrt{d}$$

where

d=approximate horizontal distance in kilometers between control point positions traced along existing level routes.

S=propagated standard deviation of elevation difference in millimeters between survey control points obtained from the least squares adjustment. Note that the units of b are (mm) / √ (km).

The elevation difference accuracy pertains to all pairs of points (but in practice is computed for a sample). The worst elevation difference accuracy (largest value) is taken as the provisional accuracy. If this is substantially larger or smaller than the intended accuracy, then the provisional accuracy takes precedence.

As a test for systematic errors, the variance factor ratio of the new survey is computed by the Iterated Almost Unbiased Estimator (IAUE) method described in appendix B. This computation combines the new survey measurements with existing network data, which are assumed to be correctly weighted and free of systematic error. If the variance factor ratio is substantially greater than unity, then the survey does not check with the network, and both the survey and the network data will be examined by NGS.

Computer simulations performed by NGS have shown that a variance factor ratio greater than 1.5 typically indicates systematic errors between the survey and the network. Setting a cutoff value higher than this could allow undetected systematic error to propagate into the national network. On the other hand, a higher cutoff value might be considered if the survey has only a small number of connections to the network, because this circumstance would tend to increase the variance factor ratio.

In some situations, a survey has been designed in which different sections provide different orders of control. For these multi-order surveys, the computed elevation difference accuracies should be grouped into sets appropriate to the different parts of the survey. Then, the largest value of b in each set is used to classify the control points of that portion, as discussed above. If there are sufficient connections to the network, several variance factor ratios, one for each section of the survey, should be computed.

3.5 Geodetic Leveling

Geodetic leveling is a measurement system comprised of elevation differences observed between nearby rods. Leveling is use to extend vertical control.

Network Geometry

Order / *Class*	*First I*	*First II*	*Second I*	*Second II*	*Third*
Bench mark spacing not more than (km)	3	3	3	3	3
Average bench mark spacing not more than (km)	1.6	1.6	1.6	3.0	3.0
Line length between network control points not more than (km)	300	100	50	50 (double-run) 25 (single-run)	25 10

New surveys are required to tie to existing network bench marks at the beginning and end of the leveling line. These network bench marks must have an order (and class) equivalent to or better than the intended order (and class) of the new survey. First-order surveys are required to perform check

connections to a minimum of six bench marks, three at each end. All other surveys require a minimum of four check connections, two at each end. "Check connection" means that the observed elevation difference agrees with the adjusted elevation difference within the tolerance limit of the new survey. Checking the elevation difference between two bench marks located on the same structure, or so close together that both may have been affected by the same localized disturbance, is not considered a proper check. In addition, the survey is required to connect to any network control points within 3 km of its path. However, if the survey is run parallel to existing control, then the following table specifies the maximum spacing of extra connections between the survey and the control. At least one extra connection should always be made.

Distance, survey to network	Maximum spacing of extra connections (km)
0.5 km or less	5
0.5 km to 2.0 km	10
2.0 km to 3.0 km	20

Instrumentation

Order *Class*	*First* *I*	*First* *II*	*Second* *I*	*Second* *II*	*Third*
Leveling instrument					
Minimum repeatability of line of sight	0.25"	0.25"	0.50"	0.50"	1.00"
Leveling rod construction	IDS	IDS	IDS† or ISS	ISS	Wood or Metal
Instrument and rod resolution (combined)					
Least count (mm)	0.1	0.1	0.5-1.0*	1.0	1.0

(IDS—Invar, double scale)
(ISS—Invar, single scale)
†if optional micrometer is used.
*1.0 mm if 3-wire method, 0.5 mm if optical micrometer.

Only a compensator or tilting leveling instrument with an optical micrometer should be used for first-order leveling. Leveling rods should be one piece. Wooden or metal rods may be employed only for third-order work. A turning point consisting of a steel turning pin with a driving cap should be utilized. If a steel pin cannot be driven, then a turning plate ("turtle") weighing at 7kg should be substituted. In situations allowing neither turning pins nor turning plates (sandy or marshy soils), a long wooden stake with a double-headed nail should be driven to a firm depth.

Calibration Procedures

Order *Class*	*First* *I*	*First* *II*	*Second* *I*	*Second* *II*	*Third*
Leveling instrument					
Maximum collimation error, single line of sight (mm/m)	0.05	0.05	0.05	0.05	0.10
Maximum collimation error, reversible compensator type instruments, mean of two lines of sight (mm/m)	0.02	0.02	0.02	0.02	0.04
Time interval between collimation error determinations not longer than (days)					
Reversible compensator	7	7	7	7	7
Other types	1	1	1	1	7
Maximum angular difference between two lines of sight, reversible compensator	40"	40"	40"	40"	60"
Leveling rod					
Minimum scale calibration standard	N	N	N	M	M
Time interval between scale calibrations (yr)	1	1	—	—	—
Leveling rod bubble verticality maintained to within	10'	10'	10'	10'	10'

(N—National standard)
(M—Manufacturer's standard)

Compensator-type instruments should be checked for proper operation at least every 2 weeks of use. Rod calibration should be repeated whenever the rod is dropped or damaged in any way. Rod levels should be checked for proper alignment once a week. The manufacturer's calibration standard should, as a minimum, describe scale behavior with respect to temperature.

Field Procedures

Order *Class*	*First* *I*	*First* *II*	*Second* *I*	*Second* *II*	*Third*
Minimal observation method	micro-meter	micro-meter	micro-meter or 3-wire	3-wire	center wire
Section running	SRDS or DR or SP	SRDS or DR or SP	SRDS or DR† or SP	SRDS or DR*	SRDS or DR§
Difference of forward and backward sight lengths never to exceed					
per setup (m)	2	5	5	10	10
per section (m)	4	10	10	10	10
Maximum sight length(m)	50	60	60	70	90
Minimum ground clearance of line of sight (m)	0.5	0.5	0.5	0.5	0.5

Field Procedures—Continued

Order *Class*	*First* *I*	*First* *II*	*Second* *I*	*Second* *II*	*Third*
Even number of setups when not using leveling rods with detailed calibration ...	yes	yes	yes	yes	—
Determine temperature gradient for the vertical range of the line of sight at each setup.....	yes	yes	yes	—	—
Maximum section misclosure (mm).....	3√D	4√D	6√D	8√D	12√D
Maximum loop misclosure (mm).....	4√E	5√E	6√E	8√E	12√E
Single-run methods					
Reverse direction of single runs every half day.....	yes	yes	yes	—	—
Nonreversible compensator leveling instruments					
Off-level/relevel instrument between observing the high and low rod scales.....	yes	yes	yes	—	—
3-wire method					
Reading check (difference between top and bottom intervals) for one setup not to exceed (tenths of rod units).....	—	—	2	2	3
Read rod 1 first in alternate setup method.....	—	—	yes	yes	yes
Double scale rods					
Low-high scale elevation difference for one setup not to exceed (mm)					
With reversible compensator.....	0.04	1.00	1.00	2.00	2.00
Other instrument types:					
Half-centimeter rods.....	0.25	0.30	0.60	0.70	1.30
Full-centimeter rods	0.30	0.30	0.60	0.70	1.30

(SRDS—Single-Run, Double Simultaneous procedure)
(DR—Double-Run)
(SP—Spur, less than 25 km, double-run)
D—shortest length of section (one-way) in km
E—perimeter of loop in km
† Must double-run when using 3-wire method.
* May single-run if line length between network control points is less than 25 km.
§ May single-run if line length between network control points is less than 10km.

Double-run leveling may always be used, but single-run leveling done with the double simultaneous procedure may be used only where it can be evaluated by loop closures. Rods should be leap-frogged between setups (alternate setup method. The date, beginning and ending times, cloud coverage, air temperature (to the nearest degree), temperature scale, and average wind speed should be recorded for each section plus any changes in the date, instrumentation, observer of time zone. The instrument need not be off-leveled/releveled between observing the high and low scales when using an instrument with a reversible compensator. The low-high scale difference tolerance for a reversible compensator is used only for the control of blunders.

With double scale rods, the following observing sequence should be used:

backsight, low-scale
backsight, stadia
foresight, low-scale
foresight, stadia
off-level/relevel or reverse compensator
foresight, high-scale
backsight, high-scale

Office Procedures

Order *Class*	*First* *I*	*First* *II*	*Second* *I*	*Second* *II*	*Third*
Section misclosures (backward and forward)					
Algebraic sum of all corrected section misclosures of a leveling line not to exceed (mm)....	3√D	4√D	6√D	8√D	12√D
Section misclosure not to exceed (mm).....	3√E	4√E	6√E	8√E	12√E
Loop misclosures					
Algebraic sum of all corrected misclosures not exceed (mm).....	4√F	5√F	6√F	8√F	12√F
Loop misclosure not to exceed (mm).....	4√F	5√F	6√F	8√F	12√F

(D—shortest length of leveling line (one-way) in km)
(E—shortest one-way length of section in km)
(F—length of loop in km)

The normalized residuals from a minimally constrained least squares adjustment will be checked for blunders. The observation weights will be checked by inspecting the postadjustment estimate of the variance of unit weight. Elevation difference standard errors computed by error propagation in a correctly weighted least squares adjustment will indicate the provisional accuracy classification. A survey variance factor ratio will be computed to check for systematic error. The least squares adjustment will use models that account for:

gravity effect or orthometric correction
rod scale errors
rod (Invar) temperature
refraction—need latitude and longitude to 6″ or vertical temperature difference observations between 0.5 and 2.5 m above the ground
earth tides and magnetic field
collimation error
crustal motion

Appendix B

MINUTES OF SEPTEMBER 25, 2012
SEWRPC TASK FORCE ON DATUM MIGRATION

KWB/lgh
11/19/12
Minutes-Review Preliminary Draft TR No. 50. (00207333).DOC

MINUTES

MEETING OF THE TECHNICAL TASK FORCE CREATED BY SEWRPC TO REVIEW THE PRELIMINARY DRAFT OF SEWRPC TECHNICAL REPORT NO. 50

DATE: September 25, 2012

TIME: 9:00 A.M.

PLACE: Commissioners' Conference Room
Regional Planning Commission Offices
W239 N1812 Rockwood Drive
Waukesha, Wisconsin

Members Present

Kurt W. Bauer, Chairman	Executive Director Emeritus, SEWRPC, County Surveyor Kenosha, Milwaukee, Walworth, and Waukesha Counties
Earl F. Burkholder	Consulting Geodetic Engineer
Robert W. Merry	Geomatics Manager, Aero-Metric, Inc.
Glen R. Schaefer	Geodetic Engineer, Wisconsin Department of Transportation
Jeffrey B. Stroub	Vice President, Aero-Metric, Inc.

Guests Present
None

SEWRPC Staff Present

Philip C. Evenson	Special Projects Advisor
Donald P. Simon	Chief Planning Illustrator, SEWRPC; Deputy County Surveyor for Kenosha, Milwaukee, Ozaukee, Walworth, and Waukesha Counties
Lynn G. Heis	Recording Secretary

CALL TO ORDER AND ROLL CALL

Chairman Bauer called the meeting to order at 9:00 A.M. Roll call was taken by circulating an attendance signature sheet, and a quorum was declared present.

INTRODUCTION

Chairman Bauer welcomed the Task Force members to the Commission offices; and, on behalf of the Commission, thanked the members for their willingness to serve on the Task Force, and to make their experience and knowledge available to the Commission as a public service.

CHARGE TO COMMITTEE

Chairman Bauer indicated that the Commission's charge to the Task Force was to conduct a critical review of the preliminary draft of SEWRPC Technical Report No. 50, *Cost Estimate for Resurvey of Regional Control Survey Network,* September 2012, and to recommend needed changes in the findings and recommendations set forth in the report.

PROPOSED PROCEDURE

Chairman Bauer indicated that the procedure proposed to be followed in the conduct of the Task Force work was to review on a page-by-page basis the preliminary draft of the report concerned. He noted that all members of the Task Force had been provided with a copy of the draft for review prior to the meeting. He noted that the report was intended to describe the scope and cost of the work required to replace the four foundational elements of any good parcel-based land information or public works management system:

1. A map projection and related datums;
2. A survey control network that manifests the projection and datums on the surface of the earth;
3. A large-scale topographic map of the area concerned; and
4. A matching large-scale cadastral map of the area concerned.

The replacement of these foundational elements would be required for any sound migration of the existing parcel-based land information and public works management systems being developed within the region from the legacy datums in use to one of the newer datums created and promulgated by the National Geodetic Survey. The existing land information and public works management systems, while under development, are operational and functioning well within the Region.

Chairman Bauer said that it was hoped that the Task Force could complete its work in a single meeting. The proceedings of that meeting would be set forth in the minutes. A copy of those minutes would then be provided to all Task Force members for review, and the Task Force members would be asked to indicate their approval or conditional approval of the minutes, or to request a second meeting to act on the minutes. The work of the Task Force would be concluded when the minutes of the meeting had been approved.

REVIEW OF PRELIMINARY DRAFT OF REPORT CONCERNED

The Task Force then undertook a page-by-page review of the preliminary draft of the report concerned, that draft being dated September 2012. The following comments were raised, discussed, and acted upon in the meeting.

Mr. Evenson suggested that the proposed type of Commission report be changed from a Technical Report to a Memorandum Report. He noted that the former type of report was intended to make available information assembled on a work progress basis by the Commission staff during the course of a planning program; the latter being intended to document the results of locally requested special studies. He also suggested that in order to reflect the full scope of the report its title be changed to: "*Estimate of the Costs of Converting the Foundational Elements of the Land Information and Public Works Management Systems in Southeastern Wisconsin from Legacy to New Datums.*" Following a brief discussion, the suggested changes were approved by consensus.

Mr. Schaefer noted that he had provided to the Commission staff a number of editorial corrections which he understood had been made. One of these relates, he said, in identifying specific datums, to use of the full year—for example, 2007—in the notation, instead of the abbreviation 07; and that this manner of notation be used throughout the text. He also noted that the word "benchmark" was to be used throughout the text to two words, "bench mark." The suggested changes were approved by consensus.

Mr. Schaefer noted that the National Geodetic Survey (NGS) may have developed guidelines on standards and specifications for Global Positioning System (GPS) surveys based upon the Wisconsin Department of Transportation (WisDOT) guidelines appended to the draft report. If this was in fact the case, he suggested the report should append the NGS rather than the WisDOT document to the final report. Mr. Merry indicated that he did conduct a literature search in an attempt to find applicable GPS survey standards, and based upon that search concluded that the WisDOT guidelines were the best available.

Mr. Burkholder then referred to the last paragraph on page 1 of the report and asked why reference was made to the Clarke Spheroid of 1866. Chairman Bauer indicated he believed the reference was desirable since other spheroids—ellipsoids—were used for the newer datums, and this should be understood by all of the potential readers of the report, the great majority of whom would not be geodesists.

Mr. Schaefer referred to the third line of the first paragraph on page 1, indicating that the term "Geographic Reference System" should be changed to "Geodetic Reference System."

Mr. Burkholder referred to the second full paragraph on page 4, recommending that the last word of the first line of the last sentence be changed from "no" to "little."

Mr. Schaefer questioned the meaning and relevance of the second sentence of the second full paragraph on page 4, noting that if the sentence was construed as referring to NAD 83, the statement was incorrect since that datum was not related to military or navigational issues. If, however, the sentence was construed as referring to the use of WGS 84, it was correct. Chairman Bauer responded that in his opinion, NAD 83 would not have come into being if military needs had not required a change in the mapping spheroids and related datums originally used worldwide such as those based on the Clarke and Bessel, spheroids, among others. The development of NAD 83 was certainly not required to meet land surveying or civil engineering needs, the legacy 27 and 29 datums and related State Plane Coordinates and Mean Sea Level elevations being perfectly adequate for civil applications. Mr. Schaefer responded that the legacy horizontal and vertical datums were not integrated, that is, were not related to a single ellipsoid and, therefore, to be consistent with state-of-the-art geodetic practices would eventually have had to be replaced. Chairman Bauer indicated that the fact that the 27 horizontal datum was based upon the Clarke Spheroid and the 29 vertical datum was based upon Mean Sea Level and not to a spheroid, was a matter of indifference to practicing land surveyors and civil engineers. Massive civil engineering works, such as the transcontinental railway systems, the interstate highway system, the air navigation system, the U.S. Geological Survey quadrangle mapping program, the U.S. Coast and Geodetic Survey nautical and aeronautical charting programs, and such large local civil engineering projects as construction of the deep tunnel combined and sanitary sewer overflow abatement system in the Milwaukee area were all built utilizing the legacy datums. Upon further discussion it was the consensus to leave the paragraph as written.

Mr. Burkholder called attention to the second sentence of the third full paragraph on page 4 indicating that in his opinion the use of the phrase "patently absurd" seemed harsh. Chairman Bauer indicated that in his opinion the idea that the new datums would in some way result in more accurate maps was indeed absurd and this, in his opinion, should be said. He noted that accurate maps could be, and historically have been, prepared without reference to an identified projection or attendant datum. Mr. Schaefer observed that the use of a common datum and projection, while not needed to produce accurate maps, was needed to permit the areawide correlation of otherwise disparate maps and mapping related data. Upon

discussion it was agreed that the following sentence should be added to the end of the third full paragraph on page 4:

> "Importantly, the use of a common datum and projection permits ready correlation of disparate surveying and mapping programs, minimizes the effort required for transformation of data from one datum to another, and reduces confusion in the use of both analog and digital spatial related data."

Chairman Bauer called attention to the second full paragraph on page 5 and suggested that the second and third sentences of the paragraph be revised to read as follows:

> "Adjustment of the NAD 83 and NAVD 88 datums have resulted in the creation of NAD 83 (1991), NAD 83 (2007), NAD 83 (2011), NAVD 88 (2007) and NAVD 88 (2012). NGS is presently in the process of creating NAD 83 (2022)."

After further discussion it was agreed that the following footnote should be added to page 5.

> The NGS does not regard the various versions of NAD 83 or NAVD 88 as "new datums." The "datum tag" used is considered by the NGS to identify differing "realizations"—that is, refinements or adjustments—of the datum concerned. From this viewpoint, the first new datum proposed to be introduced by the NGS since the introduction of NAD 83 datum would be the ITRF-17 datum. From the Commission standpoint, the various adjustments of the NAD 83 and NAVD 88 datums are, in effect, new datums since the coordinate position and orthometric height of a monumented survey station would have different values under each adjustment.

In answer to a question by Mr. Evenson, Mr. Schaefer replied that NAD 27 did not evolve into a similar series of adjustments as the NAD 83 datum because the 27 datum was not mathematically related to the earth's center of gravity as is the 83 datum. Mr. Burkholder noted that more precisely stated, the datum was not related to the earth's center of mass—the center of gravity being the center of mass only in a uniform gravity field; however, he said, the earth's gravity field is not uniform. Chairman Bauer indicated that while Mr. Schaefer provided a scientifically correct response to Mr. Evenson's question, another reason might be advanced, namely, that the 27 datum and the State Plane Coordinate Systems based upon it and the 29 vertical datum were perfectly adequate for land surveying and most civil engineering applications.

Mr. Burkholder, referring to the second full paragraph on page 5, indicated that it was his understanding that migration to the ITRF 17 datum would involve relatively small changes in position values. Mr. Merry disagreed, indicating that it was estimated that the shifts in horizontal position from NAD 83—not WGS 84—to the ITRF 17 might approximate, or exceed, 2.2 meters.

Both Mr. Schaefer and Mr. Merry indicated that to be technically consistent the penultimate sentence of the second paragraph should be revised by removing the reference in the sentence to WGS 84.

Mr. Burkholder and Mr. Merry referred to the last paragraph on page 5, questioning the use of the term "some" in referring to practicing surveyors and land information system managers questioning the continued use of the legacy datums within the region. Chairman Bauer indicated that, of course, it was not known how many practitioners have raised, or may raise, the question; but Commission staff experience in dealing with private sector land surveyors, public works engineers, and land information system managers clearly indicated that a relatively few in each category continued to raise the question, and that the majority of the practitioners concerned do not raise the question. After some discussion, it was agreed that the phrase "but not all" would be inserted in the text to clarify the use of the word "some."

Mr. Evenson referred to the last paragraph on page 5 and suggested that the second sentence of the paragraph identifying Mr. Donald G. Dittmar, as one land information system manager that has raised the issue of conversion from the legacy to the newer datums, be struck. Mr. Evenson indicated that it would be more politic to avoid identifying a specific individual in this case, as well as being consistent with historic Commission practice. Upon some discussion it was agreed to eliminate the initial phrase in the sentence referring to Mr. Dittmar and to revise the sentence to read:

> "Indeed the Commission convened an interagency staff meeting to address these questions."

Mr. Evenson in a related matter called attention to the first partial paragraph on page 6 and suggested that the last sentence of the paragraph be revised to also eliminate the reference to Mr. Dittmar, the sentence being reworded to read as follows:

> "It was, nevertheless, agreed that it would be helpful to those staffs for the Commission to develop an estimate of the probable costs entailed in the transformation of the existing control survey network and attendant foundational mapping elements to the NAD 83 (2007) and NAVD 88 (2007) datums."

For the same reason Mr. Evenson suggested that the first phrase of the first sentence of the first full paragraph on page 6 be struck, the phrase "in response to Mr. Dittmar's request" being replaced with "accordingly."

Mr. Schaefer called attention to the first line on page 7 indicating that the phrase "Geodetic Reference Spheroid of 1980" should be replaced by the phrase "Geodetic Reference System of 1980 (GRS 80)."

Mr. Schaefer also called attention to the second full sentence on page 7 which indicated that State Plane Coordinates on the new system were expressed in meters in order to avoid confusion with such coordinates on the original State Plane Coordinate System which are expressed in U.S. Survey Feet. He indicated the reason cited was questionable and that the phrase "in order to avoid confusion with State Plane" should be struck and replaced with the word "while", and that the word "which" in the sentence also be struck. He indicated that it was his understanding that the use of meters as the unit of measurement in the new State Plane Coordinate System was proposed because the Federal government was at the time promoting the use of the metric system within the United States.

Mr. Schaefer also called attention to the last sentence of the first partial paragraph on page 7 indicating that the term "spherical coordinates" in the sentence be changed to "geodetic coordinates."

Mr. Schaefer called attention to the first full paragraph on page 7 and suggested that the third sentence of the paragraph be revised to read as follows:

> "An example of a portion of a topographic map at a scale of 1 inch equals 100 feet is provided in Figure 1."

Mr. Burkholder called attention to the last paragraph on page 7, noting the reference to National Map Accuracy Standards. He indicated that these standards were intended to be applicable to hard copy maps and were developed by the Federal government before the digital computer age. He observed that spatial data accuracy in the digital arena is a major issue being discussed within various national professional organizations—such as the American Society of Civil Engineers, Geomatics Division—because the National Map Accuracy Standards are not applicable to the manipulation of digital spatial data. Chairman Bauer indicated that, in his opinion, the acid test of the accuracy of digital spatial data was whether or not the data when printed out in hard copy form met the National Map Accuracy Standards or

other specified standards such as the Commission cadastral mapping standards. Mr. Stroub agreed and indicated that the practice of Aero-Metric, Inc. was, as appropriate, to simply accompany digital data topographic map files with a statement saying that the data, if printed out, would meet National Map Accuracy Standards. Such a statement and test in effect, he said, encapsuled the related accuracies in the digital data from which the maps are plotted. Chairman Bauer indicated that it was not clear to him what the professional deliberations within the national organizations related to. For example, he asked, are they intended to relate to the accuracy with which computer hardware, such as a digitizer, can plot a point identified by survey coordinates, an accuracy that would probably be expressed as absolute in millimeters; or were they concerned with, for example, the placement of pixels comprising a line map or an orthophotograph in an absolute or in a relative position. In any case, as a practical matter, he said the National Map Accuracy Standards and the Commission standards for cadastral mapping had served well as applied to production of the base maps required for the development of the land information and public works management systems within the Region.

Mr. Stroub called attention to the cost figures for topographic and cadastral mapping given on pages 9 and 10. He noted that the figures given were reasonable approximations of the costs entailed in preparing the maps concerned to the Commission's high standards, and that the total costs of transforming the foundational elements of good parcel-based land information and public works management systems given were realistic. He noted that those costs could be significantly reduced, but only by lowering the Commission recommended standards.

In answer to a question by Mr. Burkholder, Chairman Bauer indicated that the report did indeed provide an alternative and less costly means of providing one of the foundational elements concerned, namely through the substitution of orthophotographs for topographic line maps. Mr. Evenson noted that the report also indicated that there were commercially available transformation programs that could be used for the transformation of some types of attribute data contained in the system files, but such programs if applied to transform the foundational elements could significantly degrade the quality and utility of the land information and public works managements systems that are based upon those elements. Mr. Evenson concluded his observation by indicating that the report does not state or imply that "everything" in such systems would need to be replaced even in "starting over."

Mr. Schaefer importantly observed that realistically it is simply impossible to truly "start over" with an existing spatial data system. Firstly, he said, such systems contain invaluable historic data of a specified level of accuracy. Secondly, he said, no matter what standards—including specification of the datums to

be used—are adopted at the initiation of a system, between the time of initiation and time of completion of the system, events – especially changing technology – will require adaptation of, or fundamental change in, the system concerned. He noted that the need for change actually may be a perceived need, as opposed to an actual need, and that consequently a need exists to educate users of the systems. Mr. Evenson agreed and indicated that the report was intended in part to be educational. He noted that experience has indicated that land information system managers are sometimes asked questions by users that they are unable to answer, as for example: "Why can't we move to a new datum?" If the response is because migration is too costly, the next question asked often is: "How much would it indeed cost?" The report is intended to respond to these questions, providing system managers with information needed to respond to such questioning users.

Mr. Stroub indicated that in his opinion the report is an excellent one, and should help questioning users to better understand the implications of migrating to a new system. The need for education of not only users, but also of the surveying, engineering, and land information system communities will obviously not end with the publication of the report. He indicated that he is often appalled by the lack of understanding of the accuracies built into the systems through the foundational elements and of the implications of those accuracies. Chairman Bauer agreed, noting that the Commission in a related matter had published detailed instructions on how to use GPS technology with the legacy datums, yet Commission staff are often confronted by surveyors and engineers who do not know that GPS technology can be readily used with the legacy datums.

Mr. Burkholder called attention to the last paragraph on page 9 and first partial paragraph on page 10 and questioned the procedure described for the production of the needed cadastral maps, given that the maps would be in digital form. Chairman Bauer indicated that the Commission practice was to produce the needed cadastral maps by having an experienced registered land surveyor plot each parcel within a U.S. Public Land Survey System (USPLSS) quarter section on dimensionally stable base material. In the procedure the coordinate positions of the (USPLSS) section, quarter section and center of section corners and the lengths and bearings of the quarter section lines are used as control. The attendant topographic maps are used for needed ground truth, that is for providing accurate locations and configurations of such planimetric features as building outlines; roadway pavements; railway tracks; fences; and lake, stream and water course shorelines and thread lines. The property boundary lines are plotted by the land surveyor in much the same way as the boundaries would be surveyed in the field. The process requires an overview of all of the property boundary lines within the quarter section, and substantial analysis, synthesis and experienced judgment are required in the plotting of the lines. The property boundary lines, as plotted on

the dimensional stable base material, are then converted to digital format using digitizer hardware. It may be possible, he said, to construct the parcel boundaries directly in digital format by use of computer assisted drafting hardware and software, but this is not how it has been done by the Commission. Mr. Burkholder suggested that the described procedure raised the issue of the need for digital standards. Chairman Bauer indicated that the most fundamental accuracy standards for the cadastral mapping were those given in the paragraph referred to by Mr. Burkholder, just as the National Map Accuracy Standards were the most fundamental standards governing the quality of the Commission topographic maps. Chairman Bauer noted that Commission specifications for both topographic and cadastral mapping also included specifications for the digital file organization, these specifications being essential for the convenient plotting and use of the digital map files.

Mr. Merry indicated that the American Society for Photogrammetry and Remote Sensing (ASPRS) provided detailed model specifications for various types of mapping as did the National Standards for Spatial Data Accuracy (NSSDA). In applying these standards, he said, it is important to identify whether they are to be applied to hard copy or digital formats, and especially important to identify the publication scale at which the standards are to be applied. However, he agreed with Chairman Bauer that references to the National Map Accuracy Standards—with respect to topographic mapping—and to the Commission standards—with respect to cadastral mapping—encapsulated the more detailed digital standards in a practical manner.

Mr. Stroub noted that the NSSDA did not really constitute an accuracy statement, but rather a reporting mechanism; while the National Map Accuracy Standards did indeed constitute an accuracy statement. The former is concerned with the process used to reach an end product; the latter is concerned with the accuracy of that product, an accuracy that can be verified by field test.

Mr. Schaefer observed that the relative position of two points on a map may be more critical than the absolute position of either one. He observed further that in producing boat sheets and nautical charts the U.S. Coast and Geodetic Survey had required that those sheets and charts met National Map Accuracy Standards, at the publication scale. Both hard copy and digital maps, he noted, can be reproduced at larger or smaller scales than intended, but the statement that the map meets National Map Accuracy Standards is applicable only at the originally specified publication scale. Moreover, he said, many factors determine the accuracy of a map, including the specifications governing the original survey and the specifications governing the drafting and the printing processes. Mr. Stroub indicated that these observations related to

issues that end product users unfortunately often do not understand. After some further discussion, it was agreed that the following sentence should be added at the end of the first partial paragraph on page 10:

> "The constructed maps are then transformed into digital form."

Mr. Burkholder called attention to the second full paragraph on page 10 and suggested that the last sentence be revised to read as follows:

> "This practice introduces a small difference that could be up to 0.01 foot in 100 feet in the values concerned."

Mr. Schaefer called attention to the last sentence of the first partial paragraph on page 14 and questioned whether the use of orthophotographs in the preparation of the plan portion of public works construction plans and profiles had been universally abandoned. He noted, that WisDOT in fact uses only line maps in the plan portion of the construction project documents concerned. Mr. Stroub indicated that the statement was too broad and that orthophotographs are used by some engineers and agencies for the plan portion of the construction project documents. Upon further discussion it was agreed that the sentence should be revised to read as follows:

> "For this reason, the use of orthophotographs in the preparation of the plan portion of the public works construction plans and profiles has been found by some engineers and agencies to be less satisfactory than the use of line maps."

Mr. Schaefer called attention to the penultimate sentence on page 14 and suggested that it be revised to read as follows:

> "Software – known as VERTCON – available from NGS permits the conversion between the new and legacy vertical datums at an expected mean error of approximately 0.02 meter, adequate for land information system purposes and for some land and engineering survey purposes."

Mr. Schaefer suggested that the text be expanded to include a similar reference to NADCON.

In answer to a question by Mr. Evenson, Mr. Merry indicated that some "handheld" GPS devices will let the user select a desired datum, including NAD 27, and will provide absolute positions to within a few

meters. Mr. Evenson observed that in the discussions with land information system managers concerning dynamic versus static spatial location needs, no one had raised the use by the police, fire, emergency medical, and transit agencies of GPS receivers that operate on the NAD 27 datum.

Mr. Burkholder called attention to the last sentence of the penultimate paragraph on page 15, and suggested that the word "legacy" be used to modify "foundational elements."

Mr. Schaefer called attention to the penultimate sentence in the first partial paragraph on page 18 and indicated that the correct terminology was "Continuously Operating Reference Stations (CORS)."

Mr. Simon suggested that the first sentence of the first partial paragraph on page 18 be stressed, given that he has experienced widespread misunderstanding concerning this issue. After further discussion it was agreed that the sentence concerned should be used to begin a new paragraph and that the paragraph should read as follows:

> "The Commission staff has demonstrated that it is possible to utilize GPS technology cost effectively with the existing CORS network established within the Region by WisDOT to obtain accurate State Plane Coordinate Values on the NAD 27 datum. Moreover, the Commission has provided a detailed example of how GPS technology and the WisDOT CORS system can be used to obtain accurate coordinate values of survey points on the NAD 27 datum. This example is set forth in Appendix G of SEWRPC Technical Report No. 49, *Bidirectional Transformation of Legacy and Current Survey Control Data Within Southeastern Wisconsin,* May 2010.

Chairman Bauer noted that at this point in its deliberations, the Task Force had completed its review of the Commission report and would now begin its review of the appended Aero-Metric, Inc. report.

Mr. Schaefer suggested that Aero-Metric use the same format for the datum identification notations that it was agreed would be used in throughout the Commission report. Mr. Schaefer noted that the NAVD 88 (2007) adjustment and the NAVD 88 (2012) adjustment differed by up to 2.4 centimeters in some locations, even though WisDOT followed NGS directions in making the 2007 adjustment. The 2012 adjustment, he noted, closely matches the 1991 adjustment, but does not match the 2007 adjustment at all points. In answer to a question by Mr. Merry, Mr. Schaefer indicated that the 2007 adjustment would remain as an historic vertical realization even though the NGS is not publishing superseded data – a problem for users. Mr. Merry observed that it was important to users that superseded control survey data

be made readily available and not lost over time. This was important because users may have relied in the past on the superseded data and those data may, therefore, be involved in needed transformations.

In answer to a question by Mr. Schaefer, Mr. Merry indicated that the resurvey was based upon NAD 83 (2007) because this was the direction given to Aero-Metric, Inc. by the Commission staff. Chairman Bauer indicated that NAD 83 (2007) and NAVD 88 (2007) had been specified as the new datums concerned at the request made during the discussions held with land information system managers operating within the Region. Mr. Schaefer observed that if and when funding for a resurvey became available, the migration should be from the legacy datums to the latest current national datums in effect at the time. Upon further discussion it was agreed that the following footnote should be added to the last paragraph on page 18 of the Commission report.

> "The land information managers concerned specifically requested that the desired cost estimate be made for the migration of the existing control survey network within the Region from the legacy datums to the NAD 83 (2007) and NAVD 88 (2007) datums. The costs presented in this report are applicable to the migration of the legacy datums in use within the Region to any of the NAD 83 and NAVD 88 realizations. It is not known at this time if those costs would also apply to the proposed ITRF-17 datum. The different datum realizations and the new datum would provide different coordinate values and different elevations between the datum realizations and the new datum as well as between the various datum realizations and new and the legacy datums."

In answer to a question by Mr. Burkholder, Mr. Merry indicated that the proposed resurvey would result in an independent redetermination of both the horizontal and vertical position of the survey points and bench marks within the Region. The positions and elevations of the CORS stations in and adjacent to the Region would provide the framework for the resurvey and data related to the CORS stations would be perpetuated in the resurvey. In answer to a further question by Mr. Burkholder, Mr. Merry indicated that the resurvey would not, in effect, be duplicating work done in previous height modernization programs since those programs never included the USPLSS corners within the Region. In answer to a yet further question by Mr. Burkholder, Mr. Merry indicated that the resurvey would establish a primary control survey network consisting of the monumented USPLSS township corners thereby providing a stable framework within which the monumented section, quarter section and center of section corners can be located to a specified level of accuracy. Being tied to the CORS network through the township corners, all of the survey data can be adjusted to achieve the desired level of accuracy.

Mr. Burkholder indicated that in his opinion the approach being taken for the resurvey was imminently sound, but he questioned if it could be afforded.

Chairman Bauer questioned whether it would be possible to simply occupy each USPLSS corner with GPS equipment to obtain new horizontal and vertical positions for the corners. Mr. Merry indicated that could be another approach, but it would not provide the corner positions to within the desired accuracy levels. In answer to a question by Mr. Burkholder, Mr. Schaefer indicated that he accepted Mr. Merry's response to Chairman Bauer and also the approach proposed to be taken to the resurvey.

Chairman Bauer indicated that in his opinion establishing the primary network as proposed was intuitively desirable because it provided an integrated framework and control throughout the Region and facilitated proceeding with the work on a township or series of townships basis. Mr. Merry agreed, indicating that the proposed primary network would facilitate a sub-regional approach in a manner that the CORS network alone would not. He noted that the need for and value of the proposed primary network was set forth on page 2. Mr. Schaefer observed that if the resurvey were carried out on a township by township basis, the coordinate values of the USPLSS corners along common township boundaries might differ slightly.

[Secretary Note: the meeting was adjourned at 12:00 noon for lunch and reconvened at 12:30 P.M.]

In answer to a question by Chairman Bauer, Mr. Merry indicated that the use of base stations located within each township was proposed to support the resurvey of the section, quarter section and center of section corners at the desired level of corner position accuracy.

Mr. Burkholder noted that the results of the resurvey would be recorded in various documents some of which were specifically identified in the Aero-Metric report. He indicated that he assumed that these documents would be available in both hard copy and digital form and asked which of the two forms would be considered the primary form. Chairman Bauer indicated that the Commission's practice made the hard copy versions of the "Record of U.S. Public Land Survey Control Station" – an example of which was given on an Exhibit C on page 7 – and the "Control Survey Summary Diagram" – an example of which was given in Exhibit E on page 12, the primary record. Digital versions of these documents were made available on the Commission website. Chairman Bauer observed that hard copy documents were the only form that was known to be permanent in that digital records had not yet stood the test of time for

permanence. Changes over time in computer hardware and attendant software may make digital records inaccessible if an agency such as the Commission cannot at some future time afford costly changes in available hardware and software that may be needed to continue to use the data. Indeed, the Commission had experienced the loss of topographic mapping of a large area within the Region due to a combination of deterioration of the electronic data and changes in hardware and software. Fortunately the Commission had retained hard copies of the maps on dimensionally stable base material. Natural events such as major sun spot bursts, or acts of vandalism by "hackers" may actually destroy the data.

Mr. Schaefer noted that from a land surveying perspective, the County Surveyor is the one that is required to certify to the information shown on the "Record of U.S. Public Land Survey Control Station" sheets. He noted that while the geodetic survey engineers involved in a resurvey could provide some of the information displayed in the upper portion of the sheet, they could not certify to the information concerning the perpetuation of the public land survey corners given in the lower portion of the sheet. He asked how this problem was intended to be resolved. Chairman Bauer indicated that, in his opinion, this was indeed a problem in that while the geodetic survey engineer involved in the resurvey would be provided with the latest version of these sheets for use in recovering and occupying the monumented corners, the condition of the corner monumentation—whether or not the monuments had been disturbed or destroyed—would have to be observed and noted on the sheets together with observed changes in the witness marks and bench mark monumentation. The annotated sheets would then have to be provided to the County Surveyor and Commission staff, which then would have to perform the necessary monument perpetuation work, draft new location sketches and certificates, and return the revised sheets to the geodetic survey engineer who would then have to revisit the corners concerned. For this, as well as for, among other reasons, he indicated he was concerned that Aero-Metric may have underestimated the cost of the survey work and of the attendant documentation. Mr. Merry indicated that he was confident that the cost estimates provided were adequate.

Mr. Schaefer noted that the "Record of U.S. Public Land Survey Control Station" form as reproduced on page 7 did not identify the unit of measurement and suggested that a statement be added to the form in an appropriate location indicating that all measurements were given in U.S. Survey Feet. He noted that practitioners and users are increasingly unaware of the difference between the U.S. Survey Foot and the International Foot, a difference which in some cases may lead to significant difference in control survey data. Mr. Merry agreed, indicating that he was aware of some software programs that did not operate correctly because of confusion between the two units of measurements.

Mr. Schaefer also suggested that the angles and bearings be properly expressed on the form as for example: 1° 24′ 03″.

Chairman Bauer called attention to the first paragraph on page 10 describing an alternative means for the resurvey of the vertical control network. He observed that in his opinion, this approach was convoluted, replete with uncertainty, and a poor substitute for the first alternative described on page 8. He said, however, it was less costly and for that reason, at Mr. Merry's recommendation, had been included in the total cost of a migration.

In answer to a question by Mr. Schaefer, Chairman Bauer indicated it was the Commission long-standing practice to provide a combination scale and sea level reduction factor on the control survey summary diagrams. He noted that it was apparently difficult enough for some practicing surveyors and public works engineers to understand the use of this single factor, much less the use of two separate factors for scale and sea level reduction. Indeed, he said, WisDOT project engineers have apparently never been able to understand the implication and use of the factor giving rise to the use of county coordinate systems. In answer to a further question by Mr. Schaefer, Chairman Bauer indicated that both ground and grid level distances are given on the diagrams. In answer to a further question and comment by Mr. Schaefer, Chairman Bauer indicated that the combination factor is indeed computed for the center of the USPLSS six-section diagram, and that ground level distances on the perimeters of the six-section areas would differ slightly from distances on the perimeters of adjacent diagrams. Mr. Burkholder noted, however, that the grid distances would be identical.

CONCLUSION AND ADJOURNMENT

There being no further questions or comments Chairman Bauer noted that the Task Force had completed its charge to critically review the preliminary draft of SEWRPC Technical Report, *Cost Estimate For Resurvey of Regional Control Survey Network,* September 2012; including the *Report on Cost Resurvey of SEWRPC Control Survey Network* and other appendices provided by the formal Aero-Metric, Inc. report. These reports and appendices will now become SEWRPC Memorandum Report No. 206. He indicated that unless he hears to the contrary, the two reports as amended may be considered to meet with the approval of the Task Force members.

Chairman Bauer indicated that the Task Force members would receive a preliminary draft of the minutes of the meeting for review and comment. Proposed changes should be provided to the Commission staff either by means of a returned annotated hard copy, or by means of a transmitted annotated electronic

copy. The necessary changes will then be made, and a final copy of the minutes provided to the Task Force members together with a self-addressed, stamped, post-card ballot, indicating the members approval, disapproval, or conditional approval of the final draft of the minutes. He noted that the minutes would be published as an Appendix to the Memorandum Report.

Chairman Bauer once more thanked the Task Force members for their diligent review of the two reports and for their contribution of their time, knowledge and experience as a public service to the work of the Commission.

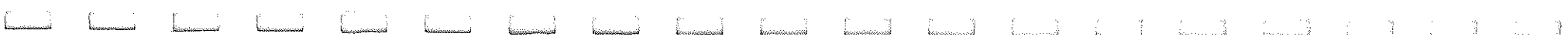
The meeting was adjourned at 2:30 P.M.

Respectfully Submitted,

Lynn G. Heis
Task Force Recording Secretary

[Secretary Note: The foregoing minutes were approved by the Task Force by mail ballot, the last ballots being returned on November 19, 2012.]

KWB/lgh/dps
11/19/12; 11/24/12
Minutes-Review Preliminary Draft TR No. 50. (00207333).DOC



As the Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Project Manager, we are providing to you herewith 12 copies of this report for distribution to the members of the MCAMLIS Steering Committee. In this respect, it should be noted that Mr. John LaFave, the designated Milwaukee County Land Information Officer is being separately provided with a copy of the report. It would be very much appreciated if you would when distributing copies of the report, you advise the members of the Steering Committee that should they desire additional copies of the report, or have any questions on the report, they should contact the Commission offices.

Sincerely,

Kenneth R. Yunker, P.E.
Executive Director

KRY/KWB/lgh
Shaw ltr-MR. No. 206 (00208187).DOC

Enclosures