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Memorandum

Date:	December 31, 2008
To:	Steve Arndt; UW-Oshkosh
Copy:	James Rabe, City of Oshkosh
From:	Jim Bachhuber and Joe Hanson; Earth Tech AECOM
Subject:	University of Wisconsin-Oshkosh Campus Memo Report: Stormwater Pollution Analysis Methods and Results

Background / Scope of Work

The analysis described in this memorandum was conducted in partial fulfillment of the University of Wisconsin-Oshkosh (UW-O) Campus Municipal Separate Storm Sewer System (MS4) General Permit. This report documents the stormwater pollution analysis conducted for the area of the UW-O Campus regulated under the MS4 permit. The permit requires an estimate of the annual stormwater pollution loadings (sediment and phosphorus) for all storm sewer outfalls that meet the regulatory definition of an "MS4". This pollution loading analysis establishes the base pollution load and the pollution reduction resulting from the existing stormwater management measures on the campus.

The analysis used the Windows™ version of an urban pollution loading model "Source Loading and Management Model" (WinSLAMM) to model annual pollutant loadings under the following two scenarios:

1) Base Conditions: October 1, 2004, land use conditions with no Best Management Practices (BMPs) applied.

2) Existing Conditions: October 1, 2004, land use conditions with the existing levels of stormwater management measures applied.

If under scenario 2, the existing BMPs were not sufficient to meet the required 40% Total Suspended Solids (TSS) reduction, additional conceptual management measures would be evaluated to achieve this goal.

Summary of Methods for Pollution Load Modeling – Base and Existing Conditions

This section summarizes the analysis conducted for UW-O to determine the base conditions pollutant load and the amount of pollutant load reduction currently being achieved by UW-O's existing stormwater management practices. The pollution loads are modeled using a software program: Windows based Source Loading and Management Model (WinSLAMM) The policies and procedures set forth by the Wisconsin Department of Natural Resources (WDNR) to analyze pollution loading in developed urban areas were followed throughout the process. These policies can be found at the WDNR website: http://www.dnr.state.wi.us/runoff/stormwater/muni.htm

Pollution Load Model Input Information

A GIS database was created characterizing the UW-O Campus in terms of urban stormwater pollution generation. Information in the database includes:

- Subbasin delineations (based on the 2008 City of Oshkosh city wide stormwater plan)
- Hydrologic soil groups (based on USDA NRCS soil data)
- Land use conditions as of October 2004 (source data provided by UW-O and field verified by site visit in May, 2008)

Area of Analysis

All of the lands within the campus boundary of UW-O as of October 1, 2004, were analyzed with the exceptions as described below. The following list summarizes the lands excluded from the analysis in accordance with WDNR policies:

- All City of Oshkosh street right-of-ways (all roads through and around the UW-O campus)
- There are three UW-O parcels not contiguous with the campus or Titan Stadium area. Because of the parcels' land cover (2 of the parcels are recreational fields) and the parcel size (there is no MS4 within the parcel) these parcels were excluded from the analysis; however, these parcels are incorporated with the City of Oshkosh's WinSLAMM analysis.

Stormwater Model Description

WinSLAMM version 9.3.0 was used to conduct the analysis. The following supporting parameters files were used:

- WisReg - Green Bay 1969.ran (the 1 year rainfall file was used since street cleaning was not evaluated as a management measure)
- WI_GEO01.ppd
- WI_SL06 Dec06.rsv
- WI_AVG01.psc
- WI_DLV01.prr
- WI_Res and Other Urban Dec06.std
- WI_Com Inst Indust Dec06.std

WinSLAMM "dat" files were created specifically to represent each delineated drainage basin of the campus. Each "dat" file included surface area values and descriptions for each "source area" feature within the drainage basin. Source areas in WinSLAMM consist of rooftop, parking, driveway, sidewalk, and landscaped areas. Each source area was further defined in the WinSLAMM "dat" file based on direct observations and discussions with UW-O staff.

Existing Stormwater BMPs

UW-O currently has three types of existing best management practices in place. These practices are:

1) sidewalk disconnection;
2) biofilter and rain garden treatment.
3) An underground proprietary treatment device (Stormceptor™) located at the Titan Stadium area.

Each of these management measures was modeled for its TSS reduction capabilities. The existing practices are described below.

Disconnection: This refers to impervious surfaces, such as sidewalks, which drain directly onto pervious (vegetated) surfaces and allow for some stormwater infiltration before runoff enters the conveyance system. Directly connected source areas are those impervious surfaces that drain into a stormwater conveyance system without passing over pervious surfaces.

In accordance with WDNR policies, the analyzed base condition used a fixed connection factor for impervious source areas. Upon investigation of the UW-O campus it was estimated that sidewalk source areas on the campus had a higher degree of "disconnection" than the fixed base condition. Thus the higher disconnection factor was taken into account when modeling the campus under the existing managed condition.

Biofilters/Rains Gardens: Biofilters and rain gardens are specially constructed landscaped depressions in the ground surface. During rain events, stormwater enters the rain garden or biofilter and soaks into an area with a mixture of sand, compost and top soil before being allowed to either infiltrate into the ground or exit through one or more under drain pipes. The under drain pipes are typically designed in biofilters and not in rain gardens. Biofilters and rain gardens also feature landscaping of various plant species which contribute with aesthetic value and enhance the infiltration rate of the soil.

UW-O has constructed rain gardens and biofilters during renovations in recent years. In addition to the newly constructed facilities, some of these treatment devices service lands that were fully or partially developed prior to October 1, 2004. The pollution control from these existing developed lands was applied to the equivalent land area as of October 1, 2004. The pollution control effectiveness of the biofilters and rain gardens were modeled using data provided by UW-O and data from GIS. A summary of the biofilter and rain garden's characteristics used for inputs to the SLAMM model is found in Table 1.

Another stormwater detention basin receives runoff from a portion of Parking Lot 34. According to information provided by UW-O this basin was constructed in the early 1990's. No other design information was available. Because of the age of the basin, it is likely that water pollution control was not a design objective of the basin. Thus, this basin was not included in the analysis of existing management measures.

Table 1: Biofilter and Rain Garden Characteristics for Modeling Purposes

BMP Type	Contributing Drainage Area (acres)	BMP Top Surface Area (sf)	BMP Bottom Area (sf)	Assummed Total Depth (ft)	Outlet Structure
Parking Lot Biofilter	1.32	4,734	1,071	5	Two 4" dia. under drain pipes
Parking Ramp Rain Garden	1.25	15,816	3,580	5	10' broad-crested weir
Tennis Court Rain Garden	0.82	9,487	2,147	5	10' broad-crested weir

Note: Based on plans provided by UW-O, and for modeling purposes, the biofilters and rain gardens were assumed to have a total depth of 5 feet. Also, it was assumed that each raingarden had a high-flow outlet represented by a 10 foot broad-crested weir.

Stormceptor™: This device receives runoff from most of the Titan Stadium playing field and grand stands area. It consists of a 6 foot diameter underground settling chamber. The device traps floatable material, litter and larger sediment particles. According to the model, it traps very little "total suspended sediment" size particles (generally, these are sediment particles below a size of 0.125 mm). This device was not included in the analysis for achieving the required TSS controls on the campus.

The approximate locations of the existing best management practices are shown on Figure 2. It is important to note that the biofilters and rain gardens were modeled according to their performance while treating present day land use conditions. This performance level was then applied to the same contributing drainage areas under the October 1, 2004 land use conditions.

Results - Base and Existing Conditions

The results of the WinSLAMM modeling analysis are shown in Table 2. This table shows the annual Total Suspended Solids (TSS) and Total Phosphorus (TP) loadings under the base and existing conditions (see definitions on page one of this memo). The table shows the TSS control effectiveness for the existing BMPs since TSS is the regulated pollutant in the existing MS4 permit.

Table 2: Annual Base and Existing Conditions Pollution Loads

Scenario	Total Suspended Solids (TSS)		BMP Reduction		Total Phosphorus (TP) Campus Load
	Campus Load	BMP Reduction	Individual	Cumulative	
	(tons/yr)	(tons/yr)	%	%	(lbs/yr)
Base Conditions	13.9	0.0	0.0	0.0	109
Effectiveness of Existing BMPs:					
Impervious Area Disconnection (sidewalk)	13.0	0.9	6.5%	6.5%	99.0
So. Campus Parking/Pedestrian Mall BMPs	12.8	0.2	1.4%	7.9%	106.0
Existing Conditions	12.8	1.1	7.9%	7.9%	96.0

The University's annual base conditions TSS load is 13.9 tons per year. After accounting for the TSS control from the existing BMPs analyzed, the existing conditions TSS load is 12.8 tons per year, which represents a TSS reduction of 7.9%.

There are two figures at the end of this memo showing relevant information to the modeling effort:

- Figure 1: UW – Oshkosh Campus SLAMM Source Area Map. This map shows the source areas for each drainage system within the modeled campus area that was used in the SLAMM input (*.dat) files.
- Figure 2: Existing Best Management Practices: This map shows the approximate locations of the existing BMPs and the current campus parcel boundaries.

Proposed Management

Since the existing management practices do not achieve the 40% TSS control required under the MS4 permit, additional stormwater pollution management measures were investigated. The campus needs to reduce TSS loading by an additional 4.4 tons per year to achieve a 40% reduction.

In order to help target the source areas most critical to achieving the pollution control requirement, Table 3 was developed. The pollution loading for each impervious source area identified in the UW-O campus is listed in Table 3. Having a loading for each of the impervious source areas allows for concentrated treatment efforts toward the areas with highest pollution loading. Note, there area other source areas not shown on Table 3 which account for the base loading difference between 13.9 and 9.28 tons/yr.

Table 3: Sediment (TSS) Loading by Source Area

Source Area	Acres on Campus	Base Campus Load (tons/yr)
Parking	24.45	5.68
Rooftop	22.31	1.56
Sidewalk (100% connected)	12.93	2.03
Total	**59.69**	**9.28**

As shown in the table, parking lots account for the highest sediment loading for impervious surfaces on campus. Even if 100 percent of the sediment from rooftops and sidewalks were treated, the 40% reduction goal (reduce the sediment load by 4.4 tons/yr) could not be achieved.

Therefore, the conceptual application of new best management practices would be best used in treatment of the parking lot runoff. Because the parking lots are scattered throughout the campus, a centralized treatment approach (wet detention ponds) was not deemed to be feasible.

UW-O has proposed removing three parking lots (totaling 1.76 acres) and replacing them with grass areas. This change in land use would provide additional TSS control. The campus has also proposed integrating biofiltration treatment to ten other parking lots (totaling 10.3 acres) on the campus property. Table 4 shows the pollution control results that these proposed best management practices would yield when implemented. Figure 3 shows the locations of the parking lots being considered for removal or biofilter construction.

This proposal includes modifying the basin serving Lot 34 to improve the pollution control capabilities of this basin. As previously discussed this basin was likely not designed for pollution control. However, by rehabilitating the device, the campus could take credit for the additional pollution control.

Table 4: Proposed Best Management Practices: Pollution Control

Parking Lot #	Acres	Proposed Treatment	TSS Base Load (tons/yr)	TSS Load with Proposed Treatment (tons/yr)	TSS Control (tons/yr)	Percent Control
14	0.68	Removal*	0.16	0.02	0.14	88%
5a	0.76	Removal*	0.17	0.02	0.15	88%
19	0.33	Removal*	0.08	0.01	0.07	88%
10	0.46	Biofilter	0.11	0.01	0.10	90%
11	0.47	Biofilter	0.11	0.01	0.10	90%
12	0.68	Biofilter	0.16	0.02	0.14	90%
18	0.82	Biofilter	0.19	0.02	0.17	90%
23	0.38	Biofilter	0.09	0.01	0.08	90%
25	1.74	Biofilter	0.40	0.04	0.36	90%
27	1.33	Biofilter	0.31	0.03	0.28	90%
29	0.75	Biofilter	0.17	0.02	0.16	90%
30	2.09	Biofilter	0.48	0.05	0.43	90%
34	1.57	Biofilter	0.36	0.04	0.33	90%
Total:	**12.07**		**2.78**	**0.28**	**2.49**	

*Note: This implies that a parking lot would be removed and replaced with a grass area having a silt-type base soil.

As shown in Table 4, the BMPs proposed by UW-O would acquire an additional 2.49 tons of TSS control per year. This level of control, combined with the existing BMPS equates to an overall control level of 28% TSS. This means that the campus would still need to reduce the sediment loading by 1.91 tons/yr in order to achieve the 40% reduction requirement.

Proposed treatment cost estimates: Table 4 shows a total of 10.3 acres of parking lot identified for biofilter treatment. Based on certain assumptions on runoff volumes, and biofilter depth, it requires approximately 2,000 square foot of biofilter area per acre of parking lot, to achieve 90% TSS control for the treated area. Using cost estimates developed for the City of Oshkosh in their city-wide stormwater management plan, each 2,000 square foot biofilter may cost about $32,000 to construct. Table A-2 shows the unit costs used to develop this estimate. Using an estimate of $32,000 per acre of construction costs, it would cost $329,600 to treat the entire 10.2 acres of identified parking lot.

Conclusions

As stated in the UW-O MS4 Permit, the campus must provide:

> ***"2.7.1*** *To the maximum extent practicable, implementation of storm water management practices necessary to achieve a 20% reduction in the annual average mass of total suspended solids discharging from the MS4 to surface waters of the state as compared to implementing no storm water management controls, by March 10, 2008. The permittee may elect to meet the 20% total suspended solids standard on a watershed or regional basis by working with other permittee(s) to provide regional treatment that collectively meets the standard.*
>
> *Note: Pursuant to s. NR 151.13(2), Wis. Adm. Code, the total suspended solids reduction requirement increases to 40% by March 10, 2013."*

The stormwater pollution modeling evaluation conducted for the University of Wisconsin-Oshkosh followed the guidelines provided by the WDNR for compliance with the MS4 Permit. As a result of this evaluation the following conclusions are made:

1. Accounting for all of the existing management measures, UW-O is currently reducing its pollution load by 1.1 tons per year (7.9%). Therefore the University has not met the TSS reduction requirements of their MS4 Permit for neither the 2008 goal (20%) nor the 2013 goal (40%).
2. Since both the 20% and 40% TSS removal goals have not been met, additional best management practices are necessary for UW-O to gain MS4 compliance. Proposed BMPs include the removal of three existing parking lots as well as new biofilter design and construction to treat 10.3 acres of existing parking lots.
3. After construction of the proposed BMPs takes place, the campus would be at a 28% TSS control level. It will still need to reduce sediment loading by 1.9 tons/year. An alternative to the campus constructing more BMPs to further reduce the annual sediment loading may be for the campus to work cooperatively with the City of Oshkosh. Section 2.10 of the MS4 permit allows for intergovernmental cooperation to perform one or more of the conditions in the permit. It may be more feasible to achieve the UW-O pollution control requirements on various locations throughout the city. This approach would likely require long-term agreements between UW-O and the city to define the roles and responsibilities of each party.
4. The University of Wisconsin - Oshkosh should review these results with the WDNR to finalize their MS4 permit compliance for the TSS reduction requirements.

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Attachment A: Supporting Documentation

Table A-1
Drainage Basin & Source Area Summary

		SOURCE AREA (acres)					
BASIN ID	**TOTAL ACRES**	**ROOFTOP**	**PARKING**	**DRIVEWAY**	**WALK**	**LANDSCAPE**	**OTHER IMPERVIOUS**
55	5.71	0.00	0.00	0.00	0.00	5.71	0.00
81	2.04	0.00	0.00	0.00	0.00	2.04	0.00
82	10.89	0.00	0.10	0.00	0.25	9.25	1.29
83	2.30	0.00	0.00	0.00	0.00	2.30	0.00
84	6.28	0.72	1.25	0.00	0.51	3.80	0.00
85	26.82	4.19	5.57	0.16	2.36	13.82	0.72
88	19.93	4.37	5.77	0.43	1.51	7.85	0.00
91	47.83	10.38	5.38	0.00	6.15	25.92	0.00
93	8.67	0.97	3.61	0.07	0.31	3.71	0.00
94	23.59	1.43	0.58	0.79	1.27	17.24	2.28
100	3.40	0.25	2.19	0.00	0.57	0.39	0.00
TOTAL	157.46	22.31	24.45	1.45	12.93	92.03	4.29

Table A-2
Biofilter Unit Cost Estimate

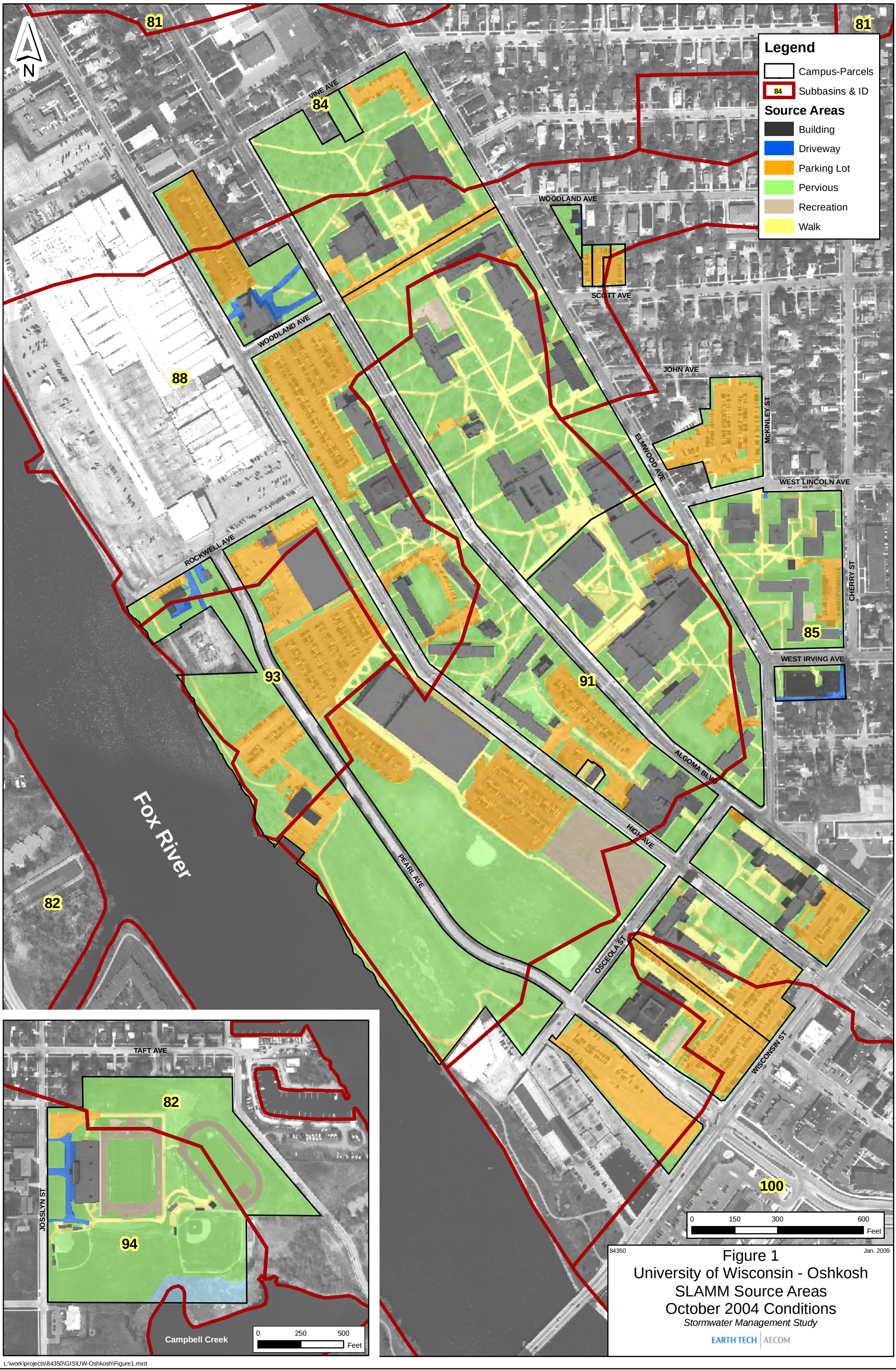
Item	Unit	Cost per Unit	Quantity	Cost
Biofilter Plants	SF	$ 5.00	1000	$ 5,000
Excavation	CY	$ 12.50	185	$ 2,315
Engineered Soil Backfill mixing	CY	$ 7.50	111	$ 833
Seeding No. 10 @ 1.5 lbs/1000sf*	1000 sf	$ 9.12		$ -
Class 1A Urban Mat	SY	$ 17.92		$ -
Seeding 10' perimeter No. 75 @ 0.4 lbs/1000sf*	1000 sf	$ 17.92	2.04	$ 37
Drain Tile - Perforated 4-inch	LF	$ 9.00	67	$ 603
Drain Tile - Unperforated 4-inch	LF	$ 9.00	40	$ 360
Drainage System Connection	Unit	$ 1,500.00	1	$ 1,500
Compost	CY	$ 32.40	33	$ 1,080
Topsoil	CY	$ 9.87	33	$ 329
Pea Gravel	CY	$ 10.00	37	$ 370
Mason Sand	CY	$ 10.00	44	$ 444
Subtotal				$ 12,872
Contingency	%	15%		$ 1,931
Design Fees	%	10%		$ 1,287
Total				**$ 16,000**

NOTE: Table A-2 is an estimate for a 1000 sq. ft. Biofilter.

* Section 630-Seeding, Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, 2008 edition

Attachment B
Supporting Figures

- Figure-1: UW-O Campus Map showing SLAMM Source Areas
- Figure-2: UW-O Campus Map showing Existing BMP Locations
- Figure-3: UW-O Campus Map showing Proposed BMPs



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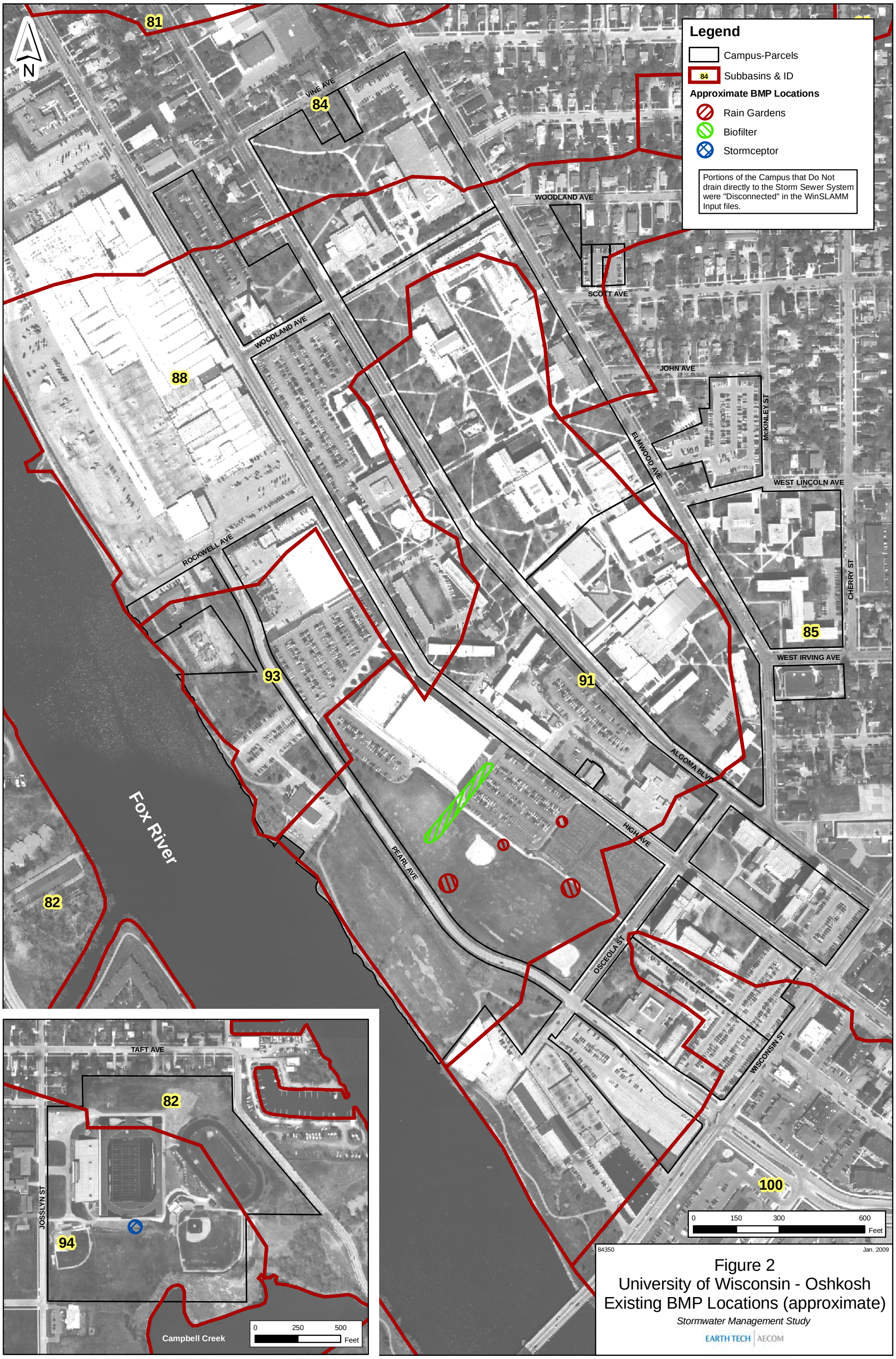

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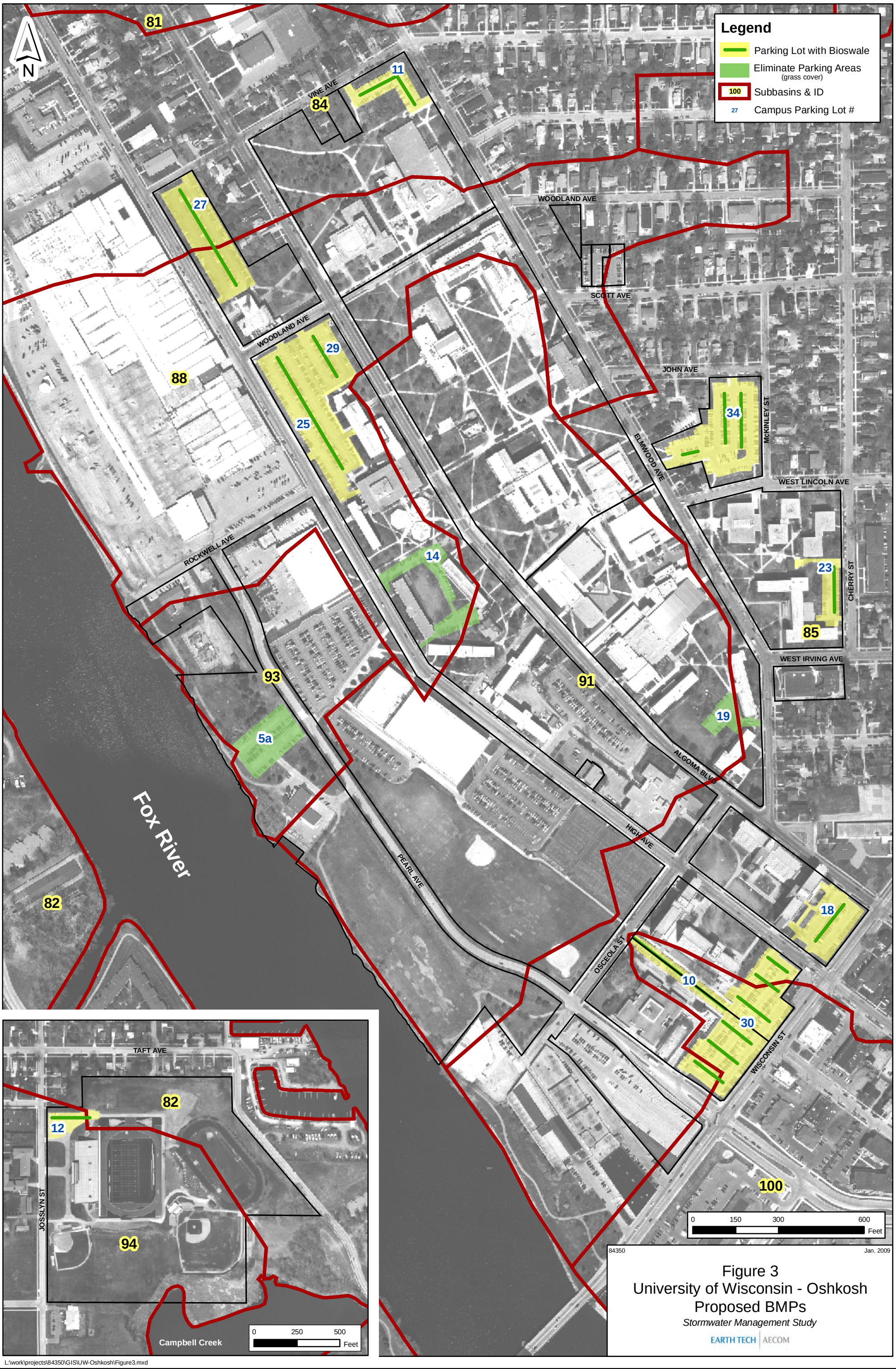

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