2.1 ASSESSMENT OF EXISTING HYDROLOGY AND STORM WATER MANAGEMENT SYSTEMS

Impervious Area

Figure 2.1 shows the Kenwood Campus drainage divide. Storm water from the north half of the campus discharges westward to a combined sewer in E. Edgewood Avenue, which overflows to the Milwaukee River. Storm water from the south half of the campus discharges west and south, to a combined sewer in E. Park Place, which overflows to the Milwaukee River. Approximately 62 acres of the campus drain to the north and 37 acres drain to the south. The campus contains approximately 57 acres of impervious surface, which is about 57 percent of the total area. There are 30 acres of impervious surface in the northern drainage area (48 percent), and 27 acres of impervious surface in the southern drainage area (73 percent). Downer’s Woods are a large portion of the pervious area in the northern drainage area.

Soil Conditions

General: The primary sources for soils data are the NRCS (formerly SCS) soil surveys and actual soil boring logs from boring taken for specific projects. The NRCS’s Soil Survey of Milwaukee and Waukesha Counties\(^1\) does not show specific soil types for the Kenwood Campus or the four remote sites, as these locations are all within urbanized areas that have previously been subjected to significant disturbance. Data from soil borings for projects within the Kenwood Campus and at the remote sites can also be used to determine the hydrological characteristics of the soils.

The NRCS has a hydrological classification system for soils that rates the infiltration capacity of the soil\(^2\). Soils are classified as hydrological soil classifications A, B, C or D, with A being the most permeable, and D being the least. Group A soils are primarily composed of sands and gravels, while Group D soils are primarily comprised of silts and clays. The NRCS’s hydrological analysis methodology\(^3\) uses runoff curve numbers (RCN) to compute the amount of runoff from various land cover types, and has assigned the RCN’s based on the cover type and soil group. Land use types within Group A soil areas have lower RCN’s than the same land use types within Group B, C, or D areas, with Group D areas having the highest RCN’s. Hydrological soil classifications have no impact on the RCN for impervious areas.

Kenwood Campus: The NRCS Soil Survey does not show a soil type for the Kenwood Campus area. This indicates that there has been significant soil disturbance within an urbanized area. The NRCS does not assign a hydrological soil classification to this type of soil.

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\(^1\) U.S. Department of Agriculture, Natural Resources Conservation Service, “Soil Survey Geographic (SSURGO) database for Milwaukee and Waukesha Counties”, February 2004


The University prepared a report entitled “UWM as a Zero – Discharge Zone: A Storm Water Master Plan for the UWM Campus”, dated May 5, 2006\(^4\). Chapter 3 of the Report, entitled “Runoff Modeling” begins with an M.S. Engineering Thesis by Elizabeth Locke\(^5\) which states that the Kenwood Campus has Group C soils, described as clay loams, soils low in organic content, and soils usually high in clay.

Soil borings within the Kenwood Campus, obtained from the UWM Geologic Sciences Department, show that the main soil constituent is clay, which supports the assumption of Group C soils.

Kenilworth Building: The NRCS Soil Survey does not show a soil type for the Kenilworth site. This indicates that there has been significant soil disturbance within an urbanized area. The NRCS does not assign a hydrological soil classification to this type of soil.

Hydrological analysis for the nearby Park Lafayette Condominium Development assumed Group C soils for that site. Soil borings at the Park Lafayette site show the main soil constituent is clay\(^6\).

Plankinton Building: The NRCS Soil Survey does not show a soil type for the Plankinton site. This indicates that there has been significant soil disturbance within an urbanized area. The NRCS does not assign a hydrological soil classification to this type of soil.

The Plankinton site is located very close to the Milwaukee River, and has a pile-supported foundation. This suggests soils with a high organic content, and a high groundwater table.

Soil borings at and near the Plankinton site, including borings taken for the Milwaukee Metropolitan Sewerage District’s (MMSD) Water Pollution Abatement Program (WPAP), show substantial fill and clay\(^7\).

Group C soils would be assumed for a hydrologic analysis of the Plankinton site.

Great Lakes Research Facility: The NRCS Soil Survey does not show a soil type for the Great Lakes Research Facility site. This indicates that there has been significant soil disturbance within an urbanized area. The NRCS does not assign a hydrological soil classification to this type of soil.

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\(^4\) Wasley, James et al., “UWM as a Zero-Discharge Zone, A stormwater masterplan for the UWM Campus”, May 2006


\(^6\) Wisconsin Testing Laboratories, LLC, “Geotechnical Investigation – Proposed Park Lafayette, E. Lafayette and N. Prospect Avenue, Milwaukee Wisconsin”, November 2005

The Great Lakes Research Facility site is located on the estuary of the Kinnickinnic River, adjacent to the Greenfield Slip. Soils with a high organic content and a high groundwater table would be expected at this site.

Soil borings at or near the Great Lakes Research Facility site, including borings taken for the MMSD’s WPAP show substantial fill and clay.

Group C soils would be assumed for a hydrologic analysis of the Great Lakes Research Facility site.

University Services Site: The NRCS Soil Survey does not show a soil type for the University Services area. This indicates that there has been significant soil disturbance within an urbanized area. The NRCS does not assign a hydrological soil classification to this type of soil.

Group C soils would be assumed for a hydrologic analysis of the University Services site.

**Storm Water Management**

General: Storm Water Management is necessitated by development within the natural environment that increases the rate and volume of storm water discharge and contributes pollutants to the runoff. It is comprised of three components: conveyance of runoff; control of runoff quantity; and removal of pollutants from the runoff. Storm water conveyance is accomplished by means of overland flow, pipes, and open channels. Storm water quantity control is accomplished by temporary storage, to reduce the peak discharge rate and prolong the duration of the discharge. Storm water quality control involves a variety of measures to prevent the entry of pollutants, picked up by the storm water during the conveyance process, from entering watercourses.

Kenwood Campus: The Milwaukee Metropolitan Sewerage District partnered with James Wasley and an interdisciplinary team at the University of Wisconsin-Milwaukee on two projects: A study aimed at demonstrating the potential for UWM’s urban campus to utilize best management practices to become a stormwater friendly landscape, and the design of a demonstration project that fits the framework of the stormwater study.

The study report, titled “UWM as a Zero-Discharge Zone” outlines the masterplanning project, which created an inventory of design opportunities to transform the UWM campus into a testing site for urban stormwater best management practices. The ultimate goal is achieving a 100-year zero-discharge condition for the campus as a whole. The study has catalogued the potentials on campus for green roof retrofits, downspout disconnections, and the redesign of both pedestrian and vehicular hardscaped areas. The

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The design project, “The Pavilion Gateway Demonstration Project\(^9\), details the redesign of four acres of the UWM campus to meet this same ‘zero-discharge’ standard. The Pavilion Gateway Project proposes the creation of five gardens and other interconnecting landscape features, totaling approximately 13,000 square feet of enhanced landscaping. Components of the project include 32,000 square feet of internally drained roofs captured and day lit to create sculptural water features; 39,000 square feet of externally drained roofs captured through 31 sculptural downspout disconnections on 7 different buildings; the elimination of 2-½ parking lots and 11,000 square feet of asphalt with a net loss of only 5 parking spaces; 20,000 square feet of pervious paving of various types installed for demonstration purposes; and the creation of a scientific research garden capable of replicating radically different soils profiles native to Wisconsin, as well as of the infrastructure necessary to treat the entire demonstration site as an ongoing research project and outdoor classroom.

Figure 6.5 shows the storm water conveyance system that serves the Kenwood Campus. Figure 2.1 shows the topography of the Kenwood Campus area, and the drainage divide, with approximately 62 acres draining to the north, and approximately 37 acres draining to the south. Both of the major drainage areas discharge to the west, eventually reaching the Milwaukee River via the City of Milwaukee’s combined sewer system. Note that a significant portion of this storm water enters the MMSD’s Deep Tunnel System and is then conveyed to the MMSD’s treatment plants for treatment prior to discharge to Lake Michigan. There are occasions, during extreme precipitation events, that the storm water is bypassed around the Deep Tunnel System and is discharged, combined with wastewater, directly to the river. A reduction in the rate and volume of storm water discharge would reduce the frequency of these “overflow” events. This is the basis of UWM’s goal to become a “zero-discharge zone”.

Kenilworth Building: The Kenilworth building, located at 1925 East Kenilworth Place, is approximately 34,000 square feet. The Kenilworth Building provides storage and research facilities for the School of Fine Arts and also contains a UWM Parking and Transit office and retail tenants. The site, as it is currently developed, is served by City of Milwaukee combined sewers in N. Prospect Avenue, E. Kenilworth Place, and N. Farwell Avenue. It does not contain any storm water BMP’s.

Plankinton Building: The Plankinton Building, located at 161 West Wisconsin Avenue, is home to the School of Continuing Education. The School occupies the top two floors of the historic building overlooking the Grand Avenue Mall. The remodeled 100,000 square-foot facility contains multimedia classrooms, meeting rooms, computer labs, dining facilities and offices. The Plankinton Building is served by City of Milwaukee combined sewers in W. Wisconsin Avenue, N. Plankinton Avenue and N. 2nd Street.

There is a separate storm sewer in Wisconsin Avenue, owned by the MMSD. These mains convey wastewater and storm water discharge from the building, and collect storm water from the site and adjacent right-of-way.

**Great Lakes Research Facility:** The Great Lakes Research Facility, which houses the Great Lakes Water Research Institute, is located at 600 East Greenfield Avenue, and is approximately 98,000 square feet. It is the primary home of the UWM Center for Great Lakes Studies, and also houses a federally funded biomedical and environmental research laboratory and the University of Wisconsin Sea Grant Institute. The Water Institute teamed up with the Milwaukee Metropolitan Sewerage District (MMSD) in 2003 to test a method of water pollution control. A portion of the roof was converted to a 10,000 square foot green roof. There is a combined sewer outfall in Greenfield Avenue, owned by the MMSD, that handles storm water discharge from the building, the site, and the adjacent right-of-way.

**University Services Site:** The University Services building, located at 115 by other tenants. The UWM building portions cover approximately 150,000 square feet. The site is served by City of Glendale separate storm sewers in N. Lydell Avenue, E. Reindl Way, N. Hubbard Street and E. Fiebrantz Avenue. These mains convey storm water discharge from the building, and collect storm water from the site and adjacent right-of-way. As it is currently developed, the site does not contain storm water BMP's.

**Storm Water Regulations**

Storm water management within the master plan area is regulated by the local municipalities, the MMSD, the Wisconsin Department of Natural Resources (WDNR), and the United States Environmental Protection Agency (USEPA), and the U.S. Army Corps of Engineers (CORPS). Regulatory requirements from the Federal government, such as the National Pollutant Discharge Elimination System (NPDES) are applied through State and local programs. Impacts to waterways and wetlands are also regulated by all of the above listed entities. The Kenwood Campus and the Kenilworth, Plankinton, and Great Lakes sites are located within the City of Milwaukee, and are subject to Milwaukee’s Ordinance 120 requirements. The University Services site is located in the City of Glendale, and is subject to Glendale’s Storm Water Management Ordinance. Following is a list of the applicable regulations:

- NR 216 (Comm 60) Storm Water Discharge Permits
- NR 151 (Comm 60, Comm 82, Comm 85) Runoff Management
- NR 116 – Wisconsin’s Floodplain Management Program
- Chapter 30 – Navigable Waters, Harbors and Navigation
- City of Milwaukee Ordinance - Chapter 120
- City of Glendale Ordinance - Title 6, Chapter 5
- Milwaukee Metropolitan Sewerage District – Chapter 13
- Section 404 of the Federal Clean Water Act

**NR 216 (Comm 60) Storm Water Discharge Permits**

NR 216 of the Wisconsin Administrative Code covers three types of storm water discharge permits: Municipal, Industrial and Construction Site. UWM
must meet the Construction Site Storm Water Discharge Permit requirements.

The cities of Milwaukee and Glendale have initiated regulations and actions that will meet the Municipal Storm Water Discharge Permit. The cities have adopted MMSD Chapter 13 regulations, and must enforce NR 151 post-construction storm water performance standards.

The Construction Site Storm Water Discharge Permit is applicable to UWM. Subchapter III of NR 216 describes the permit requirements that apply to construction sites that are one or more acres of disturbed land. To obtain a Construction Site Erosion Control and Storm Water Discharge Permit, the landowner must:

- Develop a Storm Water Pollution Prevention and Erosion Control Plan describing the best management practices that will be used on-site for erosion control. The Wisconsin Construction Site Best Management Practice Handbook was written by the Department to assist landowners and contractors in developing a Construction Site Erosion Control Plan. Conformance with the handbook is required under NR 216.46(1).

- Submit a Construction Site Notice of Intent form to the WDNR of the Department of Commerce before construction begins.

- Implement best management practices, as described in the Storm Water Pollution Prevention and Erosion Control Plan, to help control erosion and prevent contamination of storm water.

- Conduct weekly on-site inspections through the duration of the project.

Municipalities are authorized to provide technical reviews and administration of the construction site permit. Subchapter III of NR 151 reiterates the construction site requirement of NR 216. A permit is not required for routine maintenance, if the site is less than 1 acre.

**NR 151 (Comm 60, Comm 82, Comm 85) – Runoff Management**

Chapter NR 151, Runoff Management, of the Wisconsin Administrative Code provides runoff pollution performance standards and practices to achieve water quality standards. Subchapter III focuses on non-agricultural performance standards for development and redevelopment. Construction sites of one or more acres require an erosion control plan using BMPs.

The construction site erosion control plan should show BMPs that, by design, achieve, to the maximum extent practicable, a reduction of 80 percent of the sediment load carried in runoff, on an average annual basis, as compared with no sediment or erosion controls, until the construction site has undergone final stabilization. Generally, current erosion control plans will meet this requirement.
Maximum Extent Practicable (MEP) is the degree to which BMP’s are required to perform, and considers available technology, cost, safety, welfare, endangered resources, historic resources and geographical resources. MEP allows “flexibility” in meeting standards.

Post-construction performance standards for new development and redevelopment are provided in NR 151.12 and are applicable to all land disturbances that are one or more acres. Post-construction performance standards apply to control of total suspended solids, peak runoff discharge rates, infiltration, protecting certain natural resources, and controlling fueling and vehicle maintaining maintenance areas.

BMPs shall be designed, installed and maintained to control total suspended solids carried in runoff from the post-construction site. BMPs for new development, by design, should reduce to the maximum extent practicable, the total suspended solids load by 80 percent, based on an average annual rainfall, as compared to no runoff management controls. BMPs for redevelopment, should be designed to reduce, to the maximum extent practicable, the total suspended solids load by 40 percent, based on an average annual rainfall, as compared to no runoff management controls.

BMPs by design shall be employed to maintain or reduce the peak runoff discharge rates, to the maximum extent practicable, as compared to predevelopment conditions for the 2-year, 24-hour design storm applicable to the post-construction site. Redevelopment sites are exempt from peak runoff reduction.

Infiltration of storm water may be required. An infiltration facility should provide 60 percent of the pre-development infiltration, for non-residential areas, for the 2-year, 24-hour storm, using no more than 2 percent of the site area. This administrative rule has numerous exceptions and prohibitions related to redevelopment areas.

Lakes, streams, and wetlands are “protected areas” and require buffers for certain uses. The buffers range from 10 to 50 feet, with many variables. Fueling and maintenance areas have special requirements in NR 151.

**NR 116 – Wisconsin’s Floodplain Management Program**

Municipalities are required by State Statute 87.30 (1) to adopt reasonable and effective floodplain zoning ordinances within their respective jurisdictions to regulate all floodplains where serious flood damage may occur. The purpose of these rules is to provide a uniform basis for the preparation and implementation of sound floodplain regulations.

The 100-year rainfall event produces a water surface that, when mapped with topography, generates a floodplain that is regulated by municipalities for navigable waters relating to NR 116. This Administrative Code prohibits a development from increasing the water surface of a floodplain by more than 0.01 feet, without providing compensatory floodplain volume.
Chapter 30 – Navigable Waters, Harbors and Navigation

Chapter 30 of the Wisconsin statutes regulates navigable waters. Chapter 30 was changed in 2004 to reduce the frequency of permits. This change will allow grading more than 75 feet from a navigable waterway without obtaining a Chapter 30 permit from WDNR.

City of Milwaukee Ordinance - Chapter 120

The City of Milwaukee’s stormwater requirements are found in Chapter 120 of the City’s Code of Ordinances. If the development or redevelopment causes an increase of 0.5 acres or more of impervious area, the release rate and requirements are governed by MMSD’s Chapter 13 rules for water quantity control. If the development or redevelopment disturbs more than an acre of land and does not cause an increase of 0.5 acres or more of impervious area, the peak runoff flow rates under post-development conditions shall be at least 10% less than the peak runoff rates under pre-development conditions. The City has adopted NR151 requirements for water quality, without amendment.

City of Glendale Ordinance - Title 6, Chapter 5

The City of Glendale has adopted MMSD’s Chapter 13 rules for water quantity control with one amendment. The 100-year post-development peak runoff discharge shall not exceed the more restrictive of either 0.5 cfs per acre or exceed the maximum hydraulic capacity of existing downstream conveyance, drainage, or storage facilities. The City has adopted NR151 requirements for water quality, without amendment.

Milwaukee Metropolitan Sewerage District – Chapter 13

The MMSD’s Chapter 13 rules define storm water management requirements for the entire MMSD service area, which includes the Cities of Milwaukee and Glendale. The rules apply to proposed developments which will result in a net increase in impervious surfaces of 0.5 acres or greater.

The Chapter 13 rules allow two methods for determination of the volume of detention required. Under the Allowable Release Rate Method, the detention volume is computed based on an allowable discharge from the developed site of 0.5 cfs per acre for the 100-year storm event and 0.15 cfs per acre for the 2-year storm event. Under the Volumetric Method, the detention volume is computed based on the volume of runoff in the outflow hydrograph for developed conditions being equal to or less than the volume of runoff in the outflow hydrograph for existing conditions, during the critical duration on the affected watercourse.

Section 404 of the Federal Clean Water Act

The Corps of Engineers (COE) regulates discharges to “Waters of the U.S.”, including filling and excavation of wetlands. Section 404 applies to most wetlands in the State connected to federal jurisdictional navigable waterways. All COE regulated activities under Section 404 must comply with the water quality certification of Chapter NR 299 of the Wisconsin Administrative Code. Wetlands not governed by Section 404 are governed by WDNR via water quality standards for surface waters in Chapter NR 102 and Chapter NR 299 of the Wisconsin Administrative Code. Land
disturbances within a wetland boundary require a NR 103 Water Quality Certification to be issued by the WDNR.

### 2.2 WATER CONSUMPTION

The Kenwood Campus and the remote sites all receive potable water from Lake Michigan. The Kenwood Campus, Kenilworth, Plankinton and Great Lakes sites are within the City of Milwaukee, and receive water from the Milwaukee Waterworks. Table 3.1 summarizes the water consumption information for the Kenwood Campus and the Great Lakes Water Facility. There was a slight decrease in water usage at the Kenwood Campus between FY 2006-07 and FY 2007-08. This is attributed to a decrease in requirements for landscaping irrigation. The Great Lakes Research Facility there was a significant increase in water consumption from FY 2006-07 to FY 2007-08. Water usage at the Great Lakes Facility is heavily dependent on the number and types of research experiments in process, and can vary greatly from year to year. Water consumption information for the Kenilworth and Plankinton sites was not available.

Table 2.2.1 – Water Consumption for Kenwood Campus and Great Lakes Research Facility

<table>
<thead>
<tr>
<th></th>
<th>FY 2006-07</th>
<th>FY 2007-08</th>
<th>FY 2006-07</th>
<th>FY 2007-08</th>
</tr>
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<td>Jul</td>
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<td>8,350</td>
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<td>Aug</td>
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<td>12,915</td>
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<td>117,024</td>
<td>172,047</td>
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</table>

ccf = Cubic Feet, 1 ccf equals 7.48 gallons

The University Services Center is in the City of Glendale, which is a member of the North Shore Water Utility. Water consumption information for the University Services Center site was not available.

The City of Milwaukee is adjacent to one of the largest fresh water supply in the world. Water used on the campus is taken from and returned, after cleaning, to Lake Michigan. There is no reasonable limit to the supply of fresh water available to campus facilities within the Lake Michigan watershed. The sustainable aspects of water consumption for these facilities are in the energy and chemicals required to convey and treat the water. A reduction in water consumption will result in the conservation of
energy and chemicals; and the materials and energy required to make those chemicals. Expending more limited resources and energy to avoid using Lake Michigan water in favor of other sources such as storm water and groundwater does not appear to be an appropriate sustainable strategy.

The reduction of water consumption also reduces the amount of wastewater produced, which, combined with a reduction in storm water discharge to the combined sewer system will contribute to a reduction in sewer overflows that discharge pollutants into the rivers and ultimately, Lake Michigan. The University's Storm Water Management Plan recognizes this value, with its "Zero Discharge Approach" for storm water.

2.3 KENWOOD CAMPUS ENERGY, WATER, AND EMISSIONS

Energy and Emissions

In order to begin to estimate energy consumption and campus greenhouse gas emissions for the Kenwood campus, a preliminary inventory was conducted. The inventory used the Clean Air Cool Planet Campus Carbon Calculator to consider electricity and natural gas use in calendar year 2007. The calculations factored in UWM-specific variables including local temperature, campus population (considered to include full time enrollment of students, faculty, staff), regional fuel mix, and total building space. Many other factors contribute to Kenwood campus' complete energy and emissions, such as transportation (university fleet, commuting students/faculty/staff), waste, and water; however, this investigation focuses on electricity and gas in the context of campus population and square footage of campus buildings. Water consumption is addressed separately from energy.

In the 2007 calendar year, it was reported that the Kenwood campus consumed 528,381 mmBTU (million British Thermal Units) of natural gas and 68,570,961 kWh (kilowatts) of electricity. These energy inputs resulted in emissions of 27,975 MT eCO$_2$ (metric tones of carbon dioxide equivalents) from natural gas and 59,862 MT eCO$_2$ due to electricity. [A carbon dioxide equivalent is a measure used to compare the emissions from various greenhouse gases. Based upon their global warming potentials, the carbon calculator used for this emissions inventory translates methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6) into CO$_2$ equivalents.] This means that of the emissions factors considered for the campus in this study, approximately 68% of emissions were generated from electricity and 32% from natural gas.

Carbon emissions for UWM can be compared on a -per student and -per built square foot basis. Densely built, the Kenwood campus contains 3,954,881 gross square feet of space. This results in average emissions of 50 pounds of eCO$_2$ per square foot. Similarly, based on reported data, the energy use intensity is calculated to be 305.7 kBTU/gsf. In 2007, UWM had a total campus population of 28,465, with a full time student enrollment of 23,828; 1,385 faculty; and 3,252 staff. Hence, in terms of emissions by population, Kenwood campus emitted 3.69 MT eCO2 per full-time student or 3.09 MT eCO2 per capita in 2007.
Water

Water consumption on Kenwood campus was measured independently of energy implications, although ultimately it is also a factor in energy use. Over calendar year 2007, the Kenwood campus consumed 92 million gallons. The peak monthly water use was recorded in April, when 9.6 million gallons were consumed. This equates to a daily use of 318,190 gallons, approximately equivalent to the volume of half of an Olympic swimming pool each day.

Cost Implications

As shown in Table 1, energy costs vary seasonally. Water costs hold relatively constant, while gas and electricity vary with the highest natural gas costs seen in February and the highest electricity costs in August, according to reasons including varying climate demands on different systems. Similarly, natural gas costs are lowest in June while electricity is lowest in February.

Table 2.3.1. Kenwood campus utilities costs 2007