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Review Date: January 2016
Introduction

1.1: Stormwater Management Background

Stormwater runoff is generated when precipitation events cause water to flow over land or impervious surfaces without percolation into the ground. The purpose of stormwater management is to ensure a timely response for control of stormwater runoff, reducing the damage and disruption caused by flooding. In an urban setting with great amounts of impervious surfaces, it is particularly important to recognize the potential for stormwater events and proactively prepare. Stormwater can be proactively managed by identifying areas of concern that are likely to be impacted by such runoff in the form of flooding and creating a comprehensive plan to minimize disruption and damages as well as expedite cleanup and resumption of activities in disturbed areas.

1.2: Purpose of the Stormwater Management Plan

Duquesne University is committed to ensuring that stormwater is managed in a long-term, comprehensive and planned fashion. The purpose of the SWMP is: (1) to identify areas of concern on campus susceptible to stormwater damage; (2) outline preventative actions taken to minimize risks and; (3) to provide minimum control measures, including identification of responsible parties, warnings and post exposure measures.

This Stormwater Management Plan (SWMP) is not required by the US Environmental Protection Agency or the PA Department of Environmental Protection. This plan should become part of the management and operations system and focus on short and long-term opportunities to implement additional stormwater control measures.

Cooperation and communication are crucial for the development and implementation of this SWMP. This plan aims to provide a proactive approach to mitigating potential stormwater events and all designated employees must be familiar with the plan. The SWMP will be reviewed and updated at least annually to include changes and expansion of campus and may also serve to develop full understanding of potential water flow in the event of a water main break, a major water line break, or a weather-related incident on campus.
1. Site Information

2.1: Description of Campus

2.1.1: Land Use Allocation

Duquesne University is located in the uptown neighborhood of Pittsburgh, Pennsylvania. The campus is bordered to the south by steep, rocky bluffs overlooking the Monongahela River and expands outward to include more than 49 acres of primarily self-contained urban property. The main campus property is bisected by the Armstrong tunnel which runs beneath the ground, underlying several buildings. More recent structural acquisitions by the University have extended the campus from a relatively self-contained entity into a more urban area of the City of Pittsburgh.

The Duquesne Campus consists of 41 buildings, two parking garages, two athletic fields, and several small parking lots. Many of the University buildings are older construction, pre 1970, and exist in a variety of styles reflecting the time periods in which they were built. The Campus also hosts a large amount of green space and permeable walking surfaces, such as the major campus thoroughfare, Academic Walk. Other features include two open air athletic fields composed of water permeable artificial turf and an asphalt hockey/basketball court.

Underlying the surface of the property is a network of tunnels or utility chases that provide utilities between buildings. Many of the campus buildings are interconnected by the tunnel system which opens into building sublevels. There are 17 tunnel openings, independent of buildings, and 32 openings into University buildings, with some buildings having entrances to multiple tunnels, as illustrated in Appendix B.

2.1.2: Areas of Concern

Due to the geology and slope of the land on which the campus is situated and the locations of several buildings, certain areas historically or rationally have a greater likelihood of flooding, and care must be taken to avoid damage after heavy precipitation events. These areas, indicated on the Appendix C map, include:

Table 1: Areas of Concern during Precipitation Events

<table>
<thead>
<tr>
<th>Building</th>
<th>Specific Area of Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.J. Palumbo Center</td>
<td>Rear and west sides of building</td>
</tr>
<tr>
<td>Bayer Learning Center</td>
<td>Rear loading dock</td>
</tr>
<tr>
<td>Canevin Hall</td>
<td>North side of building</td>
</tr>
<tr>
<td>College Hall</td>
<td>East and south sides of building</td>
</tr>
<tr>
<td>1204 Fifth Avenue</td>
<td>Basement</td>
</tr>
<tr>
<td>Towers Living Learning Center</td>
<td>Rear ramp and loading dock</td>
</tr>
</tbody>
</table>
Koren Building, 718 Fifth Avenue  |  Basement  
Mary Pappert School of Music  |  South side of building, basement  
Mellon Hall  |  Basement, loading dock  
Muldoon Building, 1000 Fifth Avenue  |  Basement  
Power Recreation Center  |  Basement, University Bookstore lower level  
Rockwell Hall  |  Basement  
School of Law  |  South side of building  

2.2: Geology

The surface geology of the Duquesne University Campus is characterized by its location relative to the Monongahela River. The river is located approximately 500 feet south of the campus and causes unique topographical features and overland flow. The banks of the Monongahela before meeting the Allegheny River rise sharply into steep, rocky bluffs. The campus is generously sloped with the high point at the southern bluff border. A total decline in elevation from the south end of the facility to the northwest end is 110 feet, with an average slope of 8.7 percent. A topographic contour map is provided as Appendix D.

The Campus subsurface is comprised primarily of three soil complexes, Culleoka, Rainsboro, and Warton; the bluff surface is composed of Weikert soils with rock outcrops. These soils and their locations and characteristics are illustrated in Appendices E, F and G. The soils underlying campus are primarily Culleoka complex, 70.2 percent, and range from gently sloping, to moderately steep, to steep. Culleoka complex soils are characterized as well drained with low available water capacity and a nonexistent frequency of flooding and ponding. The surface of this soils complex has a slope of between 8 and 25 percent. Culleoka complex soils are characterized as well drained with low available water capacity and a nonexistent frequency of flooding and ponding. The slope of the Culleoka complex soils ranges from 0 to 35 percent.

Other soils include gently sloping Rainsboro complex, 26.6 percent, and gently sloping to moderately steep Warton complex, 2.7 percent. The gently sloping Rainsboro complex soils are characterized as moderately well drained with high available water capacity and a nonexistent frequency of flooding and ponding. The surface of this soils complex has a slope of between 8 and 25 percent. Warton complex soils are moderately well drained with a moderate available water capacity of approximately 8.1 inches. These soils have no frequency of flooding or ponding. The slope of these soils is between 0 and 8 percent.

The bluffs are composed of Weikert rock outcrops and are extremely steep; this complex includes both Weikert and similar soils and rock outcrops with a slope of 25 to 50 percent. Weikert soils are characterized as having a very low available water capacity and are excessively drained.

Though the soils underlying the University have been mapped, since the property is in an urban area, a great deal of variation exists. In an urban setting, soils are mapped by the primary identifiable component; the remainder of the soils is described as “urban land”. These soils are
those which were human transported at some time in the past and are not identifiable as having any primary component.

Crucial to the movement of water is the depth of a restrictive feature; the soils beneath the University have a depth of 10 to 40 inches until reaching lithic bedrock depending on soil type. See Appendix H.

2.3: **Groundwater**

Duquesne University is in the Lower Monongahela watershed. The University sits high above the Monongahela River, at an elevation of approximately 800 feet above the river.

The water table beneath the soils mapped on university property varies; soils in the Culleoka complex generally have a depth of greater than 80 inches before reaching the water table. Rainsboro soils typically have a depth of between 19 and 30 inches above the water table and Warton complex soils are present at a depth of between 18 and 36 inches. Weikert soils are generally more than 80 inches above the water table.

While these are the normal depths for the soils types found beneath University property, this is an urban setting which has been frequently disturbed through history and variation may likely exist.

2.4: **Precipitation Analysis**

A ten-year historical record of monthly precipitation, 2006-2015, at Pittsburgh International Airport (located roughly 15 miles northwest of the University) was analyzed to obtain precipitation statistics. This data is located in Appendix I. Pittsburgh has a mean annual precipitation total of 38.6 inches. In the period examined, the months of May through August had the greatest average monthly precipitation, greater than 3 inches per month.

An analysis of the frequency of higher monthly precipitation for the ten years in question as compared to the rainfall for 2015 per month revealed higher monthly precipitation less than 10 percent of the time annually. During the month of June, the greatest frequency of higher monthly rainfall occurred averaging 4.23 inches. (A 100 yr. 24 hr. rainstorm is 5.5 in. of rain. A 100 yr. 1 hr. rainstorm intensity is 2.5 in.)
2.5: **Existing Stormwater Control on Campus**

There are two primary means for stormwater control on campus; either the water is absorbed or it is channeled away through the combined city sewer system (underground storm water conveyance piping system). Beneath the campus is a large network of underground tunnels and pipes, illustrated in Appendix A of this plan, that are connected to the surface by manholes. As the Duquesne campus has expanded, The University has been granted authority over the sewer system underlying a major portion of the campus from the City of Pittsburgh; Duquesne University is responsible for storm sewers on University property above Fifth Avenue to the Bluff and west of Stevenson Street.

Like much of the City, the majority of the campus sewer system is combined, serving as both a municipal sanitary sewer and storm sewer. All water collected in the sewer system is channeled to the municipal wastewater treatment facility. The Power Recreation Center was completed in 2007, and construction of this building allowed for an opportunity to divide the sewer system. Through the systems are divided, at this time, both sanitary waste and stormwater are funneled into a combined sewer with the capability of division at a later date.

Sixty one storm sewer openings throughout campus serve to channel water off the streets and away from University. Since the University has been granted authority of the underlying sewer system from the City of Pittsburgh, it is the responsibility of the University to maintain these sewer openings to ensure proper function during precipitation events. The Stormwater drains on campus are cleaned to remove any debris compromising the drains.

Duquesne University, though located in an urban area, invests a great deal of resources into providing green spaces on campus. These green spaces assist in the control of precipitation by providing an opportunity for the water to be absorbed into the ground. Some of the hardscape paving used on campus, such as the brick walkways and artificial turf, is also permeable to water, proving further opportunity for absorption.

The sewer system and green space/absorption areas at the University are typically sufficient to contain the average precipitation event without flooding. However, when precipitation exceeds the maximum manageable amount of absorption and release into the sewer system, flooding and serious damage may occur.

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2. **Responsible Parties**

Duquesne University is responsible for initial response to potential flood events. To facilitate an effective response, a Stormwater Emergency Response Team (SERT) has been established by the Director of Environmental Health and Safety to manage and direct necessary operations as the incident commander during an excess precipitation event. The Director of Environmental

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Health and Safety is responsible for training the SERT and ensuring that members are capable of performing assigned duties.

The SERT consists of key individuals from the Facilities Management and Environmental Health and Safety Departments. These individuals are responsible for flood response in a specific area of campus when notified of a potential event. Primary response occurs when the Incident Commander activates the Stormwater Warning System, discussed below; this system notifies the three operations leaders of the likelihood of flooding, prompting their initiation of response by trained designated primary responders. The Operations Leaders will work together in such an event to ensure an appropriate response to critical areas. The Public Safety Department works closely with the SERT in the event of a precipitation event to provide necessary assistance.

The Environmental Health and Safety Department has primary responsibility for monitoring weather conditions and for triggering various levels of readiness notifications to the SERT and affected areas. The Director of Environmental Health and Safety is the individual primarily responsible for communicating information and directing flood response activities. The Incident Commander is the liaison with local police and fire departments, as well as responsible for communication with University administration during such events.

The Director of Environmental Health and Safety may designate a secondary on-call safety officer who, at the Director’s instruction, provide for management of a precipitation event. Environmental Health and Safety is further charged with ensuring that the proper supplies are available to SERT members, such as sandbags, submersible pumps, and generators for flood prevention.
prevention measures. Areas affected by flooding may not be re-entered until declared safe for re-occupancy by Safety Officials.

When flooding is discovered by an individual outside of the response team, the Public Safety Office must be contacted immediately at extension 2677. At that time, Public Safety must notify the Director of Environmental Health and Safety or the designated on-call Safety Officer for coordination of response with the necessary SERT personnel. Public Safety shall also be responsible for initiating an evacuation of an area or buildings by orders of the Director and securing the area to prevent access to unauthorized personnel when necessary.

Facilities Management has a variety of responsibilities in response to a precipitation event. This department is primarily responsible for physical flood prevention measures such as placement of sandbags, transporting and setting up generators, submersible pumps, and regular checks of outside drainage in areas of concern. During flood events, Facilities is responsible for de-energizing and locking out equipment in affected areas when a safe opportunity is available so as to minimize damages. During and after such an event, Facilities is responsible for containing flood waters as well as minor cleanup operations, coordinating such remediation with Environmental Health and Safety to determine the safe and appropriate methods to use.

3. Minimum Control Measures

4.1 Preventative Actions

The SWMP is designed to function continuously 24 hours a day; response during precipitation events accounts for only a fraction of the plan. The SERT is charged with employing preventative actions to avoid damages during such events. To prevent potential flooding events on the Duquesne University Campus a variety of preventative measures will be engaged, beginning with research into critical areas and simulated precipitation event scenarios, and further including routine monitoring of weather conditions.

By examining known areas of concern and working to discover those unknown, the SERT can more fully prevent and prepare for precipitation events that could cause property damage. Campus buildings were evaluated to locate all grade openings in relation to storm water intakes and determine bottom floor elevation, relative to a common point. This information as well as all building water entry history and large storm event performance was examined to determine areas of vulnerability and whether any prior events had the potential for a more significant water introduction.

The tunnels or utility chases are below the surface of the ground and interconnect buildings throughout the campus. The location of these channels is firmly established in relation to the buildings, and the elevation at which the channels connect to buildings relative to floor elevation
of buildings was determined to better be able to take preventative minimizing damages in both areas.

Some of the Campus buildings are equipped with drains in subgrade areas. The location and function of interior subgrade drains, as well as whether such drains discharge or are connected to sump pumps has been determined and documented. An ongoing effort is being taken to determine the capacity of stormwater for which such drains are designed to handle.

Monitoring of weather conditions must play a major role as a preventative measure. Daily weather conditions are monitored for both current conditions and future forecasted events that could lead to a potential introduction of high stormwater runoff flows. Potential events are communicated to the SERT pursuant to the Stormwater Warning System, described in the next section. Individuals assigned to monitoring are made aware of severe storm, flood watches, and warning signs for potential high runoff through this system. Local conditions taken into account include current snow pack as well as snow melt runoff and rain. The potential for drains to be blocked by snow or ice, straining drain capacity are also considered.

Based upon weather conditions and the Stormwater Warning System, observation and response measures are focused on established, pre-determined areas of concern. SERT team members are organized to monitor areas of concern when the Stormwater Warning System is activated, utilizing knowledge of grade level building openings, alternative runoff paths and relative elevations of below grade vulnerability to focus response.

4.2: Stormwater Warning System

An effective and reliable stormwater warning system is essential. The components of this system include an established method of communicating potential flooding to members of the ERT, communication of potential flooding to building occupants, the protocol for moving items to be protected from ground floor levels to upper floors into pre-determined locations, and a plan outlining the steps necessary to protect items that cannot be relocated.

The Environmental Health and Safety Department has the primary responsibility for monitoring weather conditions and, in conjunction with the University Emergency Operations Team, for triggering various levels of readiness notifications to the SERT and affected areas. The Director of Environmental Health and Safety is the incident commander and is primarily responsible for communicating information and directing flood response activities. Anticipated or observed weather conditions leading to a warning response are communicated in accordance with the University Emergency Operations Plan.
4. Damage Discovery and Response

Specifically designated primary responders are charged with initial discovery and response to stormwater events. These responders will act in accordance with training and capabilities. An individual discovering flooding or damage of any magnitude must immediately contact their Operations Leader who can then coordinate the appropriate action with the incident commander and other Operations Leaders. The information provided must include the exact location of the damage; the conditions in that area, especially circumstances that might hinder response; information as to whether the space is occupied; and injuries, if any.

During a stormwater event, the primary concern must be with minimizing damages. The Operational Leaders, in communication with the Incident Commander, must direct activities to stop stormwater flow and to remove valuables from the affected areas. The Incident commander is responsible for contacting Public Safety as necessary to provide support for removing people from the affected and surrounding areas.

Equipment and supplies is available to the SERT during a stormwater event. Response equipment includes but is not limited to: sandbags, submersible pumps, generators, and industrial fans. These articles are placed near areas of concern for use during a stormwater event.

5. Post Exposure Measures

A pre-identification of the most vulnerable or susceptible areas on campus must include post-exposure recovery plans to expedite cleanup and resumption of operations in exposed areas. If a damaging stormwater event occurs, the SERT, and most particularly the incident commander and operational leaders, must coordinate remediation. University Risk Management is involved in any post exposure efforts to assess the damages incurred and contact and coordinate with the insurance company.

Facilities Management must coordinate with Risk Management, EH&S, SERT, and remediation contractors to determine appropriate remediation procedures and ensure that such procedures are followed. It is further the responsibility of Facilities Management to contact remediation contractors if damaged building materials need to be removed, or dried and disinfected or when the water is hazardous or biohazardous. Affected areas must be declared ready for re-occupancy by Risk Management and EH&S prior to resumption of activities.

After any damaging stormwater event, the Stormwater Management Plan must be reviewed and changes made accordingly to prevent any similar occurrence in the future. Changes to the Plan must be made and assessed by the members of the stormwater team in cooperation with Risk Management, Environmental Health and Safety, and Public Safety. The Incident Commander is
responsible for evaluating the performance of the SERT during the event, and if necessary members will undergo new trainings to prepare for future stormwater incidents.

6. Management of Change and Continuing improvement

Below grade areas inherently can experience water infiltration if consideration is not given in storm water management design to address what is considered in excess of normally high events. Extreme events can exceed relied upon storm systems leaving low building areas vulnerable if contouring is not considered to provide suitable grade level alternative flow paths away from building openings. Based on this changes in both the creation of below grade areas and/or use of such areas below grade spaces should be assessed for potential vulnerability and extreme events considered in the design or protection and/or use of these spaces.