U.S. Department of Veterans Affairs

Office of Construction & Facilities Management

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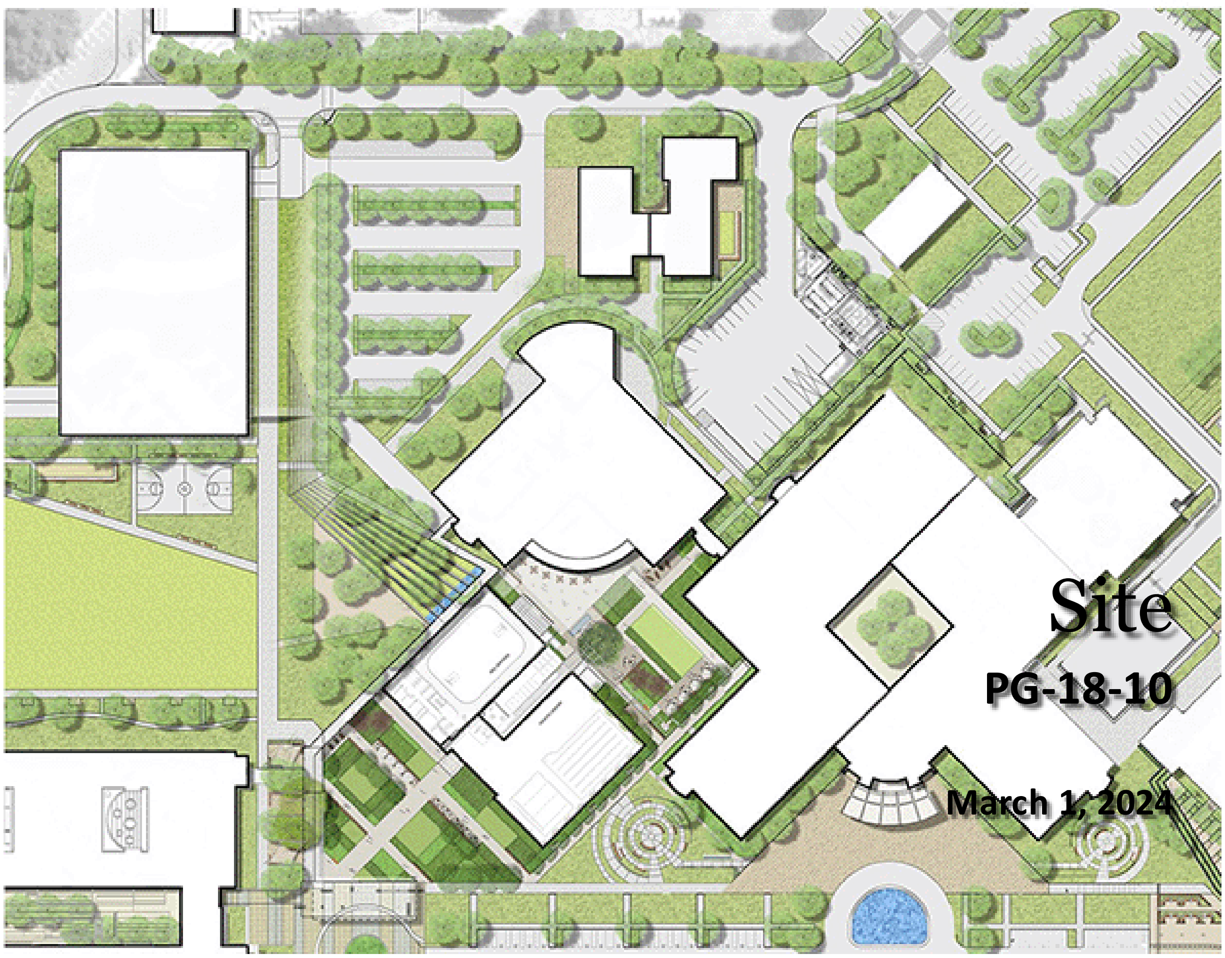

Site

PG-18-10

March 1, 2024

designmanual

Site Design Manual

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TABLE OF CONTENTS

1 General Requirements 1-1
1.1 Purpose 1-1
1.2 Responsibility 1-1
1.3 VA Standards 1-1
1.3.1 Design Manuals (PG-18-10) 1-1
1.3.2 Design Submission Requirements (PG-18-15) 1-1
1.3.3 Master Construction Specifications (PG-18-1) 1-2
1.3.4 Design Alerts and Standards Alerts 1-2
1.3.5 Design Guides (PG-18-12) 1-2
1.3.6 Design and Construction Procedures (PG-18-3) 1-2
1.3.7 Standard Details and CAD Standards (PG-18-4) 1-2
1.3.8 The VA BIM Guide 1-2
1.3.9 Physical Security and Resiliency Design Manual for VA Facilities (PG-18-10) 1-2
1.3.10 Cost Estimating Design Manual (PG-18-10) 1-2
1.3.11 Sustainable Design Manual (PG-18-10) 1-2
1.3.12 Seismic Design Requirements (H-18-8) 1-3
1.3.13 Fire Protection Design Manual (PG-18-10) 1-3
1.3.14 Architectural Barriers Act Accessibility Standard (ABA) 1-3
1.3.15 Barrier Free Design Standard (PG-18-13) 1-3
1.3.16 Signage Design Manual (PG-18-10) 1-3
1.3.17 Parking Design Manual and Demand Model (PG-18-10) 1-3
1.4 Additional Design Criteria and Standards 1-3
1.4.1 Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act 1-3
1.4.2 FAA Regulations 1-4
1.4.3 National Fire Protection Association 1-4
1.4.4 American Standards for Nursery Stock 1-4
1.4.5 National Environmental Policy Act (NEPA) 1-4
1.4.6 State Historic Preservation Office (SHPO) 1-4
1.5 Coordination 1-5
1.6 Local Codes and Requirements 1-5
1.6.1 Stormwater Management 1-5

1.6.2 Local Utility Providers ... 1-5
1.7 Criteria Unique to VA ... 1-5
1.7.1 VA-Provided Materials ... 1-5
1.7.2 Parking Requirements ... 1-6
1.7.3 Proprietary Items ... 1-6
1.7.4 Computer Aided Facilities Management Requirements (CAFM) ... 1-6
1.8 Sustainability ... 1-6
2 Site Selection and Pre-Design ... 2-1
2.1 Site Selection ... 2-1
2.1.1 Site Specific Goals and Objectives ... 2-1
2.1.2 Facility and Land Area Requirements ... 2-1
2.1.3 Site Research and Data Collection ... 2-1
2.1.4 Site Visit ... 2-2
2.2 Pre-Design Considerations ... 2-2
2.2.1 Opportunities and Constraints ... 2-3
2.3 Sustainable Site Selection ... 2-3
2.3.1 Greenfields ... 2-3
2.3.2 Climate Resilience ... 2-3
2.3.3 Access to Public Transportation ... 2-4
2.4 Soils Investigation ... 2-4
2.4.1 Soils Investigation Scope ... 2-4
2.5 Topographic Surveys ... 2-5
2.5.1 Survey Scope ... 2-5
2.5.2 Utility Surveys ... 2-6
3 Site Conceptual Design ... 3-1
3.1 Overview ... 3-1
3.2 Low Impact Development (LID) ... 3-1
3.2.1 Site Planning ... 3-1
3.2.2 Hydrologic Management ... 3-2
3.2.3 LID Management Practices ... 3-2
3.3 Location of Proposed Facility ... 3-2
3.3.1 Existing Conditions ... 3-2
3.3.2 Exterior Layout Parameters ... 3-4

3.3.3 Dimensional Requirements ... 3-5
3.3.4 Spacing Requirements ... 3-5
3.4 Building Orientation ... 3-5
3.4.1 Solar Orientation ... 3-6
3.4.2 Prevailing Winds ... 3-7
3.5 Traffic Impact Studies ... 3-7
3.5.1 Traffic Study Documentation ... 3-8
3.6 Permitting Requirements ... 3-9
4 Site Layout Design ... 4-1
4.1 Overview ... 4-1
4.2 Site Limits & Security Setbacks ... 4-1
4.3 Building Functions ... 4-1
4.3.1 Building Entrances ... 4-1
4.3.2 Flagpoles ... 4-2
4.3.2.1 Number of Flagpoles ... 4-2
4.3.3 Outdoor Building Uses ... 4-3
4.3.4 Loading Dock Design ... 4-4
4.3.5 Utility Yard Design ... 4-5
4.4 Vehicle Circulation ... 4-5
4.4.1 Public Access ... 4-5
4.4.2 Site Entrances ... 4-6
4.4.3 Drop-Off at Building Entrances ... 4-7
4.4.4 Emergency Department Access ... 4-7
4.4.5 Fire and Emergency Equipment Access ... 4-9
4.4.6 Public Transportation ... 4-9
4.4.7 Basic Roadway Design Requirements ... 4-10
4.5 Parking Lot Layouts ... 4-12
4.5.1 Parking Lot Locations ... 4-12
4.5.2 Number and Type of Parking Stalls ... 4-13
4.5.3 Accessible Parking Spaces ... 4-13
4.5.4 General Parking Lot Design Requirements ... 4-13
4.5.5 Sustainability in Parking Lots ... 4-14
4.6 Design of Pedestrian circulation ... 4-15

4.6.1 Walkway Network Hierarchy 4-15
4.6.2 Walkway Configurations 4-19
4.6.3 Walkway Design Requirements 4-20
4.6.4 Curb Ramps 4-20
4.6.5 Ramps and Steps 4-23
4.6.6 Furnishings 4-24
4.7 Bikeway Guidelines....4-24
4.7.1 Bikeway Inclusion 4-24
4.7.2 Bikeway Classification 4-24
4.7.3 Bikeway Pavement Widths and Clearances....4-26
4.7.4 Bikeway Paving Materials....4-27
4.7.5 Bikeway Gradients and Curvature 4-27
4.7.6 Stopping Distances and Street Crossings....4-28
4.7.7 Bicycle Parking....4-30
4.8 Site Grading....4-30
4.8.1 Grades at Buildings 4-31
4.8.2 Turf grades 4-31
4.8.3 Pavement Grades 4-32
5 Site Utility Systems 5-1
5.1 Overview of Utilities 5-1
5.1.1 Local Coordination 5-1
5.1.2 Utility Locations 5-2
5.2 General Utility Design Requirements.... 5-2
5.2.1 Clearances and Crossings 5-2
5.2.2 Existing Utility System Demolition 5-2
5.2.3 Redundancy.... 5-2
5.2.4 Utility Pipe Design.... 5-2
5.2.5 Design Standards and Details 5-2
5.2.6 Minimum Depth of Cover.... 5-3
5.2.7 Utilities Distribution Type.... 5-3
5.2.8 Horizontal Clearance.... 5-4
5.2.9 Vertical Clearance.... 5-4
5.3 Contract Documents 5-5

5.3.1 Calculations and Review Submittals ... 5-6
5.4 Cathodic Protection ... 5-6
5.4.1 Cathodic Protection Analysis ... 5-6
5.4.2 Corrosion Protection ... 5-6
5.4.3 Existing Cathodic Protection ... 5-6
5.5 Water Supply ... 5-7
5.5.1 Potable Water Demands (Average Daily Demand) ... 5-8
5.5.2 Potable Water Flow (Design Flow Rates) ... 5-9
5.5.3 Potable Water Sources ... 5-9
5.5.4 Non-Potable Water Demand ... 5-10
5.5.5 Non-Potable Water Sources ... 5-10
5.5.6 Water Distribution Systems ... 5-10
5.5.7 Water Distribution Design Plans ... 5-12
5.6 Water Storage ... 5-13
5.6.1 Mission Critical Facilities for Water Demand ... 5-13
5.6.2 Design of On-Site Water Storage Facilities ... 5-14
5.7 Domestic Water Pumping Systems ... 5-15
5.7.1 Pump Types ... 5-15
5.7.2 Pump Applications ... 5-15
5.8 Irrigation Distribution System ... 5-17
5.8.1 Automatic Irrigation ... 5-18
5.8.2 Irrigation System Connections ... 5-18
5.9 Sanitary Sewer Systems ... 5-18
5.9.1 Sanitary Sewer types ... 5-19
5.9.2 Sanitary Sewer Design Requirements ... 5-19
5.9.3 Mission Critical Facilities for Sanitary Sewer ... 5-21
5.9.4 Sewage Pumping Equipment (Outside) ... 5-22
5.10 Storm Sewer Systems ... 5-23
5.10.1 Storm Sewer Design Requirements ... 5-23
5.11 Gas Distribution System ... 5-25
5.12 Oil and Gasoline Supply Systems ... 5-25
5.13 Fuel Storage Facilities ... 5-25
5.13.1 Above-Grade Fuel Storage (AST's) ... 5-25

5.13.2 Underground Storage Tanks (UST's) 5-26
5.13.3 Fuel Storage for Mission Critical Facilities 5-27
6 Stormwater Management.... 6-1
6.1 Overview.... 6-1
6.2 Stormwater Attenuation 6-1
6.2.1 Pre-Developed Flow Rates 6-1
6.2.2 Post-Developed Flow Rates.... 6-2
6.3 Stormwater Quality 6-2
6.4 Stormwater Management Plan 6-2
6.5 Best Management Practices (BMPs) 6-3
6.5.1 Green Roofs.... 6-3
6.5.2 Stormwater Ponds 6-4
6.5.3 Stormwater Wetlands 6-4
6.5.4 Infiltration Practices.... 6-5
6.5.5 Filtering Practices 6-5
6.5.6 Treatment Swales 6-6
6.5.7 Pre-Treatment Practices 6-6
7 Erosion and Sediment Control.... 7-1
7.1 Overview.... 7-1
7.2 National Pollutant Discharge Elimination System Program (NPDES).... 7-1
7.3 Erosion and Sediment Control Strategies 7-1
7.4 Erosion and Sediment Control Plans 7-2
7.4.1 Erosion Control Best Management Practices (BMPs).... 7-2
7.4.2 Sediment Control Best Management Practices (BMPs).... 7-4
8 Landscape Design 8-1
8.1 Overview.... 8-1
8.2 Sustainability 8-1
8.2.1 Water.... 8-1
8.2.2 Soils 8-1
8.2.3 Vegetation.... 8-2
8.2.4 Human Health and Well-Being 8-3
8.3 Landscape Plan 8-4
8.3.1 Landscape Design Guidelines 8-4

8.3.2 Parking Lot Landscaping 8-5
8.3.3 Tree Selection Criteria in Parking Lots 8-6
8.3.4 Concentric Plant Zones 8-6
8.3.5 Plant Selection 8-7
8.4 Other Landscape Design Elements 8-7
8.4.1 Healing Gardens 8-7
8.4.2 Turf Grass 8-9
8.4.3 Maintenance 8-9
8.4.4 Site Security 8-9
8.4.5 Existing Trees and Other Vegetation 8-9
8.5 Xeriscape 8-10
8.5.1 Xeriscape Principles 8-10
8.6 Irrigation Design 8-11
8.6.1 Efficient Systems 8-11
8.6.2 Water Sources for Irrigation 8-11

1 General Requirements

1.1 Purpose

This manual is a directive for Architect and Engineer (A/E) design professionals for the planning and design of the site layout, parking, pedestrian and traffic circulation, grading, stormwater management, building location and orientation, site utilities, landscaping, irrigation, and other related systems at U.S. Department of Veterans Affairs (VA) facilities. As a healthcare organization, VA's focus is in treating veterans who, in some cases, have severe disabilities, including sight, hearing, and mobility. A/Es must always keep the interest of the sick and/or disabled veteran in mind when making decisions in locations where design choices affect veterans.

This design manual shall be utilized for all VA projects, i.e. major, minor, and NRM projects. It is expected that systems designed shall meet their primary intent of providing an accessible, safe, reliable, and sustainable facility. In order to provide the latitude needed to accommodate new technologies, methods and materials, and/or pre-existing field conditions, technical deviations from the stipulations of this manual may be made only if a safe, reliable, and sustainable design shall result. Such deviations must be approved by VA. Deviations that are not permitted are requirements included in public laws, federal regulations, executive orders, and all applicable codes.

1.2 Responsibility

A licensed Professional Civil Engineer and Licensed Landscape Architect shall work together to design the site access, drainage, and layout. The Civil Engineer shall be responsible for the site drawings. A licensed Landscape Architect shall be responsible for the landscape planting plans.

1.3 VA Standards

The VA standards are described in this section. The majority of the manuals and design references can be found on the VA's Office of Construction & Facilities Management Technical Information Library (TIL) at www.cfm.va.gov/til. All the manuals and references in this section are found on the TIL unless otherwise noted.

1.3.1 Design Manuals (PG-18-10)

These references are intended to convey general and specific VA design guidelines for medical and support facilities.

1.3.2 Design Submission Requirements (PG-18-15)

These references provide a staged list of tasks in various design categories to define the A/E scope and assure thorough and timely completion of the final design package and bid documents.

1.3.3 Master Construction Specifications (PG-18-1)

This reference defines a standardized method for the A/E to assure that the contractors provide equipment and systems that meet the design intent in terms of performance, quality, regulatory compliance, and cost.

1.3.4 Design Alerts and Standards Alerts

Alerts are issued on an as-needed basis to provide VA personnel and the A/E consultants with a listing of the most common, repeated, or critical design errors and omissions experienced by the VA on projects.

1.3.5 Design Guides (PG-18-12)

Provides the designer with specific layout templates and medical equipment lists for all types of spaces/uses and specific design parameters for structural, electrical and mechanical design.

1.3.6 Design and Construction Procedures (PG-18-3)

This reference establishes minimum consistent design/construction practices and references the VA Hospital Building System (VAHBS) methodology.

1.3.7 Standard Details and CAD Standards (PG-18-4)

The VA has adopted the U.S. National CAD Standard (NCS) Version 4. A link to the NCS standards is found on the TIL web site.

1.3.8 The VA BIM Guide

VA has adopted BIM to achieve better quality documents for construction and to provide electronic data for facilities management.

1.3.9 Physical Security and Resiliency Design Manual for VA Facilities (PG-18-10)

Sets physical security standards required for facilities to continue operation during a natural or man-made extreme event and for facilities that are required to protect the life safety of patients and staff in an emergency.

1.3.10 Cost Estimating Design Manual (PG-18-10)

The purpose of the cost estimating manual is to provide general and specific VA cost estimating philosophies for medical facilities.

1.3.11 Sustainable Design Manual (PG-18-10)

The *VA Sustainable Design Manual* sets forth sustainability-related requirements that all projects must comply with.

1.3.12 Seismic Design Requirements (H-18-8)

This reference establishes code and other requirements, including occupancy categories, for new or existing VA facilities located in seismic areas so these facilities remain functionally operational after an earthquake.

1.3.13 Fire Protection Design Manual (PG-18-10)

This manual provides the fire protection engineering design criteria for all categories of VA construction and renovation projects.

1.3.14 Architectural Barriers Act Accessibility Standard (ABA)

This document contains scoping and technical requirements for accessibility to sites, facilities, buildings, and elements by individuals with disabilities for Federal facilities. The requirements are to be applied during the design, construction, additions to, and alteration of sites, facilities, buildings, and elements to the extent required by regulations issued by Federal agencies under the *Americans with Disabilities Act of 1990* (ADA). ABA replaces the *Uniform Federal Accessibility Standards* (UFAS), which was the VA's previous standard for accessibility.

1.3.15 Barrier Free Design Standard (PG-18-13)

This supplement to ABAAS tailors some of the requirements to better meet the barrier-free needs of the VA in its health care facilities.

1.3.16 Signage Design Manual (PG-18-10)

This reference provides guidelines for the design of signs and provides detailed information on the development of a signage system.

1.3.17 Parking Design Manual and Demand Model (PG-18-10)

The goal of this document is to guide the VA's planners, managers, and designers with the best design and management practices that shall be considered when contemplating parking solutions. Parking on VA campuses must be properly planned and designed so that the VA realizes the maximum return on its investments, and so the needs of the VA's employees, visitors, and patients are fulfilled.

1.4 Additional Design Criteria and Standards

When developing a site, there are several other industry design standards that are applicable to VA projects. The standards, codes, and guides listed below are to be reviewed and incorporated on a project specific basis.

1.4.1 Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act.

Section 438 of the Energy Independence and Security Act of 2007 (EISA) requires federal agencies to develop and redevelop applicable facilities in a manner that maintains or restores stormwater runoff to the maximum extent technically feasible. The direction of the statute is to maintain or restore the pre-development site hydrology during the development or redevelopment process (http://www.epa.gov/owow/NPS/lid/section438/).

1.4.2 FAA Regulations

The following references provide Federal Aviation Authority (FAA) regulations for structures within the affected air space of an airport, obstructing marking and lighting requirements, and heliport designs. These references are to be applied on a project specific basis (http://www.faa.gov).

- Federal Airline Regulations Part 77 – Objects Affecting Navigable Space
- Advisory Circular 70/7460-1K – Obstruction Marking and Lighting
- Advisory Circular 150/5390-2B Heliport Design

1.4.3 National Fire Protection Association

The National Fire Protection Association develops and publishes codes and standards intended to minimize the possibility and effects of fire and other risks (http://www.nfpa.org).

1.4.4 American Standards for Nursery Stock

The American Nursery and Landscape Association has developed a standardized system of sizing and describing plants to facilitate the purchase and planting of nursery stock (http://www.anla.org/).

- American Standard for Nursery Stock

http://agri.nv.gov/Brochures/ANLAStandard2004.pdf

1.4.5 National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

To meet NEPA requirements federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS). EPA reviews and comments on EISs prepared by other federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

1.4.6 State Historic Preservation Office (SHPO)

The purposes of SHPO include surveying and recognizing historic properties, reviewing nominations for properties to be included in the National Register of Historic Places, reviewing undertakings for the impact on the properties as well as supporting federal organizations, state and local governments, and private sector. States are responsible for setting up their own SHPO; therefore, each SHPO varies slightly on rules and regulations.

1.5 Coordination

The A/E shall coordinate all work to avoid design conflicts and eliminate potential change orders. Of particular focus shall be concealed and underground areas and site utility coordination.

The A/E shall coordinate with federal, state, county, and local agencies to determine required permitting for the project and provide the VA Project Manager with a summary of the permit requirements, copies of permit applications and copies of correspondence, meeting minutes and other supporting documentation.

1.6 Local Codes and Requirements

While Federal Departments and Agencies are generally exempt from following state and local codes, the A/E shall bring local and regional climatic and geographic conditions and provisions of local building codes that are significantly different from national codes and conditions to the attention of VA. Of particular focus shall be local codes, code amendments, and/or conditions related to coastal, hurricane-prone, arctic, seismically active regions, or other climatic or regional conditions that warrant additional measures to protect the integrity of systems.

1.6.1 Stormwater Management

Local stormwater management and permitting requirements must be researched. Local requirements may differ from federal and state regulations. All applicable local requirements must be considered when designing the project. The more stringent requirements between the federal, state, and local regulations shall be used in all cases.

1.6.2 Local Utility Providers

The A/E shall follow the rules and regulations of local utility companies, where applicable. The A/E shall investigate potential rebates, etc., offered by local utility companies, for the use of specific types of equipment and provide a detailed summary of potential savings to the VA Project Manager.

The A/E shall coordinate with local utility providers to verify the location, size and characteristics of existing utility mains and/or service lines available for connection to the proposed facility. The A/E shall forward copies of correspondence, meeting minutes and applications for utility service from utility company representatives to the VA Project Manager. The Facility Chief Engineer will negotiate for new services or changes to existing building services as necessary.

1.7 Criteria Unique to VA

1.7.1 VA-Provided Materials

The VA Project Manager will provide the following data to the A/E:

- Facility Development Plan
- Building number assignments (the VA will provide or assign building numbers)

- All existing drawings of the site, especially any utility plans.
- Design objectives
- Limitations
- Design criteria specific to this project
- Site requirements
- Sustainability Goals – The goals shall be established by the Integrated Design Team (VA and AE). Overarching goals may be directed solely by the VA.

1.7.2 Parking Requirements

VA will quantify the number of required parking spaces for employees, visitors, motorcycle, disabled persons and van spaces. The A/E shall provide a parking tabulation on the contract drawings indicating the total number of VA facility parking spaces, existing spaces lost to construction, new standard spaces, and new standard and van spaces for the disabled. Parking lots and spaces shall be designed according to the *VA Parking Design Guide*.

1.7.3 Proprietary Items

The use of trade names or other indications that identify a product of an individual manufacturer on any project shall not be used under any circumstance, unless specifically approved by VA. Where VA authorizes specific products, etc., the following shall be identified:

- Where necessary to identify existing equipment,
- Where an existing system is to be extended and competitive manufacturers cannot meet performance or dimensional requirements,
- When required by a public utility or municipal system as a condition of service. This shall be stated explicitly in the specifications.

1.7.4 Computer Aided Facilities Management Requirements (CAFM)

The VA intends to implement Computer Aided Facility Management (CAFM) systems in all new and replacement hospital construction, and as feasible in all existing hospitals. The CAFM concept requires that all pertinent data regarding a facility be contained in a master digital database, accessible by facilities personnel at their workstations for use in operations,

energy/cost management, and maintenance and for planning modifications in facility infrastructure due to space utilization changes. The transfer of the appropriate data shall be in the COBIE format developed by the A/E and contractor.

1.8 Sustainability

There are numerous sustainable design requirements contained within this Manual. Many of these requirements align with laws and other federal mandates. In addition, designers should familiarize themselves with overall sustainable design goals contained within the *VA Sustainable Design Manual*.

2 Site Selection and Pre-Design

2.1 Site Selection

Many factors affect the selection of a site for a new project or a new addition. The A/E, along with VA and the end user, shall consider the functional layout for specific buildings along with functions required for the site. The site shall be analyzed in terms of existing utilities available, site access, existing of hazardous waste, etc. Site specific goals and objectives, verifying the program requirements, developing functional relationships, defining spatial relationships, providing an inventory of the area and accomplishing a site visit are all responsibilities of the A/E in evaluating a proposed site.

2.1.1 Site Specific Goals and Objectives

Goals and objectives for the project are derived from the integrated project team. The team's specific needs shall to be determined for the following:

- Functional requirements
- Creation of organizational efficiency and safety
- Relationship to adjacent functions
- Space provisions for renewable energies, i.e. solar PV, ground source heat pumps, wind, etc.

2.1.2 Facility and Land Area Requirements

Once the goals and objectives have been adopted, the development requirements and the spatial needs of these requirements can be identified so as to secure a proper site. Accurate project requirements are fundamental to organizing and locating project elements on a proposed site. Failure to anticipate true programmatic and spatial needs can create incompatible land use and inefficient spatial arrangements, especially on small or confined sites. The land area or spatial requirements are determined by the size of the various facilities and other activities to be included within the area to serve the facilities such as driveways, walkways, parking, open space, and consideration of future expansion. The new site must consider an analysis of the space needed for renewable energies for the current project development as well as any future campus requirement.

2.1.3 Site Research and Data Collection

Research of the project site data will typically occur simultaneously with the analysis of project requirements and functional relationships. This research includes the collection of base maps and data about the environmental and manmade characteristics of the area and its environment. Existing maps and other data shall be used whenever possible to prevent duplication of information. The data to be collected shall include the following:

- Locating and obtaining old drawings from the VA;
- Environmental Assessments that meet NEPA requirements;
- Obtaining drawings from local utility companies;
- Aerial photographs;

- Soil Conservation Service soil surveys;
- USGS topographic surveys;
- Background data such as the Property Maps;
- Significant architectural, cultural, or historical features;
- Significant climatic conditions such as wind, sun, and precipitation;
- Significant views to be enhanced or obscured;
- Proposed modifications or changes that will impact the project and surrounding area;
- Identifying location, size, and provider of available utility services in public rights-of ways;
- Setback and zoning requirements of the local jurisdiction;
- Flood plain limits;
- Boundaries and location of surrounding wetlands or protected waterways, etc.;
- Locations of nearby bodies of water subject to tide fluctuations;
- Sea-Level Rise projections for nearby bodies of water;
- Stormwater management requirements;
- Locate existing access points for the project site for vehicles and pedestrians;
- Locating the surrounding properties access points;
- Off-site traffic patterns;
- Research easements on the property;
- Research available public transportation information and routes;
- Research location of legacy trees.

To assist the A/E with gathering this information, the A/E shall use the provided Site Development Information Form, included in Appendix A to this document. This form will assist the A/E with researching the existing conditions of the site that might affect either the design or construction of the proposed VA facility. It is not intended to be all inclusive and some items may or may not be applicable to a specific site based on the intended use. At a minimum, each item shall be reviewed to determine if it is applicable and then addressed.

2.1.4 Site Visit

In the pre-design phase, the A/E shall visit the project site to see the surrounding environment.

During the site visit, the A/E shall accomplish the following:

- Review and verify existing information. Photography, field sketches, and notation are commonly used methods of recording information.
- Evaluate the compatibility of existing on- and off-site conditions.
- Discover previously unknown or unrecorded conditions and factors.
- Evaluate the design qualities and visual qualities of the site.

2.2 Pre-Design Considerations

The pre-design phase includes verifying and recording the previously mentioned collected data in a series of maps, charts and text that document all existing conditions, both within and outside the proposed project area. This information provides a basis for the evaluation of the impacts that the proposed development has on existing conditions. During the pre-design phase, it is important to understand the impacts various elements found during research can have on the project area and determine the viability of the site.

2.2.1 Opportunities and Constraints

The evaluations made in the site analysis are recorded on a map that summarizes the opportunities and constraints for development. The opportunities and constraints evaluation is used to verify the adequacy of the site for the proposed project.

The opportunities and constraints map interprets area features as either opportunities to be explored and enhanced or constraints to be avoided or mitigated. Opportunities and constraints maps shall define the following:

- Natural features to be preserved for environmental protection.
- Natural features to be conserved.
- Natural features that affect construction (poor soils, steep slopes, etc.).
- Climatic impacts of temperature, solar radiation, wind, and precipitation.
- Existing structures or other landmarks to be preserved or enhanced because of historic, architectural, or other significance.
- Existing structures or other landmarks that share functional relationships and connections with the future development.
- Existing structures or other features that have a negative impact on the area through poor siting, visual intrusion, deteriorated condition, noise, or some other factor.
- Vehicular or pedestrian circulation points of conflict and opportunity
- All utilities to serve the area or that will impact development.
- Required buffers, setbacks, or hazard zones as well as easements and rights-of-way that will restrict use of area.
- Important visual nodes such as points of entry or major intersections.
- Desirable visual impact to be enhanced and undesirable impacts to be screened.
- Significant vegetation, especially trees and shrubs.
- Permitting requirements.

2.3 Sustainable Site Selection

2.3.1 Greenfields

Avoid greenfield properties, whenever possible.

2.3.2 Climate Resilience

Evaluate project site(s) for potential impacts from climate change. At a minimum, consider sea level rise, wildfire risk, higher mean temperatures, thawing permafrost, and an increase in extreme weather intensity and frequency. Utilize the results of this evaluation to inform site selection and all stages of planning and development.

2.3.2.1 Sea Level Rise Site Selection

During site selection, evaluate potential sites using the procedures outlined in Section 2.3.2.2, below. Avoid sites with high risk of impact from Sea Level Rise (SLR).

2.3.2.2 Sea Level Rise Design Considerations

Incorporate SLR considerations into the planning and design of construction and renovation projects for all VA facilities located within coastal areas. Evaluate SLR vulnerability using the U.S. Army Corps of Engineers' Sea-Level Change Curve Calculator to determine low, intermediate, and high projections. Use the project's estimated useful life as the duration for calculation purposes. Once estimated SLR has been determined, add worst case tropical cyclone surge, tide, and wave data to determine high-water line for planning. Compare the resulting flood hazard area and flood elevation with the elevations of critical site facilities for the three SLR-influenced estimates. The selection of SLR estimate to use in decision-making shall be based on the risk associated with the facility. If determined to be vulnerable to flood effects, consider alternate site locations or physical modifications necessary to reduce the threat of SLR on facilities and infrastructure.

2.3.2.3 Sea Level Rise Coordination

Coordinate facility planning with local and regional climate change adaptation plans.

2.3.2.4 Wildland Fire Risk

Avoid sites that have high risk of wildfire. Design to meet requirements of the current version of NFPA 1144 (Standard for Reducing Structure Ignition Hazards from Wildland Fire).

2.3.3 Access to Public Transportation

Whenever possible, prefer sites that have nearby access to one, or more, modes of public transportation.

2.4 Soils Investigation

Once VA has "out right" control of the site, the A/E shall obtain the initial site soils investigation during the pre-design phase. An experienced licensed Geotechnical Engineer shall develop a geotechnical subsurface exploration and report. The time frame of obtaining the investigation shall be coordinated early in the process. In some projects, a preliminary investigation will need to be done early in the conceptual design with a more detailed investigation during the site plan phase. The A/E shall adjust the timeframe of obtaining the investigation on a project specific basis.

2.4.1 Soils Investigation Scope

The extent of the soils investigation varies on the project size and type. The A/E shall specify the information needed to the geotechnical engineer based on each prospective project. The scope of the project would generally include boring tests or other testing methodology, such as cone-penetration tests, test pits, etc. The type and number of the soil tests will be determined by the A/E based on the project size and scope. The experience of the A/E and geotechnical engineer will form the basis of the final investigation needs. The soil testing needs to be done within the proposed building and pavement locations. Infiltration testing shall also be required in proposed storm water management locations on the site. Therefore, the conceptual plan needs to be selected and far enough along to know this information before initiating the geotechnical investigation. All the tests shall be analyzed and design recommendations will be given to the A/E.

The soils investigation will provide information and geotechnical engineering recommendations relative to:

- soil conditions,
- general discussion of foundation support conditions,
- groundwater conditions,
- general discussion of potential foundation systems and capacities,
- site stripping,
- spread footing foundation design and construction,
- subgrade preparation for grade supported slabs,
- deep foundation design and construction,
- subgrade preparation for exterior pavements,
- parameters for determining lateral load resistance of foundation elements,
- settlement caused by grade raises,
- OSHA excavation considerations,
- preloading / surcharge loading recommendations,
- lateral earth pressures and drainage for cantilever retaining walls,
- Site Class determination for seismic design,
- typical pavement thickness and composition,
- recommendations for light automobile and frequent truck traffic,
- infiltration tests for potential bioretention basins,
- hydrologic soil classification,
- computed seismic response spectrum at the ground surface, and
- recommend seismic design response spectra, including SDS and SD1.

The above list is typical information obtained during the soils investigation but, is not an all-inclusive list. The geotechnical engineers shall produce a report that is submitted to the A/E addressing the appropriate information required by the building type and size.

2.5 Topographic Surveys

As soon as possible after the site has been identified, the A/E shall obtain a topographical survey. The time frame of obtaining the survey shall be coordinated early in the process.

2.5.1 Survey Scope

The A/E shall determine the specific requirements for the topographic survey on a project by project basis. The survey shall be prepared by an experienced licensed surveyor, who will certify the work. In general, the following items shall be included on the survey plan.

2.5.1.1 Property Information

The surveyor shall locate all the property lines as well as any easements within the property. Metes and bounds for the property will be provided.

2.5.1.2 Surface Features

Anything that is above the ground surface shall be located by the surveyor. For example, pavements, curb lines, building outlines, sidewalks, bollards, signs, flagpoles, utility structures, power poles, guy wires. Basically, anything that is visible to the eye. Descriptive information regarding types of existing pavements shall be included on the survey plan.

2.5.1.3 Site Elevations

The surveyor shall provide at least two benchmarks for the project site. The benchmarks shall be tied to the State Plane Coordinate system where the project is located. Elevations consist of site contours and spot elevations. The spot elevations shall be provided at all building edges/corners, doors, pavements, curb and gutter, sidewalks, along property lines, utility structures, ditch flow lines, toes and tops of slopes, etc. The surveyor will provide contours for the entire project site based on 2’ (600 mm) intervals at a minimum. The contractor shall also provide the point data and surface model to the A/E when the survey plan is submitted.

2.5.2 Utility Surveys

The surveyor shall do research with the local utility companies, existing VA facility (if applicable), and utility location services to locate all the underground utilities running through the project site. If the local user does not feel that existing utility maps cover the existing situation, the A/E shall engage a surveyor to get a more thorough picture of the existing conditions. If warranted, the surveyor shall utilize underground-radar-detection technology and professionals in this field to map out existing underground utilities that potentially impact the design of new or renovated utilities.

Underground utilities are to include storm sewer, sanitary sewer, water gas, communication, fiber optic, electrical, fuel, irrigation, and chilled water and steam lines. The depth of all the utilities shall be noted by listing invert elevations at all structures. The size and materials of utility lines shall be noted. The survey plan shall include all the utility companies, contact names, phone numbers, and email addresses (if available) for the local utility companies that serve the project site.

3 Site Conceptual Design

3.1 Overview

Once the specific project area has been determined, the next step is integrating the proposed facility into the surrounding environment of facilities, traffic, and circulation. The primary objective of the conceptual design is the development of the site plan that blends existing conditions and future facility requirements. The research and data collection done in the pre-design phase shall assist with the conceptual design.

The end user shall be an active participant in the early site conceptual design. The input from personnel who have an association with the project will provide feedback as to specific site needs, i.e. the need for on-site recreation area, a place for employees to gather for organizational functions, or additional screening to shield outdoor storage.

3.2 Low Impact Development (LID)

Low Impact Development (LID) involves a design approach that begins early in the site design process, well before the designer makes decisions about density, placement of buildings, configuration of roadways and other infrastructure, and the design of structural stormwater best management practices (BMP's). The strategy consists of design approach that discerns how water moves through the landscape under existing conditions, and then works with those site characteristics and drainage patterns to integrate the development design with natural drainage features and functions. There are three major components to LID design that the A/E shall consider.

3.2.1 Site Planning

Overall site planning shall make efforts to preserve natural vegetation, minimize the creation of impervious surfaces, and maximize the use of existing drainage patterns and drainage features. This type of planning requires an analysis of the site and its local setting, to develop an understanding of natural features, existing drainage patterns, and the water course that will receive drainage from the project. Site planning involves the following:

- Use site hydrology as the integrating framework;
- Control Stormwater at the source;
- Preserve natural drainage paths and features (not just the regulated resources areas);
- Consider ridges for development and valleys for stormwater management;
- Identify areas with soils most conducive to infiltration and use them for that purpose;
- Strategically place impervious areas where soils are less conducive to infiltration, to minimize the loss of natural recharge;
- Minimize impervious surfaces – build "up" rather than "out";
- Minimize impervious surfaces – carefully consider road lengths and widths, parking requirements, pedestrian access; and
- Minimize directly connected impervious surfaces.

3.2.2 Hydrologic Management

The A/E shall provide a design that provides for the “disconnection” of impervious surfaces from the site drainage collection system. This involves such measures as directing roof runoff and runoff from pavements to overland flow, to encourage surface infiltration and water quality treatment, to help reduce the increase of runoff from these paved surfaces. Techniques used for hydrologic management are as follows:

- Design to maximize roof disconnection;
- Provide for collection of roof runoff for irrigation purposes (rain barrels and cisterns);
- Maximize disconnection of impervious surfaces;
- Maximize drainage flow paths over pervious areas; and
- Consider overland drainage versus piped systems.

3.2.3 LID Management Practices

- Minimize runoff from roofs (e.g. green roofs)
- Minimize runoff from pavements (e.g. permeable pavement systems)
- Convert concentrated flow to sheet flow (e.g. level spreaders)
- Manage sheet flow (e.g. vegetated buffers)
- Manage concentrated flow (e.g. dry wells, bioretention areas)

3.3 Location of Proposed Facility

Each project site shall be analyzed to see how a new facility will “fit” within the existing property lines and which orientation will provide the best energy reduction opportunities. Locating the building footprint within the project site is an important first step for the A/E during the conceptual design phase. The A/E must also keep in mind the parking areas, traffic circulation patterns, expansion possibilities, etc. to make sure that the intended project site has enough room to accommodate all the required functions of the facility.

3.3.1 Existing Conditions

The A/E shall consider the following existing factors when preparing the overall site conceptual design and placement of the building and pavements:

3.3.1.1 Minimize Site Disturbance

A/E shall place the building on the site in locations that minimize modifications to the natural topography. Keeping the topography similar to existing conditions helps provide lower construction expenses, shorter construction times, and minimize erosion potential. Concentrate development in areas with minimal non-engineered slopes and existing infrastructure and mitigate any construction disturbance.

3.3.1.2 Wetlands & Protected Waterways

The initial site investigation and analysis will identify if there are wetlands or waterways near or on the proposed project site. The existing wetland and waterway boundaries are defined by Federal Agencies. If wetlands or protected waterways are on the site, the new building and paved areas need to be positioned so that all the required Federal setbacks from the wetlands and waterway boundaries are met. Use the most stringent setback distances prescribed in federal, state or local regulations. All wetlands and waterways on federal lands must be identified and protected throughout the site design, construction process and after the project is finished.

3.3.1.3 Vegetation

A/E shall analyze the type, size, amount and condition of the existing vegetation and the importance of maintaining the existing landscaping to the Owner. The conceptual layout design shall protect and preserve existing vegetation to both reduce maintenance and enhance sustainability.

3.3.1.4 Development of Prime Farmland and Protect Soils

Avoid or limit development of prime farmland. Protect soils designated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) as prime farmland, unique farmland, or farmland of statewide importance. Additional information on the preservation of agricultural land is available in Section III, Soils, of the Sustainable Sites Initiative Guidelines (http://sustainablesites.org) and Performance Benchmarks 2009.

3.3.1.5 Protect Floodplain Functions

Protect floodplain functions of the site by avoiding or limiting development within the 100-year floodplain.

3.3.1.6 Preserve Historic Properties, Including Landscapes and Archaeological Sites

Protect properties and landscapes listed on, or eligible for, the National Register of Historic Places.

3.3.1.7 Preserve Threatened or Endangered Species and Their Habitats

Avoid development of areas containing habitat with threatened or endangered plant and animal species.

3.3.1.8 Site Drainage

A/E shall review the existing site drainage to study how stormwater runoff travels across the site and identify areas of potential flooding prior to initial placement of the building.

Goals for site layout with respect to site drainage are as follows:

Preserve and maintain natural drainage areas, floodplains and waterways. Increasing or decreasing the amount of water flowing into waterways can drastically affect natural ecosystems.

Limit development in floodplains to open spaces and recreation areas first, parking areas second and structures only if absolutely necessary.

Avoid placing structures directly in existing drainage paths. Doing so can cause significant additional site work and cost easily avoided with slightly different building location or orientation. Additionally, areas where stormwater traditionally flows typically have soils not suitable for construction.

3.3.1.9 Climate

The principal climatic variables are radiant energy, temperature, air movement and humidity. The A/E shall take these variables into consideration when studying the location of the structure on the site. Properly locating and orientating the building in response to the local climate can reduce initial construction cost, as well as energy use over the life of the building.

3.3.2 Exterior Layout Parameters

3.3.2.1 Improve Connection to Surrounding Destinations and Neighborhoods

New development shall connect to existing open space corridors, sidewalks, transit, bike lanes, trails, and street networks. It shall also incorporate urban design features and elements from surrounding neighborhoods (streetscaping, wayfinding, etc.) to ensure new development compliments existing community characteristics.

3.3.2.2 Develop a Network of Complete Streets

If the project involves the development of a street network, the street design shall support multiple modes of transportation in addition to ecosystem services.

3.3.2.3 Security Landscaping Design Opportunities

Thoughtful use and design of setback space can provide an opportunity to activate underutilized space, while increasing the safety of employees and integrating the building with the local community. Setback space can be used to enhance employee and community morale by preserving or enhancing open space, creating outdoor spaces for social interaction such as pedestrian plazas, gardens or amenity areas for employees and visitors. Incorporate landscape security features such as tables, benches, flowerpots, and changes in topography instead of relying exclusively on bollards or fences.

3.3.3 Dimensional Requirements

The A/E when considering the site conceptual design shall also include dimension factors including the building dimension, or footprint, and the following factors (see Figure 3-1);

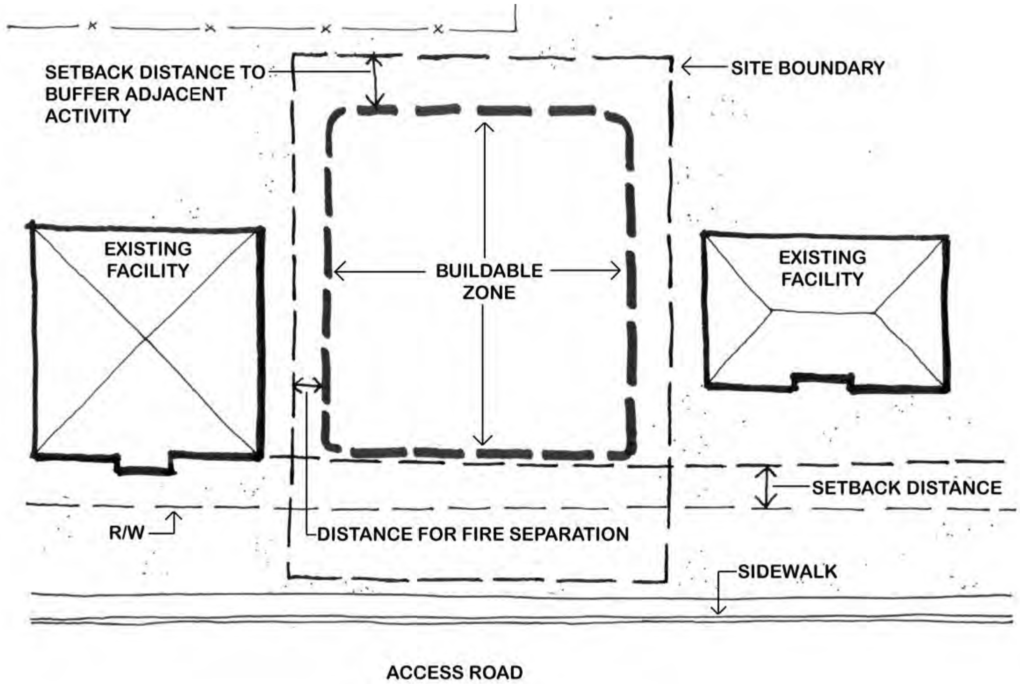

Figure 3-1

- *Buffer Zones*: Buffer Zones provide setbacks and safety protection from:
- Airfield and helipad clearances
- Noise abatement
- Physical security clearances
- Storage and handling hazardous material clearances
- Separation of incompatible land use or functions.

3.3.4 Spacing Requirements

Spacing between buildings and functions is normally determined by their:

- Functional relationships
- Operation efficiency
- Fire protection clearances
- Physical security requirements
- Parking requirements
- Future expansion
- Open space

3.4 Building Orientation

Examining potential building orientation goes hand in hand with locating the building and surrounding functions on the site. The correct orientation will enhance energy conservation.

Consideration of building views to surrounding project areas and day lighting potentials is also important to the orientation on site. The A/E shall orientate the building to take advantage of solar gain in cold climates or to protect against solar gain in hot climates.

3.4.1 Solar Orientation

Proper orientation of the building with respect to the path of the sun can reduce total building energy use by as much as 30 to 40 percent. When possible, the long axis of the building shall be aligned ranging from 5° to 25° from the east as indicated in Figure 3-2. Correct orientation of the building relative to existing site features and solar exposure can have a significant impact on the expense of heating and cooling the building over the lifetime of the building. Energy modeling shall be used to determine optimal building orientation with regard to solar heat gain.

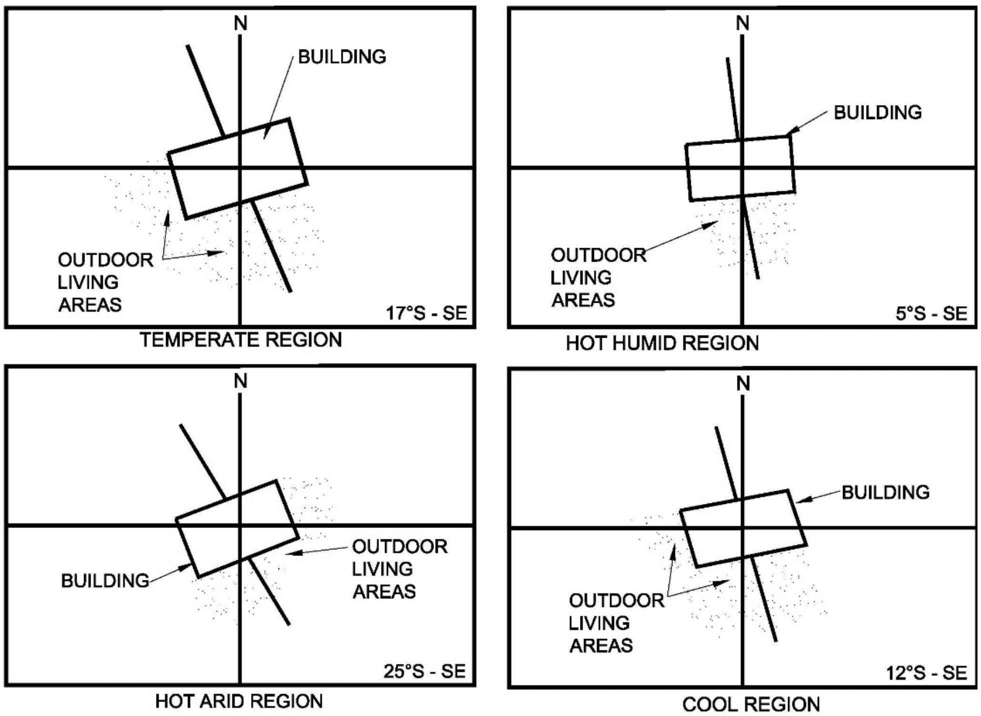

Figure 3-2

3.4.2 Prevailing Winds

The A/E shall research the prevailing winds at the site and consider these winds when orientating the building and its intended functions. Because windbreaks are most effective when placed perpendicular to the principal direction of the wind, limit the use of windbreaks only where the direction of the wind is predictable. The A/E shall orientate the building to take advantage of solar gain in cold climates. The skin of the building facing the prevailing winds may be treated to block prevailing winds to reduce energy consumption. See Figure 3-3 for example.

At the end of the Pre-Design Phase an overall plan shall be submitted to VA showing the proposed site.

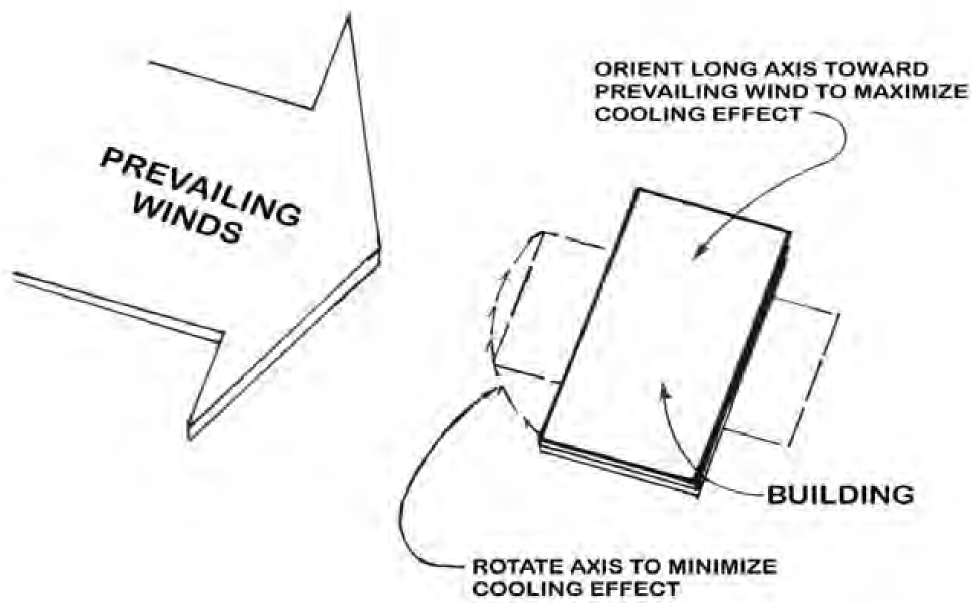

Figure 3-3

3.5 Traffic Impact Studies

Another site development consideration for each project is the traffic impact the new or renovated facility has on the surrounding project area. The A/E shall provide consideration to projects where high traffic demand is anticipated, or has been identified as a requirement by VA. A traffic impact study may be needed to ensure that traffic operations to and from the site, as well as through the site, is safe and efficient. In addition, it is also necessary to make sure that the traffic to and from the proposed development will not place a major burden on the roadways which will be used in traveling to and from the site. To ensure that traffic visiting a site will not have a major impact on a surrounding roadway network; many municipalities require that a traffic study be performed prior to approval. The local jurisdiction will make the decision if a traffic impact study is necessary.

Additionally, a traffic study will be performed when there is the potential for the project to create a significant number of traffic conflicts under future conditions. The potential for traffic conflicts will depend upon the trip generation of the project as well as the congestion in the area surrounding the project site. Typically, a project which generates fewer than 25 peak hour trips will not be expected to significantly contribute to traffic congestion, whereas a project which generates more than 50 peak hour trips will generally be considered a potentially significant trip generator.

The potential for significant impacts is highly dependent upon the circulation system in the project vicinity. If the project access is through a congested intersection, a relatively small trip generator could significantly increase the potential for traffic conflicts. If a project is located in a congestion-free area with many alternative routes available to disperse project traffic, a relatively large trip generator may have no significant impact. The trip generation of the project and the sensitivity of the project vicinity to additional traffic are both critical.

3.5.1 Traffic Study Documentation

Traffic impacts (and how to mitigate them) are an important consideration for any minor or major VA project when a significant development is proposed. Public policy makers, citizens and developers all have a stake in understanding and responding to additional demands on the transportation system. All share the common interest of a well-functioning network. A properly developed traffic impact study can provide the factual basis for good decision making and facilitate the timely implementation of necessary improvements.

A traffic impact study shall answer the following fundamental questions:

- What are the existing traffic conditions, future conditions without the development, and future conditions with the development in place?
- Can the existing and planned transportation system accommodate the additional traffic generated by the planned development?
- Are roadway system improvements needed beyond those already programmed or included in the local transportation plan?
- What needs to be done in the immediate vicinity of the site to meet the access needs of the development?

A committee of the Institute of Transportation Engineers (ITE) completed a “Recommended Practice for Traffic Access/Impact Studies” in 1991. This recommended practice continues to be the standard for most studies of this type. It is intended to provide guidance and encourage consistency in planning site access, on-site circulation and parking layouts, and off-site improvements for proposed developments.

In accordance with ITE guidelines, a typical traffic impact study report would include the elements shown in the following outline:

- Introduction
- Base Traffic Condition
- Site Traffic Generation
- Site Traffic Distribution

- Non-Site Traffic Projections
- Traffic Assignments
- Review of Site Plan
- Discussion of Future Traffic Conditions
- Summary of Findings and Recommendations

Traffic impact studies are sometimes conducted by or for public agencies to address the impact of major community facilities. The more typical role of local government, however, is to establish guidelines and follow through with reviews of studies for proposed private developments. In many communities, traffic impact studies are a standard part of the development review process.

3.6 Permitting Requirements

As the site has been selected and the layout of the new project is being considered, the A/E needs to start considering what permits will be required for each particular project site. The impacts of permits affect both time and design, so it is imperative that the A/E researches all the permitting requirements early in the design phase.

Typical permits that need to be researched to see if they are applicable for each site are as follows:

- National Pollution Discharge Elimination System (NPDES) – This is a permit for the EPA, but may be regulated by the local State Agency.

4 Site Layout Design

4.1 Overview

At Schematic Design Phase 1, the A/E shall prepare a preliminary “engineered” site plan. The site plan will indicate the final building location and orientation, parking lot locations, entrance and access roads, pedestrian walkways, utility yards, site utility locations, security measures, outdoor patios, and all other features that make for a functioning facility. The site plans shall be drawn to an indicated scale with accurate locations, dimensions and elevations for all facilities and site improvements. The site plan shall provide sufficient detail to serve as the basis for design development and construction documents. The engineered site plan shall be prepared per the following guidelines.

4.2 Site Limits & Security Setbacks

In addition to all applicable VA design requirements, the A/E shall design the site with the intent to meet the local buildings codes and zoning requirements where applicable.

Refer to the *VA Physical Security and Resiliency Design Manual* for appropriate setbacks between buildings and roads, parking lots, etc.

4.3 Building Functions

During this phase, the A/E shall get more in depth with space planning of the building interior as well as the functions/services provided on the exterior of the buildings.

4.3.1 Building Entrances

Entrance locations to buildings are critical and shall be based on the requirements in Section 4.6 (Exterior Entrances and Platforms) of the *VA Architectural Design Manual*. The A/E shall comply with vertical clearances of buildings and canopies over roadways and vehicular access areas, and snow melting requirements at specific entrances where needed. The drop-off shall have canopy cover designed to accommodate a public bus. Figure 4-1 shows a typical front entrance to a VA facility.

Figure 4-1

4.3.2 Flagpoles

4.3.2.1 Number of Flagpoles

Locate a minimum of one flagpole for displaying the US Flag near the administration building or near the public main entrance to the facility. Verify with the user of the facility if additional flagpoles are required for State and VA flags. There shall be no more than three flagpoles on the VA site.

4.3.2.2 Flagpole Height

In all instances, the State and VA flags must fly lower than the US flag. Flag poles shall be a minimum of thirty-feet tall, unless limited by applicable law or regulation. Table 4-1 shows the minimum and maximum flag sizes for specific heights of flagpoles.

Height of Flagpole	Minimum Flag Size	Maximum Flag Size
15’	2.5’ x 4’	4’ x 6’
20’	3’ x 5’	5’ x 8’
25’	3’ x 5’	5’ x 8’
30’	4’ x 6’	6’ x 10’
40’	5’ x 8’	8’ x 12’
50’	6’ x10’	10’ x 15’
60’	8’ x 12’	12’ x 18’
70’	10’ x 15’	15’ x 25’
80’	10’ x 19’	20’ x 30’

Table 4-1

4.3.2.3 Flagpole Strength

Select flagpoles capable of supporting the largest flag intended to be flown in the highest wind speed to which it will be subjected. Verify with local city or county planning department to verify the project site’s municipality’s requirements before deciding on the height the flagpole.

Figure 4-2 shows the maximum steady wind expected at an elevation of 30’ (9 m) above ground level within a fifty-year period of recurrence. Areas with the same maximum constant or steady wind speed are indicated. Because wind speeds are usually not constant, and where gust are involved, flagpoles are listed with a constant wind speed and with a 1.3 gust factor. The A/E shall use Figure 4-2, the height of the pole chosen based on flag size, and then analyze the structural foundations required for each flagpole.

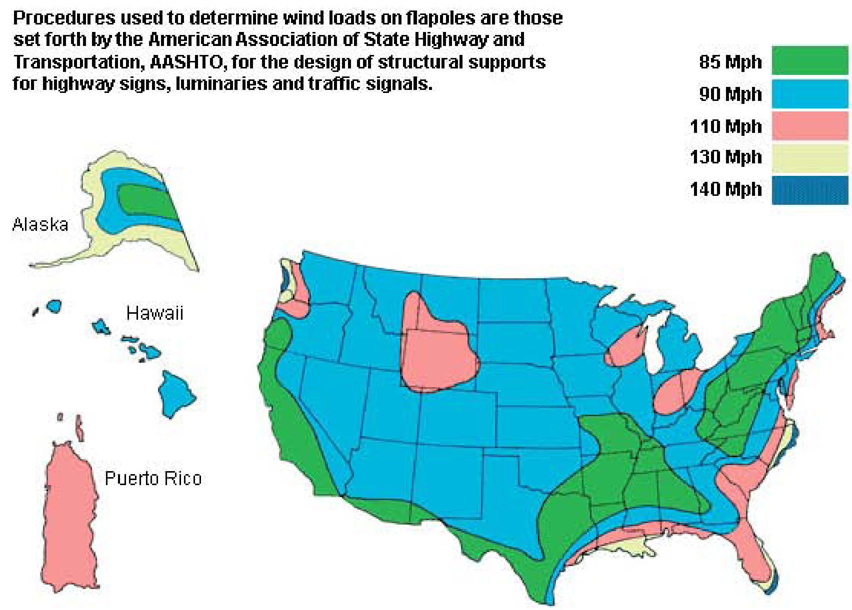

Figure 4-2

4.3.2.4 Flagpole Material

Flagpoles shall be stainless steel or aluminum as per VA Standard Specification Section 10 75 00. Aluminum flagpoles generally come standard with a satin or brushed finish. Designers shall identify special cleaning requirements for satin and brushed finishes and discuss those requirements with facility operations and maintenance staff before settling on material type.

4.3.2.5 Flagpole Lighting

Provide lighting in accordance with the *VA Lighting Design Manual*.

4.3.3 Outdoor Building Uses

Exterior areas can provide healing environments for veterans. Outdoor spaces that encourage social interaction can promote emotional connections important for human health, while providing quiet outdoor spaces for site users to enjoy. Moreover, such features can enhance employee morale and retainment. Where conducive and appropriate, outdoor dining patios, recreation areas, and/or healing gardens shall be included near the building. These exterior building functions shall be shown on the site plan. See Chapter 8 – Landscape Design for more information on how to incorporate the outdoor spaces.

4.3.4 Loading Dock Design

Service vehicles range in size from pickup trucks and vans to garbage and large delivery trucks. These vehicles generally require larger turning radii, more room to maneuver, and holding space while deliveries or service occurs. Service areas shall be designed to provide space for the largest service vehicle that would use that area. Service traffic shall be separated as much as possible from the traffic aisles of parking lots.

Coordinate with VA to determine what the dock area will be used for and how many docks are needed for each specific project. The VA facility will provide information on the existing volume of truck activity and projection of future activity, and if the dock area will be used for parking the facility equipment and vehicles. Figure 4-3 shows a typical loading dock layout.

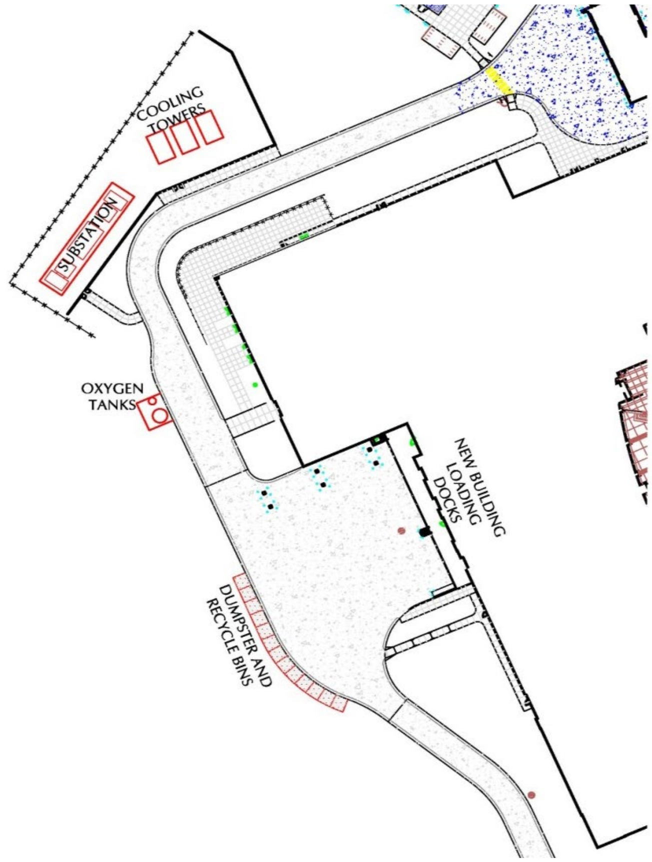

Figure 4-3

The site plan shall address where all the dock uses are located. Within the truck dock area, the A/E must give consideration on the separation of clean items going in versus soiled items going out. The dumpster, recycle, bio waste, and construction debris bins or areas must be in a separate more remote area from the actual dock where new and clean materials are brought into the facility and unloaded.

4.3.4.1 Refuse Haulers

Work with VA to determine the refuse collection requirements during the layout and siting of parking areas. Dumpsters shall be located to accommodate user convenience, ease of access for emptying, sanitation and clean material control, and aesthetic appeal. Besides addressing refuse collection requirements in terms of siting, access, and circulation, the A/E shall provide:

- Screening for the dumpsters with fences, walls, or shrubs, and securable gates;
- Protection with concrete-filled pipes or bollards to keep fences and walls from damage caused by vehicle operations; and
- The relevant layout/access for the type of refuse hauler for the project location depending on if a side or front load is required.

Design adequate space for truck maneuverability. Utilize a turning movement computer program to ensure that the appropriate truck can get into and out of the dock with no more than a three point turn. The analysis must take into consideration the movement of a truck coming into the dock, while there are trucks already sitting in other dock spaces. The loading dock paved area shall be constructed of concrete and be of a thickness to withstand heavy truck traffic and excessive turning movements.

Depending on the categorization of the facility, the dock area may need to be secured. If this is the case, adequate space needs to be provided along the service yard access road for trucks to “queue” without backing up other vehicular traffic.

4.3.5 Utility Yard Design

The utility yard will house the mechanical and electrical structures (i.e. Central Plant) needed to serve the new facility. Locate the mechanical and electrical structures in accordance with *VA Master Construction Specifications (PG-18-1)* and other *VA Design Manuals (PG-18-10).*

For exterior utility yards, the A/E must lay the area out to provide the required clearance spaces for all equipment. The layout must also include access to the equipment. For instance, a WB-65 flatbed must be able to access oxygen tanks. Exterior utility yards must be secured as per the *VA Physical Security Manual*. The area shall also be screened from the users of the facility by use of a screen wall, fence, or landscape planting. The A/E shall work with VA to determine the best location of the yard. Figure 4-3 above shows a typical utility yard for a hospital facility. In many cases the utility yard will be in the same general location as the loading docks.

4.4 Vehicle Circulation

Design circulation to promote safe and efficient movement of vehicles and pedestrians. Maintaining maximum separation of vehicles and pedestrians helps promote safety. The A/E shall analyze the access into and out of the project site as well as the roadways that are built to connect parking lots, driveways to front entrances of the main buildings, emergency department access, mass transit requirements, and fire truck access within the site. The A/E shall follow the *VA Physical Security Manual* in respect to the distances between paved roads, parking, and structures.

The A/E shall design vehicle circulation to create a readily comprehensible route and easy way-finding for patients, visitors, and building operations. Circulation for visitors shall be separated from service deliveries as much as possible. Clarity for the patient as to the front entrance and location of parking shall drive design decisions.

4.4.1 Public Access

VA roadways feeding into public rights-of-way shall be coordinated and approved by the local jurisdiction. Access to the site from public rights-of-way shall be conducive with the surrounding properties and their respective driveways. Design roadways into and out of the site to line up with driveways across the public rights-of-way with right-angle turns into the site with adequate turning radii. Any deviation from this driveway alignment will require approval by the local jurisdiction.

4.4.2 Site Entrances

Site entrances provide the first encounter with VA, the hospital facility campus, and its streetscape for visitors and personnel. Site entrances project an image of VA to the outside world. Main site entrances, as the primary access and initial orientation point for the most traffic entering the facility site, deserves the highest level of treatment and shall accommodate pedestrians as well as vehicles. Figure 4-4 shows an example of a boulevard site entrance.

Figure 4-4

Site entrances shall be designed to:

- provide a queuing area for waiting vehicles, multiple through-lanes or a passing lane for vehicles that are not required to stop, and channelization for left and right turns;
- take vehicles to their destination and return with minimum interference or travel through parking areas, service areas, or emergency zones;
- enter and exit the site at the same point or on the same access road to discourage through traffic on site;
- provide separation of service drives from emergency drives;
- at the main entrance, provide a planted center median that is large enough to accommodate a gatehouse and entry landmarks such as flagpoles or monuments;
- include elements such as trees and light fixtures to accent and spatially define the entrance;
- provide a prominent but simple entry sign and clear, grouped directional signs;
- provide entry walkways and bikeways that are physically separated from vehicle traffic lanes but maintain access to a gatehouse checkpoint;
- use planting material to screen perimeter fences near the entrance; and
- consider the use of walls to further define the entrance, reduce noise, and screen unwanted views.

4.4.3 Drop-Off at Building Entrances

For VA buildings that require a patient drop-off zone (typically, but not limited to, facilities that include one or more of the following services: outpatient or temporary clinical treatment, ambulatory care facilities, in-patient visitor or extended stay, main hospitals, spinal cord injury facilities, emergency walk-in, and nursing home care units), the interior road system shall provide this drop-off point at or near the main entrance to the building, separate from entries into parking lots.

The designer shall ensure that, per VA's Physical Security and Resiliency (PSR) Design Manual, section 4.3 "Patient Drop-offs", these areas "must not be located under occupiable portions of the building or near staff-only entrances". Also, "drop-offs and staging areas for vehicles, including public transportation vehicles, must be separated from the protected building structure by at least 50 feet (15 m)."

The interior road is most efficient if designed as a one-way system into and out of the front of the building. The roadway will include a drop-off lane where cars can pull off and park along the curb, and an adjacent through-traffic lane. All necessary traffic signs and pavement markings shall be incorporated into the design. Drop-off lanes must be designed in a manner that no lighting will be blocked or cause blind spots for safety.

The design of the patient drop-off point needs to be coordinated with the structural and architectural designers to account for the required canopy located at the entrance to the building, according to the section 4.6.2.1 "Canopies" in the VA's Architectural Design Manual. As part of the canopy requirement, the design may also consider an entrance pavilion, within the 50 feet standoff distance, that is structurally independent of the facility and provides the required protected walkway from the drop-off point to the building entrance.

The two-lane road configuration described above, and the canopy described in the Architectural Design Manual must be understood as minimum acceptable requirements; however, deviation from these requirements (i.e., larger canopy cover and/or additional lanes) could be pursued if the project-specific conditions and needs (weather, traffic volume, type of services, operational factors, etc.) justify the additional cost and real estate.

The designer shall consider using roundabout configurations for the patient drop-off road. Whether a roundabout, curved lanes or composite segments are used, the geometric and pavement design will comply with the requirements stated below in section 4.4.5 "Fire and Emergency Equipment Access". Depending on the approved program, the designer may also consider adding a secondary drop-off point to alleviate traffic flow issues.

The drop-off entrance area shall have a flush curb with the pavement surface and will need to meet the requirements of the PSR Design Manual, section 3.6.2 "Stationary (Passive) Anti-Ram Rated Vehicle Barriers".

The pavement surface at patient drop-off areas shall be of a material and finish that make it easy to maneuver for those with mobility challenges (canes, wheelchairs, limited mobility, etc.). Height differences at curbs along drop off areas shall be colored or marked differently than the roadway pavement so that the changes in elevation can be easily identified by those with vision impairments. Guide bricks or tactile pavement may also be used to enhance pathways.

Design of drop-off at building entrances and related roadways and canopy features shall conform with all submission requirements outlined in PG 18-15 "Minimum Requirements for A/E Submissions", for each phase of the project.

Figures 4-5 and 4-6 are examples of drop off lane configurations.

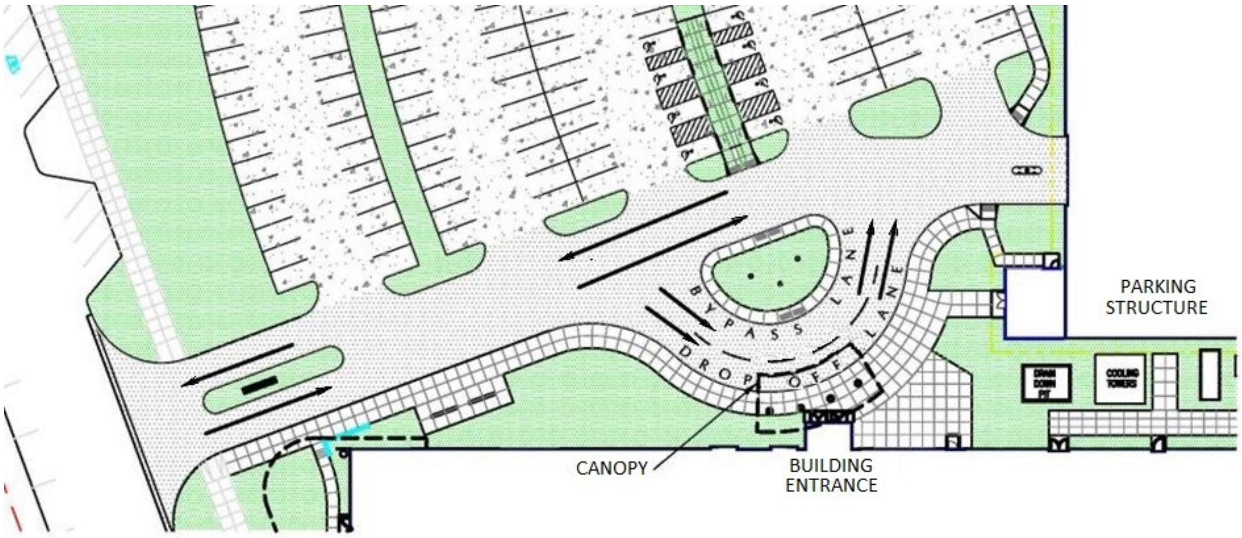

Figure 4-5

Figure 4-5

4.4.4 Emergency Department Access

Work with VA on a project-by-project basis to determine what is required and desired for circulation for the Emergency Department (ED) access. ED access shall be designed similar to the front entrance drop off but, on a smaller scale and requires a canopy over the drop off lanes. The ED drop off location will need to meet the requirements of the *VA Physical Security and Resilience Design Manual*. Provide spaces for ambulance parking near the ED drop-off entrance. Consult with VA to determine the number of spaces required. If a special drive is installed to accommodate emergency vehicles, it must provide sufficient room for the vehicle to turn and exit the site and adequate support for the vehicle weight.

4.4.5 Fire and Emergency Equipment Access

Fire truck lanes and/or routes must be provided so that all sides of new structures are accessible by the local fire department. Fire truck access must follow the requirements stated in NFPA and must be able to handle H30 loading. Fire Lane signage and paint marking shall be installed along the designed fire lane route.

For exclusive fire department access ways, the width must be a minimum 20’-0” (6 m) wide from face of curb to face of curb. The 20’-0” (6 m) width must be unobstructed for the entire width as well as have an unobstructed height clearance of 13’-6” (4 m). Verify the actual clear width needed with the local fire department to make sure there is adequate room for truck stabilizers.

The surfacing of the fire lane is generally asphalt or concrete. The designer may also use grass pavers for the fire truck lane as an alternative to hard surfacing, but must have a sidewalk down the middle of the lane or edging to delineate the fire lane. The sidewalk allows for the fire department to easily locate the fire lane and is plowable in regions that have snow. Coordinate with local Fire Department to determine what is acceptable for the fire lane surfacing material.

Through the parking lot area and especially the front entrance drop-off, the island radii must be designed so that a fire department truck can maneuver the turns without tires going off the pavement or doing additional turning movements.

For all projects the fire truck must be able to access the site by two distinct entrances from the surrounding public roads. If the fire truck route cannot be a through-route, a turnaround must be provided. As per NFPA, any dead-end route longer than 150’-0” (50m) must provide a turnaround. The turnaround shall be either a full cul-de-sac configuration or design that allows for a maximum of a three-point turn. Verify with the local Fire Department what type of turnaround is allowed.

4.4.6 Public Transportation

The A/E shall work with the local community to determine if there are any public transportation networks available or planned that would allow access to the VA facility. Provide pedestrian access to transportation networks, and protective structures, as needed.

4.4.7 Basic Roadway Design Requirements

When designing the roadways within the project site follow the following requirements:

4.4.7.1 Roadway Width

Principal roads and primary service roads shall be a minimum of 24'-0" (7 m) wide between faces of curbs. For the main traffic circulation roads, consideration shall be given for a 28'-0" (8.5 m) to 30'-0" (9 m) wide road. Any service lane or one lane of traffic that is not adjacent to parking stalls shall be 16'-0" (5 m) wide unless the site constraints do not allow for that. In that case, a minimum of 12'-0" (4 m) wide between faces of curbs may be used, but must be approved by the VA.

4.4.7.2 Turning Radii

The radii of curbs at all road intersections shall be a minimum of 25'-0" (8 m), but recommended to be 30'-0" (9 m). The minimum turning radius along the centerline of thru-drives or drives that allow entrance or exit from the site shall be 50'-0" (15 m). Curves along the roadway shall be a minimum of 100'-0" (30 m). It is the responsibility of the A/E to determine that the trucks and vehicles traveling the roads within the site have the appropriate turning radii without clipping the curbs or entering into the opposing lane of traffic.

4.4.7.3 Curb and Gutter

All roadways on the project site shall have curb and gutter. Curb and gutter shall consist of a minimum 6" (150 mm) vertical curb with concrete gutter or granite curbs. The use of sloped or rolled curbs requires special approval by the VA.

4.4.7.4 Concrete Jointing

When concrete is used for the road surface, jointing shall be no greater than two times the pavement thickness. The width to length ratio for joints shall be no more than a 1.25 ratio. For example, for a 6-inch (150 mm) thick concrete pavement, the jointing dimension of panels will be between (10'-0" x 12'-0" and 12'-0" x 15'-0") (3m x 4m and 4m x 4.5 m). Along radii, all joints shall be perpendicular to the pavement edge. All joints shall be a minimum of 2'-0" (600 mm) long.

4.4.7.5 Vertical Curves

When two sloped sections of roadway intersect, and the algebraic difference between the two slopes is greater than 4%, a vertical curve shall be installed. Vertical curves shall be a minimum of 50'-0"' (15 m), with 100'-0" (30 m) preferred.

4.4.7.6 Safety

Safety shall be a major consideration in the design of roadways. This primarily involves eliminating physical obstructions, maintaining visibility, and providing traffic control devices and barriers. Generally, these actions will also improve the appearance of the streetscape by reducing clutter and coordinating various streetscape elements.

All signs, light poles, hydrants, fences, and other physical obstructions shall be set back a minimum of 2’-0” (600 mm) from the face of the curb. Where there is no curb, this setback shall be increased to a distance of 10’-0” (3 m).

Avoid barriers to sight lines. These include both barriers that might prevent drivers from seeing other vehicles or pedestrians and barriers that might block the view pedestrians have of oncoming vehicles. Because eye level will vary between pedestrians and drivers in different types of vehicles, obstructions at various heights shall be considered. For drivers in an automobile, the critical area of view is generally below 4'-6" (115 mm), so while pedestrians may be able to see over a barrier such as a low-growing shrub, a driver's view may be blocked. Conversely, a driver in an automobile may be able to see beneath a low-branching tree, but the view of a pedestrian or driver in a truck may be obstructed.

Clear sight lines are especially critical at street intersections, driveways, and pedestrian crossings. At each corner of an intersection, a triangular area whose sides extend back a minimum of 50’-0” (15 m) from the face of the curb shall be kept clear of visual obstructions. Figure 4-7 shows the triangular area. A similar clear area shall be maintained, if possible, at driveways and mid-block pedestrian crossings. Some objects, such as traffic signals, post-mounted signs, or high-branching trees, may still be located within this area and not significantly affect visibility. However, the placement of individual objects must be coordinated with each other so that they collectively do not create a visual obstruction.

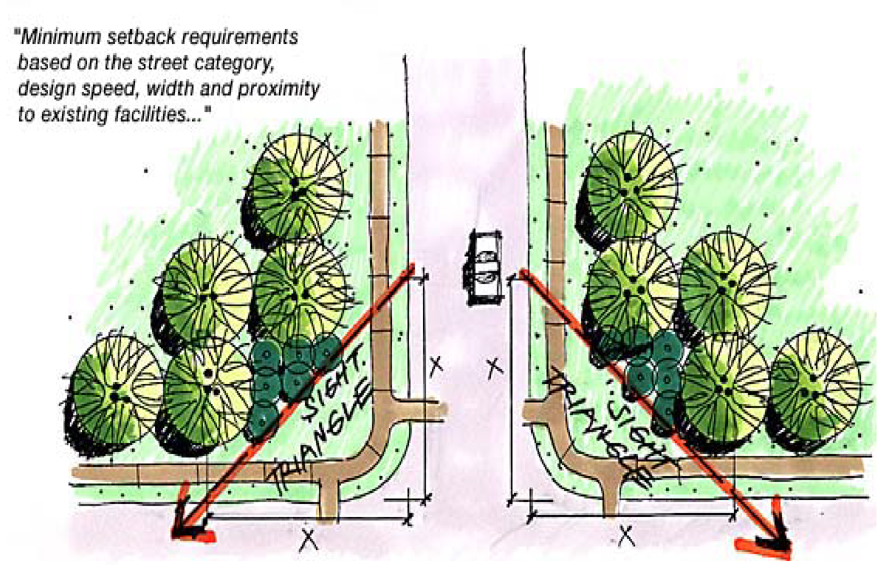

Figure 4-6

Street lighting levels shall allow drivers at nighttime to clearly distinguish the alignment of the road and quickly ascertain signs, traffic control devices, obstacles, pedestrians, and other vehicles. Intersections, pedestrian crossings, and other potentially hazardous locations shall be minimized by the use of appropriate luminaires that direct the light in a manner that will not interfere with the driver's view.

All intersections shall include some form of traffic signal or signage. A case-by-case analysis shall be conducted to determine if a signal is warranted at locations where the VA property joins the public roadway.

Regulatory and directional signs shall be unobstructed, easily discernible, and properly located so that they can be ascertained by drivers in a timely manner and without undo distraction.

Medians may be used to reinforce the streetscape hierarchy but also to separate opposing traffic, channelize turns to minimize conflicts, and provide a mid-crossing island for pedestrians.

4.5 Parking Lot Layouts

The first and last impression for a visitor, patient, and employee of their experience at a new facility involves a parking space. For the majority of VA properties, parking areas are the most visible site element. Parking requirements and design shall follow the requirements of the *VA Parking Design Manual*.

4.5.1 Parking Lot Locations

Provide a limited number of vehicular entrances and exits to parking lots and structures. Align entrances and exits into different lots, or adequately separate to provide safe sight and maneuvering distances.

4.5.1.1 Siting

Patients require ease of access to the medical facility. This translates to locating parking areas convenient to building entrances and also includes:

- Parking for high turn-over or short-term use (e.g., visitor, outpatient, or delivery) shall be located in a separate lot or signed and placed nearest the entrance;
- Separating patient and employee parking areas;
- Minimizing excessive grading operations and balancing cut and fill;
- Integrating adequate parking spaces with surrounding facilities and existing circulation patterns;
- Preserving sight lines to entries and significant landscape and architectural features;
- Minimizing negative impacts to the natural environment such as unnecessarily removing mature vegetation or degrading soil stability;
- Creating multiple smaller parking areas rather than one large mass; and
- Providing easy and clear pedestrian circulation access from the parking lots to the building.

4.5.1.2 Orientation

To create safe and convenient parking areas, the orientation and configuration of the parking area must be considered early in the siting process.

- Align rows of parking spaces perpendicular to the facility minimizing the number of pedestrian aisle crossings; and
- Provide access points and crosswalks from parking areas to facility entries.

4.5.1.3 User Walking Distance

Locate patient parking closest to the building, as related to staff and visitor parking. Parking spaces for a specific facility shall not be more than 250’-0” (76 m) from the facility entrance.

4.5.2 Number and Type of Parking Stalls

VA will provide the number of stalls needed for the project. Clearly indicate all required parking stalls on the site plan to allow validation that stall quantities have been satisfied. Work with VA to determine desired distribution of stalls in terms of employee stalls versus patient/visitor stalls and where these shall be placed on the site plan. Locate visitor, accessible, and reserved parking at the front entry of the facility. The Spinal Cord Injury (SCI) parking shall be clearly identified and shall be proximal to SCI entrances. The employees parking area shall be separate from the patient's parking lots. The A/E shall coordinate with the VA if there is a desire for some oversized parking spaces for RV's or other vehicles with trailers or campers and motorcycle spaces. If there is a need, these spaces shall be identified on the site plan with dimensions as per the *VA Parking Design Guide.*

4.5.3 Accessible Parking Spaces

Plan accessible parking spaces to be as close to the entrance as possible and design not to require pedestrians to cross a drive lane unless absolutely necessary. Each accessible parking stall shall have a striped access aisle on both sides of the stall and required signage. If there are multiple entrances to the facility, distribute the accessible stalls accordingly. Verify with the VA if there shall be more accessible stalls provided than those required by code. Also verify if the VA requires accessible stalls in the employee parking area. The number of accessible parking stalls and the design shall be designed according to the *ABA* and the *VA Parking Design Guide* and the *Barrier Free Design Standard*.

The A/E shall verify the need and location of having specific parking stalls for spinal cord injury patients. The stalls must be the closest to the facility doors and provide a route to the medical facility for the users in front of the cars. The route may not cross the drive lane. The spinal cord accessibility stalls shall have a maximum of 2% cross-slope. The A/E shall consult the *VA Parking Design Guide* and *Spinal Cord Injury Design Guide*.

4.5.4 General Parking Lot Design Requirements

When designing the parking lots within the project site follow the following requirements:

4.5.4.1 Geometry

Entrance and exit curb cuts into and out of parking areas shall be minimized. Coordinate entrances and exits to the VA with the appropriate local jurisdiction/agency. Eliminate dead-end parking areas. Locate aisles and rows of parking parallel to the long dimension of the site with parking on each side of an aisle. Use rectangular parking areas to minimize land area requirement.

4.5.4.2 Stall Dimensions and Orientation

Parking stall widths and lengths shall be as per the *VA Parking Design Guide*. The highest stall capacity achievable for a parking lot is when 90-degree stalls are used. Parking at angles other than 90-degrees may be used only when justifiable. Written request shall be submitted to the VA Project Manager for deviation of the stall angle.

4.5.4.3 Islands

Islands shall be at least 8’-0” (2.5 m) wide and include plantings and trees. Islands shall be installed at the ends of parking rows at a minimum.

4.5.4.4 Curb and Gutter

All parking lots on the project site shall have curb and gutter unless otherwise directed by the VA. Curb and gutter shall consist of a minimum 6” (150 mm) vertical curb with a concrete gutter or granite curb. The use of sloped or rolled curbs requires special approval by the VA.

4.5.4.5 Concrete Jointing

When concrete is used for the parking lot surface, the jointing shall be no greater than two times the pavement thickness in feet. The width to length ratio for joints shall be no more than a 1.25 ratio. For example, for a 6” (150 mm) thick concrete pavement, the jointing dimension of panels will be between (10’-0” x 12’-0” and 12’-0” x 15’-0”) (3 m x 4 m and 4 m x 5 m). Along radii, all joints shall be perpendicular to the pavement edge. All joints shall be a minimum of 2’-0” (600 mm) long.

4.5.4.6 Parking Lot Lighting

Lighted parking areas shall provide adequate lighting for safety and comfort, and also minimize nighttime lighting pollution. Design lighting to comply with the *VA Lighting Design Manual*. Fixtures shall be cut-off fixtures. Lighting shall not disturb nearby residential areas. Lighting standards or poles vary from 20’-0” to 30’-0” (6-9 m) tall and shall be located in islands or on parking area perimeters. Poles that are not protected by a curb or other structure shall be constructed with a concrete base at least 4’-0” (2 m) high or be buffered by concrete filled pipes or bollards.

4.5.5 Sustainability in Parking Lots

With sustainability a goal for every VA project, there are design methodologies that can be incorporated within a parking lot to help create a friendlier, more sustainable environment. Chapter 8 in this manual has more information on landscaping within parking lots as well.

4.5.5.1 Concrete

In order to reduce heat island effect and improve durability, concrete is preferred in lieu of asphalt unless otherwise directed by the VA. Driving surface material selection shall be driven by a lifecycle cost analysis.

4.5.5.2 Porous Pavements

Figure 4-7

If porous pavements are to be used they are to be located only in parking stall spaces and not drive aisles within the parking lots. The A/E shall determine if using the porous pavement is advantageous to the area in which the project is located. If the project is in a location where snowfall and ice occur in the winter, porous pavements may not be the best option due to ice melt and sand spreading operations that could clog the open pavement system. The A/E shall explain the maintenance requirements of a porous pavement system to the VA facility to determine if that is something they want to be responsible for over the life of the parking lot. Porous paving systems increase the perviousness by at least 50%, reducing the amount of low reflective material and increasing infiltration of stormwater. The A/E shall take into consideration how the porous paved parking spaces shall be striped.

4.6 Design of Pedestrian circulation

An integrated pedestrian circulation system can reduce the use of the automobile and creates opportunities for healthful activity. Walkways (i.e. sidewalks) shall be logically connected and designed to provide clear, unobstructed routes through the site. The walks shall be interconnecting throughout the site and connect to building entryways, curb ramps, parking areas, public access points, pedestrian landscaped features, such as, open area plazas, courts, atriums and other site elements.

4.6.1 Walkway Network Hierarchy

Based upon projected levels and types of use for the exterior roads surrounding the project site, as well as the interior VA circulation system, a hierarchical pedestrian circulation system shall be planned that organizes walkways into a logical network according to each segments function and reinforces the function through the width, treatment, amenities, and location of each segment.

Figure 4-8

4.6.1.1 Primary Walkways

Primary walkways are those segments that link major generators of pedestrian activity and carry the highest volume of pedestrian traffic. Primary walkways shall:

- be at least 8’-0” (2.5 m) wide to comfortably accommodate two-way traffic;
- have hard surface paving to accommodate a high level of use of all types;
- be well lighted for nighttime activity; and
- be furnished at a relatively higher level with amenities such as benches and trash receptacles.

Figure 4-9

4.6.1.2 Secondary Walkways

Secondary walkways are those segments that link secondary generators of pedestrian activity and carry moderate volumes of pedestrian traffic (See Figure 4-10). The majority of walkways on a facility shall fall into this category. Secondary walkways shall:

- be at least 6'-0" (1800 mm) wide to comfortably accommodate two people walking abreast and allow passing room;
- have hard surface paving to accommodate a moderate level of use of all types;
- be well lighted along those segments that receive nighttime activity; and
- be furnished at a moderate level with amenities.

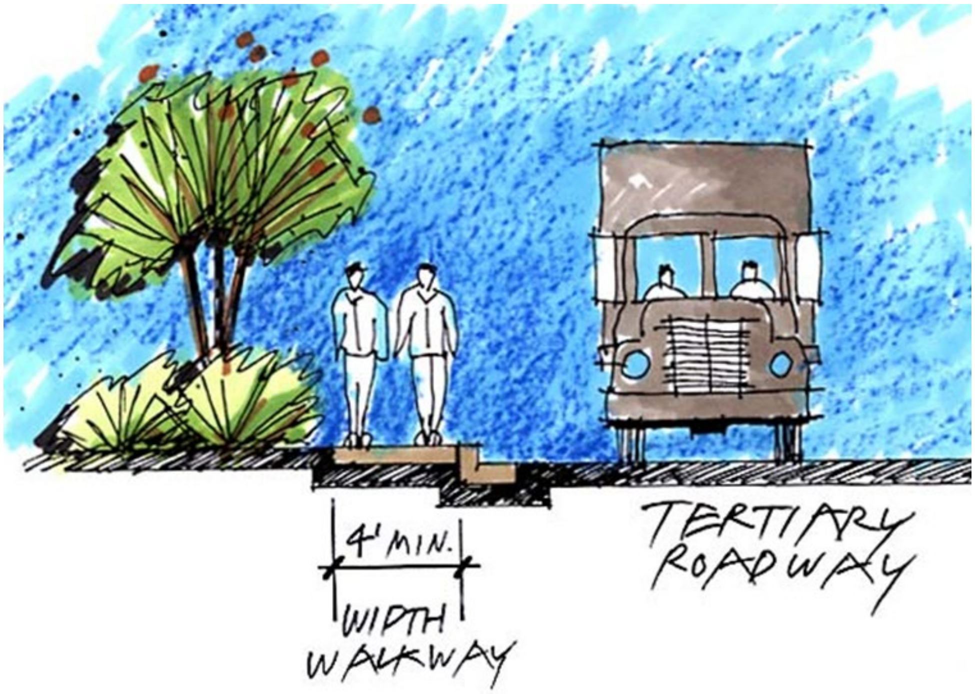

Figure 4-10

4.6.1.3 Tertiary Walkways

Tertiary walkways are those segments that provide physical and visual continuity within the pedestrian network but carry a low volume of traffic. They are also used as recreational paths such as jogging trails or fitness courses. Tertiary walkways shall:

- be at least 4’-0” (1200 mm) wide to comfortably accommodate one-way traffic;
- have hard surface paving, depending on the volume and type of use;
- have lower-level or no lighting; and
- be furnished at a relatively lower level with amenities.

4.6.2 Walkway Configurations

Walkway systems are developed in response to the levels and patterns of user demand and provide direct routes between destinations. The walkways shall incorporate required and anticipated access. Walkways shall be provided along the building side of all parking lots and within large lots to provide clear and safe access to buildings. Narrow, hard-to-maintain planting strips between walkways and buildings shall be avoided. Mow strips are now acceptable for the narrow spaces. Along the edge of walkways opposite buildings, planting areas can be used to help soften the appearance of buildings. Topography and vegetation can be used to direct movement and emphasize sight lines. If possible, new walkways shall be laid out to accommodate existing mature trees. To provide for pedestrian security, walkways that are located away from active areas like streets shall avoid places for concealment and shall be adequately lighted if they may be used at night. Incorporate shading and weather protection as necessary.

Figure 4-11

Three types of walkway systems are suggested to meet varying site demands for pedestrian circulation. All three systems provide functional access between facilities.

4.6.2.1 Grid Walkway System

A grid path system is composed of straight lines and right angles and tends to provide the most direct access between locations. The grid system is appropriate in formal landscapes and in areas with strong architectural definition.

4.6.2.2 Curvilinear Walkway System

A curvilinear path system is less formal and shall be used to encourage pedestrian interaction with the landscape where direct access to facilities is not critical. Figure 4-10 shows a curvilinear path system.

4.6.2.3 Organic Walkway System

An organic system is unique in that the sidewalk patterns are defined by the space outside of the sidewalk and therefore vary in width. Because of this, organic sidewalks are less formal and often respond to natural elements in the surrounding landscape.

4.6.2.4 Pedestrian Concentration

The space required to accommodate pedestrian movement increases at the point of origin and destination where movement slows. Pedestrian movement is also interrupted when people meet, gather, wait, or sit. In areas of pedestrian concentration (i.e. building entrances, drop-offs, and small outdoor spaces between buildings), the space shall be developed to accommodate these needs. General design techniques include:

- Widening walkways at the points of origin and destination;
- Providing adequate space for people to concentrate outside of the pedestrian flow;
- Locating areas for people to sit on the edge or outside of the pedestrian flow;
- Providing both shaded and sunny areas for people to congregate or sit.
- Providing shelter at congregation areas, especially where waiting is anticipated;
- Arcaded walks can provide direct connections between buildings and provide protection from the sun or inclement weather to allow year-round use of the pedestrian system and are appropriate in some climates.

4.6.3 Walkway Design Requirements

When designing walkways within a project site, the following requirements apply:

4.6.3.1 Walkway Width

Walkways shall be at least 6’-6” (2 m) wide, and 8’-6” (2.5 m) wide where walks abut parking stalls. All walks shall be designed to accommodate people with mobility issues.

4.6.3.2 Walkway Material & Thickness

Unless otherwise directed by VA, concrete shall be the material of choice for walkways. For walkways designed solely for pedestrian traffic, provide a thickness of at least 4-inches (100 mm). In cases where a walkway will also be used as a travel path for light truck traffic, provide a thickness of at least 6-inches (150 mm). Where walkways cross driveways, provide a thickness that is at least 6-inches (150 mm), but no less than the driveway thickness. Where walkways will serve as fire truck access, follow NFPA requirements in coordination with local fire department.

4.6.3.3 Walkway Joints

Install expansion joints whenever a walkway is directly adjacent to a roadway pavement, parking lot, building, or structure.

4.6.3.4 Walkway Grade

Design walkway grades to comply with the *VA Barrier-Free Design Guide*.

4.6.4 Curb Ramps

Provide curb ramps to accommodate persons with disabilities, carts, and baby strollers. Design curb ramps to comply with Sections 405 and 406 *ABAAS,* and the *VA Barrier Free Design Standard*.

4.6.4.1 Curb Ramp Locations

Provide curb ramps at all intersections as well as where walkway routes cross a roadway. Maintain adequate sight lines to give both pedestrians and drivers an unobstructed view at crosswalks. At each corner of an intersection, provide a triangular area clear of visual obstructions whose sides extend back a minimum of 50’-0” (15 m) from the face of the curb. Provide tactile warning at curbs, ramps, etc.

4.6.4.2 Curb Ramp Type

Perpendicular curb ramps are the most desirable orientation since they do not require a pedestrian to travel across the ramp area if they do not intend to make use of it. Perpendicular curb ramps shall have a running slope that cuts through the curb at right angles or meets the gutter grade break at right angles.

4.6.4.3 General Curb Ramp Requirements

- Curb ramps shall be 6” (150 mm) thick concrete.
- The running slope shall be 1% minimum and 5% maximum.
- A landing with minimum dimensions of 5’-0” x 5’-0” (2 m x 2 m) shall be provided at the top of the curb ramp.
- Running and cross-slopes of the ramp and landing shall be 2% maximum. The exception to this where there are mid-road crossings or when the street grade exceeds 2%.
- Flare sides with a slope of 10:1 maximum, measured along the curb line, shall be provided where a circulation path crosses the curb ramp.
- Storm sewer intakes, grates, access covers, or other appurtenances shall not be located on curb ramps, landings, transitions, and gutter areas within the pedestrian access routes.
- Grade breaks shall not be permitted on curb ramps, transitions, landings, and gutter areas within the pedestrian access routes.
- Vertical changes in level shall not be permitted on curb ramps, landings or gutter areas within the pedestrian access route.
- Beyond the curb line, a clear width of 5’-0” x 5’-0” (2 m x 2 m) minimum shall be provided within the width of the crosswalk and wholly outside the parallel vehicle travel lane.
- Ramps shall have a textured, non-skid surface.

4.6.4.4 Detectable Warning Surfaces

Install Detectable Warning Surfaces anywhere a walkway transitions into a vehicle roadway. Install systems compliant with Section 705 of ABAAS. Figure 4-13 shows an example of tactile warning surfaces.

- *Contrast* - Detectable warning surfaces shall contrast visually with adjacent walking surfaces.
- *Size* - Detectable warning surfaces shall extend 24" (600 mm) minimum in the direction of travel and the full width of the curb ramp, landing, or transition.
- *Location* - The detectable warning surface shall be located at the back of the curb line and perpendicular to the line of travel.

Figure 4-12

4.6.4.5 Crosswalks

Locate and clearly designate crosswalks to encourage pedestrians to use safe street crossings. At a minimum, install crosswalks at all street intersections where there is pedestrian traffic and a curb ramp location.

- Mark crosswalks with clearly visible painted stripes or by street paving that is consistent with the walkway paving material.
- Crosswalks shall be the width of the adjacent walkway, but a minimum of 6'-0" wide (1800 mm). Mid-block crosswalks between intersections are dangerous and shall be avoided except in those cases where intersection crossings are few or very inconvenient. When possible, install traffic control signals at mid-block crossings.
- Adequate street lighting shall be installed at each crosswalk to provide for clear nighttime visibility for both pedestrians and drivers.
- Adequate sight lines shall be maintained to give both pedestrians and drivers an unobstructed view at crosswalks. At each corner of an intersection, a triangular area whose sides extend back a minimum of 50' (15 m) from the face of the curb shall be kept clear of visual obstructions. A similar clear area shall be maintained, if possible, at mid-block pedestrian crossings. Some objects, such as traffic signals, post-mounted signs, or high-branching trees, may still be located within this area and not significantly affect visibility. However, the placement of individual objects must be coordinated with each other so that they collectively do not create a visual obstruction.
- Where a walkway and bikeway intersect, pavement markings shall be provided to warn both pedestrians and bicyclists.

4.6.5 Ramps and Steps

Minimize the use of stairs along walkways because they are more difficult to negotiate or, for some users, impassable. Where significant grade changes along a walkway cannot be avoided, ramps and steps may be required for the convenience of the pedestrian and to maintain continuity in the walkway network. Follow the requirements of the *ABAAS* and the *VA Barrier Free Design Standard.*

4.6.5.1 Ramps

To provide wheelchair access, ramps shall be used to accommodate significant changes in grade. Ramps will generally be necessary adjacent to or near any stairway to provide a similar level of convenience and walkway continuity for physically challenged persons. To achieve the same vertical climb, ramps require significantly more horizontal distance than stairs, so careful planning that minimizes grade changes along a walkway and that integrates ramps into the site development plan is recommended.

- Where walkways exceed slopes of 1:20, ramps shall be utilized with or without adjacent stairways.
- Ramps will be sloped between 1:20 and a maximum of 1:12.
- A five-foot-long landing shall be provided for at least every 2'-6" (760 mm) of vertical climb. A 6’-0” (1800 mm) long level platform shall be provided at the top and bottom of a ramp.
- Ramps shall be no less than 4’-0” (1200 m) wide.
- All ramps shall be adequately lighted to ensure safe nighttime use.
- All ramps shall have handrails on both sides that extend beyond the top and bottom of the ramp. Design railing elements to comply with *ABAAS*.

4.6.5.2 Stairs

Stairs may be used in conjunction with, but not in lieu of, ramps. All variations from this requirement must be approved by the Authority Having Jurisdiction.

- Stairs shall be a minimum of 5’-0” (1500 mm) wide or equal to the walkway width.
- Stairs with less than three risers shall be avoided because they are difficult to see and can present a hazard.
- All steps in a single stairway shall maintain the same tread width and riser height. Riser height shall be between 5” (125 mm) and 7” (200 mm), and tread width shall be between 12” (300 mm) and 16” (400 mm). A general formula for riser-to-tread proportion is twice the riser height plus the tread width equals 26” (660 mm). A 5-3/4" (146 mm) riser with a 14-1/2" (368 mm) tread is preferred.
- All stairs with three or more risers shall have handrails on both sides that extend beyond the treads at both the top and bottom of the stairway.
- All exterior stairs shall have a distinct color change at the top and bottom step nose.
- Steps shall have solid risers with rounded or chamfered nosing.

- All steps along main pedestrian walkways shall be adequately lighted to ensure safe nighttime use. A stairway greater than 4’-0” (1200 mm) in height or consisting of more than nine risers shall be broken by a landing.

4.6.6 Furnishings

Site furnishings, including benches, trash receptacles, drinking fountains, bus shelters, and kiosks or information signs, shall be part of a coordinated system that provides pedestrian amenities within the walkway network. Site furnishings shall be selected and sited to support the function of a walkway.

- Where possible, furnishings shall be grouped together rather than scattered to consolidate the space required and to provide complementary functions. A greater number and type of furnishings shall be located in higher-use pedestrian traffic areas than in lower-use areas.
- Furnishings shall be located adjacent to rather than on walkways, in a manner that does not impede pedestrian traffic.
- Provisions to accommodate the mobility impaired shall be incorporated into the design and siting of furnishings. This includes a provision for space adjacent to walkways for seating for wheelchairs.
- Site furnishings shall be simple and straightforward in their design and reflect the architectural character of the facility. The same types of furnishings shall be consistent in their design and use. Different types of furnishings shall be unified in their design by the use of common materials, finishes, and details.
- Site furnishings, where provided, shall be durable and low maintenance.

4.7 Bikeway Guidelines

Bikeways pose unique planning and design challenges because the bicycle is not compatible with automobiles or pedestrians, the automobile being a hazard to the bicyclist and the bicycle presenting dangers to the pedestrian. The following guidelines address the various factors for bikeway planning, including levels of separation from roadways and walkways, widths and clearances, paving materials, gradients and curvature, stopping distances and street crossings, and bicycle parking.

4.7.1 Bikeway Inclusion

Evaluate site for potential of installing bikeways. In locations where bicycling is common, or is on the verge of becoming common, install bikeways. At a minimum, provide a bikeway onto the property with access to the main campus building. If space permits, install bikeways between all campus buildings.

4.7.2 Bikeway Classification

Bikeways shall be planned and designed according to classifications that define the level of separation they maintain from roadways and walkways. The ideal solutions for the development of bikeways is to physically separate them from both roadways and walkways.

With proper planning, this can sometimes be accomplished, but cost considerations and a lack of adequate space can often make such separation impractical.

4.7.2.1 Class I Bike Path

A Class I Bike Path is intended for the exclusive use of bicycles. While it may parallel a roadway, it is physically separated by distance or a vertical barrier (see Figure 4-12). A Class I Bike Path provides the safest and most efficient means of bicycle travel and is the preferred option for bikeway development. Crossings of a Class I Bike Path by pedestrians or automobiles shall be minimized. If a Class I Bike Path does not closely parallel a roadway, it shall be designed to provide appropriate bikeway gradient and curvature. Class I Bike Paths require the greatest amount of space and advanced planning to reserve land and assure appropriate routing.

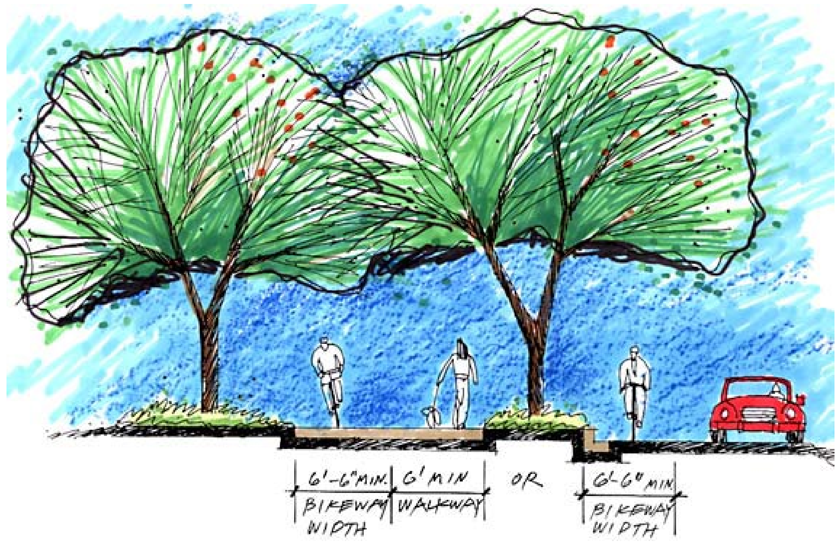

Figure 4-13 - Class I Bike Path

4.7.2.2 Class II Bike Lane

A Class II Bike Lane shares the right-of-way with a roadway or walkway. It is indicated by a bikeway pictograph on the pavement and a continuous stripe on the pavement or separated by a continuous or intermittent curb or other low barrier (see Figure 4-13). Because some separation is provided for bicycle travel, a Class II Bike Lane provides some level of safety for the bicyclist and pedestrian. While crossings by pedestrians or automobiles are discouraged, they are not as controllable as they are on a Class I Bike Path because the Class II Bike Lane is adjacent to the

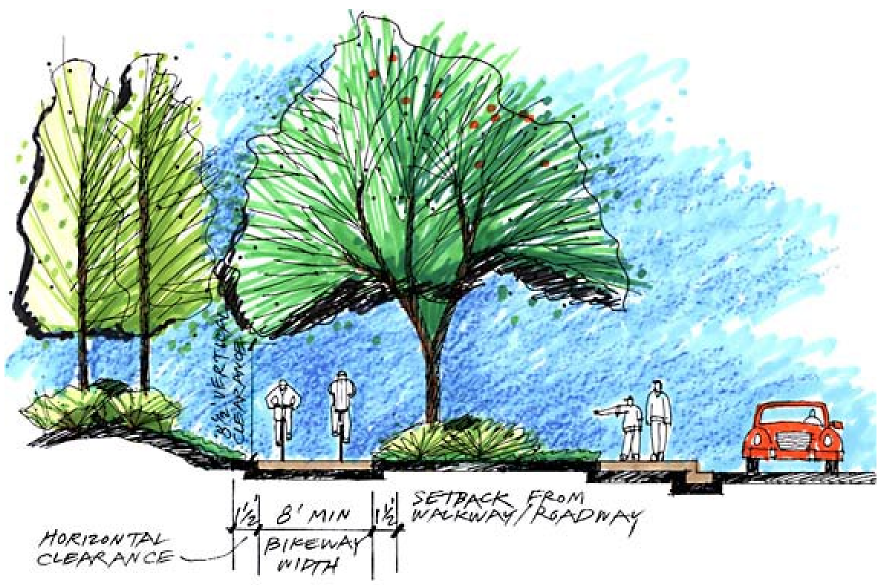

Figure 4-14 - Class II Bike Lane

walkway or roadway. Because Class II Bike Lanes are tied to the adjacent roadway or walkway, route selection is important to maintain appropriate bikeway gradients and curvature. Class II Bike Lanes generally require less space than Class I Bike Paths because they follow the alignment of and share the right-of-way with a roadway or walkway.

4.7.2.3 Class III Bike Route

A Class III Bike Route also shares the right-of-way with a roadway or walkway. It is not indicated by a continuous stripe on the pavement or separated by any type of barrier, but it is identified as a bikeway with signs (see Figure 4-16). Because no separation is provided, there is a higher potential for safety conflicts between automobiles and bicycles and between bicycles and pedestrians. Class III Bike Routes provide continuity within the bikeway network and designate preferred shared routes to minimize potential conflicts. To maintain safety for bicyclists and pedestrians, Class III Bike Routes shall be developed, if possible, only where automobile and pedestrian traffic is moderate to light. Because Class III Bike Routes share the roadway or walkway, route selection is important to maintain appropriate bikeway gradients and curvature. Class III Bike Routes require the least space because they share the pavement with a roadway or walkway.

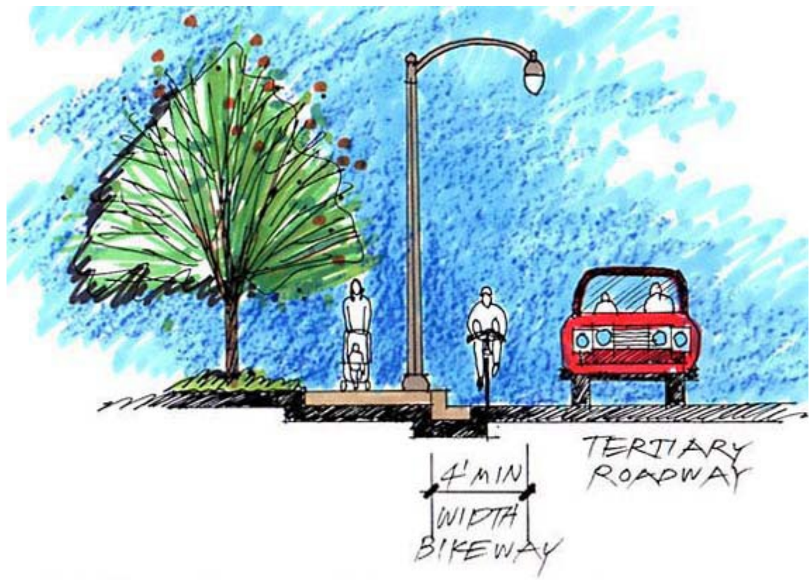

Figure 4-15 - Class III Bike Lane Route

4.7.3 Bikeway Pavement Widths and Clearances

4.7.3.1 Bikeway Pavement Widths:

- The basic minimum width for one lane of travel is 4’-0” (1200 mm). This shall be adjusted based upon the bikeway classification and traffic conditions.
- A minimum of eight feet of pavement shall be provided for a two-way Class I Bike Path. This width will also allow access by maintenance vehicles on Class I Bike Paths that are isolated from roadways.
- A minimum of 6'-6" (2000 mm) of pavement shall be provided for a one-way Class I Bike Path or Class II Bike Lane. This width will allow one-way travel with room for passing.
- Two-way bikeways are not recommended adjacent to roadways because of the complications that would result at intersections. Instead, opposing one-way lanes shall be located on opposite sides of the street.

- A minimum of four feet of pavement shall be provided for a one-way Class III Bike Route. Since a Class III Bike Route is not separated from the adjacent roadway or walkway, a passing bicycle can use the walkway or roadway pavement. If bicycle, pedestrian, and/or automobile traffic makes passing in this manner difficult or unsafe, a pavement width of 6'-6" (2000 mm) shall be provided for a one-way Class III Bike Route.

4.7.3.2 Bikeway Clearances

Because a bicycle and rider are considerably wider than that part of the bicycle that makes contact with the road and a bicyclist is taller than an individual on foot, horizontal and vertical clearances shall be provided along the bikeway.

- A minimum horizontal clearance of 1'-6" (450 mm) (2'-0" desirable) (600 mm) shall be provided from the edge of the bikeway pavement to any stationary object or change in grade.
- A minimum of 8'-6" (2.5 m) of vertical clearance shall be provided from the bikeway surface to any stationary overhead object.

4.7.4 Bikeway Paving Materials

Hard paving materials are the most appropriate for bike travel and can be traveled on even in wet weather. Bikeways shall be either concrete or asphalt. The pavement for Class I Bike Paths that are isolated from roadways shall be capable of supporting a maintenance vehicle. The pavement normally used for a roadway or a hard walkway surface is generally acceptable for an adjacent Class II Bike Lane or Class III Bike Route.

The surface of the bikeway pavement shall have a smooth but not slick finish, which can be dangerous to bicyclists during wet conditions. Hard materials such as exposed aggregate concrete or masonry units shall be avoided because their irregular and rough surface is difficult and uncomfortable to negotiate.

The bikeway shall be compacted and leveled to the elevation of the pavement surface to lessen the hazard in running off the edge of the bikeway and to help reduce breakage of the pavement along the edge.

Expansion and control joints in the bikeway pavement shall run perpendicular to the direction of travel and be as narrow as possible.

If possible, drainage inlets shall not be located along the bikeway. If inlets along the bikeway cannot be avoided, as in an existing street right-of-way, grates shall be turned so that the openings run perpendicular to the direction of travel or modified to provide support for passing bicycles.

4.7.5 Bikeway Gradients and Curvature

Because bicycles are vehicles, albeit human-propelled, bikeway design factors such as gradient and curvature are more critical considerations for user comfort and safety than they are in walkway design. For Class II Bike Lanes and Class III Bike Routes, the gradient and/or curvature of an existing walkway or roadway may exceed those that are desirable for a bikeway, and this shall influence route selection.

4.7.5.1 Bikeway Gradients

Gradients between 3 percent and 5 percent will place some strain on a bicyclist, but the desirable gradient for a particular bikeway is related to the length of the grade. A 15 percent grade is the maximum for short runs, and 10 percent is the recommended maximum for distances of no greater than 50’-0” (15m). A maximum grade of 4.5 percent is recommended for distances of no greater than 100’-0” (30 m). For longer distances, grades not exceeding 3 percent are desirable. On straightaway portions of a bikeway, cross slopes that exceed 2 percent will be uncomfortable for the average bicyclist.

4.7.5.2 Bikeway Curvature

The radius of curvature for turns on a bikeway is measured to the inside edge of the pavement. The turning radius that is required is directly related to the speed of travel. The greater the design speed of the bikeway, the larger the required turning radius (see Figure 4-17).

At 10 mph (4.5 m/s), an 18’ (5.5 m) turning radius is preferred and a 15’ (4.5m) turning radius is a comfortable minimum. For various bikeway classifications or conditions, the design speed may considerably exceed 10 mph (4.5 m/s) and turning radii must be adjusted accordingly.

As the turning radius decreases, the bank (or superelevation) of the bikeway shall increase to safely accommodate the design speed. If the bikeway shares the right-of-way with a walkway, banks shall be limited to a 6% slope for the comfort of pedestrians. On tight turns, it may be necessary to widen the pavement along the inside edge to accommodate the turning movement of bicyclists. Figure 4-15 shows the Radius of Curvature and Superelevation Based on Design Speed.

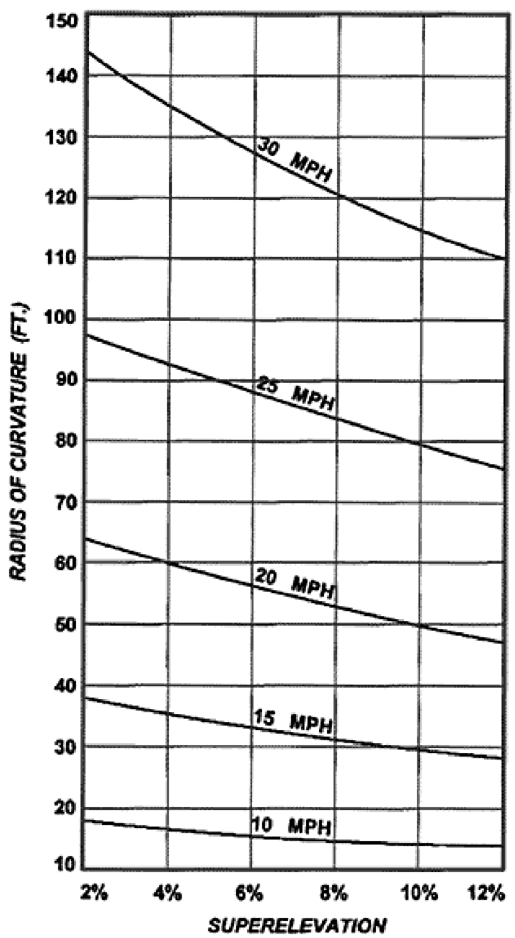

Figure 4-16 - Radius of Curvature vs. Superelevation

4.7.6 Stopping Distances and Street Crossings

Potential conflicts caused by intersections or obstructions shall be minimized through the layout and design of bikeways and adjacent areas.

4.7.6.1 Stopping Distances

Stopping distance is the distance required for a bicycle rider to see an object or situation, react, and brake to a stop. It is determined by a combination of factors, including the initial velocity of the bicycle, the reaction time of the rider, and the gradient and material of the bikeway.

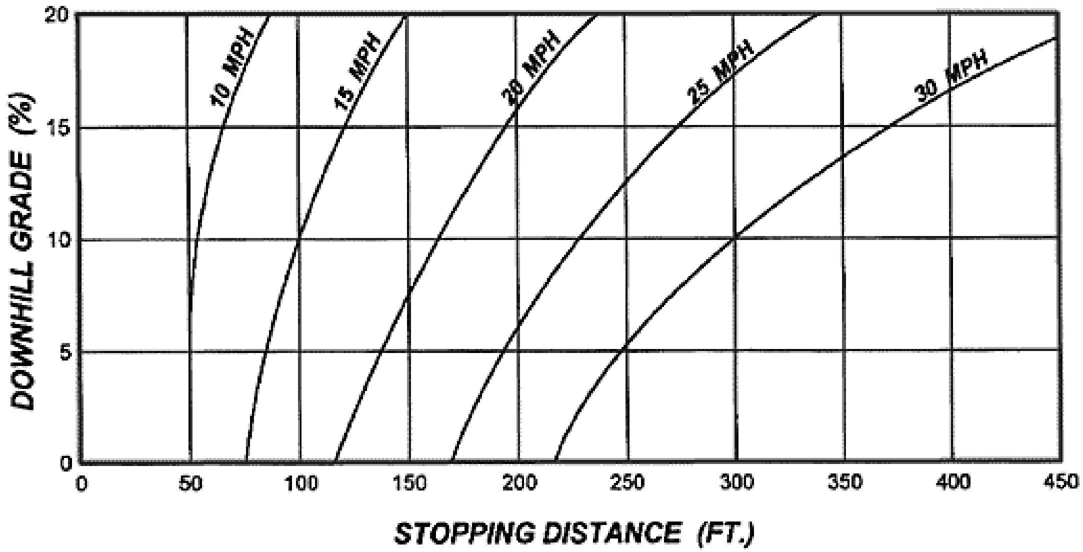

Figure 4-17

Adequate stopping distances shall be maintained along bikeways at all locations of possible conflict. This includes maintaining clear site lines for bicyclists at intersections with roadways and walkways and avoiding vertical curves that could block a rider's view too close to intersections, turns, or potential obstructions. The area around horizontal curves shall also be kept clear to the extent necessary to maintain required sight lines to potential hazards. Where sight lines are less than desirable, signs warning bicyclists of an approaching conflict shall be installed.

4.7.6.2 Street Crossings

Most bicycle-automobile accidents occur at intersections. Unless all bicycle street crossings are grade separated, conflicts will continue to exist but can be minimized. Crossings shall be marked with clearly visible painted stripes or by a change in the street paving consistent with the bikeway paving material. If the bikeway is not located on the roadway, curb-cut ramps shall be provided at each crossing. A textured finish shall be applied to the ramp to act as a warning of impending vehicle traffic.

Where possible, bicycle crossings shall be located slightly away from road intersections so that they do not interfere with the turning movement of vehicles. Such a location will allow a turning automobile to stop for crossing bicycles but still clear the intersection. Such a crossing would apply only to a bikeway not located on the roadway. If the bikeway shares the right-of-way with a roadway, automobiles may be allowed to enter the bikeway at an intersection approach to begin a turning movement.

In such cases, the bikeway markings shall not continue through the intersection and shall be a broken stripe at the approach to the intersection to indicate to both the bicyclist and the driver that an automobile may enter the bikeway. If an intersecting roadway is minor, then the bikeway markings may cross it and continue through the intersection.

4.7.7 Bicycle Parking

The provision of an adequate number of properly located and secure bicycle parking facilities is a significant element in the development of a viable bikeway network. When compared to automobile parking, these facilities are inexpensive and can generally be placed relatively close to destination points. Parking facilities equal to the demand shall be located near all bikeway network destination points, preferably within 50’-0” (15 m) of main entrances. An adequate number of bicycle parking spaces are especially important near the entrances to the facilities. Covered bicycle parking areas shall be provided in climates where protection from the elements is necessary.

Parking facilities shall be located such that bicycles do not impede pedestrian traffic but are in an area that can be visually supervised. Bicycle racks shall be spaced two feet on center to facilitate use. Racks shall be such that a wheel and the frame can both be anchored to prevent theft. Racks shall be carefully integrated into the overall site design to prevent clutter. Many racks, such as precast units set flush with the pavement, are unobtrusive, especially when not in use. To help support the use of the bicycle network, showers and lockers shall be considered in facilities that are primary destination points.

4.8 Site Grading

Site grading is managing and designing the topography of the site for the proposed project. Topography is the primary determinant in the amount, direction, and rate of runoff. Consider the effects of rainfall in the fully-designed scenario and how it compares to the pre-developed flows when grading a new project site. Chapter 6 – Stormwater Management for requirements of storm runoff and best management practices.

Strive to balance the cut and fill on the site. Facilities and parking areas shall be sited to take advantage of existing topography. Graded slopes shall be gradual and avoid abrupt changes in gradient. The grading plan shall detail earthwork cut and fill from the new building wall perimeters, surface drainage design, pavement grading, by showing proposed contours and spot elevations at critical design areas.

Use 2’-0” (600 mm) contours at a maximum intervals, but preferably 1’-0” (300 mm), to show grading of the entire project site. The design engineer shall ensure there are not any areas on the site that will have standing water, unless a specific stormwater management practices so dictates.

- The placement of facilities on a site changes drainage conditions by increasing impervious surfaces, primarily rooftops and pavements. This results in a greater volume and velocity of water to be managed. The negative effects of impervious surfaces can be reduced through the following:
- Avoid the creation of unnecessary impervious surfaces;

- Evenly diffuse drainage across the site. Avoid concentrating drainage at one point by dividing the site into more than one drainage basin.
- Use islands, median, curbs and gutters to control drainage within parking areas. Curbs strategically allow introduction of runoff into designated catch basins.
- Divide large expanses of impervious surface (i.e. parking lot) into smaller areas to help control runoff, reduce the size of necessary drainage structures, and avoid drainage system back-up.

4.8.1 Grades at Buildings

Earthwork adjacent to the building shall be located at least 6" (150 mm) below the finished floor, except where sidewalks or other site improvements are adjacent to the building. Grades shall drain away from the building at a minimum of 5-10% within the first 10'-0" (3 m), especially in locations where there are ground level windows, downspouts or roof drain overflows. Verify the slope required away from the building walls with the geotechnical report. Under no circumstances shall the grade fall towards the building. Coordinate surface grades with architectural, structural, and mechanical design to provide proper surface drainage. Locate the finish floor elevation of the buildings so that if drainage structures are blocked, the water will not back up into the buildings.

4.8.2 Turf grades

If grass ditches or swales are used, they must be sloped at a minimum of 2%. Turf areas shall be sloped at a minimum of 2% and maximum of 25% (4:1). The maximum slope for mowing machinery is 25%. Any turf that slopes in excess of 25% must be approved by the VA. Any slopes over 6% shall have an erosion control mat/blanket with seed mixture on the final graded surface.

4.8.3 Pavement Grades

The grades required for paved areas are shown in the Table 4-2. See the curb ramp section for required grades at curb ramps. Direct water concentrated in parking lots and along curbs away from major pedestrian areas and routes.

Table 4-2

Item	Description	Pavement Type	Minimum Slope	Maximum Slope	Recommended Slope
Roadway	Longitudinal		0.5%	10%	5%*
	Transverse	Concrete	1%	3%	2%
		Asphalt	1.5%	3%	2%
Parking Lot	Cross-slope	Concrete	1%	5%	2%
		Asphalt	2%	5%	2%
	Accessible		0.5%	3%	
Curb and Gutter	Longitudinal slope		0.5%	5%	1%
Sidewalk – Accessible Route **	Longitudinal		0.5%	3%	2%
	Transverse		0.5%	2%	2%
Sidewalk – Non-Accessible Route	Longitudinal		0.5%	5%***	2%
	Transverse		0.5%	2%	2%

<u>Table 4-2 Notes:</u>

* Truck Routes shall be no more than 5% slope.

** Accessible Routes must have a cumulative slope less than 3%

*** The maximum slope shall be 5% with the exception of if the sidewalk is parallel to a roadway that is steeper than 5%. When a sidewalk is great than 5% slope, the sidewalk shall be designed per ADA/ABA. If a sidewalk exceeds the maximum grade, the A/E shall consider using ramps or steps as described herein.

5 Site Utility Systems

5.1 Overview of Utilities

VA Facilities shall develop and adopt a consolidated utility program that designates planning corridors for utility lines, so that all the utilities are centralized. These corridors shall indicate the location of both existing lines that are appropriately located and all future lines. Existing lines that are located outside these corridors shall be relocated, if possible, in association with new construction or renovation projects. The designation of corridors in advance will facilitate the planning and construction of walkways to minimize potential direct and indirect impacts to both utilities and new pavement and building improvements. These corridors shall be located along a site's perimeter and not cross a site diagonally or indiscriminately because future realignment of existing systems will increase the costs of future developments.

The A/E shall show all existing and new site utilities on all utility plans. For clarity of the design of the specific utility systems, the A/E may elect to indicate the specific design for the utility system on separate plan sheets. However, each plan sheet shall indicate the appropriate horizontal and vertical relationship between all utilities. The following underground systems will be designed and shown on the site utility drawings:

- Site utility tunnels and vaults
- Potable water distribution, pumping and storage
- Fire protection water distribution, pumping and storage
- Sanitary sewer system
- Storm drainage system
- Reclaimed/reuse water distribution, pumping and storage
- Chilled water distribution
- Irrigation water distribution, pumping and storage
- Natural gas distribution system
- Oil and fuel systems (for horizontal alignment information only)
- Duct banks, vaults and conduit systems
- Hot water distribution (for horizontal alignment information only)
- Steam system distribution (for horizontal alignment information only)
- Street lighting, area lighting and traffic signal systems
- Aerial power and communications systems (for horizontal information only)

5.1.1 Local Coordination

The A/E shall work with the local utility companies on each project to determine what existing public lines are available, what capacity the lines have, and the process if any public lines need upgrading or relocating due to the new VA project. Most local utility companies have existing maps of the project site and surrounding public lines. The A/E shall set up meetings early with all utility companies to discuss the project scope and obtain maps and general information. The A/E shall verify if there will be connection fees and what permits will be required by the local utility companies.

5.1.2 Utility Locations

Utility lines shall be centralized and located to minimize the need for later adjustment, accommodate future building expansions, and to allow servicing the lines with minimum interference to traffic and interruption of other utility services. Utility lines shall not be located beneath proposed pavement areas (i.e. roads, sidewalks, and bike paths) unless absolutely necessary. Utility line crossings of the roadway shall intersect on a line perpendicular to the roadway alignment.

If a conventional storm sewer system is used, storm sewer inlets and grates shall be located away from pedestrian travel areas and shall not be located such that they conflict with vehicles. Inlets placed in parking areas shall be located outside of typical wheel paths and away from the sides or rear of parked cars. Depressions surrounding inlets or grates shall be designed following the same criteria as pavement.

5.2 General Utility Design Requirements

5.2.1 Clearances and Crossings

The A/E shall design the site with the fewest crossings of utilities possible. The A/E shall consider the following order of priority for underground facilities:

- Sanitary Sewer
- Storm Sewer
- Water main
- Other utilities

5.2.2 Existing Utility System Demolition

The existing utilities will be located by the topographic survey and other various maps as per Chapter 2. If an existing utility needs to be relocated or inactive due to the new project, the existing utility shall be removed in its entirety unless otherwise approved by the VA. Abandoning utilities in place shall be avoided unless it is absolutely necessary or in the best interest of VA.

5.2.3 Redundancy

If stormwater or sanitary sewer sumps, pumps, and lift stations are utilized, the A/E shall use redundant pump systems in the event of a pump failure.

5.2.4 Utility Pipe Design

Each utility system has pipe size, slope, and location requirements in this Chapter. The A/E shall follow those requirements.

5.2.5 Design Standards and Details

The A/E shall follow the more stringent between the VA standards, the local standards, and the details when preparing utility design for each project. Modify specifications to reflect the more stringent requirements.

5.2.6 Minimum Depth of Cover

Indicate by notes on drawings or detail section, the minimum depth of cover required over each specific utility system. All buried utilities shall have underground detectable warning tape installed in the trench.

- Minimum cover for storm sewer lines shall be at least 2’-0” (600 mm) from finish grades.
- Top of potable water, chilled water, fuel and appurtenances shall be at least 1’-0” (300 mm) below frost penetration.
- The minimum depth of sanitary sewer lines at the terminus point shall be 4’-0” (1200mm). Where practical, top of sewers shall be at least 1’-0” (300 mm) below frost penetration. Where such depth below is not practical, provide freeze protection and/or supporting foundations to a depth below the frost line and securely fasten sewer to foundation.

5.2.7 Utilities Distribution Type

The utility distribution type shall be determined on a project by project basis. The A/E must consider the existing site conditions and budget when deciding what type to use.

5.2.7.1 Trenches

Generally, do not install more than one utility system in the same trench. However, due to site constraints and value engineering, multiple utilities in the same trench may be evaluated by the government on a per case basis. Prior to approving any multiple line trench, the A/E shall document that the use of the multiple line trench will not negatively impact the utility system, adequate clearances are provided for the operation and maintenance of the systems, and that the joint trench will not pose any constructability constraints. There must be a minimum of 12” (300 mm) between the outside diameters of all pipes to obtain the required compaction.

5.2.7.2 Trenchless Techniques

When specific site conditions warrant, the A/E shall consider trenchless techniques installing new utilities and the rehabilitation of existing utilities. Trenchless techniques included directional boring, jack and bore, micro-tunneling, and pipe bursting. Such techniques shall be evaluated on a cost-benefit basis, including the initial construction costs, mitigation of interruptions of service, negative impacts of other site functions, and longevity of the system. Trenchless construction will be evaluated by the government on a per case basis. Prior to approving any trenchless technique, the A/E shall document that the use such techniques will not negatively impact the utility service life or capacity. The carrier conduit (pipe conveying the fluid or cabling system) shall be meet or exceed the parameters for the piping system as specified in the Master Specifications. Proper soil testing shall be performed and results show that boring, tunneling, etc. will not have any effect on the area/pavement/building being bored under.

5.2.7.3 Tunnels

Tunnels are the system of choice and shall be utilized by the A/E when the site and budget allows. Tunnels offer an opportunity to keep all the utility lines centralized and easily accessible.

5.2.8 Horizontal Clearance

The horizontal clearance shall be measured between the outside dimension of the pipe, duct bank, or structure.

5.2.8.1 Water and Sanitary Sewer

Maintain a horizontal clearance between potable water mains and gravity flow sanitary sewer/sanitary sewer force mains of at least 10 feet (3m). The horizontal clearance between potable water mains and sanitary sewer mains may be reduced to 6'-0" (1800 mm) when: local conditions prevent a horizontal clearance of 10'-0" (3 m), the water main invert is a minimum of 18" (450 mm) above the crown of the sewer, and the water main is in a trench, separated by undisturbed soil.

When the specified horizontal clearance cannot be met, the water main shall be constructed with mechanical joint ductile iron pipe per *Specification 33 10 00 – Water Utilities*, and the sanitary sewer shall be constructed with mechanical joint pressure rated ductile iron pipe per *Specification 33 30 00 – Sanitary Sewage Utilities*. Horizontal clearances shall comply with the requirements of the State Health Department, Department of Environmental Quality, or agency governing the facility of potable water mains and systems.

5.2.8.2 Water and Chilled Water

Maintain a horizontal clearance of at least 6'-0" (1800mm) between potable water mains and reclaimed/reuse and chilled water mains.

5.2.8.3 Water and Storm Sewer

Maintain a horizontal clearance of at least 5'-0" (1500mm) between potable water mains and storm sewers.

5.2.8.4 Duct Banks and Piped Utilities

Maintain a horizontal clearance of at least 3'-0" (900 mm) between duct banks and piped utilities.

5.2.9 Vertical Clearance

The vertical clearance shall be measured between the outside dimension of the pipe, duct bank, or structure. For insulated piping, the clearance shall be measured to the outside of the insulation. At utility crossings where adequate compaction of the bedding material cannot be obtained, use flowable fill in the zones were compaction is impossible or impractical.

- Maintain a minimum vertical clearance of at least 1'-0" (300 mm) between all utilities at crossings unless otherwise specified below.

- At crossings of potable water mains and sanitary sewers, storm sewers, force mains, reclaimed/reuse mains, or chilled water mains, where the potable water main crosses above the other utility, the minimum vertical separation shall be 18” (450 mm), or as required by the State Health Department, Department of Environmental Quality, or agency governing the facility of potable water, whichever is greater.
- Where 18” (450 mm) cannot be maintained or where potable water lines cross under gravity sewers, reclaimed/reuse mains, or chilled water mains, additional protection shall be provided as required by the agency governing the facility of potable water. Additional protection shall consist of constructing both piping systems with ductile iron pipe with restrained mechanical joints or use of concrete encasement. The additional protection shall extend a minimum distance of 10’-0” (3 m) outside the limits of the crossing.
- Sanitary sewer force mains shall only cross under potable water mains with a minimum vertical clearance of 18” (450 mm). When the vertical clearance between the potable water main and the force main is less than 18” (450 mm), both the water main and the force main shall be constructed with restrained mechanical joint ductile iron pipe as indicated above for additional protection.
- The preferred vertical clearance between duct banks and piped utilities shall be 2’-0” (300 mm) and the minimum vertical clearance shall be 18” (450 mm).
- The minimum vertical clearance to all steam, pumped condensate, and hot water, and other utilities shall be at least 18” (450 mm). When this vertical clearance cannot be maintained, the insulation thickness on the steam, condensate, or hot water main shall be increased by 50%.

5.3 Contract Documents

All existing and new utilities shall be indicated on "CU-Series" drawings (see *VA Design and Construction Procedures*, “Drawings,” and the VA National CAD Standard Application Guide). The “CU-Series” drawings shall be utilized to evaluate potential utility conflicts between various existing and new utility systems.

All site utility design, potable and fire protection water distribution, water storage, water pumping, groundwater wells, sanitary sewer collection, force mains and pumping, storm drainage, reclaimed/reuse water distribution and storage, chilled water distribution, irrigation water distribution and storage, gas distribution, oil and fuel systems, and duct banks shall be indicated on the “CU-Series” drawings.

Design of steam, hot water, and oil and fuel distribution systems shall be indicated on the “MS-Series” drawings. The horizontal alignment of the steam and hot water distribution systems shall also be shown on the “CU-Series” drawings. At crossings of new and existing utilities, the inverts and/or the vertical clearance between the utilities shall be indicated on the plan view or the vertical profile of the utility system.

Design of duct banks for power and telecommunications shall be indicated on the “CU-Series” drawings.”

Cabling and hardware for the power and telecommunications distribution systems shall be indicated on the “ES-Series” and “T-Series” drawings, respectively.

Design of building foundation drains shall be shown on the “A-Series” drawings and details for the foundation drains shall not be shown on Site Utility ("CU-Series") drawings. However, the design of all lift stations and piping from the low point of the foundation drainage system to the storm sewage system or point of discharge shall be indicated on the “CU-Series” drawings.

5.3.1 Calculations and Review Submittals

Submit calculations required under the contract to include the following systems:

- Cathodic Protection
- Storm Drainage
- Water Gas
- Irrigation Pumps
- Sanitary Sewage
- Oil and Gasoline Supply

5.4 Cathodic Protection

Cathodic protection for ferrous piping, tanks, conduits, and appurtenances shall be designed in accordance with NACE International Standards. The analysis shall consider coating, lining, passive and induced current systems. The evaluation of the systems shall consider the initial and long-term operational cost, risk of damage during facility, and in-situ verification of the system. Cathodic protection systems for Underground Storage Tanks (UST) containing fuels or other regulated substances shall comply with all federal and state Environmental Protection Agency (EPA) rules and regulations.

5.4.1 Cathodic Protection Analysis

Submit a cathodic protection analysis with recommendations at the first review when ferrous piping, tanks, conduits, and appurtenances are to be installed in direct contact with the soil. The A/E shall coordinate the requirements to establish the existing soil parameters with the project geotechnical investigation.

5.4.2 Corrosion Protection

Corrosion protection of ductile iron piping, fittings, and appurtenances shall be designed in accordance with the Ductile Iron Pipe Research Association (DIPRA) publication, “The Design Decision Model for Corrosion Control of Ductile Iron Pipe.”

5.4.3 Existing Cathodic Protection

Contact the VA Medical Center's engineering personnel, and conduct site surveys to determine the type and extent of existing cathodic protection systems. For a new site, contact the previous owner, owners of adjacent property, and local utility companies for information of cathodic protection systems in operation that could affect the project design. The site survey shall review the configuration of adjacent overhead power lines, light rail transportation systems, and other conditions that could generate stray currents. When modifying or rerouting existing utility systems equipped with cathodic protection system, the analysis and design shall include the impact on the overall existing system. Insertion of sections of non-metallic piping sections within a ferrous piping system can have profound impacts on the existing system.

5.5 Water Supply

Few, if any entirely new water supply systems will be constructed for VA projects unless the project is a new campus. Generally, the project will involve upgrading and/or expansion of existing systems. Where existing systems are adequate to supply existing demands, plus the expansion proposed, no additional facilities will be provided except necessary extension of water mains. In designing main extensions, consideration will be given to plan future development in adjoining areas so that mains will be properly sized to serve the planned developments. Selection of materials, pipe, and equipment shall be consistent with system operating and reliability considerations, energy conservations, and the useful life of the project.

Figure 5-1

If the VA facility is located near a municipality or other public or private agency operating a water supply system, this system shall be investigated to determine its ability to provide reliable water service to the facility at reasonable cost. The investigation must consider future as well as current needs of the existing system and, in addition, the impact of the project on the water supply requirements in the existing water service area. Among the important matters that must be considered are: quality of the supply; adequacy of the supply during severe droughts; reliability and adequacy of raw water pumping and transmission facilities; treatment plant and equipment; high service pumping for fire flow; storage and distribution facilities; facilities for transmission from the existing supply system to the project; and costs. In situations where a long supply line is required between the existing supply and the facility, a study will be made of the economic size of the pipeline, taking into consideration cost of construction, useful life, cost of operation, and minimum use of materials. With a single supply line, the on-site water storage must be adequate to support the mission requirement of the facility for its emergency period. A further requirement is an assessment of the adequacy of management, operation, and maintenance of the public water supply system.

The following items, as well as others, if circumstances warrant, will be covered in the investigation of existing sources of supply from Government-owned or other sources.

- Quality history of the supply; estimates of future quality.
- Permits from regulating authorities and compliance history.
- Description of source.
- Water rights.
- Reliability of supply.
- Quantity now developed.
- Ultimate quantity available.
- Excess supply not already allocated.
- Raw water pumping and transmission facilities.
- Treatment works.
- Treated water storage.
- High service pumping and transmission facilities for fire flow.
- Rates in gal/min at which supply is available.
- Current and estimated future cost per 1,000 gallons (3800 liters).
- Current and estimated future cost per 1,000 gallons (3800 liters) of water from alternative sources.
- Distance from VA site to existing supply.
- Pressure variations at point of diversion from existing system.
- Ground elevations at points of diversion and use.
- Energy requirements for proposed system.
- Sources of pollution, existing and potential.
- Assessment of adequacy of management, operation, and maintenance.
- Modifications required to meet additional water demands resulting from supplying water to the VA facility.

5.5.1 Potable Water Demands (Average Daily Demand)

If meter readings are not available for similar functions, average daily water demands, under normal operating conditions, shall be determined using the following:

- *Hospitals:* 300 gallons (1140 liters) per day per bed.
- *Laundry*: Daily flow shall be based on 2.5 gallons (21 liters/kg) per pound of laundry.
- *Ambulatory Care and Clinical Additions*: Daily flow shall be based on 0.40 gallons per day per square foot (19.57 liters per day per square meter).
- *Energy Centers*: Based on the ultimate cooling and heating capacity plus a 10% contingency for other plant activities. The average daily demand shall be the larger of the average daily demand during the peak cooling month or the average daily demand during the peak heating month.
- *Existing Irrigation Systems*: For existing irrigation systems, the demands shall be based on established irrigation controller operation, or flow metering. If such data is unavailable, the demand shall be based on a Blaney-Criddle consumptive use water balance model or other acceptable technique.

- *Fire*: The minimum fire demand shall not be less than 120,000 gallons (450 kL). The total fire demand shall be as determined by NFPA 1, Uniform Fire Code.

5.5.2 Potable Water Flow (Design Flow Rates)

If flow rate metering and data is not available for similar functions at the facility, the following flow rates shall be utilized:

- Average daily domestic flow rate for hospitals, ambulatory care, clinical additions, and outpatient clinics in GPM (liters/second) shall be determined by assuming 80% of the average domestic daily demand occurs in 16 hours (divide average domestic daily demand, in gallons, by 1200).
- Peak hourly domestic flow rate for hospitals, ambulatory care, clinical additions, and outpatient clinics shall be three times the average daily domestic flow rate.
- Fire flow for existing facilities shall be based on the established fire requirement for the facility with the largest fire demand. For new facilities, the fire flow shall be based on the design of the building sprinkler system with the acceptable hose stream requirement. The minimum flow to hydrants connected to the distribution system, for non-sprinkled facilities shall be 1,500 GPM. The total fire flow rate shall be as determined by NFPA 1, Uniform Fire Code. Refer to Article 3.3.2 for unfavorable conditions that may increase the fire flow requirements.
- If a fire flow test is greater than 1 year old, a new test shall be performed. The test shall be performed by a licensed company. The results shall be submitted by the performing company on their letterhead signed by the qualified person(s) performing the test. The results shall be maintained on site.
- Average daily flow rates for energy centers shall be determined based on the average daily demand during the peak month (total heating, cooling, and energy production), assuming that 90% of the demand occurs over a period of 20 hours. The peak hourly flow rate for energy center shall be two times the average daily flow rate.
- Average daily flow rate for irrigation systems shall be determined based on the average daily demand during the peak month, assuming that 90% of the demand occurs over a period of 10 hours. The peak hourly flow rate for irrigation systems shall be two times the average daily flow rate.

5.5.3 Potable Water Sources

The A/E shall provide connections to an adequate public water system. A minimum of two connections to the public water system are required. Each connection shall be configured with adequate valving to isolate the water source so that in the event of line failure or operational shutdowns in off-site or on-site portions of the water distribution system, the second source will be available. Each connection shall be sized for the total design flow.

Based on an assessment of the public water system, the selection of the supply points and connections to the public water system for the site shall be based on the hydraulic capacity of the public system and shall provide the best redundancy for the on-site water system. The A/E shall contact the public water system operators and consider planned expansions/upgrades of the public water system in the assessment.

The connection to the public water system, metering, backflow/cross connection protection, and off-site main extensions shall be in accordance with the rules and regulations of the local utility company. At connections where backflow prevention is required, the backflow assemblies shall be reduced pressure devices.

At each point of connection two backflow assemblies shall be installed in parallel to facilitate annual testing and maintenance of the assemblies while not interrupting the water supply.

If an adequate public water supply is not possible, an alternate water source shall be developed. Alternative water sources include groundwater wells, augmentation of the off-site public water system, and/or on-site storage. In the evaluation of ground water wells, the analysis shall include the anticipated water quality, required water treatment to comply with current and projected standards of the Safe Drinking Water Act, water rights, geo-hydrologic impacts, and potential migration of known pollution within the aquifer.

The A/E shall submit documentation for the local utility company stating that the potable water system has the capacity to provide for the projected demands and flow rates. The documentation shall include the anticipated static and residual pressure (high water elevation [HWE] of the specific pressure zone) at the point of connection for the range of anticipated flows.

5.5.4 Non-Potable Water Demand

The water quality of reclaimed/reuse water and surface waters varies significantly between communities. The variations in the water quality can significantly affect the cycles, blow-down ratios, and water treatment programs for cooling towers and nitrate loading of landscape areas. Prior to utilizing non potable water sources, the A/E shall obtain and analyze the anticipated water quality, seasonal variations, and recommend specific demand and flow rates in keeping with the parameters set forth for potable water. If a non-potable water source is utilized, the demands and flow rates discussed for potable water shall be adjusted for the anticipated water quality and utilized for the basis of design.

5.5.5 Non-Potable Water Sources

The A/E shall evaluate the potential for non-potable water for industrial water and irrigation. This evaluation shall review the life- cycle costs of available reclaimed/reuse water and surface waters.

5.5.6 Water Distribution Systems

Design the water distribution system to provide adequate water service to all facilities under the following flow scenarios:

- Peak hourly domestic and non-domestic flow rate at the design residual pressure, with the largest water source closed.

- Average daily domestic and non-domestic plus fire flow at the design residual pressure with one water source closed.

The A/E shall lay out the water system in a looped configuration/grid to the maximum practical extent. Buildings that house patients, energy centers, and facilities that have critical fire demands shall be looped by a water main. No water main shall be smaller than 8” (200 mm) in diameter and no fire hydrant branch less than 6” (150 mm) in diameter. The alignment of the water distribution system shall facilitate maintenance of the system and allow for system expansion. Do not locate water mains and appurtenances where exposing of the pipe would damage adjacent structures. Locate new water mains a minimum of 10’-0” (3 m) outside of new buildings and outside of A/E fill zones for structures.

5.5.6.1 Isolation Valves

Place isolation valves to provide control over reasonably sized areas. In general, a segment of the water distribution system can be isolated without impacting more than one service line and one fire hydrant. Install valves on all fire hydrant branches and at all building service lines.

Locate service line valves as close as possible to their connections to the distribution mains. Valves with post indicators shall be set in non-traffic areas. Post indicator valves that could be potentially damaged by vehicular traffic shall be protected by post bollards.

Locate valves in areas where they can readily be located and service equipment can access their location. In congested vehicular corridors, locate the valve so it can be accessed with minimum interruption of traffic flow. To the extent possible, avoid locating valves in areas that may become flooded, or in snow removal areas.

On campuses that contain both public and VA water systems, the valve boxes shall clearly indicate the owner of the valve.

5.5.6.2 Fire Hydrants

Fire hydrants shall be installed on the distribution systems as site conditions warrant. Typically, place fire hydrants at a nominal 300’ spacing (90 m) and within 150’ (50 m) of all fire department connections. The locations shall be along approved fire access lanes or adequate roadways. The location of the hydrants shall comply with NFPA 1, Uniform Fire Code, Annex 1.

Coordinate hydrant locations and hose thread with the fire department responding to the facility. Set hydrants on the right side of the roadway panned to be the initial access route to the site for responders. Hydrants shall be offset from roadways a minimum of 2’-6” (760 mm), and not more than 7’-6” (2300 mm) behind the face of the curb. Areas were the hydrant may be damaged by vehicular traffic shall be protected by post bollards located a minimum of 3’-0” (900 mm) away from the hydrant and configured to avoid restricting access to the hydrant.

In regions where hydrants could be subject to freeze damage, protect hydrant per local water system standards. All freeze protection materials shall be safe for potable water systems.

5.5.6.3 Water Service Meters

All building potable and industrial water services shall be equipped with meters. The meter shall be "line-size” rated for the total range of flows anticipated. To accommodate large variations in flow rates, parallel meters may be required. Coordinate remote reporting and status parameters with the facility's Energy Monitoring and Control System (EMCS) system.

All building potable water services shall be equipped with backflow assemblies. The backflow assemblies shall operate based on the reduced pressure principal and shall be "line-size" rated for the total range of flows anticipated. Locate the assembly in locations were they are protected for damage, freezing, and un-authorized operations. The location shall provide adequate access for testing and maintenance of the device.

On service lines that the system pressure is 85 psi or greater, the service line shall be equipped with a pressure reducing valve (PRV) unless this design documents state that the building system piping and plumbing fixtures are designed for a higher pressure and that the higher pressure benefits the facility.

5.5.6.4 Hydraulic Network Modeling

The design of the water system shall include hydraulic network modeling of the system. The model utilizing a program or procedure based on the basic parameters of the Hazen Williams heat loss equation and at minimum the flow scenarios indicated above. The maximum Hazen Williams roughness coefficient (CHW) shall not exceed 140. Minor losses shall be based on accepted engineering values. The modeling shall reflect the dynamic nature of the system.

Flow velocity shall not exceed 7.5 ft/s (2.3 m/s) during fire flows and 5 ft/s (1.5 m/s) during peak hourly domestic/non-domestic flows. The model shall include the characteristics of the water supply, including the approximation of the system curve for the off-site public water system and the specific pump curves for on-site pumping facilities. The approximation of the offsite public water system curve shall be based on data furnished by the local utility company and the results from flow testing of hydrants.

For systems that are being modified or realigned, the model shall include sufficient data on the existing system to evaluate the impact on the existing system and the ability of the new system to meet the projected demands. Additionally, for modifications to existing systems, the analysis shall consider the quality of the existing piping. Submit hydraulic model in electronic format according to the requirements of Article 1.7.4, Computer Aided Facilities Management Requirements.

5.5.7 Water Distribution Design Plans

The design of all water mains 8" (200 mm) in diameter and smaller may be designed based on a plan view only. Clearances between the water main and other new and existing utilities shall be noted on the drawings. However, in areas where there is utility congestion or tight clearances, a profile is strongly suggested. All water mains larger than 8" (200 mm) in diameter shall include a plan and profile of the design.

In the event that the design utilizes standard details of the local utility company, all referenced details shall be indicated on the drawings.

Due to the inherent flexibility of joint restraint system compared to traditional thrust block systems, it is recommended that the use of thrust blocks be minimized. Thrust blocking may be required at the connections to existing systems that were not constructed with joint restrain systems. The A/E shall evaluate the use of thrust blocks at the point of connection or restraining the existing water mains. The design shall include a joint restraint schedule indicating the section of the system to be restrained based on the horizontal and vertical alignment of the water mains.

5.6 Water Storage

Provide on-site water storage and/or pumping system if the water source (public water system, alternative water source including groundwater wells, etc.) cannot meet the following requirements.

Figure 5-2

- *Fire Protection*: On-site water system shall provide for the design fire flow at the design pressure based on the provisions of NFPA 1, Uniform Fire Code, and the requirements of this design manual.
- *Potable Water Uses*: On-site water system shall provide for the peak daily demand and peak hourly flow rate at a minimum residual pressure of 50 PSI (345 kPa). However, if adequate pressure to serve the user at the highest point is not possible or would result is excessive pressures in the distribution system, building booster pumps may be used in lieu of pumping the entire distribution system.
- *Unfavorable Conditions*: When any of the following unfavorable conditions occur, the minimum calculated fire demands shall not be less than 180,000 gallons (680 kL) and on-site water distribution system shall provide 3000 GPM at 20 PSI (11340 L/min at 138 kPa) residual pressure for fire protection.
    - Buildings housing patients are not completely sprinklered.
    - Combustible construction.
    - Moderate or serious fire exposures.
    - Hindrance to fire department apparatus access to building site.
    - Delayed response by inadequately staffed fire department.

5.6.1 Mission Critical Facilities for Water Demand

When the facility is classified as a mission critical facility, the following minimum on-site storage shall be provided to facilitate the operation of the facility during natural disasters or other events that would preclude the normal delivery of water: all storage volumes shall be based on the useable volume within the storage facility and the demand calculations contained in the *Physical Security Design Manual for VA* Facilities (Mission Critical Facilities). Some VA projects are for an entire new campus (major project), while others are individual building additions (minor), or interior renovations. If the project is a major project with an entire new campus, then the water storage requirements need to be for the entire campus supply. If the project is a minor project, then the storage requirements will only be for the new building(s) unless the VA has the funds allowed and it is practical to expand the storage requirements to buildings outside the scope of the minor project.

If the configuration of the storage facility will not provide for a gravity distribution meeting the design pressures and flow rates, booster pumps shall be installed as indicated in this manual. All such booster pumps and control systems shall be furnished with emergency power.

If calculations of the water storage volume excludes non-essential water demands (utilize the demand rates set forth in the *Physical Security Design Manual*), the system shall be configured to readily isolate all non-essential demands from withdrawing from the storage facility during critical events. If isolation of non-essential demands is not integrated in the design, the demands set forth in this manual shall be utilized. Locate water storage facilities as close as practical to the mission critical facility.

5.6.2 Design of On-Site Water Storage Facilities

The design of on-site water storage facilities shall conform to the American Water Works Association guidelines, and *NSF Standard 61, Drinking Water System Components – Health Effects.* The storage facilities shall be design to permit the maintenance of the tanks without interruption to the water supply to the buildings and fire protection systems.

The design of water storage facilities shall preclude un-authorized access to the storage facility. The design of the on-site water storage tank shall include an assessment of the water quality impacts, including bacteriological growth, chlorination residuals, water temperature, and including the primary and secondary water quality standards of the Safe Drinking Water Act. The storage facility shall be sited and configured to minimize the potential for airborne particles, acidic rain, spores, and other contaminants from entering the tanks.

The design shall evaluate the turnover of the tanks during normal operation and during minimum flow conditions. To prevent stagnation, the design of storage tanks for normal operations and for mission critical facilities, shall be continuously on-line with continuous flow-through.

Shall the anticipated chlorine residual fall below acceptable limits (1 ppm); pre-chlorination and/or post chlorination equipment shall be provided. Where temperatures of the water being discharged from the tank into the potable water distribution system are expected to exceed 85 F (29.4 C), provisions shall be installed to cool the water and/or prevent the temperature rise within the tank.

All water storage facilities shall be designed to facilitate visual inspection of the facility. In

regions where ice may form in the tank, provisions shall be installed to prevent adverse ice buildup within the tank, at control locations, and other areas that would impact the operation or structure of the facility. All tanks shall be provided with level gauges and isolation valves.

5.7 Domestic Water Pumping Systems

The location of the pump station and intake structure, and the anticipated heads and capacities are the major factors in the selection of pumps. The function of a pump station in the overall distribution system operation can also affect the determination of capacities. Basic pump hydraulic terms and formulas, pump fundamentals and applications, and instructions for facility, operation and maintenance are given in the *Hydraulic Institute Engineering Data Book* and *Hydraulic Institute Standards*.

5.7.1 Pump Types

There are generally two types of pumps used for potable water pumping applications-the vertical turbine pump, line shaft and submersible types, and the centrifugal horizontal or vertical split case pump designed for water-works service. If the pump station and intake structure are to be located within a surface or underground reservoir, vertical turbine pumps with the column extending down into the reservoir or its suction well will be a logical choice. If the pump station is located at an above ground storage facility, split case centrifugal pumps will be the preferred selection. These pumps are normally horizontal but vertical split case pumps are common where there is limited space. Flexible couplings will connect pump and driver shafts. Split case pump design is used for ease of maintenance of the rotating elements, which can be removed without disconnecting the suction or discharge piping.

For standard waterworks design for potable systems, pump casing will be cast iron and impellers will be bronze. Base for the pump and driver will be cast iron or fabricated steel. Pump impeller and casing may have wearing rings depending upon manufacturers' recommendations and consideration of the cost of replacing the rings. Pumps will have mechanical seals or packing seals, ball or roller bearings, and lubrication system. Pumps which may operate under extreme conditions such as at the ends of pump curves or under frequent on-off operation will have packing seals in lieu of mechanical seals. Mechanical seals will be considered for pumps likely to stand idle for long periods of time. Where scale or abrasive water conditions exist, pump linings and other material options for impeller, shaft, wear rings, and seals are available. A water analysis at the point of service must be secured and analyzed before non-standard materials be oil bathed or grease. Vertical dry pit pumps will be grease lubricated. Vertical wet pit pumps will have oil or water lubrication.

5.7.2 Pump Applications

5.7.2.1 Booster Pumps

Booster pumps may be above-ground or underground. Pump and controls selection for in-line booster pumps will consider minimum suction pressure, and automatic discharge cut-off pressure. For small booster pump applications with peak water demands of less than approximately 1500 gpm the designer shall consider a pre-assembled skid mounted package unit including all of its hydrostatic, flow, instrument and electrical components.

5.7.2.2 Pump Curves

With the system head curve defined, it is possible to select a pump to deliver the required capacity. Manufacturer's published pump head-capacity curves for the selected type of pump will be used for this purpose. Since these pump curves usually apply to a particular impeller and pump design, different manufacturers may show slightly different performance for the same type and size of pump. Therefore, several manufacturers' pump curves shall be checked to establish realistic, cost- effective criteria for the pump selection.

For pumps in a typical water supply and distribution system, only pumps with "normal rising" to "steeply rising" performance curves shall be used. Pumps with these characteristics will perform well in parallel operation and will have relatively small capacity change with pressure changes. In addition, the brake-horse power curve will be relatively flat, which will minimize the risk of overloading the motor particularly in applications in direct pressure systems with possible high pressure fluctuations.

5.7.2.3 Pump Drives

Pump drives for water supply and distribution pumps will be electric motors. Diesel or other fuels will be considered as a power source only for emergency use. Drives for fire pumps will be in accordance with NFPA 20.

5.7.2.4 Pump System

Typically for smaller facilities, design pumping systems utilizing a three pump system. One pipe shall be sized for approximately one-third of the design peak hourly water demand. Each of the other pumps shall be sized for approximately two-thirds of the design peak hourly demand. The smaller pump will operate until water demand exceeds the pump's capacity, at which point it will stop and one of the other larger pumps will start. When the demand exceeds the capacity of this larger pump, the smaller pump will restart and both pumps will operate together. The other large pump will be a standby and alternate with the first large pump. For larger facilities, based on the demand profile and the system curve, the analysis of the pumping system shall consider alternative pump configurations. All pumping configurations must be capable of meeting the peak hourly design flow and pressure with the largest pump out of service. The maximum cycles per hour for each pump shall not exceed 6 for all flow scenarios with any pump out of service.

5.7.2.5 Motors

Motors will be selected with sufficient capacity to drive the pumps under service required without exceeding 85 percent of the specified rating. Motors will be in accordance with NEMA MG1. Refer to *Hydraulic Institute* Standards for discussions on types of electric motors.

5.7.2.6 Location

Except for submersible sump pumps, pump drives shall not be placed in a pit or other location subject to flooding. Wherever possible, locate pumps so there is a positive suction head.

5.7.2.7 Variable Frequency Drives (VFD)

Provide variable frequency drives (VFD) or a hydro-pneumatic tank to maintain the pumps operation near the best efficiency point.

5.7.2.8 Control System

All pumping facilities shall be provided with a control system to control the pump operation based on the water distribution system pressure. The location of the pressure transmitters shall be remote from the pumping station to adequately monitor the system pressures and provide redundancy shall one transmitter fail. The logic of the control system shall provide for the selection of the most efficient pump operation based on the trending of the system demands.

The system shall facilitate remote monitoring of the system operation and alarm conditions. The system shall be compatible with the facility's EMCS system. The system shall provide for manual overrides on the control system for the operation of all pumps.

The control system alarms shall include low pressure, high pressure, failure to start alarms, and "NO-FLOW" shut-down controls.

System equipped with hydro-pneumatic tanks shall also be equipped with an automatic air charging systems. All air charging systems shall have oil free compressors and maintain the volume of air within the tank in accordance with the design.

Control systems in systems that include alternative water sources (groundwater wells) and on-site storage shall be fully intergraded with the well operation and storage facilities.

5.7.2.9 Emergency Power

All water pumps and associated control systems shall be on emergency power.

5.7.2.10 Pumping System Hydraulic Modeling

The design of the pumping system shall be integrated with the hydraulic modeling of the water distribution system. The system curve developed for the distribution system shall be the basis for the design. The modeling of the pumping system shall include the cycles and operating point of all pumps simulated over the full range of anticipated flows and pump status conditions.

5.8 Irrigation Distribution System

Irrigation systems shall be designed as per Chapter 8 of this manual as well as the *Sustainable Design Manual.* If an irrigation system is to be installed, the system shall meet the following requirements of this section. The intent of this system is to address the main lines and site distribution system of the irrigation system. Specifics regarding the heads, drip zones, etc., shall be designed and constructed per the VA irrigation design requirements.

The project scope of work will indicate if an automatic irrigation system is required for the project and the extents of the irrigation system. The system shall be designed based on consumptive demands for the existing and new vegetation to be irrigated and local conditions. The frequency of irrigation cycles shall be established in the programming phase.

Irrigation systems installed above the frost line shall be equipped with appurtenances and drain ports capable of evacuating all main lines and laterals.

Systems that utilize reclaimed/reuse water shall be designed to minimize the potential of the general public coming in contact with the irrigation water. All reclaimed/reuse irrigation piping, valve boxes, and appurtenances shall be labeled as “non-potable water” and identified with purple coloration.

Distribution piping shall be non-metallic to the greatest extent possible and sized for a maximum velocity of 5 ft/s (1.5 m/s).

5.8.1 Automatic Irrigation

All irrigation systems shall be provided with an automatic irrigation control system in accordance with the Master Specifications. The design of the system shall permit all irrigation to be completed between the hours of 10:00pm to 6:00am. At mission critical facilities, the controller(s) shall be interfaced with the facility’s EMCS system. The controls shall not permit irrigation (non-critical water consumption) to occur during periods when water usage is curtailed.

5.8.2 Irrigation System Connections

Minimize the number of irrigation system connections to the potable system. Equip all connections with a reduced-pressure-type backflow assembly and meter. Limit maximum flow from any connection to the potable water distribution system to 180 gpm (11 l/s). Connections to reclaimed/reuse systems are not limited to the 180 gpm (11 l/s) criterion, but rated on the hydraulics of the reclaimed/reuse distribution system and source.

Prior to connecting any existing irrigation system to a reclaimed/reuse water source, the existing irrigation system shall be dye-tested and investigated for potential cross connections to the potable water system or devices. The dye-testing shall continue for an adequate duration to ensure its detection at all sources. All connections and cross-connections to the potable water system shall be eliminated prior to making the tie-over to the reclaimed/reuse system.

5.9 Sanitary Sewer Systems

The design of a sewer system must provide an engineered system of sewers and pump stations, complete with all appurtenant facilities, sufficient in size and capacity to collect and convey the required wastewater flows to an acceptable point of discharge. The system must be practicable, economically feasible, and all components must be located to minimize the costs of facility, operation, and maintenance. Sewers and appurtenances must be structurally sound, and must protect the environment from pollution caused by leakage or overflows. Extraneous flows that hydraulically overload the system and produce flooding at sewer manholes and lift stations must be excluded. Elimination of excessive infiltration and inflow is essential in avoiding increased costs of sewer maintenance, wastewater pumping, and treatment.

5.9.1 Sanitary Sewer types

The type of sanitary sewer system will depend on the existing sanitary sewer that the new VA project will connect into. The A/E shall use a gravity system for the project unless existing conditions warrant otherwise.

5.9.1.1 Gravity

Gravity sanitary sewer lines are the most typical and preferred facility of a sanitary sewer system. However, depths of gravity sewers greater than 15’ (4.5 m) to 20’ (6 m) are usually uneconomical and other alternatives need to be considered.

5.9.1.2 Forcemain and Pumping Station

The operation and maintenance costs of a pumping station with a forcemain may offset or exceed the construction costs of a deep gravity sewer system. When it is not readily apparent which solution would be more economical, the decision to use one or the other will be based on a life cycle cost analysis. Initial capital and construction costs for pumps, ejectors, structures, force mains, etc., plus operation and maintenance costs will be compared with the costs of deep trench excavation, or other special construction methods required for a gravity system. Generally, a gravity sewer system will be justified until its cost exceeds the cost of a pumped system by 10%.

5.9.1.3 Low Pressure Systems

Some areas under consideration may be further limited by high groundwater, unstable soil, shallow rock, or extremely adverse topography, and neither gravity sewers nor pump or ejector stations will be suitable. To overcome these difficulties, low pressure systems using grinder pumps with small diameter (4 inch or less (100 mm)) pressure sewers may be utilized.

5.9.2 Sanitary Sewer Design Requirements

When designing the sanitary sewer for the project site follow the following requirements:

5.9.2.1 Design Flows

If meter readings are not available, average daily sewage flow and peak flow shall be projected to be 95% of water demand indicated in Article 5.5, Water Supply.

5.9.2.2 Off-Site Sanitary Sewer System Requirements

Comply with the requirements for off-site sanitary sewer systems. Confirm the acceptable discharge rates, effluent limitations, and permitting requirements with the local utility company.

5.9.2.3 Storm Drainage Systems

Do not connect sanitary sewer systems to storm drainage systems.

5.9.2.4 Sewer Pipes and Manholes

To the extent feasible, do not locate sewer pipes and manholes under pavement. Provide manholes at junctions, changes in direction, changes in slope, and changes in invert elevations of sewers 8” (200 mm) and above. Clean-outs are required for 4” (100 mm) and 6” (150 mm) sewers. Limit spacing between manholes to 300’ (90 m), except in straight runs of long out-fall sewers, where 500’ (150 m) of spacing is permitted.

5.9.2.5 Pipe Connections

The crown of the outlet pipe from a manhole will be on-line with or below the crown of the inlet pipe.

5.9.2.6 Pipe Flow

Do not design the sewers for full flow, even at peak rates. Trunk and interceptor sewers will be designed to flow at depths not exceeding 90 percent of full depth. Lateral and main sewers will be designed to not exceed 80 percent, and building connections shall not exceed 70%.

5.9.2.7 Extra Strength Pipe

Indicate on drawings where extra strength pipe is required to support anticipated trench and superimposed loads. Include adequate pipe bedding and, if necessary, provide structural supports for sewer pipes, manholes, inlets, and other appurtenances.

5.9.2.8 Sanitary Sewer Sizes

Limit sanitary sewers to not less than 8” (200 mm) in diameter and sanitary sewer building connections to not less than 6” (150 mm) in diameter. Building connections that do not carry sanitary waste and will transport liquids with little or no solids, such as condensate lines, can be smaller than 6” (150mm), but not smaller than 4” (100 mm).

5.9.2.9 Cleanouts

Cleanouts must be installed on all sewer building connections to provide a means for inserting cleaning rods into the underground pipe. An acceptable cleanout will consist of an upturned pipe terminating at, or slightly above, final grade with a plug or cap. Preferably, the cleanout will be of the same diameter as the building sewer, and never smaller than 6” (150 mm).

5.9.2.10 Slopes

Establish sanitary sewer slopes to provide minimum velocity of 2.0 ft/s (0.60mm/s) at the average daily flow, and a minimum velocity of 2.5 to 3.5 fps (0.75 to 1.05 m/s) at peak flows. The maximum velocity is 8-9 ft/s (2.5 m/s-2.8 m/s) The maximum slope shall be 9% and minimum slopes shall be as per the Ten State Standards.

5.9.2.11 Discharge

Discharge cooling tower drains, overflows, and blow-down piping systems to the sanitary sewage system. Provide air gaps to prevent cross connections between sewage and water systems.

5.9.2.12 Local Standard Details

Use state or local standard details for manholes, and pipe cradles. Adjust Master Specifications as necessary.

5.9.2.13 Hydraulic Calculations

Provide hydraulic calculations for the sanitary sewer system. The maximum depth of flow at peak flow shall not exceed 0.75D. Submit hydraulic calculations in electronic format according to the requirements of Article 1.7.4, Computer Aided Facilities Management Requirements.

5.9.2.14 Special Designs

There are situations when site conditions do not allow for typical sanitary sewer construction and other methodologies must be considered.

5.9.2.15 Unsatisfactory Soil Conditions

When there is existing soil that is considered too unstable for use as pipe bedding or backfill consists of silt, quicksand, peat blog, muck, and other organic material, methods must be in place to provide suitable pipe bedding.

Over-excavate native soil to just below the trench bottom, and replace with a layer of crushed stone, gravel, or other coarse aggregate. Where soils are unstable to considerable depths, the sewer shall be fully encased in concrete and supported on piles at each end.

5.9.2.16 Facility in Rock

Where sewers must be constructed in rocky terrain, trenches must be sufficiently wide to provide clearance between the sides and bottom of the pipe, and any rock in the trench. The pipe must be installed to avoid all contact with rock, or any other unyielding material in the trench. A granular type bedding or concrete cradle will normally be provided along the pipe bottom, and trenches backfilled with satisfactory materials.

5.9.2.17 Jacking, Boring, Tunneling, and Micro-tunneling

In situations where sewers must be constructed more than 15’ (4.5 m) to 20’ (6 m) below ground surface (i.e. through embankments, under railroads, primary access roads, or where the A/E deems that conditions make it difficult or impractical to excavate open trenches) seek alternative methods to install the pipe. In these cases, pipe may be pushed, jacked, bored, tunneled, or micro-tunneled into place. A casing pipe will normally be required for sewers installed using these methods except for micro-tunneling in which rigid pipe is pushed, jacked, bored, or tunneled into place. A casing pipe will always be required to protect sewers under railroads and primary access roads. The void space between the sewer pipe and casing will be filled with special aggregates capable of being blown into place, or with commercially available polyethylene or other type spacers, saddles, and seals.

5.9.2.18 Sewer Anchoring

Large lines laid underwater or below the high groundwater level may have to be anchored, using saddles and piling or concrete, to avoid floating. Guidance from pipe manufacturers shall be used in designing anchoring systems.

5.9.3 Mission Critical Facilities for Sanitary Sewer

When the facility is classified as a mission critical facility, the following minimum on-site sanitary sewage storage shall be provided to facilitate the operation of the facility during natural disasters or other events that would preclude the normal disposal of wastewater. All storage volumes shall be based on the usable volume within the storage facility and the demand calculations contained in the *Physical Security and Resilience Design Manual*. Some VA projects are for an entire new campus (major project), while others are individual building additions (minor), or interior renovations. If the project is a major project with an entire new campus, then the sanitary storage requirements need to be for the entire campus requirements. If the project is a minor project, then the storage requirements will only be for the new building(s) unless the VA has the funds allowed and it is practical to expand the storage requirements to buildings outside the scope of the minor project.

The A/E shall provide for an allowance for infiltration in the collection system. This allowance shall be based on regional accepted values and the size of the collection system. The sanitary sewage storage shall be configured to be “off-line” (no through flow) during normal operation. The sanitary sewer collection system shall be configured to divert wastewater to the storage tank during emergency events. This diversion shall be readily accomplished without entering manholes or confined spaces.

If the sanitary sewer collection system, upstream of the sanitary sewage storage tank, conveys wastewater from non-mission critical facilities (non-essential) uses, the anticipated flow from such non-essential uses shall be added to the tank capacity.

Locate holding facilities to provide gravity flow from the mission critical facilities to the fullest extent possible. Shall lift stations be required, the pumping shall be designed with 100% redundancy and all pumps and controls shall be supplied with emergency power.

Locate the storage tank to facilitate access to the tank for removal of wastewater after the re-establishment of normal sanitary sewer conveyance systems.

The tank design shall provide access points, ventilation, and aeration of the wastewater. The facility shall also provide for a system to remove the wastewater from the tank. The disposal system shall be compatible with the requirements of the downstream public sanitary sewer collection system and wastewater treatment plant.

5.9.4 Sewage Pumping Equipment (Outside)

The location of pumping facilities within a service area will be based primarily on topographic considerations and the need to provide for future development. Pump stations will be located so that all points within the intended service area can be drained adequately by gravity sewers. Any planned development within the service area, such as construction of new buildings or modifications to existing ones, or any projected shifts in population and/or workforce shall be considered. Figures 5-3 and 5-4, on the next page, show two types of sewage pumping stations: one outdoor and one enclosed. The A/E shall confer with VA to determine which is preferred.

The pump station may be designed to meet future capacity requirements, but the physical location of the station is more critical as it cannot be moved. The following general guidelines shall be used for site selection of pumping stations:

- Pumping facilities will not be constructed beneath buildings, streets, roadways, railroads, or other major surface structures, to the maximum extent possible.
- Pump stations will not be located closer than 500’ (150 m) to buildings, or other facilities to be occupied by humans, unless adequate measures are provided for odor and gas control.
- The location of pumping stations will be made with proper consideration given to the availability of required utilities such as electric power, potable water, fire protection, gas, steam, and telephone service.

Figure 5-3

- It is common practice to set the maximum liquid level in the wet well equal to the 80-90 percent flow depth of the lowest incoming sewer. All pump stations will be readily available from an improved road. There must be no physical connection between a potable water line and a sewer system. Design the pumping system to discharge at maximum sewage flow rate with the largest pump not operating. Connect the pumping system to emergency power.

Figure 5-4

- Wet well shall be large enough to allow an interval of at least 6 minutes between successive starts of the same pump motor throughout the entire range of estimated flow rates. Include high water level alarm system in the wet well, and place warning bells in the boiler plant (energy center), operator's office, or other appropriate location.

5.10 Storm Sewer Systems

Design of separate underground storm sewage systems, including building roof leader connections, manholes, clean-outs, drainage inlets (yard and curb), open drainage channels, dry wells, etc., and all appurtenances. Storm drainage system shall serve all areas under construction or affected by construction.

5.10.1 Storm Sewer Design Requirements

When designing the storm sewer for the project site follow the following requirements:

5.10.1.1 Hydrologic and Hydraulic Evaluation

Provide a hydrologic and hydraulic evaluation for the drainage and storm sewer system. The requirements of the hydrology analysis are further detailed in Chapter 6 – Stormwater

Management. The hydrologic assessment shall be based on state or local standards and shall evaluate the 2, 5, 10, 50, and 100 year storm event.

5.10.1.2 Components of Storm Sewage System

Design all components of storm sewage system on basis of not less than 10-year storm frequency for one hour.

5.10.1.3 Off-Site Receptor of Storm Water Requirements

Comply with the requirements of the off-site receptor of storm water. Retention may be required. Roof storage of storm water is not allowed.

5.10.1.4 Sanitary Sewage Systems

Do not connect storm drainage systems to sanitary sewage systems.

5.10.1.5 Storm Sewer Pipes and Manholes under Pavement

To the extent feasible, do not locate sewer pipes and manholes under pavement. Provide manholes at junctions, changes in direction and changes in slope. Limit spacing between manholes to 300' (90 m), except in straight runs of long out-fall sewers, where 500' (150 m) of spacing is permitted.

5.10.1.6 Extra Strength Pipe

Indicate on drawings where extra strength pipe is required to support anticipated trench and superimposed loads.

5.10.1.7 Storm Sewer Size

Limit storm sewers to not less than 12" (300 mm) in diameter and roof leader connections to not less than 4" (100 mm) in diameter. Establish storm sewer slopes to provide minimum velocity of 2 ft/s (0.6 mm/s) when pipe is flowing full. Maximum storm sewer design velocity shall be in non-erosive range for specified pipe material.

Figure 5-5

5.10.1.8 Inverts at Structures

The A/E shall limit sedimentation getting into pipes at the structures. Structures shall have a collection area within the structure below the pipe inverts. In Appendix B, under Pre-Treatment practices, there is an example of a deep sump inlet. This methodology shall be incorporated at all drainage structures requiring them.

5.10.1.9 State or Local Standard Details

Use state or local standard details for manholes, inlets, end walls, and pipe cradles. Adjust Master Specifications as necessary.

5.11 Gas Distribution System

Coordinate with the local utility company in the project jurisdiction regarding gas metering and regulating equipment. In many instances, the local utility company will install or relocate gas lines. The A/E shall verify who is providing the gas line at the onset of the project. Provide a gas filter upstream of meter and cathodic protection system for all ferrous piping systems.

5.12 Oil and Gasoline Supply Systems

Provide oil and gasoline supply systems to serve emergency generators, vehicles, and equipment requiring fuel. Show tank, piping (from tank to building or tank to fuel dispensers), tank and piping monitoring, pumps, and dispensers on "W-Series" drawings. Tanks, piping, pumps, and monitoring are described in Master Specification 23 10 00, FACILITY FUEL SYSTEMS. Interior requirements for emergency generators shall be shown on electrical drawings and are described in Master Specification 26 32 13, ENGINE GENERATORS.

5.13 Fuel Storage Facilities

Above-ground or under-ground storage tanks (AST’s or UST’s) can be used for storage of fuel supplies. The design of Above-ground fuel storage regulations are outlined in *The American Petroleum Institute (API) Standard 650*. This standard outlines the regulations and requirements for welded steel tanks used for petroleum material storage. This standard established minimum requirements for material, design, fabrication, erection, and testing for vertical, cylindrical, above-ground, closed- and open-top, welded carbon or stainless steel storage tanks in various sizes and capacities.

5.13.1 Above-Grade Fuel Storage (AST’s)

Due to the legal regulations surrounding aboveground storage tanks from federal, state, and local governments, there are a number of requirements for AST’s even prior to the placement of the tank at its location. Some of the requirements include a Phase 1 site assessment (testing the site and surrounding areas for undiscovered environmental issues), a geotechnical investigation, a report on drainage issues, and an overview of permit compliance issues.

Figure 5-6

5.13.1.1 Storage Tank Design

The materials used in the design and construction of an above-ground fuel storage tank must be compatible with the fuel and must be able to withstand any temperature and pressure effects. There must be a containment area surrounding the storage tank that is capable of holding the entire capacity of the vessel. Tanks used for fuel storage shall be designed with high liquid level alarms and controls to avoid overfilling. A method (mechanical, electrical, or human intervention) to disable or divert supply pumps before overfilling is also a requirement.

5.13.1.2 Operation and Management

All low pressure or atmospheric pressure fuel storage tanks shall have vents to relieve any built-up vapors. The tanks shall be operated (filled) to 80 to 90 percent capacity to avoid overfilling or liquid expansion. Materials that require internal heating elements (usually using steam to heat) shall be closely monitored and checked to ensure that exhaust lines do not leak fuel into the steam and condensate lines which could end up in waste-water ponds.

5.13.1.3 Testing and Inspection

Above-ground fuel storage vessels must be regularly tested for structural integrity on a periodic basis. If any wear or damage is evident, repairs must be made. The frequency and type of structural integrity testing is based on the design and size of the tank. The use of hydrostatic, ultrasonic, and radiographic testing is required for nondestructive determinations of structural integrity. Records must be kept and personnel shall frequently examine the outer hull of the vessel for signs of leakage or damage.

5.13.2 Underground Storage Tanks (UST's)

UST's, used to store petroleum, are regulated in the United States to prevent release of petroleum and contamination of groundwater. The EPA has regulations for the underground storage of fuels. If UST's are to be utilized on the project, the A/E must follow the federal regulations contained in 40 CFR Part 280, 40 CFR Part 281 and 40 CFR Parts 282.50-282.105. Figure 5-6 shows an UST.

5.13.2.1 Tanks

Each tank must be properly designed and constructed, and any portion underground that routinely contains product must be protected from corrosion. UST's generally fall into four different types:

- Steel-aluminum tank, made by manufacturers in most states and conforming to standards set by the Steel Tank Institute.
- Composite overwrapped, a metal tank (aluminum/steel) with filament windings like glass fiber/aramid or carbon fiber on a plastic compound around the metal cylinder for corrosion protection and to form an interstitial space.

Figure 5-7

- Tanks made from composite material, fiberglass/aramid or carbon fiber with a metal liner (aluminum or steel)
- Composite tanks such as carbon fiber with polymer liner (thermoplastic).

5.13.2.2 Piping

The piping that routinely contains regulated substances and is in contact with the ground must be properly designed, constructed, and protected from corrosion.

5.13.2.3 Spill and Overfill Prevention Equipment

To prevent spilling and overfilling associated with product transfer to the UST system, owners and operators must use the following spill and overfill prevention equipment:

- Spill prevention equipment that will prevent release of product to the environment when the transfer hose is detached from the fill pipe (for example, a spill catchment basin); and
- Overfill prevention equipment that will:
    - Automatically shut off flow into the tank when the tank is no more than 95 percent full; or
    - Alert the transfer operator when the tank is no more than 90 percent full by restricting the flow into the tank or triggering a high-level alarm; or
    - Restrict flow 30 minutes prior to overfilling, alert the operator with a high level alarm one minute before overfilling, or automatically shut off flow into the tank so that none of the fittings located on top of the tank are exposed to product due to overfilling.

5.13.2.4 Facility

All tanks and piping must be properly installed in accordance with the manufacturer's instructions and EPA requirements.

5.13.2.5 Certification of Facility

All owners and operators must ensure that one or more of the following methods of certification, testing, or inspection is used to demonstrate compliance by providing a certification of compliance on the UST notification form in accordance with 40 CFR Part § 280.22.

- The installer has been certified by the tank and piping manufacturers; or
- The installer has been certified or licensed by the implementing agency; or
- The facility has been inspected and certified by a registered professional A/E with education and experience in UST system facility; or
- The facility has been inspected and approved by the implementing agency; or
- All work listed in the manufacturer's facility checklists has been completed.

5.13.3 Fuel Storage for Mission Critical Facilities

When a facility is classified as a mission critical facility, the following minimum on-site storage shall be provided to facilitate the operation of the facility during natural disasters or other events that would preclude the normal delivery of fuel: all storage volumes shall be based on the useable volume within the storage facility and the demand calculations contained in the *VA Physical Security and Resilience Design*. Some VA projects are for an entire new campus (major project), while others are individual building additions (minor), or interior renovations. If the project is a major project with an entire new campus, then the water storage requirements need to be for the entire campus supply. If the project is a minor project, then the storage requirements will only be for the new building(s) unless the VA has the funds allowed and it is practical to expand the storage requirements to buildings outside the scope of the minor project.

6 Stormwater Management

6.1 Overview

VA Facilities shall be designed in accordance with the Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act. This act requires federal agencies to reduce stormwater runoff from federal development projects to protect water resources.

Best Management Practices (BMP's) are the methodologies that the A/E will use during the design process to protect the waters of the United States from adverse impacts of development. Land development projects shall include measures to control peak runoff rates (attenuation), provide stormwater quality treatment, use of stormwater for groundwater recharge, and to provide for stream channel protection. This Site Design Manual will provide specific parameters for sizing BMP's to meet these objectives. The specific design requirements, performance specifications, and limitations of each of these BMPs need to be determined by a qualified professional A/E and must meet all local jurisdiction requirements.

The A/E must determine the local and state requirements for stormwater management in the project area. The design A/E shall follow the more stringent design between the Federal, State, and local requirements. In some jurisdictions, there is only a requirement to meet the attenuation and quality requirements. The requirements to be followed will be by a project by project basis. This manual will focus only on the BMP'S to manage stormwater attenuation and quality.

Stormwater management must be considered by the project team early in the process and throughout the design to make sure all requirements are being met and that there is adequate room on the site for the stormwater management BMP's.

6.2 Stormwater Attenuation

Managing stormwater attenuation is in essence developing the site plan or using BMP's to control the peak runoff rates leaving the site. The purpose of managing peak runoff rates is to address increases in magnitude of flooding caused by the proposed development. The stormwater attenuation regulations require the designer to make sure that the post-developed runoff flow rate is EQUAL TO OR LESS than the pre-developed (existing) runoff flow rate. The flow rates to be analyzed for specific storm periods will be defined by the local jurisdiction. The A/E shall analyze the pre-developed flow rate and then the post-developed flow rates using the methodology in EISA Section 438. If Option 2 is used, the A/E may use the Rational Method or TR-55 methodology to determine the runoff rates.

6.2.1 Pre-Developed Flow Rates

The designer shall analyze the project site as it exists before the project starts. The designer shall verify with the local, state, and federal regulatory agency for the project site to ensure the correct land coverage "C" value is used for the pre-developed condition. For instance, in some areas, the project site in the existing condition could be 80% paved. However, because the goal is to control and improve the effects of runoff, the regulatory agency may require that the project site be analyzed as it existed prior to the current developed area (i.e. as a prairie). The local jurisdiction's standard for "pre-developed" shall be used in lieu of the EISA Section 438 requirements unless the local does not have an adopted definition of 'pre-developed flow conditions'. If the local jurisdiction does not have an adopted definition, then the EISA Section 438 definition will apply. The designer shall use an approved hydraulic modeling program to study the entire site's drainage system and the amount of flow leaving all the outlets on the project site.

6.2.2 Post-Developed Flow Rates

The project team shall work together in the early site planning phase to reduce the impact of the development on the site runoff. This focuses on reduction in the amount of paving and impervious surfaces through more efficient parking layout, building footprint reduction, green roofs, and the use of alternative paving surfaces such as pervious concrete, permeable block paving, etc. The post-developed analysis is based on the final site layout plan for the site and all the proposed surface coverings. The proposed storm sewer system shall have the same outlets as the pre-developed systems and the hydraulic modeling program shall study the proposed drainage system and what the flow rate is at the outlets in the final developed condition. If the post developed rates at the site outlets are greater than the pre-developed conditions, the A/E shall use BMP's to manage the additional runoff. To control peak rates, attenuation facilities are designed to store run off and release it over an extended period, in order to control the release rate to pre-developed levels.

6.3 Stormwater Quality

The A/E is responsible for designing methods of treatment to remove pollutants from stormwater on all new developments or re-developments that disturb over 5,000 square feet of space as discussed in the *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act, 2007*.

The Water Quality Volume (WQV) is the amount of stormwater runoff from a rainfall event that shall be captured and treated to remove the majority of stormwater pollutants on an average annual basis. The targeted pollutants are sediment, nutrients, trash, metals, bacteria, oil and grease, and organics. Each state, county, and local jurisdiction will have requirements of how to determine the WQV that the local A/E needs to design for.

6.4 Stormwater Management Plan

The A/E will be responsible for preparing a stormwater management plan that will be submitted to the regulating authority. The stormwater management plan is a report that contains a summary of the drainage system for the site in pre-developed conditions and post-developed conditions. The report will contain all the calculations for the pre- and post-developed runoff rates as well as the methodologies used to handle the attenuation and quality requirements.

6.5 Best Management Practices (BMPs)

The A/E has a wide array of BMPs to choose from in order to meet the specific management objectives (such as attenuation and water quality treatment) for each specific project. The selection of BMPs will also be determined by site specific factors such as land use, physical feasibility, watershed resources, community and environmental factors, and operation and maintenance considerations. A/E shall advise VA of the benefit and cost impacts if any of these BMP is included in the design.

BMPs can be classified according to whether they are non-manufactured or manufactured controls. Non-manufactured controls are controls that are available to the general public:

- Green Roofs
- Stormwater Ponds
- Stormwater Wetlands
- Infiltration Practices
- Filtering Practices
- Treatment Swales

Manufactured controls are patented devices that are purchased from a vendor. Examples are: Water Quality Inlets and Hydrodynamic Separator & Oil/Particle Separator. Some local jurisdictions do not allow manufactured controls. Prior to all new developments, it is the responsibility of the A/E to determine which controls are allowed within the local jurisdiction.

The following sections are not intended to be all inclusive. They provide the A/E with ideas and descriptions of the more common BMP treatment types. Selection, design and sizing of the various BMP's shall be developed on a case-by-case basis and supporting calculations provided to the VA Project Manager. Inspection and maintenance requirements are necessary to verify that each treatment control BMP performs efficiently throughout its design life. The A/E shall inform the VA of the responsibility of maintenance and what each BMP requires. All the BMP practices described below are further defined and shown in Appendix B.

6.5.1 Green Roofs

A green roof is a building roof that is partially or completely covered with vegetation and soil, or other type of growing medium. It can be applied to new construction or retrofitted to existing construction. A typical green roof includes vegetation planted in a substrate over a drainage layer and a root barrier membrane. Some green roofs are equipped with stormwater detention tanks with a recirculating system that allows for watering of the media during dry periods.

Figure 6-1

6.5.2 Stormwater Ponds

Stormwater ponds are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season) and differ from constructed wetlands primarily in having a greater average depth. Stormwater ponds are impoundments designed to collect, detain and release stormwater runoff at a controlled rate. They provide treatment through the use of a permanent pool, which helps settle solids and associated pollutants. Extended detention features can be incorporated into stormwater ponds by combining permanent micro pools or other permanent pool storage with an extended drawdown time of the water quality volume. Wet ponds are among the most widely used stormwater practices.

Figure 6-2

In addition to water quality benefits, by providing additional storage capacity and a multi-stage outlet structure, stormwater ponds can also be designed to provide flood control.

6.5.3 Stormwater Wetlands

Stormwater wetlands are constructed depressions or impoundments designed to function similar to natural wetlands. However, unlike natural wetlands, stormwater wetlands are designed specifically to treat stormwater. Direct discharge of stormwater to natural wetlands is prohibited due to critical impacts to wetland hydrology and potential habitat degradation. Wetlands are among the most effective stormwater practices in terms of pollutant removal and they also offer aesthetic value.

Figure 6-3

Stormwater wetlands are similar to stormwater ponds in that the design includes a permanent pool of water. However, the retained pool is designed with varying depths to support a wetland plant community. In addition to the settling processes that occur in the permanent pool, stormwater wetlands provide pollutant removal/uptake by vegetation and by other biological activity supported within the wetland environment. In some stormwater wetlands, such as “gravel wetlands,” the systems provide filtration, as well.

6.5.4 Infiltration Practices

Infiltration practices are designed to capture and temporarily store the water quality volume of stormwater while it infiltrates into the soil. Infiltration practices help to recharge groundwater, but must be designed and maintained to avoid clogging and system failure. Pollutants are removed through adsorption of pollutants onto soil particles, and biological and chemical conversion in the soil.

Figure 6-4

Infiltration practices differ from filtering practices in that stormwater is infiltrated through native soil and allowed to recharge groundwater, while filtration practices typically employ non-native soil materials or other media, and may use underdrains to convey the filtered water to discharge.

Infiltration BMPs can be suitable for treating runoff from drainage areas (ranging up to 50 acres in size for infiltration basins) where subsoils, groundwater conditions, and depth to bedrock are appropriate.

6.5.5 Filtering Practices

Filtering practices treat stormwater runoff by capturing and passing the water quality volume through a bed of sand, other soil material, or other acceptable treatment media to remove pollutants from the water. Sediments and other pollutants are removed by physical straining and adsorption. Filters can be constructed using common materials, or proprietary systems using various filter media can be employed. Filtration BMPs have shown to be very effective at removing a wide range of pollutants from stormwater runoff, particularly when organic soil filter media have been used.

Filtering practices differ from infiltration practices in that the stormwater filters through an engineered filter media, rather than native soil. However, filtering practices can be constructed in combination with infiltration practices, where the filtered water is discharged into the ground beneath the BMP.

Alternatively, filters can be designed with an underdrain to collect the treated water and convey it to discharge. Underdrain filters can be lined to isolate the filters from the adjacent soil material or underlying groundwater.

6.5.6 Treatment Swales

Figure 6-5

Treatment swales are designed to promote sedimentation by providing a minimum hydraulic residence time within the channel under design flow conditions (Water Quality Flow). This BMP may also provide some infiltration, vegetative filtration, and vegetative uptake. Conventional grass channels and ditches are primarily designed for conveyance. Treatment swales, in contrast, are designed for hydraulic residence time and shallow depths under water quality flow conditions. As a result, treatment swales provide higher pollutant removal efficiencies. Pollutants are removed through sedimentation, adsorption, biological uptake, and microbial breakdown.

Treatment swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Treatment swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems. Therefore, swales are best suited for areas with low flows.

Treatment swales also differ from practices such as underdrained swales (for example, “dry swales” and “bioretention swales”), which are essentially filtration practices, and “wet swales,” which are similar in function to pocket ponds.

6.5.7 Pre-Treatment Practices

Pre-Treatment facilities can reduce the amount of sediment accumulations in the primary treatment devices. See Appendix B for examples the A/E may use for pretreatment practices.

7 Erosion and Sediment Control

7.1 Overview

This chapter addresses the protection of water quality through the implementation of construction phase erosion and sediment controls. In addition to the federal and state requirements, local zoning, site planning, and development requirements may also include provisions for site management during project construction to prevent impacts from erosion and sedimentation. The A/E must follow the most stringent requirements of the project location.

7.2 National Pollutant Discharge Elimination System Program (NPDES)

The Clean Water Act authorized the US EPA to regulate point sources that discharge pollutants into waters of the United States through the National Pollutant Discharge Elimination System (NPDES) permit program. The program regulates "point sources" generated from a variety of municipal and industrial operations, including treated wastewater, process water, cooling water, and stormwater runoff from drainage systems. It also regulates discharges associated with construction activities under the NPDES Construction General Permit (CGP).

The CGP is the primary federal permit involved in land disturbance activities for VA projects. It is required for construction activity that disturbs one or more acres of land. If the construction activity creates less than one acre of disturbance, but is part of a larger common plan of development totaling over one acre of disturbance, a permit is needed. It is important to note that the one-acre threshold is for the total disturbance and does not need to be a contiguous (or connected) disturbed area to be included in the total disturbance.

EPA defines "construction activity" to include clearing, grading, excavation and other land disturbance activities related to projects such as landscaping, demolition, and building office buildings, roads and other development activities. To obtain coverage under the NPDES CGP, the "Operator" of a construction site must file a notice of intent (NOI) with the EPA, and must prepare a Storm Water Pollution and Prevention Plan (SWPPP) to govern construction activities. The SWPPP must address the management of site activities that could result in pollution of receiving waters. Thus, erosion and sediment controls comprise key components of the SWPPP. The A/E must verify who is preparing the SWPPP on a project by project basis. In most cases, the applicant is the VA and the SWPPP will be prepared by the A/E on behalf of the VA.

Note the NPDES CGP was originally issued in 2003 and re-issued in 2008. The 2008 CGP is issued for only two years to allow for modifications when construction activity effluent limitation guidelines become available. For more extensive information about this permit, who must apply, permit forms and procedures, and the specific requirements for the SWPPP, interested persons are referred to the following US EPA website:
https://www.epa.gov/npdes.

7.3 Erosion and Sediment Control Strategies

Successful erosion and sediment control depends on clear coordination of construction activities and a commitment by all project and construction staff to work responsibly. The goal of erosion control is to minimize environmental impacts and long-term maintenance and repair costs by:

- Reducing the loss of soil on a site,
- Reducing sedimentation,
- Reducing suspended solids in waterways and water bodies, and
- Preventing slope failure and structural damage.
- Methodologies must be in place that deter the excessive creation of dust in the atmosphere must be implemented.

Key strategies for successful Erosion and Sediment Control that the A/E must consider throughout the project are as follows:

- Minimize the disturbance of existing soil, topography, and vegetative cover;
- Stabilize soils that have been disturbed and control the path and velocity of runoff to protect disturbed or exposed areas;
- Deflect or filter wind in areas vulnerable to wind-related erosion;
- Reduce the amount of sediment entering or accumulating in waterways and drainage structures;
- Plan ahead and phase project to address stormwater issues and construction implementation throughout the project;
- Recognize nearby sensitive areas;
- Match erosion control strategies with construction activities;
- Understand the characteristics of site soils (i.e., potential to create off-site turbidity) and limit the amount of soil disturbance at any one time;
- Divert, dispense, and direct water run-on away from construction activity areas and toward stabilized areas; and
- Divert, disperse, and directed treated stormwater run-off from construction areas to stabilized natural upland areas wherever possible. Management of off-site discharges shall be performed in a manner to avoid localized flooding or impacts to adjacent properties.

7.4 Erosion and Sediment Control Plans

The A/E shall prepare field documents that shall be used by the Contractor. The documents shall clearly identify the erosion and sediment control measures to be used, where they will be located, how they will be constructed, and how they must be maintained.

7.4.1 Erosion Control Best Management Practices (BMPs)

Erosion control occurs with natural weather occurrences from wind and rain. It is the eroding of the exposed ground cover during construction activities. Erosion control BMP’s are methods that the Contractor shall be responsible for during the construction phase of the project. It is the A/E’s responsibility to provide a SWPPP plan that addresses the Erosion Control BMP’s. The BMP’s listed are not all inclusive.

7.4.1.1 Construction Phasing

Proper construction phasing reduces the exposure of slopes to runoff and potential erosion issues, provides for stable temporary or permanent slopes, and facilitates the establishment of vegetation. The A/E shall consider phasing of the project in preparation of the SWPPP.

7.4.1.2 Dust Control

Typical dust control measures that shall be indicated on the SWPPP include traffic control; Construction phasing; and maintenance of existing vegetation to limit exposure of soils and prevent conditions that result in dry soils and dust; application of water, calcium chloride, and temporary stabilization practices to control mobilization of dust by equipment operation or wind; and pavement sweeping to prevent accumulation of dust-producing sediment.

7.4.1.3 Grading Practices

The SWPPP shall identify grading practices such as surface roughening.

7.4.1.4 Soil Stockpile Practices

The A/E shall locate stockpile locations on the SWPPP plan. The stockpiles shall be sited to be in compliance with all permit conditions governing setbacks from adjacent property liens and water resources. Stockpile practices apply to the following:

- Topsoil,
- Excavated materials,
- Borrow materials imported to the site, and
- Construction aggregates and paving materials that area stockpiled on the site prior to use in the construction work.

7.4.1.5 Temporary and Permanent Mulching

The A/E shall consider mulching for erosion control as it is the quickest and most cost-effective method of preventing erosion. The choice of materials for mulching shall be based on site conditions, soils, slope, flow conditions, and time of year. Types of mulch are:

- Hay or Straw Mulch,
- Wood Chips or Bark,
- Erosion Control Mix,
- Erosion Control Blankets and Mats.

7.4.1.6 Vegetation

The A/E shall show the temporary and permanent vegetation (i.e. seeding) BMP’s on the SWPPP. Temporary vegetation shall be used in sensitive areas such as pond and lake watersheds, steep slopes, and streambanks. Typically, temporary vegetation is required for disturbed areas void of construction activities for 14 days. Permanent vegetation shall be installed as soon as grading operations are finalized. The seed and fertilizer mixtures shall be noted on the SWPPP and be relevant to the geographical location of the project.

7.4.1.7 Temporary Erosion Control Blanket

Erosion control blankets shall be shown on any slope that is greater than 6:1 (horizontal to vertical). An approved seed mixture is required to be installed with the erosion control blanket.

7.4.1.8 Diversion

The A/E shall show on the SWPPP where diversions and temporary channels shall be constructed across the project site to intercept runoff and direct it to a stable outlet or to a sediment trapping facility.

7.4.1.9 Slope Drain

Slope drains are flexible pipes extending from the top to the bottom of a cut or fill site. The A/E shall show where these are to be located.

7.4.2 Sediment Control Best Management Practices (BMPs)

Sediment control BMPs are methods the A/E will specify that will prevent the movement of sediments through the project site during construction. The sediment controls for each project will be shown on the SWPPP that is prepared by the A/E. General sediment controls are described in detail in Appendix C. These controls are not all inclusive. There are many new products on the market for sediment control. The A/E must choose a BMP that has three equal counterparts if specifying a particular product.

7.4.2.1 Silt Fence

Silt fence is a temporary sediment barrier consisting of filter fabric attached to supporting posts and entrenched into the soil. This barrier is installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Figure 7-1

7.4.2.2 Straw or Hay Bale Barrier

Straw and hay bale barriers are a type of temporary sediment barrier installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

7.4.2.3 Erosion Control Mix Berms

An erosion control mix berm is a trapezoidal berm that intercepts sheet flow and ponds runoff, allowing sediment to settle, and filtering sediment as well. They are an environmentally sensitive and cost-effective alternative to silt fence. An alternative to a simple erosion control mix berm is a “continuous contained berm”, consisting of erosion control mix compost encapsulated in a mesh fabric (or “filter sock”).

7.4.2.4 Temporary Check Dam

Temporary check dams are small temporary dams constructed across a swale or drainage ditch. Check dams are used to reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch.

7.4.2.5 Temporary Storm Drain Inlet Protection

A storm drain inlet protection is a sediment barrier installed around a storm drain drop inlet or curb inlet to reduce sediment discharge. The sediment barrier may be constructed of gravel and wire mesh, or concrete blocks and gravel. Sediment removal is accomplished by shallow ponding adjacent to the barrier and resulting settling of the sediment particles. If turbid water is being directed to this structure and that water does not continue to a sediment trap or basin, alternative solutions for treating the water shall be evaluated upslope of the catch basin.

7.4.2.6 Temporary Construction Exit

A stabilized construction exit consists of a pad of stone aggregate placed on a geotextile filter fabric, located at any point where traffic will be leaving a construction site to an existing access road-way or other paved surface. Its purpose is to reduce or eliminate the tracking of sediment onto public roads by construction vehicles. This helps protect receiving waters from sediment carried by stormwater runoff from public roads.

7.4.2.7 Temporary Sediment Trap

A sediment trap is a small, temporary ponding area to intercept sediment-laden runoff from small disturbed areas. Intercepted runoff is retained long enough to allow for settling of the coarser sediment particles. A sediment trap is usually installed in a drainage swale or channel, at a storm drain or culvert inlet, or other points of discharge from a disturbed area.

7.4.2.8 Temporary Sediment Basin

A sediment basin is a water impoundment constructed to capture and store sediment and/or debris. Sediment is removed by temporarily storing sediment-laden runoff, allowing time for the sediment particles to settle. In some instances, settling may be enhanced by the introduction of flocculants (see separate description of the Flocculants Best Management Practice).

7.4.2.9 Construction Dewatering

This construction dewatering practice is intended to prevent sedimentation associated with the management of water removed during construction from excavations, cofferdams, and other work areas that trap stormwater and groundwater.

8 Landscape Design

8.1 Overview

The landscape design for a VA facility shall support, accommodate, and respect the medical mission and function of the facility. Landscapes on VA facilities shall be designed to be accessible and safe for patients, have seasonal interest, and provide areas of respite.

This design manual provides guidance when constructing new, or rehabilitating existing, owned or leased facilities or when landscaping improvements are otherwise planned.

8.2 Sustainability

VA is required by law and regulation to implement sustainable practices. Refer to the *VA Sustainable Design Manual* for instructions that apply to landscaping and site development.

8.2.1 Water

Conserving and protecting water resources through water efficiency, reuse, and stormwater management are vital to the goals of sustainable landscape practices. Integrating facility design with landscape design can conserve water, reuse wastewater and greywater, harvest and use rainwater and snowmelt, reduce energy use, and protect and restore surface and ground water resources. The A/E shall consider the following site design principles to address protection and conservation of water resources:

- reduce or eliminate use of potable water for landscape irrigation and water features;
- manage storm water on-site to the extent practicable while protecting ground and surface receiving waters and ecosystems;
- design water features to use harvested runoff or snowmelt and avoid use of potable water;
- protect and enhance on-site water resources such as streams, lakes, and wetlands;
- protect riparian and shoreline buffers; and
- rehabilitate ecosystem functions of aquatic resources on-site.

8.2.2 Soils

Soils are complex, dynamic, living systems with both biological and non-biological components. On Greenfield sites, and elsewhere, the site design shall include plans for on-site soil salvage prior to construction. Wherever possible, balance cut and fill, and reuse existing soils in design instead of importing new materials to the site. Where feasible, the A/E shall consider the following design practices.

8.2.2.1 Soil Conservation

As feasible, healthy soil shall be conserved by mapping soils on site, performing tests of disturbed soils and reference soils, conserving the healthiest soils in topsoil salvage areas, and limiting work to appropriate sites for building construction.

8.2.2.2 Prevent Soil Compaction

Vegetation Soil Protection Zones (VSPZ's) shall be considered as a method to avoid soil compaction during construction and maintenance.

8.2.2.3 Soil Management

Creating and following a management plan that identifies areas of highest soil quality, limits damage to those soils, protects salvaged topsoil, and facilitates restoration of desired conditions for soils that are damaged.

8.2.3 Vegetation

When addressing vegetation issues as part of sustainable landscape practices the A/E shall consider the following design considerations:

8.2.3.1 Prevent, Detect, Control, and Manage Invasive Plants

As feasible, identify and remove all invasive species on site and develop and implement an active management plan to prevent new introductions. If invasive non-native plants are to be maintained for historic reasons, they must be actively managed so that they do not spread or cause harm to the region.

8.2.3.2 Use Appropriate, Non-Invasive Plants

Plants/seeds that are appropriate for site conditions, climate, and design intent and are nursery grown, legally harvested, or salvaged for reuse shall be used.

8.2.3.3 Use Native Plants

Where practicable, use vegetation native to the ecoregion.

8.2.3.4 Protect and Preserve All Vegetation Designated as Special Status

Identify, protect, and preserve all vegetation designated as special status by local, state, or Federal entities and protect using VSPZ methods.

8.2.3.5 Use Vegetation to Minimize Building Heating Requirements

Windbreaks for buildings shall be established to effectively block wind, but also not result in winter shading. Staggered rows of trees and dense shrubs that extend for the full length of the building's walls facing the prevailing winter wind shall be considered. Vegetation that is strategically placed can lower energy use associated with indoor climate control.

8.2.3.6 Use Vegetation to Minimize Building Cooling Requirements

Vegetation and/or vegetated structures shall be placed in strategic locations to shade buildings during the cooling season, thereby reducing energy consumption associated with indoor climate control. Deciduous vegetation or vegetated structures can shade surface areas of the west, southwest, southeast, and east walls and the roof area during summer months.

8.2.3.7 Reduce Urban Heat Island Effects

Use vegetation to reduce heat island effect, minimizing effects on microclimate. Design options other than vegetative shade include, covering structures with solar photovoltaic panels, vegetated roofs, and/or surfaces with a solar reflectance index (SRI) of at least 29; using paving materials with an SRI of at least 29; and using an open-grid pavement system (e.g. concrete-grass lattice).

8.2.3.8 Reuse Salvaged Materials and Plants

Salvaged materials and appropriate plants (where feasible) shall be reused to conserve resources and avoid sending useful materials to a landfill.

8.2.3.9 Maintain Existing Historic Landscapes and Plantings

Existing plantings and landscapes shall be maintained if they are historic in their existing form and/or protect historic properties, extend the life cycle of existing stock, conserve resources, and reduce waste. In some cases, invasive plants may have cultural or historic value and are appropriate to be used in a new design, but shall be actively managed to prevent spread.

8.2.3.10 Use Vegetation to Promote Community/Employee Morale and Well-Being Activities

Rooftop gardens, community gardens, and vertical gardens inside or outside of buildings, adjacent or connecting to the landscape shall be considered in order to promote educational programs, food access, and gardening activities for morale and community engagement.

8.2.4 Human Health and Well-Being

Incorporating natural systems and garden settings shall be a goal for integrated site design. Knowledge about the microclimates of a space (where and when the sun hits, amount of rainfall, the natural water levels, soil types, wind, and exposure to sound and light pollution) can be used by the A/E to achieve ecological design goals, enhance human comfort, and provide a restorative setting. For instance, rain gardens for stormwater management can be designed to create a social space, or a roof garden can serve as a break room. Other human health considerations shall include access to transit as well as promotion of the ability to walk to and around the site.

When addressing human health issues as part of sustainable landscape practices the A/E shall consider the following:

8.2.4.1 Increase User Ability to Understand and Safely Access Outdoor Spaces

Wayfinding shall be implemented to create an environment that makes it easy and intuitive for all users to orient themselves and navigate from place to place.

8.2.4.2 Encourage Outdoor Activities

On-site opportunities shall be provided to encourage community gardening as well as support services, such as emergency call boxes, and safety lighting. To the extent possible, on-site systems, such as trails and paths, shall be connected to local and regional systems and access to parks and open space within 0.25 mile.

8.2.4.3 Create Quiet Outdoor Spaces for Relaxation and Restoration, Small Group Interaction, and Views

Where possible seating areas with unique or beautiful views and minimal noise shall be provided, while taking into consideration an understanding of the microclimate and other site-specific conditions (e.g., sun, shade, wind, etc.). In addition, outdoor gathering spaces shall accommodate groups for the purpose of building community and improving social ties.

8.2.4.4 Views from the Outdoors from Indoors

In locations where patients may be spending considerable amounts of time, such as patient rooms, Domiciliaries, Community Living Centers, or even waiting rooms, view to the outdoors can be very therapeutic. The exterior landscape shall be designed with those patients in mind, as in some cases, these views are the only exposure to nature they may enjoy. Consequently, it is imperative that their interests and needs are taken into account when planning the design.

8.3 Landscape Plan

The landscape plan shall reflect the needs of a healthcare environment. It shall be aesthetically pleasing, reflect seasonal changes, be safe for patients, and be easily and inexpensively maintained. The landscape design shall provide a framework for the natural environment, in lieu of a framework for the building. This is the phase of facility development process where landscape elements are integrated with or into the facility to complete the project. Adopt a landscape theme based on the regional character and historical and cultural significance of the facility.

8.3.1 Landscape Design Guidelines

The basic principles of quality landscape design apply to all projects. The following are a few of the guidelines to be employed:

General Design Guidelines:

- Use hardy, regionally native or naturalized plant materials when possible.
- Create design solutions that minimize adverse impacts on the natural habitat.
- Prevent pollution by reducing fertilizer and pesticide requirements: use integrated pest management techniques, recycle green waste, and minimize runoff throughout the design process.
- Preserve and enhance existing natural landforms and vegetation.
- Maximize low maintenance landscapes.
- Maximize the use of water-efficient plant material.
- Install standardized, water-efficient irrigation systems.
- Employ foundation planting to visually anchor facilities to the ground plane.
- Ensure planting plans respond to energy conservation concerns.
- Screen undesirable elements.
- Group trees to visually separate areas from heavy traffic or other functional uses.
- Use mass plantings, berms, and architecturally compatible fencing as screens and buffers.

- Combine massing of trees and shrubs with fencing and signage to create attractive and interesting entries.
- Select plan materials to attract appropriate wildlife.
- Reduce building mass through use of foundation plantings and varying tree heights.
- Use thorn-less and non-toxic plant material near sitting areas.
- Screen incompatible elements such as chain-link fenced service, storage, utility, loading, delivery, and mechanical areas from view with architectural walls or dense evergreens if exposed to public traffic or people-intensive uses.
- Use site amenities that are durable, well-constructed, and vandal-resistant.
- Design irrigation systems to minimize opportunities for vandalism to key components such as controllers and backflow preventers.

8.3.2 Parking Lot Landscaping

The green space within parking lots shall be designed as per the *VA Parking Design Guide*. Other design considerations are:

- Parking lot landscaping shall include trees in parking medians between aisles or ends of parking rows, as shown in Figure 8-1. The trees shall be planted at the appropriate distances for the mature trees to create shade and to mitigate the heat effect of large parking areas.
- Landscape treatment of parking areas shall always consider mowing and snow removal requirements to avoid the potential of increased long term maintenance;
- Grass shall not be planted in parking medians.

Figure 8-1

- Minimize the use of medium to tall shrubs on internal curbed parking islands to preserve vehicle sightlines;
- Integrate regionally native groundcovers and small shrubs at island ends to add interest while maintaining visibility of pedestrians and vehicles;
- Care shall be taken so trees planted in parking islands do not block the view of oncoming traffic at aisle and drive intersections. No tree or other plant capable of growing taller than 30” (750 mm) shall be located within the view triangle of parking aisles to drive aisles and of drive aisles to streets.

For healthy plant growth within parking lots, it is important to provide adequate space for root growth and protecting the roots from cars. Pervious areas around trees shall have a minimum total width of 10’-0” (3 m) and provide for a separation from the outside of the mature trunk to pavement of at least 5’-0” (2 m). For healthy plant growth, it is imperative to protect vital plant components - roots, trunks, and leaves.

8.3.3 Tree Selection Criteria in Parking Lots

Trees do the most to improve the aesthetics of parking areas. There are reasons to avoid using some species and reasons to select others.

8.3.3.1 Trees to Avoid:

- Large-leafed deciduous trees like some maples that can clog drains and make walking hazardous;
- Trees with messy fruits or berries, like the female gingko, olive, or mulberry;
- Brittle-limbed species such as the Siberian elm, eucalyptus, or poplar;
- Trees susceptible to insects and diseases such as American elm, birch, hawthorn, and mountain ash;
- Short-lived trees such as Lombardy poplar, Arizona ash, and willow; and
- Trees that can damage pavements such as Norway maple, silver maple, and sycamore.
- Sap-producing trees

8.3.3.2 Trees to Select:

- That cast medium to dense shade in summer;
- Have normal lifespans over 60 years;
- That thrive in pollution and direct and indirect heat of a typical urban environment;
- That demonstrate salt and deicing compound tolerance such as red oak, white oak, and red cedar;
- Which require little pruning and are structurally sound; and
- Which are resistant to insects and diseases.

8.3.4 Concentric Plant Zones

The planting design for outdoor environments is based on site use patterns. Each project area will likely include three concentric zones of plant and landscape material intensity; an Inner Zone, an Intermediate Zone and an Outer Zone. The concentration of plant and landscape materials with similar maintenance and irrigation requirements will simplify the planting design and the economics of the facility, maintenance and irrigation practices. Three plant zones are discussed below:

8.3.4.1 Inner Zone

The Inner Zone of a planting design is the area closest to the facility with the most intense level of visibility, appearance, image, and use. The Inner Zone shall include the use of deciduous and coniferous plant materials; flowering trees and shrubs; perennials, annuals and ground covers. Low water irrigation may be provided in this zone.

8.3.4.2 Intermediate Zone

Plants shall be less intensive in the Intermediate Zone and the plant grouping/spacing requirements for plant materials shall increase. No irrigation shall be provided in this zone.

8.3.4.3 Outer Zone

The Outer Zone of a planting design is generally characterized as the area most distant to the facility with the least intense level of landscape development, using plants with the lowest water and maintenance requirements and the lowest level of human use. This zone will consider a greater increase in plant grouping/spacing requirements for plant materials; where, once established, plant and turf selections require little to no irrigation and maintenance with the exception of weed control and occasional pruning. Plant materials shall be specifically selected for plant hardiness and extremely low water requirements.

8.3.5 Plant Selection

Selected plant material shall be chosen with the following characteristics:

- Hardy and relatively pest-free;
- Regionally native, indigenous, or naturalized plant material; and
- Minimal maintenance, appropriate length of life, and irrigation requirements - Plants that can thrive without supplemental water after establishment are highly desirable. Certain plants exhibit characteristics that create a need for maintenance and attention. For example, the Century plant, a saw-tooth bladed agave, grows to immense size only to bloom in a few years and die. Mexican fan palms require specially trained personnel and equipment to remove palm fronds as the plant matures. Designs shall consider all these fixed, long term costs during the plant selection process.

8.4 Other Landscape Design Elements

8.4.1 Healing Gardens

VA encourages the use of Healing Gardens to foster healing. Healing Gardens shall be formalized with specific scheduled health strategies as a part of the design, such as gardening, teaching, or group therapy, or be created for informal, unscheduled healing uses. The medical staff shall define the uses for formal Healing Gardens. Informal Healing Gardens shall have an emphasis on the following:

Figure 8-2

- plant seasonal color,
- visual and touchable texture,
- variety,
- seating,
- provide a variety of views,
- are attractive to appropriate wildlife,
- be safe,
- provide plant scents and natural sounds,
- and have locations for individual patient privacy as well as small intimate group/family gatherings

The gardens shall be designed to accommodate various disabilities, including mobility, sight, hearing impairment, and mental health patients. Healing Gardens shall not be designed as elements to reflect the building architecture, but gardens in the true sense of the word. These outdoor spaces shall include adequate locations for seating spaced at reasonable distances so that mobility impaired patients can rest, and have adequate seating in shady and sunny locations, the type and amount depending on climatic conditions. Annuals, perennials, bulbs, flowering plants, ornamental grasses, and other seasonal plantings shall be considered for these locations.

The Architect/Landscape Architect shall coordinate the healing garden design, program and scope of passive and/or active therapeutic and rehabilitation activities with the Medical Staff.

Landscape design elements of the healing garden are used to exercise the sensory perception, minds and bodies of garden visitors. These landscape design elements to consider for Healing Gardens include:

8.4.1.1 Plants

Plant and landscape material selections are key. They provide form, texture, color, fragrance, seasonal change, life cycles and an environment for wildlife.

8.4.1.2 Accessibility

Easy access to garden areas for all visitors is essential to design. Ensure garden components, such as walkways and sitting areas, allow for wheelchair and assisted-care accessibility. Easy access for all is an essential design component. All paths and patios shall have a maximum slope of 2% in any direction. Avoid sharp color transitions or variations in surface texture that could confuse patients or cause difficulty in moving wheelchairs or walkers.

8.4.1.3 Walks and Sitting Areas

Walks and sitting areas shall provide opportunities for movement, rehabilitation and rest, observation and conversation, and the experiences of fresh air, sunlight and shade.

8.4.1.4 Sun/Shade

Walks and sitting areas shall offer opportunities in sunlight and shade through the use of plant materials, shade screens and/or shelters.

8.4.1.5 Therapeutic and Rehabilitation Options

Garden features and feature locations within the garden can be goal oriented relative to memory, strength development and travel distance. Healing gardens shall provide a sanctuary for meditation or quiet reflection and therapeutic elements such as:

- gardening;
- observations of seasonal change;
- birds or butterflies; and
- rehabilitation challenges; such as, textured walk surfaces, ramps and stairs, walking with a cane, walker, prosthetic or use of a wheelchair.

8.4.1.6 Water features

Water features can provide additional sights and sounds and/or quiet reflection.

Healing garden designs and selected garden materials shall also consider requirements for budget, maintenance, irrigation and sustainability. Healing Garden locations and types include entry, atrium, courtyard, green roof and viewing gardens.

8.4.2 Turf Grass

Extreme care must be taken when specifying turf grass varieties. They are the most expensive plant type in the landscape to establish and maintain and take a lot of water to sustain. Some of the significant issues to consider when selecting turf grass varieties for the facility include:

- Irrigation requirements
- Exposure
- Wear tolerance
- Mowing heights
- Fertilizer requirements

Consult local county extension agents or reputable nursery employees for specific information on the proper variety of turf grass for the facility. Turf grass shall be minimized and if they are used shall not be irrigated. Mowing shall be minimized for steep slopes.

8.4.3 Maintenance

The design shall incorporate low maintenance considerations in the design strategy, considering the need for weeding, pruning, water/irrigation, mowing, pest management, mulching, etc.

8.4.4 Site Security

Landscape design shall play an integral role in the site security design. In some cases, appropriate planting can be an effective barrier. The A/E shall reference the *VA Physical Security & Resiliency Design Manual* when designing the landscape features for the site. Choose plants to either open lines of sight, create barriers, screen views and direct the movement of people. In sensitive areas, planting design must closely coordinate with security.

8.4.5 Existing Trees and Other Vegetation

The VA values mature existing vegetation. Existing trees, forests, wetlands and detail plant and landscape features are important resources and visual assets that shall be preserved and enhanced for functional and aesthetic reasons. Special care shall be given in the specifications to assure that adequate protection is given to the roots and bark of mature existing trees during construction activities. Site analysis and planting design shall identify, retain and protect mature trees and vegetation, wherever reasonably possible.

Preservation of trees involves protecting as much of the root zone out to the drip line as possible. The ideal strategy to achieve this is to leave the root zone entirely uncompacted and unpaved; however, this may be difficult in an urban area. If the root zone must be paved over, the existing grades around the tree shall be disturbed as little as possible and drain openings shall be provided in the pavement to allow air to circulate in the root zone. If the root zone is damaged, the crown of the tree shall be pruned to reduce the demand for nutrients and water.

Preservation considerations shall include plant location, health and condition; site and design analysis; historical significance; and economic impacts on plant preservation, replacement plants and maintenance.

8.5 Xeriscape

The use of Xeriscape techniques shall be used as often as possible to conserve water and energy through creative and adaptive landscape design and plant selection practices.

Figure 8-3

The concept of budgeting water use in the landscape is integral to xeriscape design. Concentrating plants with similar water-use requirements or creating hydrozones, simplifies and economizes irrigation system design and maintenance requirements. Hydrozoning a landscape development project based on site use patterns, plant material densities, supplemental water requirements, and microclimates is fully embodied in the concept of water budgeting.

8.5.1 Xeriscape Principles

By applying the following principles of xeriscape design, facilities can use valuable water resources efficiently and lower maintenance requirements while increasing the aesthetic appeal of the landscape:

- Minimize Turf Areas
- Use mulches: Organic or inert mulches applied to proper depths will reduce water needs and weed growth while providing visual interest and surface erosion control. Organic mulches such as pine needles and shredded or chipped bark provide the added benefit of improving the soil through slow decomposition. Mulch shall be placed directly on the soil around all plant materials. Avoid plastic sheeting and certain plastic-based fibrous matting. These materials do not prevent weed growth and slowly decompose over time creating maintenance difficulties.

8.6 Irrigation Design

The Federal Mandates for Sustainability require VA facilities to reduce outdoor potable water usage by 50% over conventional requirements. Therefore, all planting design must consider the amount of irrigation required to establish and sustain it.

The use of drought-tolerant plants, ground covers, and landscape mulch will minimize the need for irrigation systems. Irrigation site specific requirements depend on:

- seasonal distribution of rainfall;
- precipitation deficiency;
- soil's water holding capacity; and
- location of plants and turf to be maintained.

The following irrigation design factors include:

- availability and accessibility of existing water supplies, including non-potable sources;
- amount of water required, as determined by type of plants/turf to be irrigated, climate, terrain and soil conditions;
- irrigation system requirements, automated, programmable, water and energy efficient; and
- budget requirements for system facility and operations.

8.6.1 Efficient Systems

High-efficiency irrigation systems deliver up to 95 percent of the water supplied versus conventional irrigation systems that are as little as 60 percent efficient. Research into the latest irrigation technology will save water and money. Design irrigation systems using water efficient fixtures and strategies, such as drip irrigation, low profile sprays, controller programming to provide water only where and when water is needed.

8.6.2 Water Sources for Irrigation

Because medical facilities have patients who have illnesses and are at risk for infection, potable water shall be used for irrigation in all areas, with the exception of locations where patients are extremely unlikely to access, in some cases, rainwater or other sources can be considered if risk of infection is low. In those instances, the medical staff must agree to the non-potable water use.