8

# WATER SYSTEMS

## RESPECT SCARCITY AND MANAGE RUN-OFF

## INTRODUCTION

CSUMB was allocated 1,035 acre feet of water by the Fort Ord Re-Use Authority shortly after the closure of Fort Ord. It is located in a drought-prone area with nearby aquifers suffering from saltwater intrusion. As a custodian of this limited resource, the university proposes to educate users about conservation, and to demonstrate the use of innovative water-management strategies (stewardship). A range of innovative strategies will provide resiliency, should existing water supplies become limited, or should the campus decide to achieve net positive water—an ambitious goal that will first require achieving net zero water use. A wide range of strategies includes limiting the use of potable water for non-potable uses, capturing rainwater, using greywater from washing machines for irrigation, installing dual pipe plumbing in residence halls, and treating all campus wastewater for reuse on site.

Stormwater management will provide strategies to percolate stormwater within the campus footprint. Stormwater percolation systems will mimic native landscape features and will create attractive landscaped areas along an expanded proposed trail system (placemaking). Stormwater management will also continue to include the replacement of aging pipes still in use.

The campus will continue to support sustainable regional water projects that treat and distribute wastewater for reuse, supplementing water pumped from the Salinas Valley Groundwater Basin. In anticipation of receiving 87 acre-feet a year of regionally generated recycled water from FORA, the campus has installed recycled water irrigation piping for all newly created landscapes. As a purveyor of existing campus water supplies, the Marina Coast Water District (MCWD) will continue to be an important conservation and water management partner. The campus will also consider public-private partnerships as a way to fund and build campus water infrastructure (partnerships).

## GOALS

***Achieve net zero water (exempt)***

Use non-potable water supply for all non-potable water demands in any new improvement on campus. Explore options for achieving net positive water (100 percent of water use sourced on site), creating a campus- generated potable water supply. This would require treatment of greywater and blackwater.

***Promote resiliency***

Strive to remain within the carrying capacity of the site and respect the natural hydrologic patterns, while identifying redundant systems that are resilient to natural disasters or unexpected service changes.

The goals of net zero water and resiliency are mutually supportive; they offer options for campus growth, while considering the limitations of natural resources.

***Integrate low impact design into all landscaping and outdoor areas***

The term low impact development (LID) refers to systems and practices that protect water quality and associated aquatic habitat by using or mimicking natural processes in the infiltration, evapotranspiration, or use of stormwater. The implementation of LID techniques can greatly improve the quality of stormwater runoff, restore the infiltration of water to the aquifer, eliminate costs associated with conventional drainage systems, and reduce development impacts such as erosion and flooding. LID strategies and techniques also support the university's goal to seek Monterey Bay Friendly Landscape certification for new development projects.

***Percolate all stormwater within the campus footprint***

The campus aspires to sustainably manage all stormwater on the campus through a combination of decentralized and centralized LID features that are integrated into both the open space and public realm. The Central Coast Regional Water Quality Control Board has prioritized infiltration in Monterey County as a means of protecting Monterey Bay water quality and inhibiting further saltwater intrusion. The campus's goal is to reduce reliance on off-site regional infrastructure by expanding their on-site stormwater management capabilities in an integrated fashion.

# BACKGROUND

## Guiding Policies

### *Executive Order 987 (2006)*

Supports energy conservation, sustainable building practices, and physical plant management policy at CSU campuses. Specifically, systems should be designed for optimization of energy, water, and other natural resources. CSU campuses will take the necessary steps to conserve water resources, including installation of optimized irrigation controls, reduction of water use in restrooms, and promotion of the use of reclaimed water.

### *Second Nature Climate Commitment (2007, reaffirmed 2016)*

This original commitment states that the campus will develop a comprehensive Climate Action Plan (CAP) and set a target date for achieving carbon neutrality. In 2016 the campus signed the updated commitment that incorporated adaptation to climate change and five specific measures to reduce water use and reliance on bottled water.

### *Climate Action Plan (2013)*

The CAP was developed in response to the original climate commitment. It established a carbon neutrality target year of 2030. The 2013 CAP includes recommendations relevant to this water strategy.

### *MCWD Conservation Measures*

The campus works closely with the MCWD to implement conservation measures as opportunities and funding sources are identified.

## Existing Conditions

### *Potable and Recycled Water*

CSUMB receives its potable water services from MCWD. MCWD in turn obtains 100 percent of its supply from the Salinas Valley Groundwater Basin, which extends from the Monterey Bay inland and is the source of all of the potable water supply for the former Fort Ord.

**Potable Water Supply and Distribution**

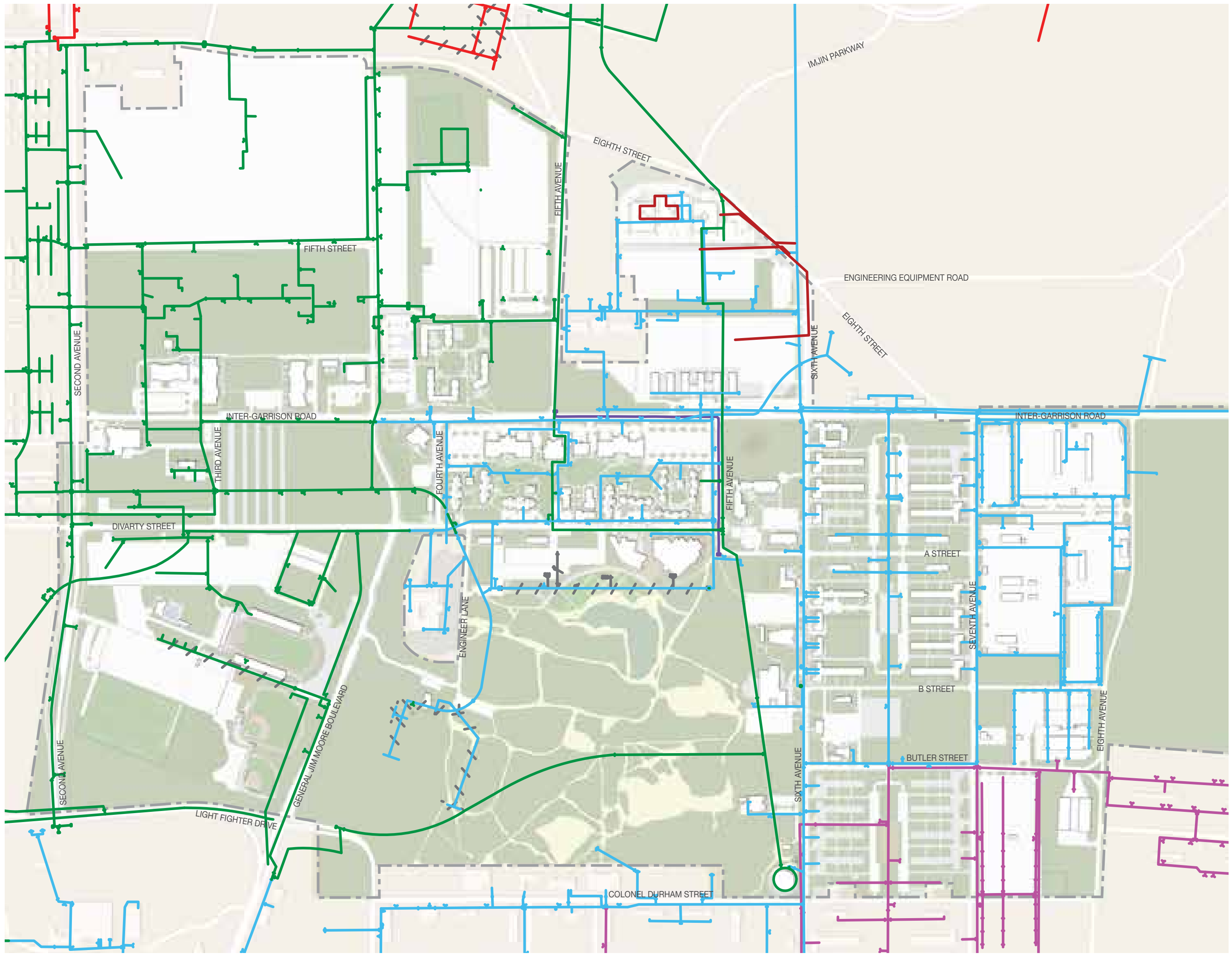
The MCWD serves the university through a campus-wide system separated into four interconnected pressure zones designated Zones A-D based on elevation range served. (See Figure 8.1.) The overall campus-wide system is connected to several existing trunk lines serving adjacent cities. According to discussions with MCWD, the system on the west side of Second Avenue was installed around World War II, the east side during the 1960s, and the center and south portions of campus in the 1980s. The existing system is primarily composed of asbestos cement water lines (standard pipe material until the 1980s) with cast iron fittings for smaller distribution pipes and cast iron or ductile iron for larger transmission lines. Any improvements to these systems will require special handling, removal and disposal of hazardous materials if overseen by CSUMB.

- Zone A serves a relatively small area located just off the northwest corner of campus.
- Zone B serves the north and west areas of the main campus. It also serves East Campus Housing.
- Zone C serves the central area of campus and the majority of the East Campus Open Space.
- Zone D primarily serves the area just south of the East Campus Open Space.

All four zones serving the campus are connected to several trunk mains, which connect in turn to adjacent cities as part of MCWD's overall system. These include 12", 14", 16", and 24" trunk lines connected to the City of Marina to the north, an 18" trunk line connected to the City of Salinas to the east, and 8" and 12" lines to the City of Seaside to the south. The main trunk line is the 24" line running along Sixth Street. Only the upper section of Zone B near the fieldhouse has exhibited pressure issues, which have been minor and related to fire flow. The district has plans in the near term that will remedy these issues by completing a loop within this upper section of Zone B. Increased storage capacity is a desire of the MCWD, in particular in Zone D, where MCWD wants to construct a one million gallon

***Figure 8.1:*** *Existing Water System Map*

- Campus Boundary
- Zone 'A' Water Line
- Zone 'B' Water Line
- Zone 'C' Water Line
- Zone 'D' Water Line
- Ex. Recycled Water Line (Unused)
- Ex. Water Tank



tank on campus. Additional storage capacity is needed in Zone B where MCWD wants to add a tank adjacent to the existing one. In this case, additional storage is needed to meet maximum daily demand and fire storage capacity.

MCWD currently holds a fifteen-foot-wide non-exclusive easement over all water distribution piping on campus. The change in ownership takes place at the meter. If there is no meter, change in ownership takes place where the meter would normally be, located adjacent to the back of curb. Backflow prevention is currently installed at all metered locations where required by the District. Water lines generally run under or adjacent to sidewalks.

#### Recycled Water

Over the past ten years MCWD has installed sections of purple pipe (recycled water ready pipe) on campus as part of a regional project to provide recycled water for irrigation. Purple pipe currently exists on Inter-Garrison Road for approximately the western half of the block between Fourth and Fifth Avenues, and on Fifth Avenue between Inter-Garrison Road and Divarty Street, as depicted in Figure 8.1. MCWD has recently partnered with the Pure Water Monterey project to provide even more advanced treated water than initially proposed to Fort Ord. The project anticipates that this water will be available by the end of 2018.

#### Fire Service Water

Fire suppression systems are fed by the domestic water distribution system. Fire hydrants are located throughout the campus at main roadways and corridors. Backflow prevention, including fire department connections and associated equipment is understood to be adequate for the campus.

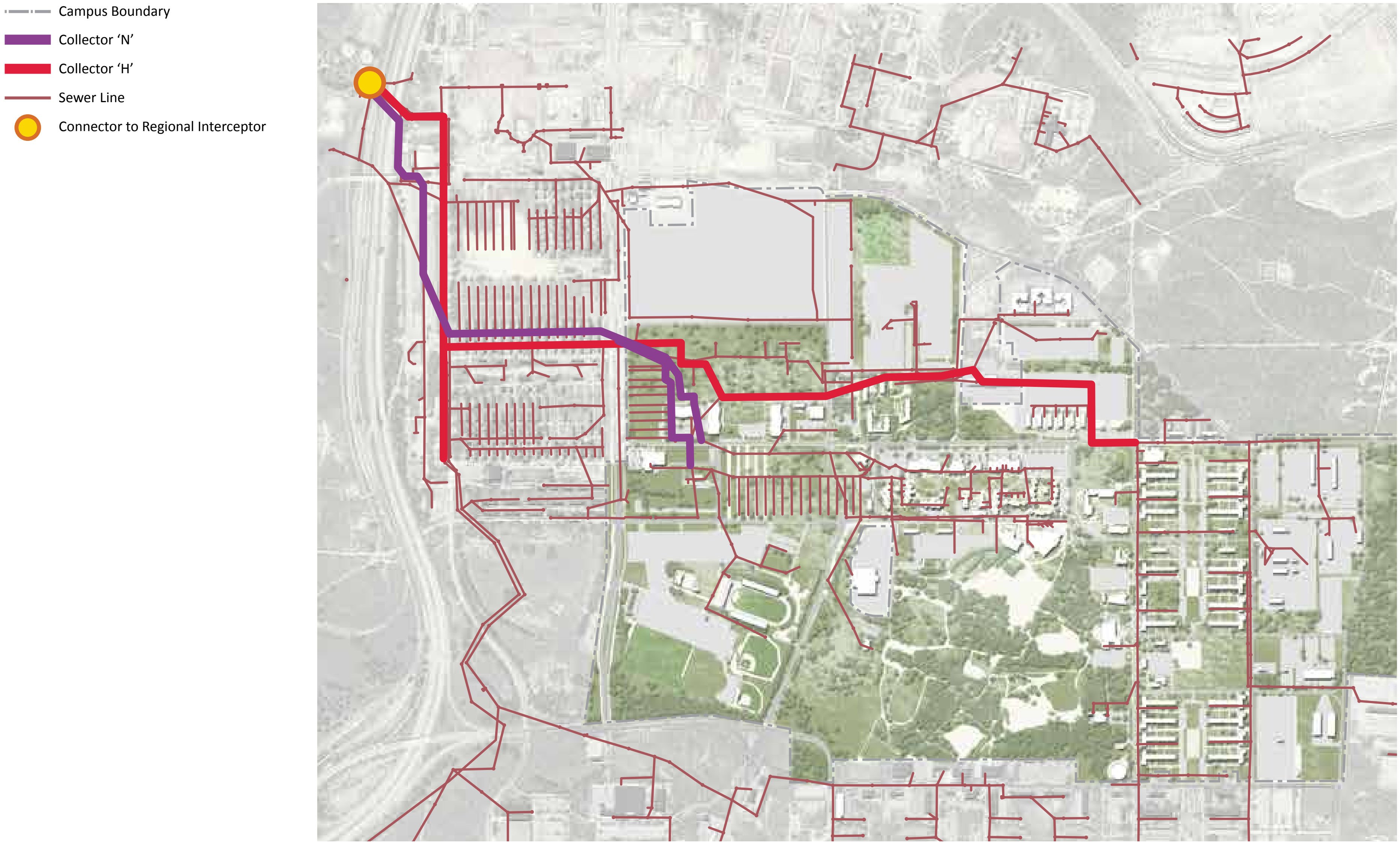
### *Wastewater Systems*

CSUMB is currently serviced by an existing MCWD-owned and maintained sewer collection network. This network includes both off-site generated flows that are routed through the campus and on-site generated flows, both of which route through primary collectors before connecting into a regional interceptor sewer.

#### Sanitary Sewer Collection

Sewer mains on campus generally follow the site topography, collecting sewage throughout campus from east to west, and draining to two main collectors shown in Figure 8.2 as Collector “H” (15” in diameter) and Collector “N” (18” in diameter). Collector “N” transitions from a 15” to 18” diameter pipe before crossing State Highway 1. Collector “N” drains into Collector “J,” which is the intercepting sewer for most of the Fort Ord Community south of Eighth Street. Both Collector “N” and Collector “J” discharge to the Monterey Water Pollution Control Agency interceptor line across Highway 1. The age of sewer facilities on campus mirrors the ages previously described for the campus water system, and aging pipes potentially require near-term replacement. The existing system is primarily composed of asbestos cement pipes, and if overseen by CSUMB, will require special handling, removal, and disposal of hazardous materials when replacing. On campus, sewer piping is within a fifteen-foot non-exclusive easement, separate from the easement defined for the water utility infrastructure. Development outside of areas currently served by existing trunk mains could require extension of trunk mains at the university’s expense.

***Figure 8.2:*** *Existing Sewer Collection and Transmission*




Source: "California State University Monterey Bay Master Plan Update Appendix D: Water Supply/Distribution, Sewer System, and Hydrologic and Drainage Impact Assessments," prepared by Shaaf and Wheeler, July 2004

### *Campus Hydrology and Stormwater Management*

Storm drainage on the CSUMB campus is currently conveyed through pipes by gravity to infiltration facilities at various locations both on and off campus. Regionally, there are two main outfall systems identified as “System C” and “System D,” also known as the 54” and 48” outfalls, respectively.

From a regulatory standpoint, CSUMB is located in the Central Coast Regional Water Quality Control Board (Region 3) of California. This region requires stormwater retention on site with infiltration as the preferred best management practice (BMP). The CSUMB Stormwater Master Plan specifies that redevelopment ultimately infiltrate on site 100 percent of runoff from a hundred-year storm. Recent development projects have included on-site infiltration facilities, which have employed LID approaches, as well as more conventional infiltration basins. Although drainage infrastructure inherited from the Army exists throughout the campus, its age has resulted in occasional pipe replacement and ongoing maintenance issues, such as flooding from pipes collapsing or filling with sand.

#### Existing Watershed Areas

The CSUMB campus is divided topographically into several watersheds as identified by the CSUMB Stormwater Master Plan and depicted in Figure 8.3. Many of these watersheds include expansive areas of impervious cover. A description of each follows along with their point of outfall.

*Sub-area A (SWMP)*

This area drains west through the proposed Seaside Main Gate project on the west of Second Avenue. The campus has had discussions with the City of Seaside about removal of the 48” pipe conveying water west to the temporary ponds west of Highway 1. Instead of requiring the developer to install a new pipe on the edge of the development to convey upstream runoff from CSUMB and Seaside properties, the campus proposes infiltrating CSUMB and upstream Seaside historic runoff on campus on the east side of Second Avenue.

*Sub-area B (SWMP)*

The Dunes developer may choose to provide stormwater infiltration facilities on CSUMB property east of Second Avenue or within the proposed park west of Second Avenue should they choose to remove the 54” pipe prior to campus development in this area.

*Sub-area C3*

This area is mostly covered by asphalt. It drains into an 18” storm drain with excess runoff flowing overland to a low spot behind the Monterey Institute for Research in Astronomy building (on the southeast corner of Second Avenue and Eighth Street) and across Second Avenue. This sub-watershed drains to System C at the regional level.

*Sub-areas DA3, DA4, and DA5*

These areas drain west across Second Avenue via the System D regional drain.

*Sub-areas DC1 and DC2*

These areas drain west across General Jim Moore Boulevard and ultimately discharge into regional System D.

*Sub-areas DD1 and DD2*

These areas drain to an existing City of Marina percolation pond that lies outside CSUMB property.

*East of DA5 and DC2*

These areas drain to County of Monterey open space on the north side of Inter-Garrison Road outside of CSUMB property.

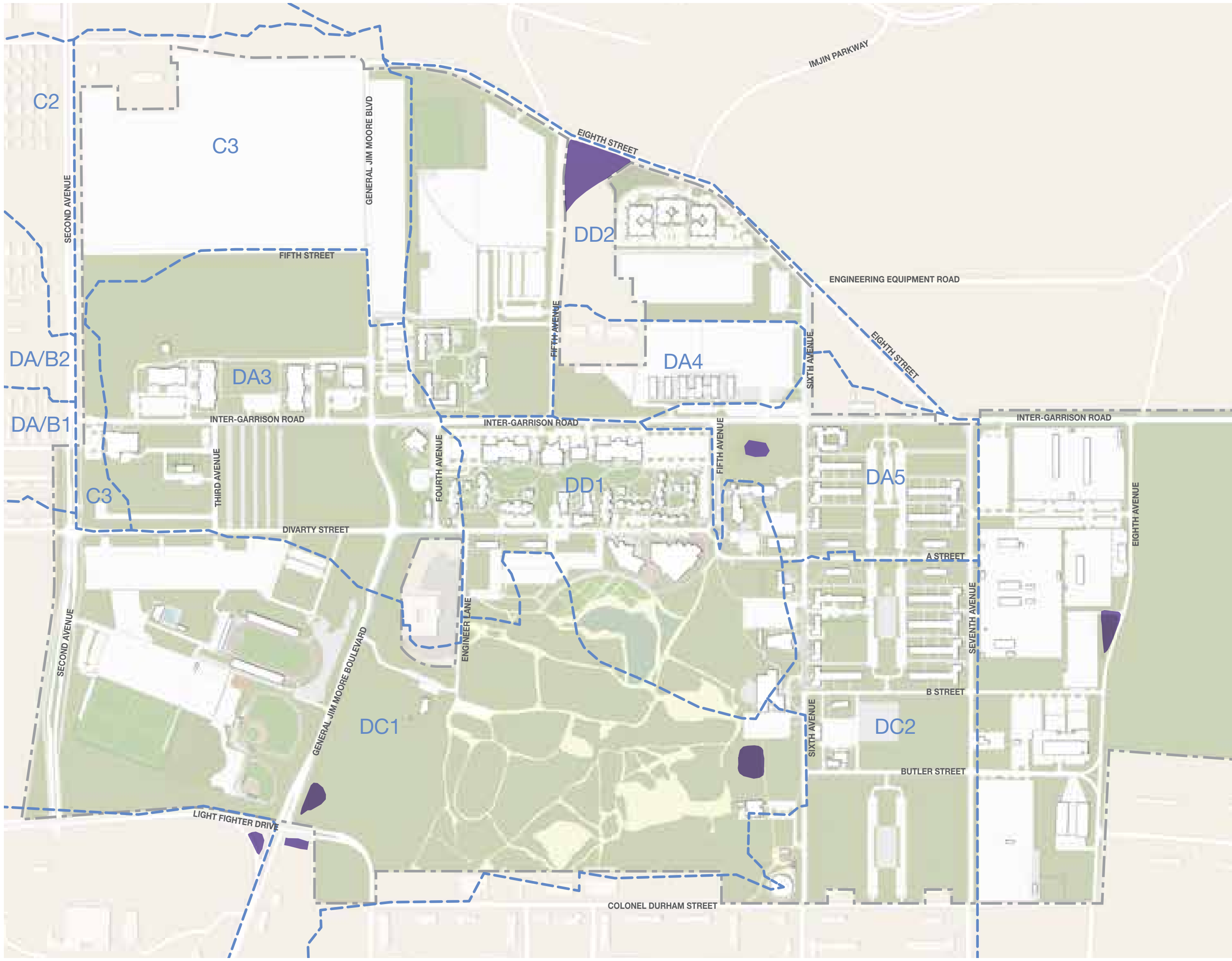
***Figure 8.3:*** *Storm Drainage Watersheds*

Campus Boundary

Watershed Boundary

Existing Percolation Basin

Note: Sub-areas A & B are outside the campus boundary




Source: California State University Monterey Bay Master Plan Update Appendix D, prepared by Shaaf and Wheeler, July 2004

## Water Demands

The water modeling approach developed for CSUMB aims to identify infrastructure strategies and approaches to reach net zero water exempt status on-site for new improvements. This goal requires that new improvements use non-potable water supplies for all non-potable water demands, but these improvements are exempted from using on-site supplies for potable demands (i.e., MCWD will continue to provide potable water to the campus). This target requires that water demands be met within the carrying capacity of the site, using scale-appropriate strategies that respect natural hydrologic patterns. This design approach incorporates ambitious indoor and outdoor water conservation practices; collection, treatment, and reuse of wastewater; and stormwater harvesting and reuse; while taking into account the local site context and prioritizing the implementation of closed-loop systems. The development of an on-site non-potable water supply system would further allow the university to achieve net zero water exempt status for the entire campus at a time beyond the current planning horizon by providing the infrastructure backbone that can be utilized during future capital improvement projects.

In an effort to reduce water usage, the campus is now metering all East Campus Housing units and new buildings, installing artificial turf, using evapotranspiration metering to reduce landscape water usage, and replacing existing urinals with waterless urinals and existing toilets with dual-flush toilets. These water-efficiency measures are accounted for in the demands described below.

To assess feasibility and evaluate strategies necessary to achieve these goals, a water model has been created in which all site water elements including supplies (potable, reclaimed wastewater, treated greywater, treated rainwater, and treated stormwater), and demands (interior non-potable, irrigation, and cooling) are evaluated within an overall framework of supply and demand. The overarching principles developed through the design process and the model's primary drivers include:

- Matching source water quality with end-use requirements and minimizing potable water use
- Aggressively conserving water in both buildings and site irrigation
- Reclaiming on-site wastewater to serve non-potable demands
- Incentivizing building-scale innovations for water conservation and reuse
- Providing the ability to incorporate future building renovations beyond the planning horizon

A description of model inputs, assumptions, and calculation methodologies are described in the following sections.

### *Demand Analysis*

#### Interior Demands

*Existing*

Existing demands were provided by CSUMB in late 2015. The most recent twelve months of data is used for the existing baseline ending on June 30, 2015.

*Proposed*

CSUMB should strive to reduce potable water use to levels below CalGreen standards in all new construction projects. For purposes of the water model, unit demands are based on CalGreen standards. Percent potable/ non-potable for new building demands varies based on program type. Overall averages are 87 percent potable and 13 percent non-potable. See Tables 8.1, 8.2, and 8.3.

#### Exterior Demands

Existing demands were provided by CSUMB in late 2015. The most recent twelve months of data is used for the existing baseline ending on June 30, 2015.

Ongoing efficiency programs and sustainable landscape projects consistent with the 2013 Climate Action Plan are expected to hold overall proposed

***Table 8.1:*** *Internal Building Unit Demands*

| Metric | Uses Per Day | CalGreen Scenario | Proposed Scenario |
|---|---|---|---|
| Occupancy Type | n/a | Student/Visitor | |
| Days of Operation | n/a | 206 days per year | |
| Occupancy Density | n/a | 30 SF/person | |
| Space Utilization Factor | n/a | 80% | |
| Water Closet (Male) | 0.1 | 1.28-GPF | 1.1-GPF |
| Water Closet (Female) | 0.5 | 1.28-GPF | 1.1-GPF |
| Urinal (Male) | 0.4 | 0.5-GPF | 0.125-GPF |
| Lavatory | 0.5, 15-sec per use | 0.5-GPM | 0.35-GPM |
| Shower | 0, 300-sec per use | 2.0-GPM | 1.5-GPM |
| Kitchen Sink | 0, 15-sec per use | 1.8-GPM | 1.5-GPM |

***Table 8.2:*** *Internal Building Unit Supply*

| Lecture Category | | |
|---|---|---|
| **Supply** | **CalGreen GPD/SF** | **Proposed GPD/SF** |
| Total Fixture Water Usage | 0.016 | 0.011 |
| Fraction that must be Potable Water | 0.003 | 0.001 |
| Fraction that can be Non-Potable Water | 0.013 | 0.010 |
| % Potable | 17.0% | 10.8% |
| % Non-Potable | 83.0% | 89.2% |
| % Process | 0.0% | 0.0% |
| Sum Check | 100.0% | 100.0% |
| **Drain** | | |
| Total | 0.014 | 0.010 |
| Fraction that can be grey water | 0.002 | 0.001 |
| Fraction that must be black water | 0.012 | 0.009 |
| W% (hazardous not to be reused) | 0.0% | 0.0% |
| X% (hazardous, requires special treatment | 0.0% | 0.0% |
| Y% (non-hazardous, able to treat and reuse) | 90.0% | 90.0% |
| Z% (consumptive use) | 10.0% | 10.0% |
| Sum Check | 100.0% | 100.0% |

***Table 8.3:*** *Residential Unit Demands*

| | Duration (Min.) | Uses/ Day | Watersense or LEED | Total LEED (gpd/cap) |
|---|---|---|---|---|
| Water Closet | - | 5 | 1.28 | 6.4 |
| Lav Faucet | 1 | 5 | 1.5 | 7.5 |
| Shower | 8 | 1 | 2.5 | 2 |
| Kitchen Sink | 1 | 4 | 1.8 | 7.2 |
| Residential Clothes Washer | 1 | 0.2 | 15 | 3 |
| Residential Dish Washer | 1 | 0.3 | 4.25 | 1.275 |
| Utility Sink (Assume same as kitchen) | 1 | 4 | 1.8 | 7.2 |
| **TOTAL** | | | | **52.575** |

irrigation demands on the main campus and east campus (East Campus Housing) constant, despite additional development.

**Annual Demand Breakdown**

For the full master plan program, the total annual water demands for CSUMB are estimated at 632 acre-feet. The breakdown between potable and non-potable by interior and exterior demand categories is shown in Figure 8.4.

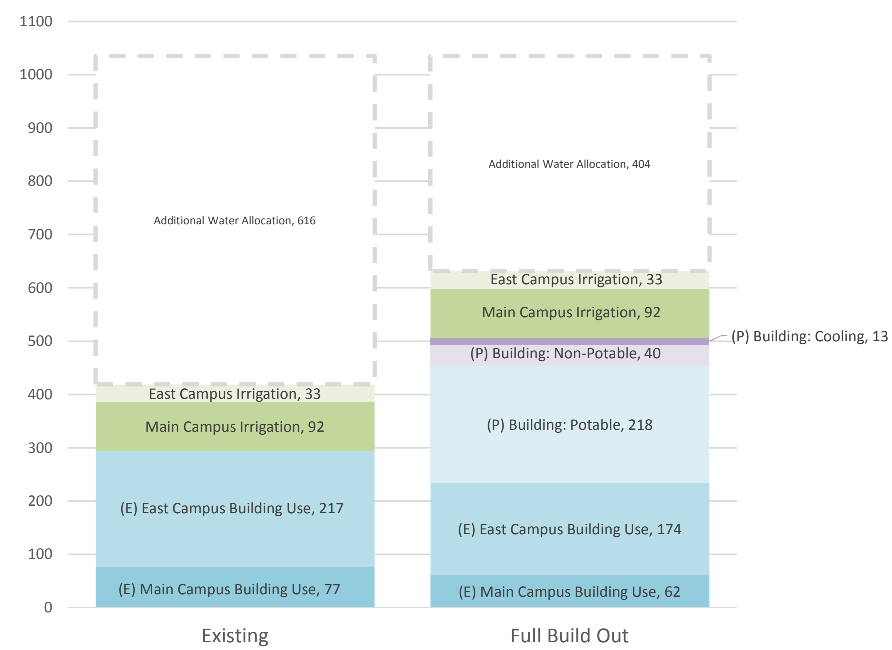
## Seasonal Water Balance Model

The water model is driven by matching water uses with appropriate source quality. The projected on-site supply of reclaimed water and harvested rainwater and stormwater, in conjunction with prioritization of end uses, drive the use and distribution of the university's on-site water sources.

On-site water harvesting potential at CSUMB is highly seasonal since the vast majority of rainfall in northern California occurs during winter months. A hydrology model was created to determine on-site water harvesting supply potential for the campus. Figure 8.5 shows the harvesting potential by month, given the rainfall-runoff relationship. For this report, the fiftieth-percentile rain year is used, though supply varies significantly from year to year. While this figure represents maximum direct runoff volumes in such a year, the ability to harvest and reuse stormwater is mostly driven by other factors, including site topography, storage capacities, and the seasonal balance of supply and demand.

Site water demands are categorized into potable uses and non-potable uses, as defined by current jurisdictional requirements. Potable uses are strictly limited to locations where water may be consumed, or has the potential for human contact such as sink fixtures. Typical non-potable uses include—but are not necessarily limited to—cooling make-up water, toilet fixture flushing, and irrigation. Figure 8.5 illustrates the seasonal distribution of on-site water supplies and demands.

***Figure 8.4:*** *Existing and Proposed Total Water Demands*

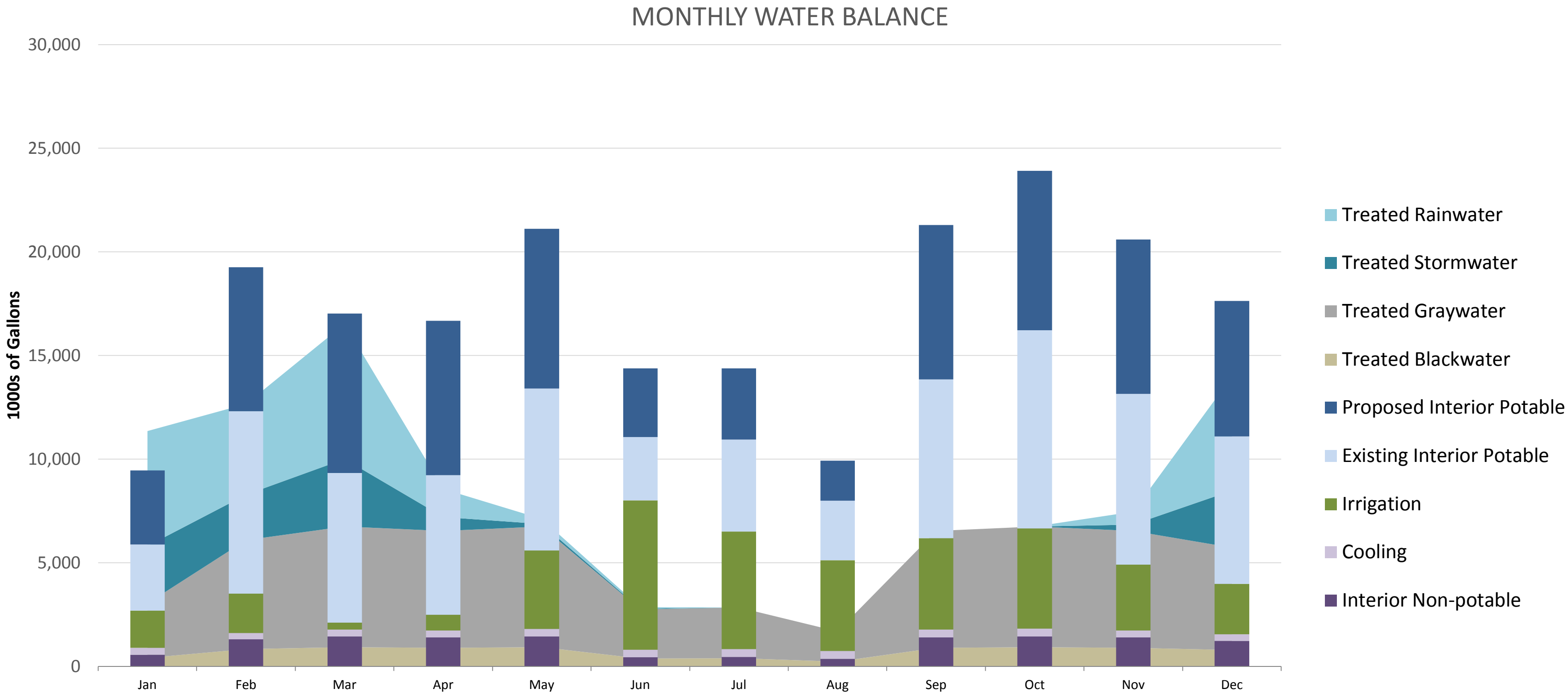



(E): Existing
(P): Proposed
All units in AC-FT

### *Model Adaptability*

The water model should not be considered static. The scenario shown is based on building programming and site configuration assumptions, along with current regulations relating to water treatment and reuse. Adjustments should be made as campus programming evolves, and in response to the expectation for more stringent water conservation and reuse requirements across the state of California in the future.

***Figure 8.5:*** *Water Model Output Indicating the Seasonal Distribution of On-site Water Supplies and Demands*




Notes:

1. Program: Existing + Capital Improvement Projects + Program for Growth
2. Rainfall: Average
3. This hydrology model employs the Soil Conservation Service (SCS) Curve Number Method
4. Direct runoff volumes were calculated based on site-specific rainfall data, anticipated site coverage and soil type.
5. Forty-six years of NOAA historic rainfall data (1969-2014) was imported from the nearest available station. (Monterey Peninsula Airport, CA Station GHCND: USW00023259).

## RECOMMENDATIONS

To meet its sustainable water goals for the buildout of the campus, the university should develop a strategic water plan based on the following three recommendations. Recommendations included education and policy, as well as implementing building and campus-wide infrastructure and design features that will reduce potable water use and allow the campus to use or treat non-potable water.

### *Education and Policy to Drive Conservation*

This approach involves educating users by sharing water meter data, holding creative competitions between users (this is often done between student housing buildings), and direct outreach. Making goals and information available to users and larger audiences improves water conservation results. At the policy level, establishing an outdoor water use policy for design and retrofit projects and reviewing landscaping and irrigation operation protocols can assist in lowering future potable water demands.

### *Emphasis on Building Scale Solutions*

Utilizing water efficient fixtures in new and refurbished buildings can assist with the overall water savings strategy. Laundry-to-landscape systems, where greywater is diverted and treated at the building cluster scale to address that cluster's irrigation needs, can be implemented to reduce water use as well. An additional building-scale solution is dual plumbing in buildings to utilize greywater or future recycled water for toilet flushing.

### *Future Ready for District Scale Water Infrastructure*

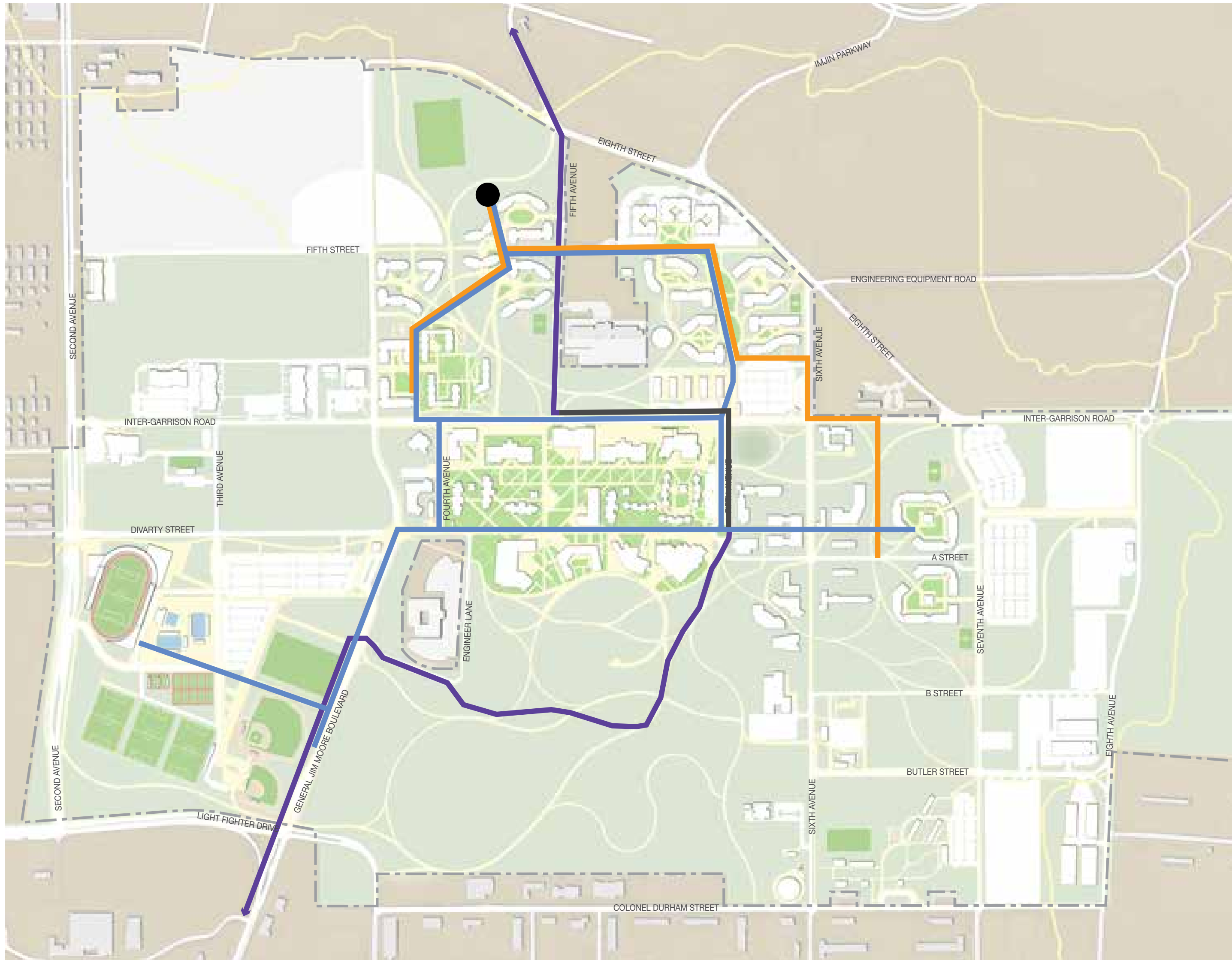
Future water savings measures should target areas with particularly high water demands, such as residential housing and sports facilities. In addition, infrastructure should be designed for compatibility with future non-potable water supply, so that future-ready scenarios are feasible when economic analyses can justify the installation of such facilities.

Examples of future-ready scenarios include:

- Design collection and conveyance infrastructure in preparation for future MCWD delivery of recycled water to the campus
- Install future stormwater retention basins in close proximity to sports fields to capture runoff for irrigation of those high-demand campus facilities; install swales along campus roads, paths, and trails.
- Install sewer collection systems at new student residential housing so that reclaimed wastewater can eventually be routed to a water recycling facility on campus for treatment, providing a supply of recycled water for future uses

***Figure 8.6:*** *District Non-potable Water System*

- Campus Boundary
- (P) CSUMB Recycled Water Line
- (P) Sanitary Sewer Line
- (E) Regional Recycled Water Transmission Line
- Future Regional Recycled Water Transmission Line
- (P) Water Recycling Facility



## WATER STRATEGIES

### Potable Water

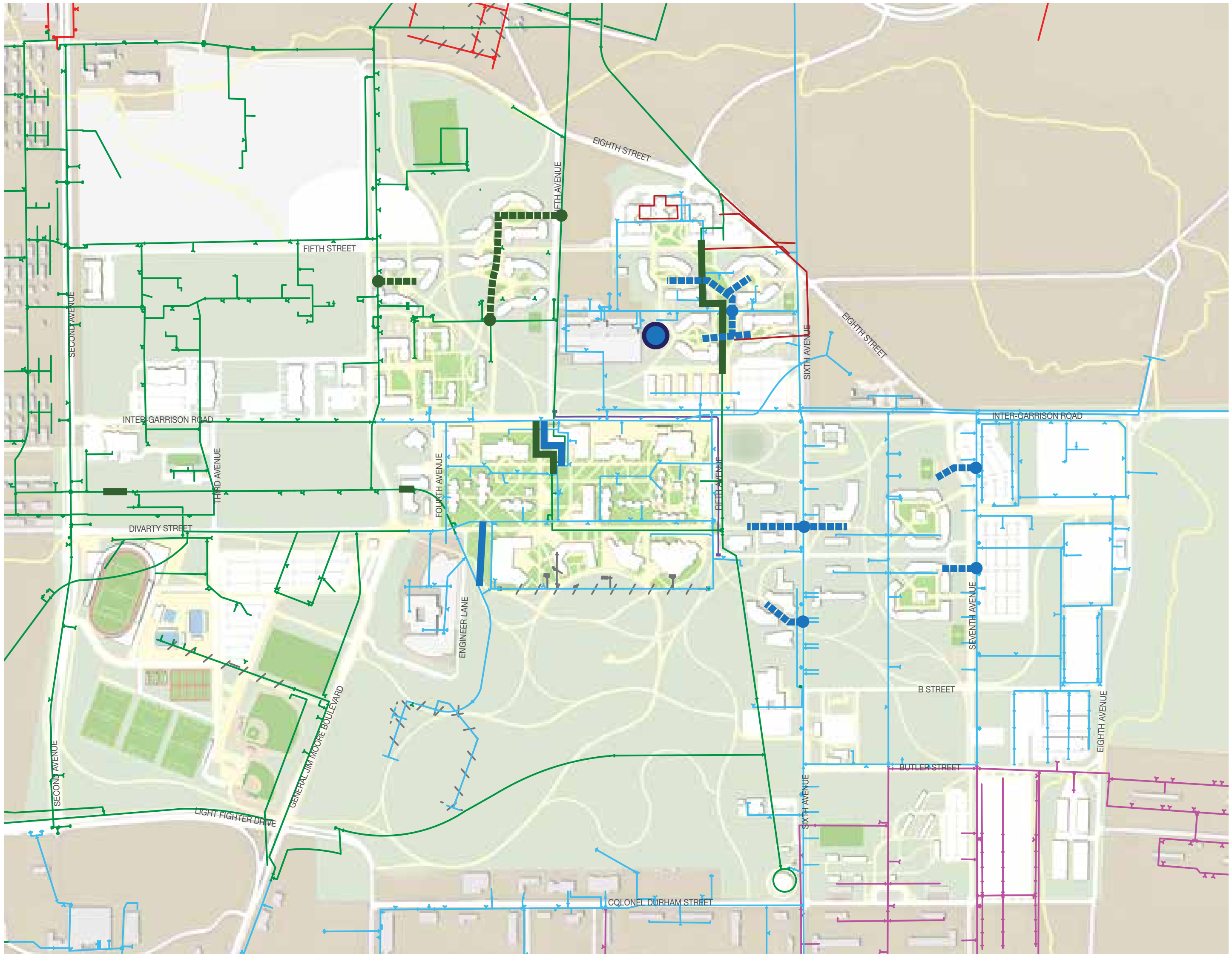
The Integrated District Water System approach developed for CSUMB seeks to minimize reliance on potable water use and maximize utilization of on-site water resources, including reclaimed wastewater and site-harvested rainwater. The potable water system described in this section and illustrated in Figure 8.7 is intended to provide reliable supply for required potable demands for the campus.

The existing water distribution infrastructure is generally adequate to service the proposed master plan improvements. The noted exceptions include the following:

- Water storage facility: to be coordinated with MCWD and located on CSUMB property, north of the Visual and Public Art buildings.
- Water services demolition: many existing services and smaller loops run through proposed development areas. These may require demolition or reconfiguration to meet the final development pattern.
- Water main relocation: a Zone B 8" water transmission line runs from the Visual and Public Art buildings north toward the Promontory housing project through a proposed development parcel. This line will require rerouting if it is impacted by final building layout.
- Water services: All new buildings will require water services to be constructed from the mains within the public right-of-way or from the existing service loops within the development areas.
- Closed loop water system: To maximize resilience and achieve net positive water, the campus could consider creating a closed loop water system where all stormwater, blackwater and greywater is reused on campus. Net positive water is defined by the Living Community Challenge version 1.1 as providing 100 percent of a community's water needs from precipitation or other closed loop water system, or recycling used site water that is purified without chemicals.

***Figure 8.7:*** *Proposed Water Distribution System Map*

- Campus Boundary
- Zone 'A' Water Line
- Zone 'B' Water Line
- Zone 'C' Water Line
- Zone 'D' Water Line
- Zone 'B' Possible Relocation
- Zone 'B' New Water Main
- Zone 'C' Possible Relocation
- Zone 'C' New Water Main
- (P) Water Storage Tank
- Point of Connection



## Sanitary Sewer

The existing sanitary sewer collection infrastructure is generally sufficient for the proposed master plan improvements, with a few exceptions (Figure 8.8):

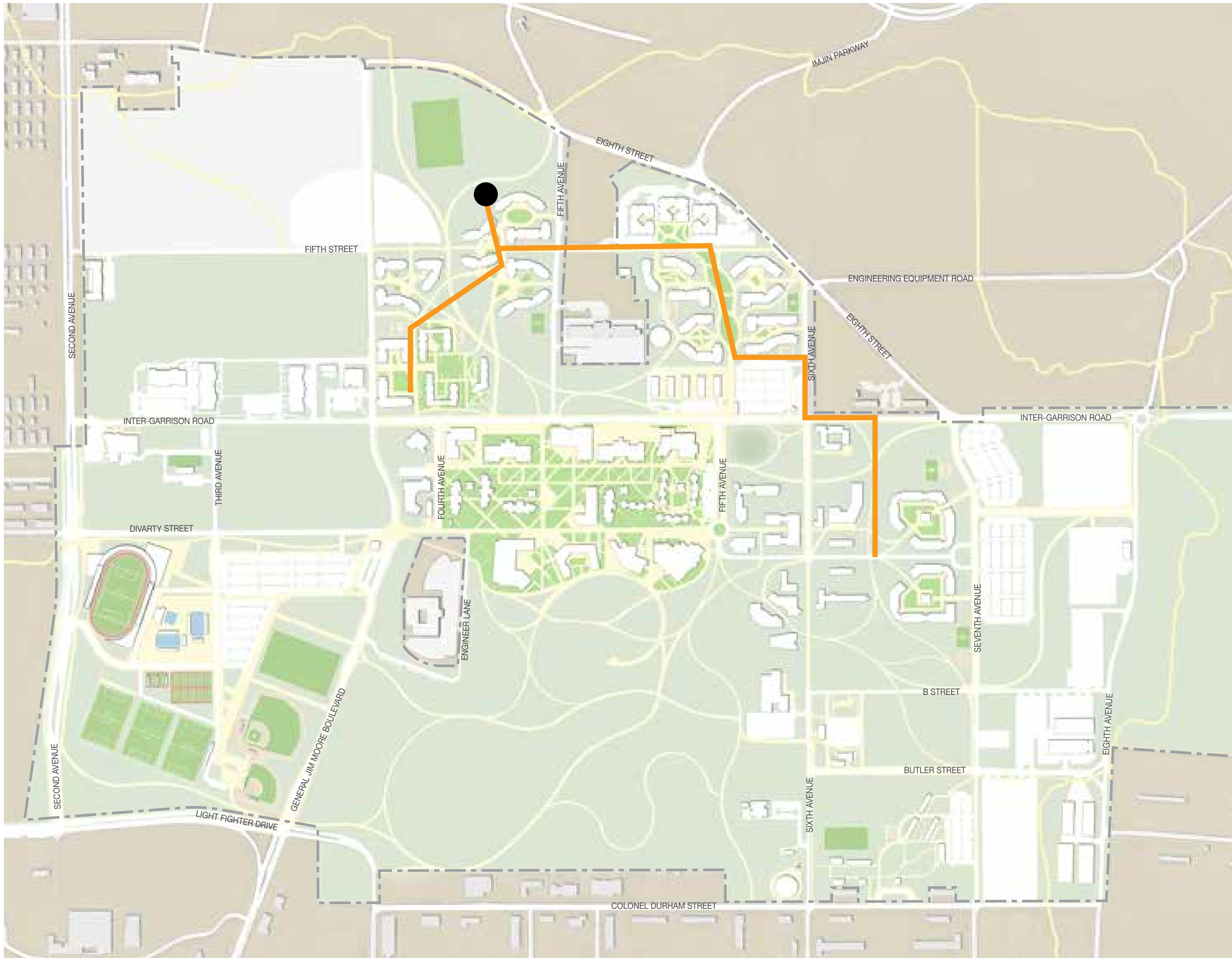
- Sewer services demolition: many existing services and smaller laterals run through proposed development areas. These may require demolition or configuration to service the final building layouts. MCWD is responsible by deed to remove any sewer main that has been out of service for more than two years.
- Sewer main relocation: some of the existing sewer mains run through proposed development areas. These include Collector H and the upper reaches of Collector N. Although these lines may require rerouting if impacted by final building layout, it is anticipated that relocation of these lines can be avoided if considered during detailed site design.
- Sewer collection mains: an on-site water recycling facility will require construction of a CSUMB-owned sewer collection network This master plan proposes a collection network that prioritizes future housing as a way to minimize infrastructure costs while maximizing sewage collected. This network can be expanded, if required, to balance summertime irrigation demands with CSUMB-produced non-potable water.

***Figure 8.8:** Proposed Sewer Collection System Map*

Campus Boundary

(P) Sanitary Sewer Line

(P) Water Recycling Facility



## Stormwater

### *Stormwater Management*

The stormwater approach for the CSUMB campus is designed to function at two complementary scales. One strategy is focused at the building cluster scale (Figure 8.9) and the other at the campus scale (Figure 8.10). By using this two-pronged approach, stormwater management can be managed as the campus exists today, and as it is developed over time. This approach meets the needs of the growing and changing campus in a sustainable manner, while at the same time adhering to regulatory requirements, aiding with the phasing strategy of new structures, ensuring a healthy ecology, and reducing operations and maintenance burdens. Strategies for on-site stormwater management will also address historic stormwater flow between surrounding jurisdictions and the CSUMB campus.

Fundamental in this approach is designing both the site-based and campus-based systems to retain stormwater for either infiltration or reuse. CSUMB is located on soils with high infiltration rates; these create a favorable environment for many LID systems.

Stormwater management infrastructure can contribute to the university's goal of using the campus as a learning laboratory. Making stormwater processes visible, and providing interpretive signage to explain those processes, will engage students, faculty, and staff by providing informal education opportunities.

### *Low Impact Development Overview*

LID is a type of stormwater BMP that prioritizes natural systems. The EPA defines stormwater BMPs as "methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources." Traditional methods of closed drainage collection and centralized detention areas act to remove stormwater runoff from the site in the quickest and most efficient manner possible. LID takes a different approach, one that looks at stormwater as an asset to be retained in an effort to mimic the natural hydrologic cycle. Decentralized stormwater collection networks may also be designed to retain stormwater for reuse as irrigation or other purposes. The implementation of LID techniques can include benefits such as greatly improving the quality of stormwater runoff, restoring the infiltration of water to the aquifer, eliminating costs associated with conventional drainage systems, and reducing development impacts such as erosion and flooding. An added benefit is the integration of BMPs to manage stormwater while at the same time improving the natural aesthetic of the campus. The following LID best practices should be followed for future development:

- Assess the site's topography, soils, vegetation, and natural drainage for integration of LID techniques to minimize future development footprint
- Assess native vegetation and soils for placement of LID facilities
- Assess primary BMP function: water quantity, quality, infiltration, and conveyance to meet Regional Water Quality Control Board Region 3 requirements and CSUMB's Stormwater Master Plan
- Minimize and manage stormwater at the source to promote infiltration across the campus and minimize the size of regional management facilities
- Minimize areas of impervious surfaces such as parking lots, driveways, courtyards and rooftops, using permeable pavements and green roofs to maximize evapotranspiration and allow infiltration of precipitation into the soils
- Manage runoff by disconnecting the impervious surfaces from one another and directing runoff to LID features such as vegetated swales, planters, rain gardens and pervious pavement
- Preserve existing trees and plant new trees in coordination with development
- Avoid compaction of soils in areas of the site that will not have structures

- Provide microdetention in landscaped areas (self-retaining areas)

Stormwater runoff should be collected throughout the site and transported, mostly through surface conveyance, to LID water quality treatment areas. These areas will act to evapotranspire, infiltrate, or treat the water. Overflow volumes will be released to a campus-scale storm drain network that leads to larger percolation landscapes.

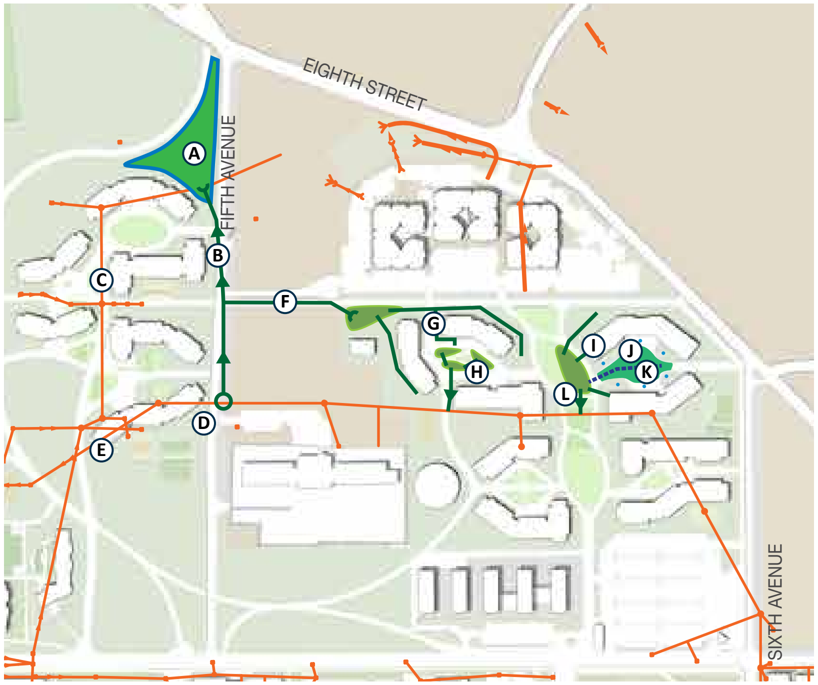
### *Building and Site Scale LID*

Localized treatment at the building or site scale utilizes a toolkit of LID BMPs that manage stormwater on a site-by-site basis (see Figure 8.9). LID strategies promote natural filtration of stormwater as close to the original location of rainfall as possible. By keeping treatment localized, the natural hydrological cycle can be more closely mimicked, and there is less complexity in the design, construction, and operation of the stormwater facilities.

Proposed BMPs include various bioretention devices, self-retaining areas, permeable paving systems or porous pavement, and surface conveyance channels, as well as infiltration trenches and other infiltration-based facilities. For CSUMB the following site design measures are proposed:

- Minimize impervious surfaces by designing narrow streets and driveways, and by constructing urban plazas with permeable pavers
- Minimize directly connecting impervious surfaces to the storm drain system; rather, route runoff to landscaped areas
- Route stormwater runoff in surface conveyances wherever possible to minimize piped infrastructure and to avoid deeper infiltration basins; such basins can diminish the site's aesthetics and create safety issues
- Integrate landscape features to provide both stormwater conveyance and stormwater treatment

***Figure 8.9:*** *Building/Site Scale BMPs*




(A) Proposed Percolation Landscape
(B) New Development Flow Storm Drain Interceptor
(C) Existing 'DD' Storm Drain System
(D) Proposed Intercepting Structure
(E) Existing 'C' Storm Drain System
(F) Alternative Storm Drain Overflow Routing
(G) Bioswale / Conveyance Swale
(H) Raingarden / Bioretention
(I) Roof Leaders To Raingarden / Rainwater Harvesting Node
(J) Pervious Pavers At Courtyard
(K) Underdrain If Stormwater Harvesting
(L) Overflow To Existing Storm Drain

- Design self-retaining areas to reduce the stormwater runoff volume
- Cluster buildings and pavement to reduce the extent of new facilities needed; this can reduce cost as well as impact

Combinations of LID strategies for a site should be chosen based on density of development (Floor Area Ratio) and design stormwater volumes. For example, denser sites, or projects with more impervious surfaces, should utilize pervious paving to a larger extent than less densely developed areas. Development can be planned so that overflows from densely developed areas first flow to less developed parcels that have excess capacity before running over into the campus-scale stormwater management network.

### *Building and Site Scale LID Toolkit*

**Bioretention**

Bioretention is the process by which contaminants and sedimentation are removed from stormwater runoff. This process involves the collection of stormwater, which is allowed to pond to slow down the runoff's velocity, thus increasing the contact time with the surface organic layer and amended soil blend. The treated runoff infiltrates over a period of time into the underlying soils. Any stormwater exceeding the bioretention's capacity is diverted away for larger storm conveyance.

**Infiltration Trench**

Infiltration trenches are subsurface facilities designed to provide on-site stormwater retention in areas of good infiltration by collecting and recharging stormwater runoff into the ground. Trenches filter pollutants to improve water quality and contribute to groundwater recharge. Infiltration trenches are relatively low maintenance and can be easily retrofitted into existing sidewalk areas and medians.

**Green Roof**

Green roofs are a way of managing stormwater in urban areas with limited space for more land-intensive BMPs. Green roofs are able to store stormwater in the soil medium during rain events, helping to detain runoff. Some of the stormwater will be taken up by the roots of the plants and some will be evaporated from the soil medium, reducing the amount of runoff from the roof. Early adoption of this practice would need to include gradual scaling up of projects to avoid common maintenance challenges and cost prohibitions.

**Self-Retaining Areas**

Self-retaining areas are landscape features that also provide stormwater runoff control and treatment. They only absorb as much water as soil and plants in the area can accommodate. Once the area is at capacity, water overflows via a storm drain. They are ideal for receiving roof runoff from downspouts and adjacent parking areas.

**Pervious Paving**

Pervious paving systems allow water to pass freely through interstitial space ingrained throughout the paving matrix, thereby transforming traditionally impervious surfaces. Several examples are pervious concrete and asphalt, interlocking pavers, and reinforced gravel and grass paving.

**Vegetated Swales**

Vegetated swales are shallow drainage ways that employ landscaping to stabilize the soil while providing water quality treatment through biofiltration. They are designed to remove silt- and sediment-associated pollutants before discharging to storm sewers, and to reduce the volume of discharge if soils allow for infiltration. The treatment area can be planted in a variety of grasses, sedges, and rushes, while the side slopes can be planted with shrubs or groundcover.

### *Campus-Scale LID*

The localized building-scale drainage network should feed into a larger campus-scale drainage network to handle overflows from large storm events. If stormwater storage and reuse is implemented in the future, these facilities should be located near campus facilities that demand high volumes of irrigation water (namely, the athletic facilities). Stormwater management will also overlap with low lying areas within permanent open space as a way to integrate with the appropriate uses of these areas. Campus open-space percolation landscapes will be designed to maximize evapotranspiration and infiltration. Water ponding will occur over a large surface area to maximize the loss of water to the atmosphere by the combined processes of soil infiltration, evaporation (from soil and plant surfaces), and transpiration (from plant tissues). These areas should not be designed as deep basins but rather as broader, shallow areas, potentially valuable campus landscape amenities that support native vegetation and wildlife habitat. (See Figure 8.10)

### *Campus-Scale LID Toolkit*

**Integrated Percolation Landscapes**

Percolation landscapes are large landscape areas filled with native vegetation that retain and infiltrate large volumes of stormwater. These areas do not need to be kept free of all activity; for example, trail networks can cross through them without adversely impacting their efficiency.

**Green Streets**

The addition of pockets or strips of vegetation within or adjacent to streetscapes provides a means for runoff to re-enter the soils through infiltration. These spaces also provide conveyance of both street runoff and flows from adjacent parcels to larger retention areas.

**Recreation Fields**

Recreation fields can retain and infiltrate infrequent storm events if designed to accept overflows from adjacent non-permeable areas, such as parking lots.

**Community Swales**

Community swales are planted water conveyance features that are linear in design to conform to the adjacent development zones (i.e., walkways, roadways, and buildings).

**Road or Campus Walkway Swale**

Road swales are shallow paved or stone-lined water courses integral with a vehicular or pedestrian circulation route. These conveyances often include intermittent inlets and are underlain by a collection pipe. The future trail network should be designed with stormwater infiltration swales to create a connected system on campus.

**Naturalized Channel**

A naturalized channel is a meandering, vegetated watercourse with natural banks. It is buffered from development zones by large uncultivated landscape.

***Figure 8.10:*** *Campus Scale BMPs*

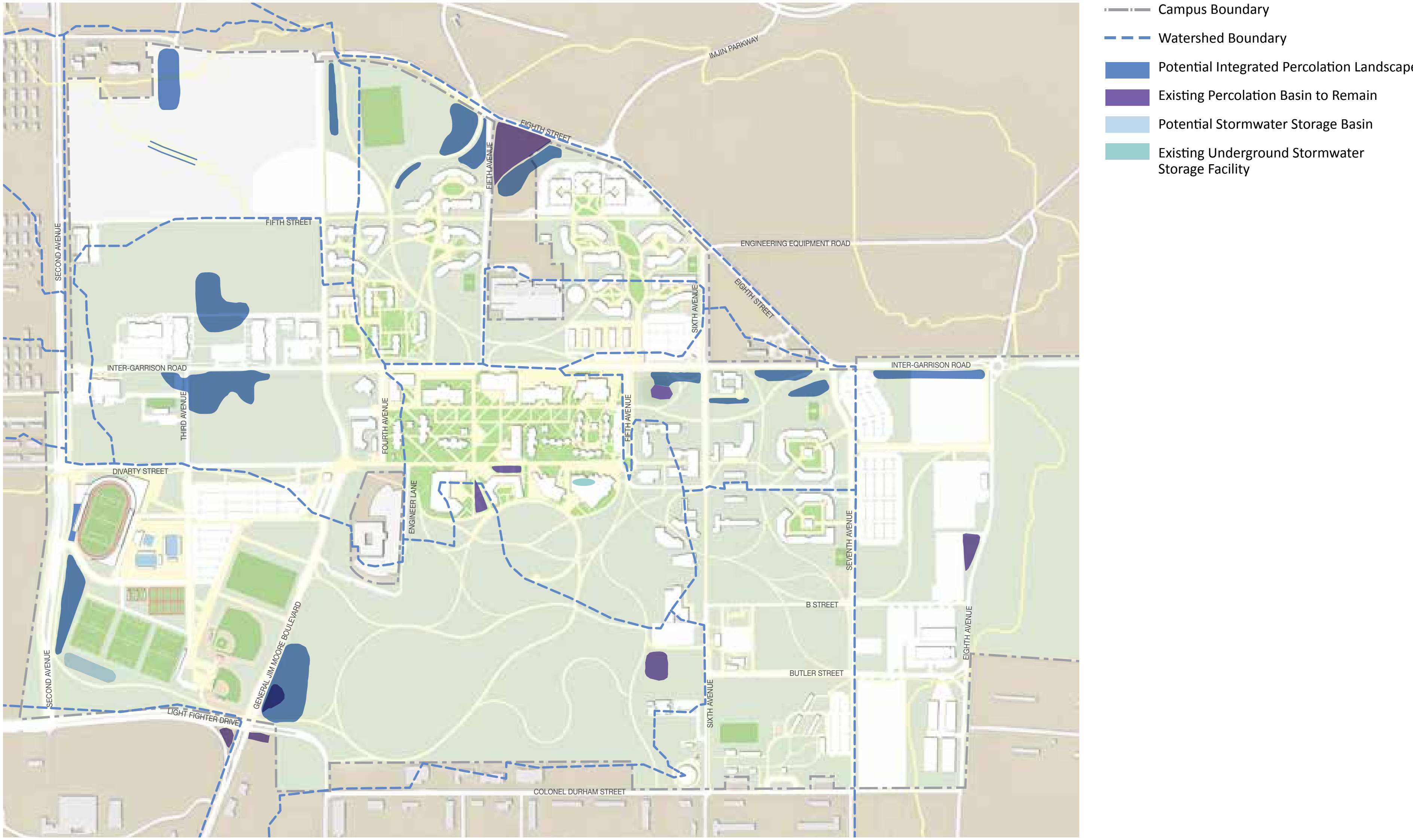


***Figure 8.11:*** *Proposed BMP Framework*