

V. Land and Facilities Plan

A. Building Plan

This section begins by examining how much land remains developable or re-developable without irreparable harm to one of the nation's most beautiful campuses. This look at potential development areas is from a long-term perspective, one often termed a "build-out scenario." The analysis shows that there are limited opportunities for new construction on the Main Campus and that many of them would require substantial investments in infrastructure that might make them financially infeasible. It also suggests that some of the Main Campus will be subject, at least in part, to redevelopment and that most major projects will need to evaluate the East Campus as an alternative to Main Campus development.

This section also includes the master plan for capital construction. Capital construction is defined as building projects costing at least \$2,000,000. Smaller projects usually do not appreciably change the utilization of space on campus, which is the focus of this master plan. The capital construction plan looks at potential projects in the next five years (through 2015) and in the six-to-ten-year time frame (through 2020).

The capital construction plan describes potential projects that will address the space deficits. It proposes specific facilities projects and discusses what they might cost. A location is proposed for some of these projects in the context of the long-range goals of the campus.

Finally, this section discusses the characteristics of building development. It describes the density goals of the campus, the desired architectural character, building safety, accessibility, and infrastructure necessary to support building development.

1. Potential Long-Term Development

Any discussion about the long-term development potential usually triggers people's passion for the campus. Some are concerned that too much development of the Main Campus may degrade its beauty. Others are concerned that the growing programs of the university and its obligation to meet the needs of the state of Colorado may be unduly constrained in the future. The long-term development potential of all university properties will be balance of these perceptions, combined with the programmatic and financial needs of the institution. There will be a greater utilization of land off of the Main Campus, primarily at Williams Village and the East Campus, with limited infill of specific areas of the Main Campus.

The long-term development potential described in this section is intended to guide the campus into a desirable campus land use arrangement. It should be used to

inform decision makers about the best place to locate campus development and to identify infrastructure that is necessary to support that development.

For the three proximate properties, Main Campus, East Campus, and Williams Village, the areas for potential development are identified in Exhibit V-A-1. The purpose of this map is to guide new uses onto building sites that can be developed while retaining or enhancing campus quality. The map identifies all the areas that are deemed developable during the master planning process. There is still substantial area for development, particularly on the East Campus and at Williams Village. In some cases, areas are identified for potential redevelopment, where underutilized facilities may be replaced with buildings that have higher and more beneficial use. The map indicates that many existing uses are best expanded adjoining their existing facilities. Existing facilities may be constrained and relocation may be the best option.

Utilization of all potential development areas would indicate a build-out situation, which is unlikely to be reached. The available sites on the Main Campus are increasingly limited and expensive. The purpose of Exhibit V-A-1 is to help ensure that inappropriate development does not occur.

a. Interpretation of Exhibit V-A-1

The Long-Term Development Plan (Exhibit V-A-1) indicates the potential areas of development in relationship to existing buildings and open spaces, both existing and planned. It should be interpreted as follows:

- Construction of new enclosed space is to occur within the designated area for development.
- The diagramed areas are building growth boundaries, not building footprints, and building development is expected to be within the boundary area.
- Open space areas, both existing and planned, are indicated to show the relationship of building to open space. Building development should be used to shape open space without encroaching on the open space.
- Only above-grade sites are shown. Underground building that is not disruptive of surface use should be permitted through the normal development review process.
- Arrows on the map extending from an existing building indicate that the adjoining development site may be needed for expansion of the program in the existing building. The potential building site should be reserved for the program expansion until such time as it is determined that the adjoining use will not need the site and it can be repurposed for an unrelated use.
- Areas indicated in purple could see new buildings and facilities over time.
- Areas indicated in blue are presently developed but are at the end of their expected life or are developed at a substantially lower density than surrounding

- areas, thus should be considered for redevelopment.
- Provisions of this exhibit apply to projects in that are subject to the capital construction process (in excess of \$2 million). Smaller projects should be evaluated through the normal development review process without the need to amend this plan.
- Construction of buildings outside of the designated development areas can occur by amending this plan.
- The boundaries of the development areas are not intended to be precisely located on the map. Edges can be adjusted to facilitate good design without amending this plan.

The development potential of the university is greatly increased over the previous plan by the densification of the East Campus and by identifying areas of potential redevelopment. There are 76 acres of potential development on all three developed Boulder campuses and another 79 acres of potential areas for redevelopment. The following sections describe each campus in more detail.

b. Main Campus Potential

The Main Campus has no substantial undeveloped acreage remaining. The useable real estate has been developed with buildings, parking lots, and improved open space. Development on the Main Campus will require removal and replacement of space in major redevelopment efforts or strategic infill developments that will meet the needs of existing programs. The limits and pace of redevelopment will depend on the amount of infrastructure improvements needed for the proposed project.

There are 41 acres on the Main Campus designated as developable areas. Approximately half (20 acres) of the developable sites are reserved for existing program expansion of adjoining uses and are indicated by an arrow on the map. Another 26 acres are proposed redevelopment sites where wholesale removal of existing buildings would be undertaken with the goal of increasing density by at least 50 percent. The remaining sites (21 acres) are potential building sites that could be considered for new programs, replacement programs, or expansion sites for existing programs.

Many of these sites are surface parking lots that may require replacement of spaces in structured parking once there are significant losses. There are two locations likely for above-grade parking structures: north of Franklin Field in Lot 396 and next to the Regent Autopark in Lots 436, 440, and 494. Additional parking under buildings may be considered for Lots 304, 306, and 308 if the development on that site has a public function. All these sites for parking are long-term potential parking facilities. The strategy during the 10-year period will be to develop remote parking lots and focus on transportation demand management strategies. (See section V-E, Transportation, for more information.)

There are substantial areas for redevelopment identified

on the map. On the Main Campus, these are primarily housing areas. Family housing facilities north of Boulder Creek are largely 40 to 70 years old and have not received any major renovations. Redevelopment will also occur in the Quad area east of Farrand Hall to increase density and at Kittredge Commons, now obsolete, to increase the number of beds.

Additional development on natural areas (prone to flooding or with steep slopes) or remaining recreation and green spaces that are needed for student life are inappropriate, as such development could compromise both safety and campus qualities. Open space may be moved and shaped to accommodate development but the overall loss of open space shall be avoided.

c. East Campus Potential

The East Campus has the largest development potential of the three developed campuses. Consistent with the previous master plan, the East Campus will become the main focus of development during the planning period and beyond. Originally designed as a low-density, suburban office park, it is now envisioned as a full university campus, with higher density buildings, a broad mix of programs, and a hierarchy of organized open spaces.

The higher density goal targets an ultimate buildout of 4 million gross square feet, perhaps 40 years in the future. This is an increase from the 1.6 million GSF originally planned in the Research Park and the 400,000 GSF of existing family housing and administrative space elsewhere on the East Campus. In total, there are 69 acres of developable area located on the East Campus.

Much of the existing development is subject to long-term redevelopment potential. Like the area north of Boulder Creek, family housing in Smiley Court is at the end of its useful life and will ultimately be replaced. The administrative and service area located on the north side of Boulder Creek is largely in the flood plain and redevelopment would require careful consideration of the substantial risk.

For additional information about the development potential of the East Campus, refer to Section B of this chapter.

d. Williams Village Campus Potential

The Williams Village campus is perceived as a residential campus for both student housing and faculty and staff. The east side of Bear Canyon Creek remains largely undeveloped with approximately 19 acres that have been designated for future faculty/staff/family housing development. On the west side of Bear Canyon Creek, 8 acres remain to be developed for student housing, support facilities such as dining, residential college facilities, recreation, and parking.

For additional information about the development potential of the Williams Village campus, refer to Section B of this chapter.

e. CU-Boulder South Potential

A conceptual land use assessment conducted by the university that was published in January 2002 defined the potential development area of the CU-Boulder South property. Of the 310 acres owned by the university, 81.50 acres are in natural areas that are unsuitable for development (e.g., in wetlands or outside the berm and subject to flooding). Another 10.40 acres are in ponds for irrigation or exposed groundwater. Another 49.19 acres are needed for potential flood storage on site to protect any on-site development, but which might be developed for recreation or athletics facilities. This results in a net of 165.23 acres that could be developed of which 32 acres could be expanded flood control storage to protect the community downstream.

CU-Boulder South continues to be studied jointly by the City of Boulder, Boulder County, and the university regarding flood potential and mitigation. No development of CU-Boulder South is planned during the 10-year period. The university will work cooperatively with the other governmental agencies on any flood mitigation strategies that might be developed.

f. Mountain Research Station Potential

The Mountain Research Station is the arctic and alpine field research facility of the university. The campus is 192 acres located near Ward, Colorado, with study centers located on Niwot Ridge in the City of Boulder Municipal Watershed. Development at the station is constrained by the available utilities and a desire to minimize development in favor of environmental investigation.

For more information about the development potential of the Mountain Research Station, refer to Section B of this chapter.



2. New Buildings Envisioned within 10 Years

The long-range plan shows where development would be appropriate. This section describes what specific development is planned in the 10-year time frame.

Exhibit V-A-3 indicates new buildings and major additions planned for the next 10 years on the three adjoining campus properties. The map shows:

- An illustration of the building footprint. The actual footprints will vary based on building design but what is shown indicates the relative size of the proposed project.
- A list of projects that may be updated periodically based on new projects or programs and funding.
- Major renovation projects where the buildings may undergo capital renewal projects or where sizeable variations will require adaptation of the building to a new program.

The map does not indicate smaller renovation projects that may occur to enhance programs or to update and modernize existing space.

The map corresponds to the capital projects list included later in this section. Projects on the capital list may or may not come forward during the 10-year planning cycle since the capital list has a longer time window than the campus master plan. Appearance of a project on the campus map does not ensure that the project will be realized in the planning period. Campus projects are selected and advanced through the capital construction process discussed in Section VI.

a. Main Campus Projects

The Main Campus will continue to see new construction but at a slower pace than the previous planning period. There are 20 new projects, major additions, or parking structures proposed. Most of the new construction on the Main Campus is focused on auxiliary enterprise functions such as the utility generation, the Student Recreation Center, residence halls, and family housing. Academic projects involve additions to the Engineering Center, Duane Physical Science Complex, and Norlin Library as well as a new Performing Arts Center.

In addition, 14 major renovations and capital renewal projects are planned, which highlights the university's desire to improve its existing facilities. Capital renewal renovation to Ketchum Arts and Sciences, Helms Arts and Sciences, Guggenheim Geography, Education, Clare Small Arts and Sciences, and McKenna Languages are proposed. Programmatic renovations of Ekeley Chemistry, Cristol Chemistry and Biochemistry, and the Fleming Building are likely to support change in mission for these facilities. Housing renovations will continue to be made to modernize facilities.

b. East Campus Projects

The East Campus will see new academic and research building development, primarily in the sciences. The

existing campus is composed of four main users: family housing in Smiley Court; general university administrative and research space located north of Boulder Creek; Intercollegiate Athletics facilities, primarily Potts Field and Prentup Field; and the CU Research Park. The Research Park is planned around a series of lease pods, which are being re-planned into a new arrangement in alignment with new density requirements and the desire to make it one integrated science campus. New buildings that are proposed include the completion of the academic wing of the Caruthers Biotechnology Building, a Chemistry and Life Sciences Building, Geosciences Addition to the McAllister Center, an addition to the LASP Space Technology Center, and several other new unspecified buildings for academic and research uses.

More detail about the new vision for the East Campus is included in Section B of this chapter.

c. Williams Village Projects

Additional student housing is planned for Williams Village. The final residence hall building may be constructed along with a new dining center that would be a scaled-down version of the Center for Community. Faculty, staff, and family housing may be constructed east of Bear Canyon Creek.

d. CU-Boulder South

The largest unmet needs for land are recreation fields to accommodate student demand, and intercollegiate athletics practice and competition fields for sports other than football. Development of the property for these uses may occur, depending on the outcome of ongoing studies of the South Boulder Creek floodplain being conducted by the City of Boulder and Boulder County. Infrastructure development, including potentially a large-scale photovoltaic array, may lead recreation and athletics uses.

e. Mountain Research Station

The Mountain Research Station is the alpine and arctic field station of the university. Its primary focus on environmental research is likely to grow in the next 10 years as research into the world's environmental problems accelerates. Development at the station will likely be to increase research facilities and to weatherize existing residential structures to increase the utilization of the station during winter months. For additional information about the Mountain Research Station, see Section B of this chapter.

3. Proposed Capital Projects List

Exhibit V-A-3 is a comprehensive list of all projects included in this plan. Each of these projects was discussed in the previous chapter within the land use categories—academic, service, athletics and recreation, or housing. Within these same categories, this exhibit indicates:

- Whether a program plan has been prepared.
- Whether a project has been funded.
- The approximate square footage (assignable and

gross).

- Whether the project is planned to be completed in 5 to 10 years (through June 2020) or 6 to 10 years (June 2025) or beyond.
- The estimated cost in 2010 dollars.

The master plan list catalogs all anticipated capital projects within the 10-year planning period. This list forms the pool of possibilities from which the five-year Capital Improvements Plan, the two-year cash-funded projects list, and the annual funding requests can be drawn.

Exhibit V-A-3 should be interpreted as follows:

- This list reflects the need, not the financial resources. CU-Boulder is committed to accomplishing as many projects as possible, but recognizes that the need and plan exceed the likely resources. The actual projects to move forward from this list will depend on a project's ability to raise funds.
- Only CU-Boulder projects are listed. Projects by the University System Administration, governmental agencies, and private tenants on campus may occur within developmental areas but are not listed on the exhibit.
- Projects may be added without amending the Campus Master Plan if there is a space need identified in this plan and a site is available within the potential development areas.

The list of capital projects shown in Exhibit V-A-3 attempts to reconcile the space needs described in Section IV.A with the potential funding stream to create a possible implementation plan. The needs far exceed the university's ability to build its way out of the deficit. Still the needs are so extensive that some building must occur if the institution is to obtain its strategic vision.

Exhibit V-A-3 can be compared to the anticipated space deficit found in Section IV.A to determine how much of the space deficit will be resolved during the planning period. For Academic space, there is a current deficit of 953,343 assignable square feet that grows to 1,157,131 assignable square feet by the end of the planning period, primarily due to the growing demand for research space. This compares to the proposed 900,426 assignable square feet that might be built during the planning period. Within the Academic category, there is also a great emphasis placed on renovating space through capital renewal projects and programmatic renovations. A total of 650,029 assignable square feet may be renovated under this plan to modernize existing facilities. While this does not add new square footage, the university intends to analyze these spaces to increase utilization and fit the right program into the right space, which may help to offset the demand for space without actually constructing new space.

Some of the capital renewal projects appear beyond the current planning period, beyond 15 years. The university is currently reassessing the priorities of the capital renewal projects and these projects may accelerate if the new criteria rank them higher than they have been in

the past.

A similar comparison can be made for each of the other categories listed in Exhibit V-A-3. In the Service and Administration category, 200,250 ASF is proposed against a need of 243,633 ASF. The proposed projects in this category are primarily infrastructure projects that address deficiencies on the Main Campus and begin to lay the foundation for growth on the East Campus. Renovations to the Power House are part of the infrastructure improvements planned. Renovation and potential expansion of the University Club would improve its usefulness, which has been underutilized since the university stopped providing overnight lodging.

In Athletics and Recreation, 247,750 ASF is proposed to meet a demand of 272,172 ASF. About one third of the added space will be for expansion and renovation of the Recreation Center. This project will likely impact the tennis courts, which will have to be replaced prior to or concurrent with the expansion. The remainder of the space will be added for athletics facilities. The new soccer/lacrosse stadium will facilitate East Campus development and the expansion of the Dal Ward Athletic Center is needed for Title IX compliance.

In Residential space, 1,162,150 ASF is proposed to meet a shortfall of 2,112,500 ASF. This largely reflects the condition of Family Housing, where the buildings are well beyond the useful life and should be replaced. It also reflects planned growth in undergraduate housing where additional buildings may be built at Williams Village and the Quad may be redeveloped to increase density on the Main Campus.

Colorado Revised Statutes 24-1-136.5(6) requires that a five-year capital planning be submitted each year to the legislature's Capital Development Committee. The exhibit and this Campus Master Plan go beyond that requirement to 10 years and beyond so that there is an understanding of when projects might be completed. The Five-Year Capital Improvements Plan is created from projects on the master plan list that are most timely. The CIP identifies proposed sources of funding and is revised annually as required by the state of Colorado.

Capital construction funding is allocated on an annual basis from fluctuating state of Colorado capital construction funds; internal university sources such as indirect cost recovery, auxiliary revenues, student fees; other governmental units, and from gifts and grants through fundraising efforts. The five-year plan may be achievable but depends upon successful competition for limited resources. A feasibility study or program plan would normally be underway in order for a typical state-funded project to be realized in five years. With new flexibility legislation passed in 2009 and 2010, cash-funded projects can be realized in three years or fewer, but are also likely to have started planning. Within 10 years, about 67 percent of the entire list may be achievable, depending on assumptions about future revenues.

4. Renovations, Capital Renewal, and Demolition

The University of Colorado Boulder is one of the oldest public institutions in the state. More than 80 percent of the buildings on campus are more than 25 years old and 45 percent are more than 50 years old. By 2015, more than 62 percent of all buildings will be more than 50 years old.¹ The oldest building, Old Main, is 134 years old. Yet the programs in these buildings are based on today's educational mission and technological sophistication.

The age of the campus presents many renovation challenges. Buildings in the 25-to-40-year-old range have many systems that are at the end of their useful life. Studies by APPA, the federal government, and private entities indicate that maintenance and renewal requirements reach a peak during this period, suggesting that there will be a substantial need for reinvestment. CU-Boulder's backlog of deferred maintenance is higher than peer institutions and its funding for maintenance has reached recommended target levels only twice in the past eight years. With these constrained resources, CU-Boulder has focused on resource conservation resulting in CU-Boulder having the lowest energy consumption of peers studied. The university will continue to make these types of investments and will make a greater effort in building renovation in the planning period.

There are three major types of renovation needs: those based on functional obsolescence, those based on regulatory changes, and those based on physical obsolescence. An analysis of the program requirements of the building occupants is used to determine functional obsolescence and whether an addition or replacement is required. Response to regulatory changes occurs when a mandate is passed by the federal or state legislatures. A building audit is used to determine physical obsolescence.

Building renovations are needed for several reasons, varying in size and complexity to address:

- Routine maintenance.
- Cosmetic upgrades done as maintenance.
- Safety deficiencies.
- Replacement of building systems and equipment that are often dysfunctional after 20 to 30 years.
- Functional updating of space to keep programs current (e.g., laboratory upgrades).
- Changes in use.
- Capital renewal of infrastructure and systems.
- Major renovation of buildings, including more suitable arrangement of space or for new programs.

Most major renovations are designed to address several of these issues at one time.

¹A 2009 analysis of campus building age by Sightlines indicated that CU-Boulder's facilities were some of the oldest buildings among peer institutions.

The campus regularly conducts renovations of buildings for functional, regulatory, and physical needs. Ongoing maintenance requirements and basic adaptations for new programs happen every year and are not specifically listed in this Campus Master Plan. In most cases, these types of projects fall outside threshold where they would meet the definition of major capital construction and are reported through other mechanisms.

Capital renewal is defined as a wholesale renovation of a building's infrastructure and systems. These types of projects typically replace plumbing, heating, electrical, and telecommunication systems as well as upgrade life-safety systems, without making major programmatic changes to a building's use. They are intended to make the building useable for another 50 to 75 years, although other renovations for programmatic uses could occur subsequent to the renewal. A greater emphasis is placed on these types of projects in this master plan. The Ten-Year Capital Plan lists seven capital renewal projects that will proceed as funding becomes available.

The Department of Housing & Dining Services executes a program that is between a typical maintenance renovation and a capital renewal. The Residential Annual Modernization Program (RAMP) is designed to update the appearance of residence halls without addressing either programmatic or major maintenance issues. A RAMP would typically address finishes and furnishings that are subject to greater abuse, such as carpet, wall paint, room furniture, and restroom facilities.

Major renovations occur when a building no longer meets the needs of its intended use. This could occur when a building has aged to the point where the programmatic arrangement is obsolete (e.g., Arnett Hall renovation, Ekeley Middle Wing renovation) or after a space has been vacated by a program (e.g., Fleming Building, Cristol Chemistry and Biochemistry). The scope of this type of renovation varies greatly depending on the extent of obsolescence or how closely the new occupant matches the vacated program.

The need to demolish Boulder campus buildings has traditionally been rare, with only two major buildings and six houses being removed in the previous 10-year period. This reflects the university's philosophy of building with the long-term view in mind, where academic buildings will last for one hundred years or more and non-academic buildings may last 40 to 50 years. This strategy creates the lowest life-cycle costs. As the university moves towards its sesquicentennial, some areas of campus are poised for redevelopment, necessitating removal of existing building inventory.

This master plan proposes that a significant number of buildings be removed in order to clear land for redevelopment. Most of these areas are in housing districts of the campus—north of Boulder Creek, portions of Smiley Court, the Dormitory Quad district, and the Kittredge Complex. The Long-Term Development

Potential Areas also indicates that academic areas in the core of campus and the research buildings north of Boulder Creek on the East Campus could be removed at some point beyond the planning period. Family housing stock is largely 40 to 70 years old and must be replaced. Wholesale replacement is contemplated along with floodway improvements along Boulder Creek. The need to add undergraduate housing likely will mean greater housing density on the Main Campus. This plan proposes removing Kittredge Commons (now rendered obsolete by the Center for Community) and replacing it with a residence hall and replacing the Dormitory Quad district (Aden, Brackett, Cockerell, Reed, and Crossman Halls) with higher density housing. These projects will require the removal of existing structures as a part of redevelopment.

Before a major building is demolished, a photographic record and basic information about the building are documented for a historical record, as has already been done for all buildings in the Grandview Area. Buildings proposed for demolition in the 10-year planning period are indicated in Exhibit V-A-4.



5. Density

Density is defined as the ratio of building area to site area and is usually expressed as floor-area ratio (FAR). Density is an important consideration in campus planning because it describes the relationship of buildings, activities, and services to their surroundings. Higher density and proximate adjacencies are desirable as they facilitate movement between classes and other activities, and can support communication between academic disciplines. Density also allows efficient delivery of services such as transportation and can reduce the need for the automobile.

Exhibit V-A-5 shows the density for the developed Boulder Campus Properties. The average density for the three developed campuses in Boulder is 0.40 FAR.

With the building types typical of CU-Boulder, some structured parking becomes necessary at density levels above 0.35 FAR if the same percentage of people continue to drive.

a. Main Campus Density

The Main Campus is the densest of the three developed properties, with a 0.58 FAR. Density on this property has been driven by the limited supply of land. There is an understanding that the opportunity to develop land does not come often, and that redevelopment is very costly. Thus, development that does occur typically involves maximizing the available land area, with one or two levels below grade, and three to five levels above.

This density has not gone unnoticed. A consistent theme of people who participated in workshops, task forces, and review boards has been that the campus is rapidly approaching the maximum density if not already exceeding it. There is a general feeling that the lawns and tree-lined walks of the traditional parts of campus are preferable to more urban environments. The higher population associated with higher building density requires more of the campus floor to be hard surfaces and pavement.

Redevelopment of undergraduate housing will increase density in the eastern quadrant and the Farrand Field area. There has been a general movement over the past 10-year period of density to the southeastern part of campus as projects like the Wolf Law Building, Koelbel Building, the Center for Community, the Smith Hall addition, and Volleyball/Basketball Practice Facility were constructed.

The Grandview area on the Main Campus is planned to be of a higher density in the long-term, partly because the historic areas around Varsity Lake to the south are considered “off-limits” for extensive development. Additions to some buildings are planned and some structures built as single-family homes will be replaced over time by larger institutional buildings. The planned maximum build-out at 550,000 GSF would mean an FAR of 1.47, which is similar to the area of campus around the UMC. This density would require structured parking in addition to transit already in the area.

Density increases on the Main Campus will be minimal, with most of the increase coming in the area north of Boulder Creek where housing will be redeveloped and limited increases in the southeastern sections. There will be little increase in the traditional core of campus. Overall the Main Campus density is expected to grow to 0.62 FAR.

b. East Campus Density

The East Campus is the largest underdeveloped parcel at CU-Boulder. The overall density of this area is 0.16 FAR, which is reflective of both its undeveloped nature and the large amount of land dedicated to flood mitigation. A large portion of the East Campus was planned as a research park for corporate and university clients and was planned for an overall density of 0.38 FAR. In practice, it was developed at a much lower density of 0.28 FAR. The original planning for the East Campus would have resulted in approximately 2 million GSF at build out or an overall density of 0.23 FAR.

This master plan proposes to increase density of the entire East Campus by doubling the planned square footage to 4 million GSF. This would raise the ultimate overall FAR to 0.46, and areas not subject to flooding would have a density matching the density of Main Campus at 0.60 FAR. The new Caruthers Biotechnology Building reflects this new density target. It and other buildings that may be built in the planning period will raise the overall density to 0.25 FAR.

c. Williams Village Campus Density

Williams Village is planned as a housing campus. It has been one of the most rapidly developing areas of CU-Boulder, nearly doubling its density in the past 10 years to 0.30 FAR. With the completion of Williams Village North, the density will be 0.34 FAR. The approved Master Site Development Plan calls for another residence hall and new support facilities that will raise the density to 0.42 FAR. Most of the density is located west of Bear Canyon Creek with a FAR of 0.48. The east side is undeveloped except for the University Residence and has a density of 0.01 FAR.

d. CU-Boulder South Density

The density of CU-Boulder South is near zero with one building sitting on more than 300 acres. No development is anticipated in the planning period, thus the density will remain near zero.

e. Mountain Research Station

The Mountain Research Station is another property that has a density near zero. This is reflective of its rural, mountain setting and its mission. Most of its development occurs within 41 acres of small buildings at the base camp. The density of this area is 0.02 FAR and may grow toward 0.04 in the planning period as laboratory additions and year-round facilities focused on environmental studies are constructed.

f. Other Properties

The university owns or leases other properties within

the city of Boulder. These are typically developed to the density of the surrounding properties. The largest such area is the area north of the East Campus. The Distribution Center (owned by the CU Real Estate Foundation) and the Center for Innovation and Creativity have a combined density of 0.40 FAR.

Other properties owned by the university such as the Academy are not included in this analysis.



6. Architectural Character

Charles Z. Klauder, leading architect of his day for many university campuses, developed the “Tuscan Vernacular Revival” style for the University of Colorado Boulder, designing 15 buildings from 1919 through 1939. Klauder explained his concept of a university campus as follows:

[A campus] should be a homogeneous, clearly to be apprehended scheme, in which there is a studied and happy balance of things, of buildings located with regard to their functions, importance, and architectural effect, of natural views conserved and topographical advantages skillfully exploited. Indeed, the development plan not only conserves views, it creates new ones in the form of delightful vistas projected between rows of buildings and ending at an imposing architectural mass embellished with entrance, tower . . . or else the view may be flung far into a magnificent distance or a lake, a river, a valley, or toward a distant mountain.

Functional arrangement of buildings, while preserving and creating views, is a defining characteristic of all of the CU-Boulder properties. One of the goals of CU-Boulder planning is to assure continuity of the Tuscan vernacular architectural style on the Main Campus. There is also the intent to assure contextual architectural quality on the other CU-Boulder properties.

The quality of the University of Colorado Boulder as an institution of higher education is reflected in its buildings—their quality, beauty, consistency, and permanence. The Main Campus is known and admired for its uniform architectural style and building materials palette. Sandstone walls, red tile roofs, limestone trim, and black metal accents are set in a verdant landscape against the mountain backdrop, providing an appealing sense of perpetuity.

a. Architectural Style

Klauder tended to design buildings symmetrical in plan and elevation. Succeeding architects have often designed asymmetrical campus buildings, while retaining the characteristic complex assemblage of forms, which is part of the delight in walking through the Main Campus. Roofs are gabled and hipped, cascading down from the higher building forms to the edges of buildings, respecting a human scale. Floor plates are narrow to capture cross ventilation and sunlight. Building wings often spread out from a central core, creating charming courtyards and forecourts. Recent buildings have built on the basic recipe for form, emulating some themes, but avoiding direct copying. Shed, pavilion, and flat roofs have been added to the Tuscan vernacular style, stretching the visual experience and reflecting a contemporary functionality.

Klauder’s design principles often suggest a transition from high forms near the center of a building to more modest forms on the periphery. A variety of heights and forms, without this pyramidal translation, has also

been successfully employed. Most building designs have been successful in keeping the scale of building in human proportions.

The textural building landscape for the Main Campus is one that retains much from Klauder’s work. Klauder utilized a palette of building materials that includes:

- Sandstone walls, quarried along the Front Range from Boulder to Loveland in colors from deep red to buff, stained with iron oxide, laid in a distinctive pattern (including flat sandstone “shiners”).
- Clay barrel-tile roofs, laid with red pans and covers of multiple hues which, from a distance, appear red.
- White limestone trim surrounding doors and windows, usually from Indiana quarries, sometimes from Texas and Kansas.
- Elaborate rustication of the limestone around major entrances.
- Ornamental limestone accents, including vertical oval “cartouches” (scrolled panels).
- Copper gutters (which over time oxidize to black).
- Black metal accessories, including wrought iron balustrades and decorative light fixtures.

Some precincts of Main Campus have developed distinctive adaptations of Klauder’s style, such as the board-formed concrete of Engineering Center buildings, or the unique cut of stone in the Kittredge Complex.

Materials should remain honest. There are many imitations of sandstone, limestone, clay tile, copper, and wrought iron, that when substituted result in a diminution of quality and substance. Substitutes should always be thought of as backup materials. When budgets do not permit the use of limestone, carefully specified and crafted poured-in-place concrete walls and precast concrete panels and trim have been successfully used. The Wolf Law Building uses black fiberglass panels which successfully emulate wrought iron spandrels on Klauder buildings.

Brick has generally not been successfully used on the Main Campus, despite several attempts, but brick is well employed as the dominant building material on the East Campus and Williams Village. Exterior wood is generally an inappropriate material for the buildings on the campus properties in Boulder. Yet wood is the dominant and appropriate exterior material for Mountain Research Station buildings.

Tuscan vernacular style has proved remarkably adaptable in housing the great variety of university programs, from parking garages to a planetarium. In response to new technology, unusual programs, advances in handling or storing materials, utilities operations, or special program offerings, building forms are both functional and continue the architectural distinctiveness of the Boulder campus. The versatile Tuscan vernacular style has been successfully adapted for 21st century uses.

The masonry walls, pedestrian scale amenities, and

open space variety on the East Campus and Williams Village create a family resemblance for all Boulder properties, but allow variation in materials, style, and cost. More references to the Main Campus style on these proximate campus properties would be appropriate.

New buildings, alternations, and additions are designed by institutional architectural firms, and reviewed by the campus architect and the University Design Review Board to assure continuity. Written design guidelines were prepared in 2007, and complement the more specific Building & Construction Standards, updated each year. For additional Main Campus design guidance, architects are urged to read *Body & Soul* by Campus Architect Emeritus William R. Deno, FAIA, and watch the companion video. Written design guidelines were prepared for the Research Park, but will likely be revised as master plans for that area are revised. The Williams Village micro-master plan provides architectural guidance for Williams Village. New buildings in the Grandview extension of the Main Campus should reflect the Tuscan vernacular in scale and form, but should use brick rather than sandstone.

b. Historic Buildings

Norlin Quadrangle Historic District buildings are of importance to the state of Colorado, documented by their placement on the state and national registers of historic places. In the designated district are both buildings designed by Klauder and those that pre-date Klauder. Newer additions to older buildings, such as Norlin Library and Ekeley Sciences, are included in the designation. Exterior alterations require advice and counsel from the State Historic Preservation Officer at the Colorado Historical Society, in addition to the usual reviews that take place for all campus buildings. Most of the Main Campus buildings pre-dating Klauder are highly valued and fit nicely with what has become the predominant style.

Many other buildings by Klauder outside the Norlin Quadrangle Historic District are of equal or greater significance. Over time, many of the older campus buildings are becoming significant to Colorado, local, and campus history. Any alterations to valued buildings on the campus deserve careful consideration. Building additions should generally continue the architectural character of the building to which they are added. Some of the structures at the Mountain Research Station are over 90 years old; consideration of the historic qualities of the buildings and the landscape should be considered as part of any new development.

c. Design for Ancillary Functions

The stylized roofscape of the Main Campus strongly suggests that rooftop mechanical and technological equipment be fully enclosed preferably, or at least hidden from view from the ground. Chillers, heat exchangers, and other equipment that is usually exposed on rooftops in commercial and industrial development

should be fully enclosed or completely screened on Boulder campuses. Exhaust stacks should be minimized, consistent with safety requirements, and integrated into the architecture. On flat-roofed buildings on all campus properties, mechanical equipment should be screened from view from the ground. These design goals have not always been met, which suggests the need for thorough design review.

Ancillary needs include service operations, adaptations to grade such as steps and ramps, all sorts of utility appurtenances, and identification signage. These often pose design challenges. CU-Boulder has adopted standards and review policies for some of these functions, such as for telecommunication appurtenances. Checklists have been prepared to help assure that program plans and schematic design adequately address service functions.

Many ancillary elements are further discussed in the outdoor areas plan (Section V.C).

7. Fire and Life Safety Consideration

Safety must be considered as development occurs. Increasing density increases the need for close attention to fire and life safety considerations. The level of life safety and fire protection of most CU-Boulder buildings is generally above normal for buildings of similar age, but at times below that of buildings built to current standards. Existing buildings are upgraded to meet or exceed the requirements of applicable codes for “existing” buildings. The durable materials of campus buildings, including masonry walls and tile roofs, contribute to fire safety. But the wide range of building uses, including the widespread use of chemicals in research and the presence of large assembly areas, inherently raises life safety and fire protection concerns.

Fire safety objectives include the protection of people and property, and continuity of facilities operations. In order to help ensure that these fire safety objectives are met, the fire safety features of many campus buildings should be maximized. The key to providing safety is ensuring adequate exiting and using a fire suppression system to prevent or minimize the spread of fires. An executive order by former CU-Boulder Chancellor Rod Park requires that all new buildings and renovations be equipped with a fire sprinkler system. This requirement has fostered tremendous improvements to life safety and property protection. Most major buildings now are protected with a fire sprinkler system and enhanced fire alarm system that is monitored remotely and continuously. Inadequate exiting has been addressed in several buildings like the Henderson Museum.

Each new capital project is reviewed to ensure life safety is maximized. Issues that are considered regarding the fire defense of campus buildings tend to fall in the following categories:

- Building/structural fire resistance.

- Code compliant fire barriers.
- Ignition prevention.
- Fuel control.
- Code compliant means of egress.
- Exit signage.
- Emergency lighting.
- Smoke management system.
- Fire suppression system.
- Fire detection and alarm system.
- Emergency notification system.
- Identification and mitigation of special hazards.
- Building services including emergency elevators and generators.
- Fire prevention including routine inspection of means of egress, storage rooms, and mechanical rooms for fire hazards.

Exhibit V-A-9, Fire Safety Status, indicates the status of fire sprinkler protection for all campus buildings according to available records. Buildings in which inadequate emergency egress has been identified as an issue are also indicated on the drawing. The plans to address emergency apparatus access are covered in the Transportation Plan (Section V.E). The university as an entity of state government is not bound by local building height restrictions. When constructing high-rise university buildings, where the highest occupied floor is more than 75 feet above the level of fire department response, care should be taken to provide built-in fire and life safety protection systems to the extent feasible, but never less than that required by applicable codes, since the responding fire department (City of Boulder for most CU-Boulder properties) may not have proper equipment and adequate expertise or personnel for high-rise fires.

Large building complexes, such as the Engineering Center, also warrant especially careful review. A fire sprinkler system in these complexes is highly desirable. The building size and complexities increase both the potential hazards and response time. Renovations or new construction should be arranged to minimize response time and take advantage of modern fire detection and suppression technologies.

Bridges between buildings, and below-grade spaces, are also of concern. These building features have increasingly been used to increase campus density. There are two emergency access and fire protection issues with such features: (1) limitations on fire department access, and (2) potential fire spread from one building to another building. Some bridges are designed for fire department access underneath the bridge, which is usually preferable, while others are not. To address the fire and emergency access, new construction should be designed such that there is always an alternative fire apparatus access route around a bridge or below-grade space. To address the fire spread potential, there should be fire separation walls and doors between buildings.

A process is in place to ensure an adequate plan review. Architects and engineers submit written code reviews

for construction projects. Campus authorities review construction documents and help ensure that code requirements are met. Compliance with code requirements includes interior building systems such as fire barriers, means of egress requirements, separation of buildings, emergency apparatus access, and adequate hydrants and water supply. New buildings are required to be fully code compliant. Renovation and remodeling activities are to meet the same standards to the extent practicable but normally exceed the code requirements for “existing” buildings.

A fire prevention and routine inspection program is established in order to reduce fire defense weaknesses attributable to misuse of the buildings and their systems, such as improper storage of combustibles or improper use of ignition sources. This fire prevention program provides occupant training as well as notification of code violations.

The Mountain Research Station (MRS) has distinctive fire protection issues, since it is somewhat remote, surrounded by forest, with buildings constructed largely of wood. The Facilities Management Department is undertaking efforts to upgrade utilities for this property, and the plan for the site (in Section V.B) proposes improvements to several structures, even though available resources are very limited for work at this site. In April 2010, a Fire Mitigation Plan was prepared for MRS. This Fire Mitigation Plan is to be implemented by Facilities Operations in coordination with the local fire protection district.

8. Accessibility

No otherwise qualified handicapped individual in the United States . . . shall, solely by reason of handicap, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving federal financial assistance.

(Section 504 of the Federal Rehabilitation Act of 1973)

The University of Colorado Boulder is committed to making all of its programs physically accessible for all persons. This requirement was extended to all branches of state and local government by Title II of the Federal Americans with Disabilities Act (ADA), which identifies:

- **Rights of accessibility, for which building design standards have been implemented.** The University of Colorado Boulder recognizes the advantages of integrating disabled students into programs and facilities. Requirements of the ADA are often exceeded to assure integration.
- **Building accessibility.** All new facilities on campus are designed to be accessible. Thanks largely to renovations funded in the 1990s, many of the academic buildings have received major ADA renovations. Many of the auxiliary enterprises of the university have been modernized since the last master plan, greatly improving access to students with disabilities.

Exhibit V-A-8 indicates the accessibility status of campus buildings on the three adjoining campuses (in 2010). Generally, there are four levels of accessibility on campus:

- **Fully Accessible.** These are new buildings or buildings that have had all accessibility renovations to essentially comply with the accessibility standards, i.e., ADA Accessibility Guidelines (ADAAG) or the Uniform Federal Accessibility Standards (UFAS).
- **Functionally Accessible.** Many of these buildings have had substantial renovations for accessibility but have some areas that remain inaccessible. These may be small tower rooms or mezzanine areas where full access is not possible, so functions or programs are duplicated in accessible areas.
- **Limited Accessibility.** These are facilities where accessibility is provided to one or more floors but large portions of the building do not comply with ADAAG. In these buildings and programs, significant program accommodations are made to ensure that access is maintained under Title II.
- **Not Accessible.** These buildings are not required to be accessible due to their function or because similar programs are provided in other buildings. For example, not all of the Family Housing units are accessible.

Analysis of the campus conducted in 2010 indicates that nearly 82 percent of the campus space falls into the fully accessible or functionally accessible categories. Family housing and smaller residence halls constitutes the largest block of inaccessible space on campus. This master plan intends to address these areas in the planning period.

The university is committed to providing access to all programs on campus. Accessibility provisions are part of all new construction and renovation projects on campus. Further improvements within existing buildings will be made as a part of renovation projects.



B. Micro-Master Plans

Micro-master plans are sub-areas that have been the subject of further study, either as a part of this master plan or during previous planning efforts. Two micro-master plans are new to this Campus Master Plan—the East Campus and the area north of Boulder Creek where family housing is located. Three micro-master plans are drawn from previous efforts—Williams Village Master Site Development Plan, Grandview Micro-Master Plan, and the Mountain Research Station Micro-Master Plan. A summary of the June 2002 Conceptual Land Use Assessment for CU Boulder South is included as reference. This section concludes with a brief overview of other properties owned by the university.

Micro-master plans are a part of the university’s planning process. They describe the direction of the overall concept for university development and serve as a guiding document for further planning and design. In some instances, that planning may have already occurred. The Williams Village Master Site Development Plan and the accompanying Design Guidelines were adopted by the Board of Regents at their October 2001 meeting. Major land use changes cannot occur without an amendment to this board-approved document. Minor updates to plans that do not materially change the land use planning are included and adopted through this document. For example, this Campus Master Plan reduces the parking ratio for residence halls from 0.5 cars per bed to 0.3 cars per bed to reflect the university’s sustainability goal to reduce vehicle-miles-traveled and the success of the educational campaign to reduce the number of cars brought to campus by residence hall students. This does not change the location of parking lots or parking structures, only the timing of when such a facility might be built.

In other cases, portions of a property may be covered by existing documents and the micro-master plan is proposing a major planning change. Designed in 1986, the Research Park is a substantial part of the East Campus. The Research Park Master Site Development Plan, Design Guidelines, and Covenants, Conditions and Restrictions (CCRs) remain in effect but should be evaluated and administered in light of the new planning direction until such time as new planning documents are adopted.

In cases where no previously adopted planning exists, the micro-master plan serves as the best information available. Planning and design decisions for projects that might occur in these areas should be administered and coordinated with the long-range planning described in the micro-master planning document.

1. East Campus Micro-Master Plan

The University of Colorado Boulder is growing as described in Section I of this Campus Master Plan. More space for learning and the creation of knowledge is

needed to support the endeavors of the institution. The Main Campus is approaching its build-out and development is becoming more difficult, requiring redevelopment of sites or major investments in infrastructure like parking and utilities. The East Campus offers opportunities to expand programs and services; reorganize teaching and research into interdisciplinary groups; construct new facilities without disturbing existing ones; and create a new, modern campus built on sustainable principles and traditional values.

The East Campus Vision Task Force met in the fall and spring of 2009–10 and discussed a strategic vision for what the East Campus might become. They envisioned a campus that physically resembled the Main Campus, with buildings organized in grids around green spaces. The buildings would be grouped in academic clusters that promote cross-disciplinary interactions. This micro-master plan embraces that vision and provides a basic framework by which it might be realized.

a. Existing Property

Largely undeveloped, the East Campus provides a clean slate in which to extend new and existing programs and an exciting opportunity to design for the future. The East Campus is generally bordered by Arapahoe Road on the north, Foothills Parkway on the east, Colorado Avenue on the south, and 30th Street on the west. The original 220 acres was acquired by the university in 1955. It was reduced to 201 acres with conveyances of rights-of-way given to the for the construction of streets and Foothills Parkway. A 4.3-acre strip sitting on the east side of Foothills Parkway was granted by the university to the Open Space Program as a preserve and for flood control. This area is still owned by the university.

The largely undeveloped land slopes gently to the northeast and benefits from the riparian landscape of Boulder Creek, Skunk Creek, Bear Canyon Creek, and retention ponds located on the northeastern edge. The retention ponds were added during the development of the Research Park, removing most of the southern property from the 500-year flood plain. The most current flood plain mapping provided by the City of Boulder shows a large conveyance zone running from Arapahoe on the northeastern edge of the property to the southern edge of Boulder Creek. Recent mapping of the South Boulder Creek basin indicates that water flows down Foothills Parkway and may increase the flooding potential of the eastern edge.

The East Campus is composed of four general land uses—the CU Research Park; family housing apartments at Smiley Court; the athletics facilities of Potts Field, Prentup Field, associated out buildings, and the Ski Shed; and the area north of Boulder Creek that has research and service functions. The Research Park is the largest of these areas and has the largest development potential. Originally planned in 1987, it was conceived as a suburban office park, where parcels of

land would be leased to university or private companies. They would then build stand-alone buildings surrounded by parking and landscaping. It was originally planned for 1.6 million gross square feet of which approximately 550,000 gross square feet was built prior to the construction of the Jennie Smoly Caruthers Biotechnology building. The suburban nature of the Research Park has resulted in very low densities and great expanses of underutilized parking lots. Smiley Court is approximately 230,000 gross square feet and there is approximately 564,000 GSF in 17 buildings north of Boulder Creek. Some of these buildings are not considered significant nor are the 6,400 GSF of miscellaneous athletics buildings.

b. Preliminary Planning

In 2005, university staff began investigating what the ultimate carrying capacity of the site might be if exclusively reserved for university uses. Shapins & Associates was retained to explore various options. They determined that the road and utility systems would likely be able to support an increase to 3.2 million gross square feet south of Boulder Creek and that the north side of Boulder Creek might accommodate up to 800,000 gross square feet with flood mitigation. Their plan, called the “Shapins Plan,” retained the curvilinear street pattern but introduced quadrangles and courtyards similar to the Main Campus. Building heights and massing were three to six stories and parking was a major form determinant. One key element of the plan was the relationship of the formal open space areas and the natural drainage ways and wetlands. The Shapins Plan was determined not to be desirable because, among other things, it did not create a phasing plan for implementation, and the orientation of many building masses created a walled edge condition along Colorado Avenue.

During the planning of the Caruthers Biotechnology Building, the design architect, Robert A. M. Stern & Associates, developed an alternative plan to test the building concept in light of the desire to increase density. The “Stern Plan” focused on creating a more traditional feel to the land planning of the campus. Two large quadrangle spaces were proposed, around which the various academic buildings would be arranged. The curvilinear roadway system would only be retained where it presently exists but otherwise, the urban grid would be extended into the campus. Unlike the Main Campus, the layout of the buildings was not strictly orthogonal, but rather a combination of buildings laid out parallel to Colorado Avenue, and buildings laid out in relationship to the McAllister Center (formerly occupied by USWest/Qwest.) The latter building, aligned tangentially to Foothills Parkway, resulted in the layout of some buildings unrelated to others. The Stern Plan showed that the 3.2 million gross square feet could be accommodated on the south side of Boulder Creek with buildings no taller than the six-story biotechnology building. The north side of the creek became relocated sports facilities, thus

lowering the available density¹. Because the Stern Plan was focused on ensuring that the new biotechnology building was properly positioned to allow maximum development, it did not fully consider the how the entire site would develop. The plans use of the urban street grid did not adequately resolve how misaligned streets would be resolved and there was a perception that there was no defined center to the campus.

3. Micro-Master Plan Process

The micro-master planning process began with the work of the East Campus Vision Task Force. The task force brought together a diverse group of faculty, researchers, staff, and students that defined the programmatic vision of what might be located on the East Campus. From their work, five interdisciplinary academic clusters emerged:

- Life sciences.
- Geosciences and environmental sciences.
- Energy.
- Astrophysical and space sciences.
- Computational sciences.²

These clusters would be interdisciplinary centers that would integrate along science lines, rather than traditional college departments, and would encourage partnerships with federal laboratories, national institutes, and elements of the social sciences. The campus would not just serve science. The task force recommended that graduate housing, support facilities, and cultural facilities be integrated into the plan so that the area was a true “campus” in total sense of the word.

With the program defined, Facilities Planning staff began integrating the programmatic requirements defined by the task force with the best elements of the Shapins and Stern plans. The plan, described below, was then presented to several boards and commissions as well as the administrators and deans. One additional element, the need for an area to construct market rate office space at a suitable rental price point to attract federal partners was added to the program requirements.

During reviews and approvals, there was generally strong support for the direction of the plan. Additional planning is necessary for the full concept to be developed. During meetings with the university’s Design Review Board, there was significant discussion about the plan and some of its elements. This discussion is documented below and may lead to some modifications to the ultimate new plan.

¹ The Stern Plan was artificially constrained by a criterion that uses had to be onsite and that athletics facilities could not be relocated to any other university property.

² The original task force report called for the fifth cluster to be social sciences, which was changed during subsequent discussions to computational sciences. Social sciences were not seen as being an independent cluster but rather integrated into the other clusters as appropriate, much the way the Center for the American West is a part of the geosciences cluster.

4. The Plan

This plan integrates the quadrangle plans of the Stern Plan with the relationship to open space of the Shapins Plan. The plan is shown in Exhibit V-B-1 and provides a general framework for future planning efforts but is not intended to necessarily be the final disposition of the land use planning. The Stern Plan established a new quadrangle as a part of the building project that is extended by this plan. The new quadrangle will be 290 feet across and 1,160 feet long, which will bring it to the edge of Boulder Creek. An extension of the center line of Shadow Creek Drive to the center line of this quadrangle creates an intersection point that becomes the relational center of the campus. This point becomes the origin from which the remainder of the campus is organized.

a. Pentagon/Pentacle Grid

The Main Campus uses a series of axial relationships between entrance elements to organize campus buildings and outdoor spaces (see Exhibit V-A-2). The Main Campus is strictly orthogonal and creates a unique sequence of experiences approaching buildings and entrances. The East Campus Micro-Master Plan proposes to impose a pentagon/pentacle grid on the property as the organizational element. From the origin point, grid lines are extended at 0o, 36o, 72o, and 90o on both sides of true north. Along the grid lines extending at 36o and 72o, secondary nodes are located in a phi relationship at 618 feet, 1,000 feet, 1,618 feet, and 2,618 feet. From each node, a new set of grid lines can be established and the intersection of the radiating grid lines creates new nodes that become new starting points and so on as needed.

A pentagon/pentacle grid has several advantages:

- The radial nature of the grid allows more relationships to be developed, allowing the randomly placed existing buildings to be tied to new development.
- The grid intersects itself at phi ratio other grid lines. The phi ratio is the same ratio as is found in the “golden section.” By using this relationship, the spaces, distances, and features remain well proportioned.
- The grid is fractal and can be broken down or scaled up to any size, thus a relationship can be established between any two points.
- The grid’s 72o angle is a close to the angular relationship of the LASP Addition (tangential to the Discovery Drive at 70o) and the McAllister Center (perpendicular to Foothills Parkway at 80o). Projected from the origin, the N72oE line passes nearby the former Sybase building creating a relationship that can be used to tie it to the rest of the campus.

The grid can be used then to set up development parcels for the rest of the campus and lay out circulation paths that will ultimately coordinate with the future development. The nodes, particularly at 1,000-foot

intervals from the origin, are key points that should be celebrated with a prominent feature. The origin point should have a memorable feature such as a large fountain or a campanile. Secondary nodes would be suitable for fountains or public art.

b. Street System

Like the Stern Plan, the urban street grid is extended into the campus by continuing 33rd Street from Arapahoe Road south over Boulder Creek; a street opposite to Shadow Creek Drive can be extended in from 30th Street; and Discovery Drive can be adjusted toward the origin point to create a street pattern that relates the urban grid to the new campus form.³ Also, 33rd Street from Colorado Avenue is extended to the Shadow Creek extension, and a loop road around the McAllister Center completes the main street system.

c. Academic / Research Clusters

The streets surround large parcels that become the blocks for buildings grouped in programmatic clusters. Two of these blocks have large quadrangles that, like the main quadrangle, have one end enclosed by the natural areas of the creek systems. The programmatic clusters are arranged thus:

- **The Life Science Cluster** is arranged around the main quadrangle. The Jennie Smoly Caruthers Biotechnology Building is located on the southeast corner of this block. The Chemistry and Life Sciences Building is proposed as a sister building with a similar footprint. Four more building sites extend north along the quadrangle for future programs as they are determined.
- **The Space Sciences Cluster** is the area of the Research Park Pod H and extends to the north, across Discovery Drive. Three more building sites exist before redevelopment is necessary.
- **The Computational Cluster** is the area of the Research Park Pod G, between Discovery Drive and Skunk Creek. Two building sites with parking are indicated.
- **The Environmental Cluster** is between Discovery Drive and Foothills Parkway. It includes the McAllister Center, which is being considered for lease by programs included in the geosciences proposal. This cluster has four large building sites available for development.
- **The Energy Cluster** is along both sides of Skunk Creek and adjacent to the Boulder Creek drainage way. This cluster includes the former Sybase building and four other potential clusters.

This distribution of clusters, site circulation, and poten-

³ The plan included in this micro-master plan shows Discovery Drive intersecting with the center point along a 72° grid line. This was done because of the existing utility infrastructure and phasing constraints caused by the need to relocate athletics facilities. The street could also come in to the center point at 90o, opposite the road from Shadow Creek Dr.

tial building sites is proposed as the best suggestion based on the growth that is planned today. It should not be considered absolute. Programmatic needs, interdisciplinary opportunities, and existing uses may dictate that sites be utilized differently than indicated. This is allowed under this plan.

Other uses support the academic and research endeavors of the East Campus. Family housing for students, faculty, and staff should be redeveloped along the 30th Street edge. City staff indicate that the 30th Street corridor will likely be redeveloping and that an urban edge is an appropriate response. This location is also more proximate to Scott Carpenter Park and within walking distance of retail services at Twenty Ninth Street Mall and the Sunrise Shopping Center at 30th Street and Arapahoe Road. Redevelopment of Smiley Court is needed since these buildings are near the end of their useful life. Increasing the density of the site should be an objective.

A public function space is reserved for the center of the campus near the origin point of the grid and at the intersection of Innovation Drive and Discovery Drive. This should be filled by a program that draws people to this part of the campus. An appropriate use might be a natural history museum, food service facility, theater or large auditorium, or recreation facility.

Administrative space continues to be located north of Boulder Creek, along with service space for the Department of Housing & Dining Services. The plan indicates property that is owned presently by the university; however, it may be necessary to purchase or swap land with owners along Arapahoe Road in order to obtain rights of way for 33rd Street and to create better commercial parcels along Arapahoe Road.

A site for a potential central utility plant is provided along the eastern edge. Utilities could be looped along the grid lines from the plant.

5. Transportation

The East Campus is a 10-minute walk from the eastern edge of Main Campus, a 30-minute walk from the western edge. Providing an efficient reliable connection between the campuses without dependence on single occupancy vehicles is paramount to the success of a large-scale development. Internally, major pedestrian routes and bikeways should reinforce the grid system. Wherever possible, modal separation should be provided between walkers and wheeled vehicles. Between campuses, some improvements have been made along Colorado Avenue but additional improvements would enhance pedestrian and bicycle flow. A connection should be planned from the underpass at 28th and College to 30th and Colorado; improvements could enhance the connection along the Boulder Creek Path; the south side of Arapahoe Road could connect family housing development to the academic functions;

and improvements along 33rd Street could link the East Campus with the Boulder Transit Village and Williams Village.

Creating a robust transit system will be important if the East Campus is to reach its full development potential. As noted in the Transportation section (Section V-E), the East Campus is not as well served by transit at the Main Campus, resulting in a higher number of single occupant vehicle uses. CU-Boulder will need to work with RTD and the city to improve transit service from outlying areas to the East Campus.

The success of the East Campus will rely heavily on inter-campus transit service. Plans are underway to re-route the Stampede service to provide 10-minute headway both directions on Colorado Avenue. As other lines are introduced into the , CU-Boulder should see if these lines can be adapted to economically increase service between the two campuses. The Buff Bus should be examined to see if it can be expanded to include the East Campus.

Parking will need to be built as the campus develops. The amount of parking will depend on the level of transportation demand management and alternative modes available. At present, parking on the East Campus is overbuilt and additional parking is only needed for convenience. An effective inter-campus transportation system combined with surplus spaces can provide remote parking in surface lots for both the East Campus and the Main Campus. Sites on Exhibit V-B-1 are indicated for potential parking structures but these structures will not be needed until the density of the East Campus approaches 0.35 FAR, which will likely be 20 years or more in the future. Development in the intervening years may make other sites more attractive and limited surface parking within development pods may further reduce the amount of structured parking needed to support the plan.

6. Building Plan

The originally adopted plan produced by Downing Thorpe and James in 1987 was modeled on a suburban business park with pods to be privately developed. A number of buildings including the McAllister Center, Center for Astrophysics and Space Astronomy (CASA), LASP Space Technology Center, and Sybase were built within this plan and have no relationship to each other. The pentagon/pentacle grid described above provides a guide for future building layouts. Building shapes should be aligned to reinforce the major open space and circulation paths. While the Main Campus is strictly orthogonal, buildings at angles of 36o and 72o should also be allowed.

The building plan reserves the center of the East Campus as a “Market Rate Overlay Zone.” This area of the campus is intended for development of buildings that are simple and economical to construct so as to be

leasable at a per square foot rate that is competitive with private sector leasing rates. These types of buildings are deemed necessary for attracting federal partners to the university. The interior sites are likely to be the last to develop long-term buildings and the visibility of these sites is less than the more prominent edge sites. Market based buildings will likely not have the same level of durability of campus buildings thus could be demolished after 30 or 40 years in order to make way for whatever building or program might be needed at that time.

7. Outdoor Areas and Landscape

The outdoor areas are divided into three main classifications: natural areas of the protected wetlands and the drainage areas, landscape buffers along the edges of the East Campus, and formal quadrangles that are surrounded by buildings. Each area has its own particular role.

The natural areas indicated in Exhibit V-B-1 are areas where development cannot occur, primarily due to the natural flooding hazard that is present. The northeast corner of the site is dedicated wetlands with no access. Surrounding this is the natural area used as a buffer from the riparian creek environments. Circulation paths, like the Boulder Creek Trail, are acceptable uses and are encouraged. These areas may be part of an overbank excavation to control flood. Use for formal recreation may be permitted if it does not impede the function of the overbank channel.

Landscape buffers are present along 30th Street and Colorado Avenue. These should be reinforced with similar plantings and treatments to create a unified edge to the campus and to set back development from the street.

Quadrangles are outdoor spaces for formal events and functions that might occur on the East Campus. As on the Main Campus, these serve as informal play areas, gathering sites, locations for student rallies and displays, and a place for graduation ceremonies. Because of this, the turf material must be durable and capable of handling programs. See Section V-C for materials that would be appropriate for use in these areas. Tree canopies are encouraged in the quadrangles to provide shade. Consideration should be given to the type of environment that is currently present: that of a flat plain along a river valley, which suggests that the plantings should be more deciduous trees rather than conifers. Each building project that abuts an outdoor area, particularly the quadrangles, will be responsible for developing their section of that particular open space.

Landscape areas that are not part of the defined outdoor areas should be designed to reflect the programmatic requirements of the buildings to which they are associated. Buildings may require courtyards, lawns, plazas, contemplative gardens, gathering spaces, or other types of functions. Each of these should be

planned with careful consideration to the micro-climate that will be created by the building being developed. Wherever possible, native and hardy adaptable plants should be used as appropriate to the micro-climate in which they are to be located.



2. Main Campus, North of Boulder Creek

The University of Colorado has identified the area north of Boulder Creek as an area appropriate for redevelopment. The North of Boulder Creek Framework Plan sets an overall framework for the mixed-use redevelopment of this area. Goals for redevelopment of the area are designed to enhance the academic mission of the university by:

- Providing housing for graduate students, students with families, faculty, and staff.
- Providing academic space and academic support spaces.
- Providing space for athletics, recreation fields, and adequate open space.
- Developing stronger connections with the Boulder community by improving connections and providing floodway improvements.

a. Setting

The area is located along the northern edge of the Main Campus of the University of Colorado Boulder, separated by Boulder Creek and a rise south of the creek of approximately 60 feet to the Main Campus. The site, roughly 50 acres including the creek area, currently houses graduate and family housing apartments, athletics practice fields, and parking areas. The site is bounded on all sides with existing development ranging from the Main Campus to the south, Boulder High School to the west, mixed residential to the north, and regional retail to the east.

Topography north of the creek is generally flat, sloping slightly from west to east. The site is home to mature shade trees and unique riparian habitat along the Boulder Creek corridor. Views include the Front Range Mountains and the Boulder Creek area. The site is easily accessible with close proximity to varied community services.

b. Planning Process

The area north of Boulder Creek was identified early on as an area of concern. Family housing is deteriorating and in need of replacement, flood concerns after incidents in Fort Collins raised issues of safety, and the need to attract graduate and international students (the major demographic groups of family housing) all promoted this area for additional study. One of eight task forces was assigned to examine the area and make recommendations on how the area should develop (see online appendices: Task Force Reports).

Once the Task Force Report was adopted, Facilities Planning formed two working groups—one comprised of internal stakeholders and one of external stakeholders—to begin the process of developing a recommended plan. Each stakeholder group was interviewed separately and a list of goals and objectives was developed. This was combined with the desired outcomes from the

task force report to become the working program for a design charrette.

The charrette was held at the Millennium Harvest House with both stakeholder groups present. The group was broken down into three subgroups and each was given a program and basic massing block that they were asked to place on a map of the area. The three groups developed low, medium, and high density scenarios and then the group discussed the strengths and weaknesses of each proposal. Facilities Planning then created the draft plan and circulated it back through stakeholder groups for comments. The final adjusted draft became the basis of the plan presented in this Campus Master Plan.

c. Building Plan

At full development, there is the potential for 1,500 apartment style living units¹, 270,000 GSF of academic or community space, and over 15 acres of recreation and athletics fields. The redevelopment of the site would utilize existing infrastructure systems and relieve pressure to develop CU-Boulder South in the foreseeable future.

The location, building mass, and land use will transition between the existing medium densities of adjacent housing north of the western half of the site, to higher density housing in the central portion of the site. The southeastern quadrant of the site is anticipated to be recreation and athletics fields that can also accommodate floodwater detention. The northeast corner of the site has the opportunity to be developed as university housing or to be reserved for a more public use, assuming that desired densities can be achieved on other parcels.

The site is intended to be a housing mix of students and other university affiliates. The concept is to provide a vibrant community that takes learning beyond the classroom or research lab and encourages interdisciplinary discussion amongst neighbors as described in the Flagship 2030 goals for university villages.

d. Transportation

An extension of the urban grid is proposed to provide a network of pedestrian, bicycle, and vehicle pathways. Marine Street will be extended through to Folsom Street, which will create a new “Main Street” and relieve traffic congestion on Arapahoe Avenue. Marine Street would accommodate bus shuttles to other parts of campus and the city. Improvements to the existing Boulder Creek Path and development of an accessible pedestrian route up the hill from the creek to the campus will be necessary for non-motorized access to Main Campus.

¹ Initial studies indicated that the maximum carrying capacity of the site would be 1,900 apartment units if all underground parking was used and the first floor of each building contained non-residential uses. That was deemed too costly and a mix of parking options would be more likely, yielding a lower number of units.

Close proximity to the campus, community shopping, and entertainment limit the regular need for cars. There are many modes of transportation that currently serve the north of Boulder Creek area. Downtown Boulder and most of the commercial shopping centers are located less than a mile from the center of the site. The area is a perfect example of a site that can accept transportation demand management (TDM) strategies.

e. Phasing

Transportation, site, flood, and housing market absorption studies will be required as a first step. These studies will help to identify development limitations and timing for the increase in housing of the area. Based on the finding of these initial studies a detailed master plan, including design guidelines, can be developed. The goal is to have the first phase of housing redevelopment start in the middle of the planning period. Private development of housing on university land is a development approach being considered in order to minimize university debt incurred.



3. Williams Village

After a 1998 study of alternative sites for student housing, the Board of Regents selected Williams Village as a preferred site for new student housing. The November 1999 Williams Village Micro-Master Plan sets the overall development framework for the site. The main land-use planning documents for the site were the August 2001 Master Site Development Plan and the Design Guidelines that were adopted by the Board of Regents in October 2001. The land use and planning principles were examined as a part of this master planning process and deemed by and large to still be relevant and it was decided that the prior plan should be extended for the duration of this planning period. Where appropriate, minor adjustments to the adopted plan are identified in the text below.

a. Setting

The 66-acre site has two high-rise residence hall complexes, a commons facility, and two mid-rise apartment-style housing buildings. A new mid-rise residence hall is scheduled for occupancy in August 2011. Other amenities include surface parking areas, two soccer fields, four tennis courts, and other recreational facilities. Much of this relatively flat site east of Bear Canyon Creek is underdeveloped. The creek and the associated floodway bisect the site, with a multi-use path along its west bank. The University Residence (home of the CU-Boulder chancellor) is on the east side and is accessed from the Frasier Meadows neighborhood.

b. Building Plan

At full development of the site, there is the potential of about 500 additional undergraduate student beds in residence hall or apartment-style living units west of Bear Creek. This could accommodate a third of the projected growth in undergraduate housing during the next decade and provide relatively affordable, conveniently located housing. The housing proposed east of Bear Canyon Creek would help meet the backlog for family housing. East of the creek, there is the potential of about 200 units of graduate/family and faculty/staff housing. The goal is to maximize the family oriented housing while maintaining a lower profile compatible with the adjacent neighborhood and within the site capacities, keeping all residential buildings out of the floodway.

Conference and Residential Academic Program (RAP) space is provided and used in conjunction with the undergraduate housing. Recreational facilities for all students will be maintained, although possibly relocated, including two soccer fields and four tennis courts, plus informal recreational fields and facilities provided for the on-site student population.

The location, mass, and demographics of housing development will transition between the existing tall towers and single-family housing to the east. Facilities housing undergraduates will be situated near the existing towers. Lower density faculty/staff housing will be next to the

Frasier Meadows subdivision to the east. Between the two will be housing for graduate students and students with families. Exhibit V-B-3 shows the relative arrangement planned for the different housing types. In all, there is the potential for about an additional 330,000 additional interior gross square feet.

Centrally located recreation fields and outdoor areas for more passive uses are to be maintained and expanded. Open space within the housing areas is based on a hierarchical system of courts and plazas, recalling elements of the Main Campus.

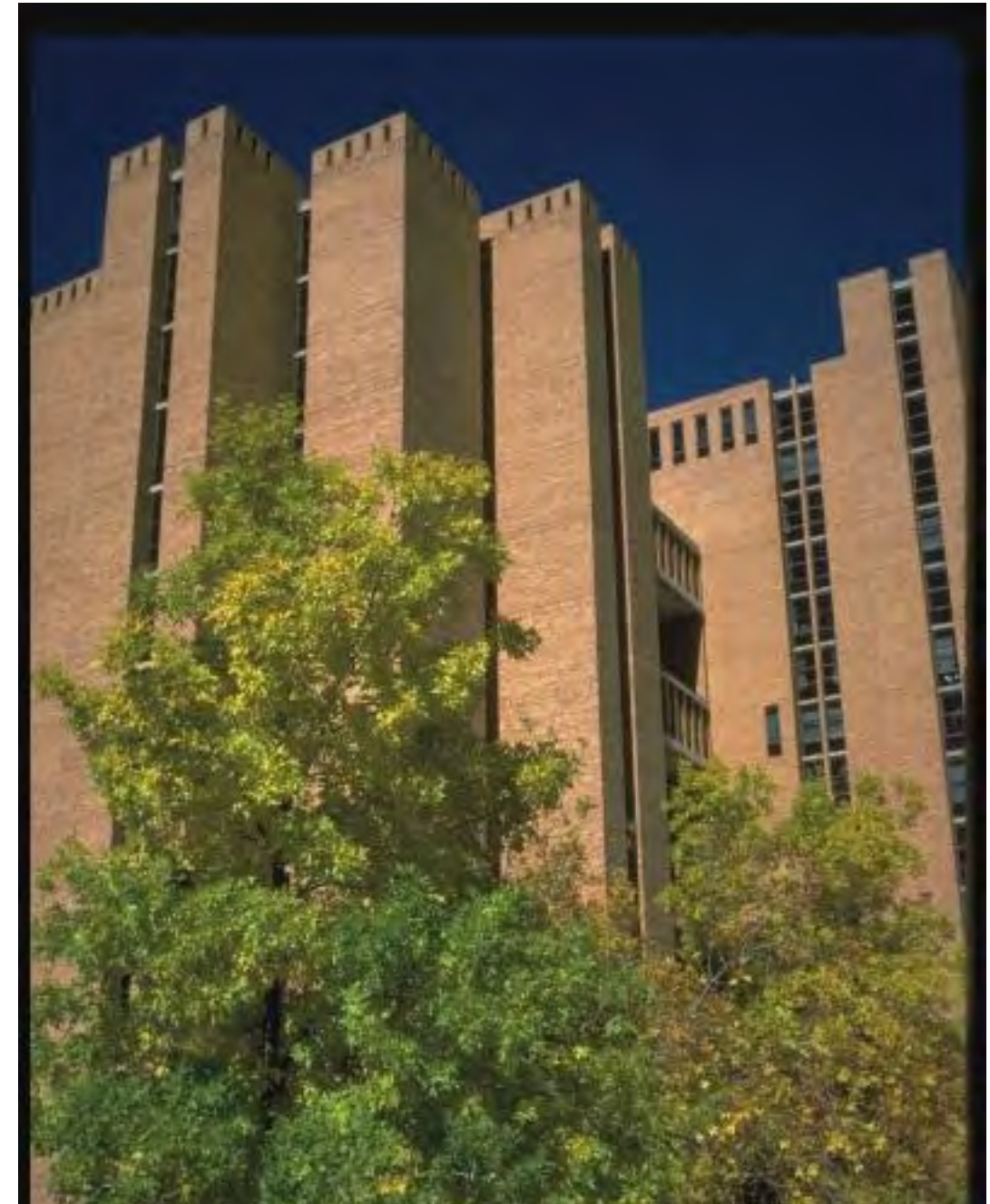
c. Transportation

An extensive network of walkways will serve pedestrians and bicyclists, including links to the Main Campus. Apache Drive will be looped back to the intersection of Baseline Road and 35th Street. The university will work with the City of Boulder to complete vacation of Apache Dr. (currently a city street) to facilitate development potential for the site. Minor streets will collect traffic onto this loop road. Faculty/staff housing will be accessed from this loop assuming new bridges over Bear Canyon Creek prove feasible. The loop road will accommodate a bus shuttle to other parts of the campus and city. Transportation linkages to adjacent neighborhoods will be limited to pedestrian and bicycle pathways. Roadway linkages are limited to discourage vehicle traffic between adjacent neighborhoods and the Williams Village campus.

To date, parking has largely been accommodated in surface lots. Ultimately, to accommodate the projected housing and to maximize open space, a combination of transportation demand management strategies and structured parking will be necessary. As noted in the Transportation plan (Section V.E) the parking ratio for the site can be reduced from 0.5 spaces per bed to 0.3 spaces per bed for the residence hall population. This reflects improvements in transit and the educational campaign by the university to reduce the number of cars brought by first-year students to campus.

d. Phasing

The goal is to continue development of the west side of Bear Canyon Creek and renovation or replacement of Darley Commons dining center within the first half of the planning period. More undergraduate student beds are possible within the planning period depending on student demand. Private development on university land is an approach being considered in order to minimize university debt incurred. The public/private funding model could be used to expedite development of the east side of the creek should there be developer interest.



4. Mountain Research Station

The Mountain Research Station (MRS) is located at an elevation of 9,500 feet in the mountains west of Boulder. The MRS site contains approximately 192 acres and is completely surrounded by the City of Boulder Watershed, Indian Peaks Wilderness Area, and Roosevelt National Forest. Development consists of approximately 65 buildings, including laboratory and office space, housing (a lodge and detached bungalows), a dining hall, a bathhouse, field shelters, storage, facility shops, and a garage. The total gross square footage of these buildings totals only 31,200 gross square feet (23,800 assignable).

As one of the top five non-oceanographic research stations in the environmental sciences, the MRS is one of the premier alpine research centers in the world. The site is nationally unsurpassed for research and teaching about alpine ecosystems, and places CU-Boulder at the forefront of research into the impacts of global warming. Since the last master plan update, total grant support for research projects using the MRS as a base have quadrupled from \$3.6 million to \$14.5 million and in 2011, researchers at MRS received the largest single award to CU for environmental sciences of \$5.9 million. The number of researchers has almost doubled from 31 to 56 in the same time period. Undergraduate field courses are at capacity and will need additional classroom space if they are to grow.

To promote CU-Boulder's leadership position in the area of environmental research science, the primary goals for the MRS are:

- Providing housing (detached bungalows) for senior research scientists.
- Providing logistical support (dry labs) for research scientists.
- Upgrading the MRS infrastructure, both technological (in conjunction with new computational laboratories) to support research scientists, and physical (maintenance garage).
- Increasing the amount and types of teaching supported by the station by providing additional classrooms.
- Managing reduction of risk due to wild fire events by establishing and implementing a comprehensive fire mitigation plan that includes: personnel training; creating defensible spaces around buildings; fuel reduction zones; road widening to allow emergency vehicles; completion of a second emergency egress route from the MRS; the installation of a cistern for water storage; the creation of fire-resistive spaces to provide emergency shelter in the event evacuation is not possible; completion of a campaign to upgrade the fire-resistance of existing buildings; and, perhaps in conjunction with a new maintenance garage, provisions for a type 6 wildland fire vehicle.

Secondary goals for the MRS include:

- Increasing the public outreach programs of the station, particularly to K-12 institutions and organizations.
- Continuing the conversion of the station from a summer-only to a year-round facility.
- Improving the public image of the station commensurate with the educational experience.
- Enhancing the relationship between activities at the station and activities on the Main Campus, in part by integrating station research with Main Campus research.
- Considering the addition of off-site parking to accommodate future growth and restrict internal guest vehicular circulation.
- Developing stronger connections to the rest of CU-Boulder by diversifying the activities offered at the station.

a. Setting

The developed portion of the station sits on a south-facing sub-ridge below Niwot Ridge. Exhibit V-B-5 shows the entire property and highlights the developed portion, which appears in more detail on the next exhibit. Most of the older buildings are sited along the 9,500-foot contour along the ridge, stretching the developed area out in an east-west line. The highest building is the water collection building at an elevation of 9,575 feet, and the lowest is the sewage treatment plant at an elevation of 9,390 feet.

The site slopes steeply to the south. Almost all areas exceed a 1-to-8 slope. Many of the level areas are boggy and have springs, suggesting high ground water. Future development will likely occur in areas with a slope. Care must be taken to minimize site impacts relating to cut-and-fill, as well as proper drainage around structures.

Como Creek traverses the site from northwest to southeast near the developed portion of the site. This creek is part of Boulder's water source and is home to the Greenback Cutthroat Trout (*oncorhynchus clarki stomias*). The creek has one of nine original populations for the trout, which is listed as a threatened species.

The University of Colorado Boulder is committed to maintaining and improving the habitat for the Greenback trout. The station installed a new wastewater treatment plant in 1999 and has worked extensively with the U.S. Fish and Wildlife Service, Colorado Department of Game and Fish, Boulder County, and the City of Boulder on management strategies. The new treatment plant adds capacity for more intensive residential uses while maintaining protections for the Greenback Trout population in Como Creek.

New development must recognize the sensitive nature of Como Creek during design and construction. No new structures should be located within 50 feet of the creek and only limited improvements should be made to existing structures within this zone. Construction techniques

must minimize soil erosion and prevent deterioration of stream quality. Site improvements will be limited to the restoration of existing natural habitat, using native and natural materials found within the vicinity of the Mountain Research Station.

The soil characteristics of the station site vary across the site. In 1997, excavation for the new hostel revealed 10 to 14 feet of glacial till in the center portion of the campus. The eastern side of the site has a much thinner deposit of till, with large rock outcroppings, suggesting bedrock much closer to the surface. The western end of the campus has numerous springs and it is likely that glacial till in this area has a high water table.

The mountain campus remains vulnerable to natural wildfire events and has been studying various responses. The mountain field station for Colorado State was destroyed by a wildfire in the mid-1990's. Twenty trees have been recently removed which were too close to existing structures. The creation of firebreaks, however, may cause more harm than good as sub-alpine crown fires will usually jump any fire breaks while allowing invasive species a foothold as they tend to flourish in cleared areas. Furthermore, the site's steep topography makes tree removal very difficult. Fire breaks also increase wind-borne damage and worsen the effects of drifting snow.

Reducing wildfire risk by tree-culling (due to pine-beetle infestation) has been considered as well. However, as it is just as likely that a tree suffering mortal pine-beetle infestation is as flammable as a drought-ravaged green tree, culling beetle-infested trees should not be considered as a sole remedy for reducing risks from wildfires. Rather, all existing or proposed development areas should develop and maintain a plan of defensible spaces that considers trees of any kind as potential fuel sources.

b. Building Plan

The following table (Exhibit V-B-4) shows how space is used at the MRS and what additional space is required to meet programmatic aspirations. The usual space standards are not designed for such a unique site, so this table has been prepared based on the specific programs conducted at the station.

The existing utility infrastructure and topographic setting determine where development can occur. The proposed land use plan reinforces the existing land use pattern and corrects some land use anomalies. All future design and construction should consider at a campus-wide level both wildfire mitigation and accessibility (passenger loading zones, restroom facilities upgrades, and accessible routes within the site from public facilities to sleeping and/or dwelling units).

As shown on Exhibit V-B-6, six potential building sites are proposed within the year-round lower shelf area.

Four western sites (Sites A, B, C, and D) are located where a logging mill was demolished and are relatively level. Sites C and D are best suited for the more public functions of the station, such as classrooms, computer labs, and research facilities with public interface. Sites A and B should be devoted to researcher housing. Site E, located east of Marr Laboratory, is appropriate for a computational lab or other expanded research functions similar to the existing Marr and Kiowa Laboratories. Site F is located at the top of a ridge and ideally suited for an astronomical observatory. One building site (Site G) is proposed within the service zone and is suitable for a garage and maintenance structure.

**Exhibit V-B-4:
Mountain Research Station
Space Requirements
Space Usage by Area**

	Description	Existing Space	New Space Needed	New Space Total	Percentage Increase
1	Teaching	1,611	500	2,111	24%
2	Research (dry lab)	2,253	2,400	4,653	52%
3	Research (computer lab)	567	500	1,067	61%
4	Housing	9,169	2,600	11,769	22%
5	Facilities Management	3,308	2,400	5,708	50%
6	Food Service	2,221	0	2,221	0%
7	Administration	1,382	0	1,885	0%
	Total ASF	20,511	8,400	28,911	29%

The Kiowa Lab Addition (currently under design) will add 1,000 GSF of flexible laboratory and teaching spaces. Should a new teaching/lab facility be built, it would be best located near the Kiowa and Marr Labs. There are also plans for a new telescope and observatory, adjacent to the existing observatory, paid for with private funds. The observatories remain unaffected by metropolitan levels of light pollution found on Main Campus.

The upper shelf area will remain intact as a housing zone, primarily for seasonal-use. The area is populated by small cabins and the Moores Collins Family Lodge, which accommodates short-term guests and is the major outreach tool for K–12 groups and research conferences. Groups of 50 guests are typical during the summers, although the MRS can accommodate a maximum of 70. The capacity of the Dining Hall is limited only by the dining room size, as the kitchen remains underutilized. The main teaching space is in the Megaron Building, a timber structure constructed in 1928. Although no new seasonal housing projects have been added to the prioritized list of capital construction projects, a new lodge located near the S Cabins would be welcomed as it is feared that the campus' lack of capacity in this regard has resulted in the loss of summer bookings. The lodge, in the form of a single-story bunkhouse (ski huts have even been suggested) could be expected to house not more than twenty short-term guests.

Nearly all the structures within the residential zone constitute the original camp settlement. Many of the structures are over 50 years old, some of which date back to the original camp. This creates a unique character to the buildings that adds to the experience of students and researchers. Capital development should consider the architectural richness of existing structures during planning and design of new and renovated structures.

One of the greatest assets of the station is the experiential educational programs. Developing nature trails throughout the site could strengthen these programs. The trails could also be used to improve site circulation, separating pedestrian and vehicle circulation. Astronomy classes are increasing.

The buildings at the station are aging and small by institutional standards. Most of the needed renovation and additions can be done as small projects, falling below the \$500,000 threshold for capital construction. Installation of 'fire mesh' at locations vulnerable to burning embers (i.e., vents and the undersides of elevated floor platforms) needs to be completed. Cabins used for long-term researcher housing should continue to be winterized as necessary.

Some capital construction projects have been identified for the later years of the planning period (to 2018), if resources become available. All future projects should consider the inclusion of fire-proof shelters or areas of refuge in the building program. These include:

- Priority #1: Locate a housing cluster for senior research scientists at Building Sites A or B. The new cluster of four 715 GSF "duplex bungalows," each with two bedrooms (one as a lock-off) and a shared kitchen and dining area, estimated at a total of 2,900 GSF (2,600 ASF)—\$1,300,000.
- Priority #2: A research laboratory, estimated at 3,000 GSF (2,400 ASF)—\$1,800,000.
- Priority #3: A maintenance garage, 3,600 GSF (2,400 GSF)—estimated to cost \$850,000.
- Priority #4: A computational lab, estimated at 900 GSF (500 ASF)—\$550,000.

These four projects should be considered opportunities rather than as yet proposed capital projects. They would be added to project lists and the five-year CIP only after full programmatic review.

c. Circulation

The site is accessed almost exclusively by vehicles using Boulder County Road 116. Vehicles coming to the station park in one of four small parking areas. The preferred on-site circulation is for visitors to park remotely and walk about the campus. The increased number of visitors and automobiles during the summer overwhelms the campus, and is therefore discouraged. During the winter, the main road is closed at the Marr Lab and during the summer at the "borrow pit."

At the main station campus, pedestrians share the roads with automobiles. Currently, there is not enough vehicle traffic to warrant separating the flows. Other pedestrian flows are related directly to research operations. Researchers usually follow the power lines up the hillside until they come back to the road, then hike the road onto Niwot Ridge.

Future expansion of the MRS should consider keeping the campus a pedestrian campus only, except for service and research vehicles. All future plans for the MRS should account for the campus' densely wooded forest location and life-safety requirements for rapid evacuations in the event of encroaching forest fires. A secondary road from the MRS leads to Sourdough Trail only and does not provide a second means for evacuations. The campus maintains an evacuation plan that involves a cooperative agreement with the City of Nederland and the use of its school buses in the event of an emergency evacuation.

d. Utilities Infrastructure

The MRS is in a remote location thereby requiring it to provide many of its own utilities. The station has its own water and wastewater plants, and relies on Xcel Energy for its electrical power.

A wastewater treatment (tertiary) plant has been built and has a summertime capacity of 16,875 gallons per day (GPD) and a winter capacity of 1,688 GPD. After the water has been treated, it is held in a pond before being released into Como Creek.

These two utilities create upper and lower boundaries to development at the station. In addition, agreements were necessary with the City of Boulder, Boulder County, and the National Forest Service regarding water use and discharge that essentially cap utilities at these levels. These factors must be considered in planning and design of new structures and ways of maximizing their potential must be used. Sustainable design techniques should be considered as development occurs on the campus, such as composting toilets, gray water systems, and raw water distribution systems for fire protection.

Electrical service comes from an overhead Xcel transmission line that crosses through the site. Telecommunications systems are as good as those on the Main Campus. The MRS transmits data through a wireless network on Sugarloaf, having scrapped a fiber optic cable (T1) that was too expensive. The Marr and Kiowa labs have full university voice and data systems. A separate fiber optic line was installed to the D1 site on Niwot Ridge to provide real-time data feeds from the measurement equipment. Capacity exists to expand the system as the campus grows; however, a growing number of mobile devices continue to be kicked off the network due to a limited number of IP addresses, although researchers with static IP addresses are unaffected.

Propane gas is the main heating fuel for winterized buildings at the station. Surface tanks are located near the buildings they serve. The propane distribution system was recently upgraded to meet current demand, but it is likely that new development will need to provide an independent service.

e. Phasing

Highest in priority at the MRS is construction of the four duplex bungalows for researcher housing, either partially or in their entirety. Next in priority for the MRS would be a research lab, followed by a computational laboratory. The research lab should be designed for flexibility as possible classroom spaces. A new maintenance garage facility will be needed regardless as the MRS extends its operations.



5. CU-Boulder South

The purchase of the CU-Boulder South property in 1997 was a strategic acquisition to help ensure the long-term viability of CU-Boulder, which remains land-deficient in accommodating its projected institutional needs. The property acquisition was a part of ensuring Front Range locations for higher education services for the citizens of Colorado.

a. Setting

The CU-Boulder South property, previously known as the Flatirons or Gateway property, is a five-minute drive along U.S. 36 from the Main Campus, at the intersection of U.S. 36 and Colorado 157. See Exhibit V-B-5. The property consists of 308 acres in unincorporated Boulder County, contiguous to the southeast boundary of the City of Boulder. CU-Boulder South is not far from other Boulder County cities and lies along the rapidly developing U.S. 36 corridor between Boulder and Denver. Louisville is two to three miles east. Urban services are nearby, including those of the City of Boulder and the city of Lafayette (which has part of its water system, Baseline Reservoir, one mile northeast).

Gravel mining occurred on the site prior to its purchase. Following acquisition, the property was re-vegetated under a Colorado Mined Land Reclamation Board permit, which is still currently open. The mining eliminated much of the original natural character of the property, in contrast to the largely undisturbed adjoining City of Boulder open space east of the property. CU-Boulder South adjoins existing urban development to the north and west, and a good portion of the site is essentially flat. An existing on-site improvement remains today as a concrete warehouse (14,173 ASF) used for university departmental storage. Use of the building is 100 percent recharged back to Research Property Services. Athletics constructed further improvements in 2003, when the Kittredge Tennis Courts (Varsity Courts) were moved to CU-Boulder South. Twelve tennis courts, spectator seating, and parking for 125 cars covers approximately 525,000 square feet. The tennis court complex is supported by portable restrooms only as no permanent restroom facilities have been constructed to date due to restrictions by the City of Boulder.

South Boulder Creek adjoins the property. Most of the property is outside of the South Boulder Creek floodplain according to FEMA (Federal Emergency Management Agency) mapping. The portion of the property south of an existing berm is likely to remain in the 100-year floodplain of South Boulder Creek. Cooperative efforts are underway with the City of Boulder, Boulder County, and the Urban Drainage and Flood Control District on a consultant's study to update flood hazard mapping and develop a new floodplain management plan for the South Boulder Creek watershed. A master plan for South Boulder Creek will include the hydrologic

information and other facilities and appurtenances needed to provide mitigation of flood hazards within the South Boulder Creek study area. A local drainage-way, Viele Channel, also crosses the property and should be studied further.

b. Building Plan

A 2002 conceptual land use assessment for CU-Boulder South identified site opportunities and constraints for the purpose of strategically locating facilities that have been developed.

In the short-term, CU-Boulder expects to continue use of the property for outdoor tennis facilities, pedestrian and bicycle trails, grazing, storage, and a cross-country running course. Outdoor research projects may also occur at CU-Boulder South, for example those related to plant ecology and environmental biology. Minor spectator facilities associated with the tennis courts have been built, but development of additional athletics fields and support facilities are not planned at this time.

c. Transportation

The site has one developed vehicular access, at a traffic signal on Table Mesa Drive just west of U.S. Highway 36. Local and regional bus routes serve this access location, with nearly direct access to Main Campus. There is a developed open space trail crossing the south portion of the property. Additional options for access will be evaluated prior to significant additional development.

d. Phasing

No development of facilities is anticipated within the planning period. Environmental, flood, wetland, and species mitigation issues continue to evolve. Studies will help identify any limitations that should be addressed, respected, or mitigated.

This property can play a significant role in providing land for CU-Boulder needs for the future, but additional development is not anticipated during the term of this Campus Master Plan. The property is an increasingly important strategic asset to help ensure that CU-Boulder can continue to provide quality education for the citizens of the state of Colorado. Improvements could be considered should outside agencies approach CU-Boulder with requests related to flood protection, drainage improvements, wetlands management, or related community infrastructure improvements on the property for the benefit of the surrounding community.



6. Grandview

The University of Colorado Boulder identified the Grandview Terrace area north of University Avenue as a logical area for expansion of the Main Campus and began acquiring the properties in the early 1960s. In 1990, the Long-Range Facilities Master Plan for the campus suggested that most of the acquired buildings in Grandview should be demolished and replaced with new, larger buildings in order to provide needed academic and research spaces. In 2000, a micro-master plan was prepared by Shapins & Associates and used to form a basic understanding about the development potential of the site. In 2001, the university and City of Boulder signed an agreement that was later overturned by the courts; however, both the city and university have continued to abide by the terms of the agreement when discussing land use issues in the area. The 2000 plan has been reconsidered in this Campus Master Plan. Although specific development plans for the area are flexible, a plan has evolved preserving some of the 1910 to 1930s era bungalows in the area, retaining useful buildings for institutional use, and identifying sites for the needed new buildings. For these reasons, the basic Grandview plan is being extended for the length of this planning period.

a. Setting

The Grandview area, located on the northwest edge of the Main Campus, is bordered by Broadway to the west, University Avenue to the south, and 17th Street to the east. To the north are the Andrews Arboretum, Boulder High School's football and track facility (Recht Field), and an enclave of single-family homes along Hillside Drive. Grandview is perched above the bluff rising from the Boulder Creek floodplain.

The university owns 26 buildings totaling approximately 193,000 square feet of building space in Grandview, including approximately 60,000 in the new Institute for Behavioral Science building. Structures are generally of modest size, including a few mid-sized buildings (a sorority, and others used as office space) and two dozen smaller 1910 to 1930s era bungalows (most of which have been used for various university offices). The bungalows generally are in poor condition and not easily accessible to mobility-impaired persons.

Although the Grandview area comprises less than 11 acres, not a large portion of the total campus, it is of strategic long-term importance to the university because of its proximity to the campus core. Grandview is within a reasonable walking distance from the existing academic buildings on campus, and much of Grandview is within the "ten minute class change area." Future growth of hard science areas is planned to be directed to the East Campus, but the Grandview area is important for growth of social sciences academic and research spaces located in the Main Campus core and within a reasonable walk.

b. Building Plan

Exhibit V-B-6 is the Micro-Master Plan map for Grandview. The Grandview long-term potential development area (as shown on Exhibit V-A-1) has been divided into two sub-areas: an area generally to be preserved and area generally to be redeveloped.

In recognition of historic preservation concerns and pursuant to its understanding with the City of Boulder, the university maintains an agreement with the city creating a 25-year preserve for bungalows it owns facing Grandview Avenue between 13th and 15th Streets as a part of the 2001 Campus Master Plan. Under the agreement, which will extend through 2025 as it pertains to the preserve, the university will not demolish or relocate bungalows within the preserve except as specified, during the term of the agreement. The bungalows in the preserve may be used in a number of ways, including university academic/research uses and housing rentals.

The rest of the university-owned property in Grandview is a redeveloping area. This includes both new and renovated buildings to provide needed academic space, including research. Incidental non-academic space uses are also possible, including day care, food services, housing, and transportation facilities such as structured parking. Three of the university buildings on the perimeter of Grandview will continue to be used as university office space during this planning period: 1505 University Avenue (Continuing Education), 1511 University Avenue (the Armory, housing the School of Journalism and Mass Communication), and 1546 Broadway.

Ultimately, the Grandview area could accommodate over half a million gross square feet of buildings if it were to be fully developed, but that is not planned during this planning period. The Proposed Capital Projects List (Exhibit V-A-3) lists a potential building project within the Grandview area totaling 100,000 square feet. Uses for the proposed development have not been specified but the site is considered suitable for several potential campus needs. Taking into account buildings removed, the net change in space will be less.

Suitable transitions between the campus and the surrounding city will be included in future building plans. Redevelopment at the corner of Broadway and University Avenue is desirable to help create a more appropriate corner and entrance to the campus. Any new development in Grandview will reference but not re-create the Tuscan vernacular architectural style of the Main Campus, which helps define CU-Boulder, much as the new IBS building does. In summary, the building plan retains aspects of Grandview's historical development, proposes an increasing synergy with the Main Campus north of University Avenue, and provides for new, more functional university spaces.

c. Transportation

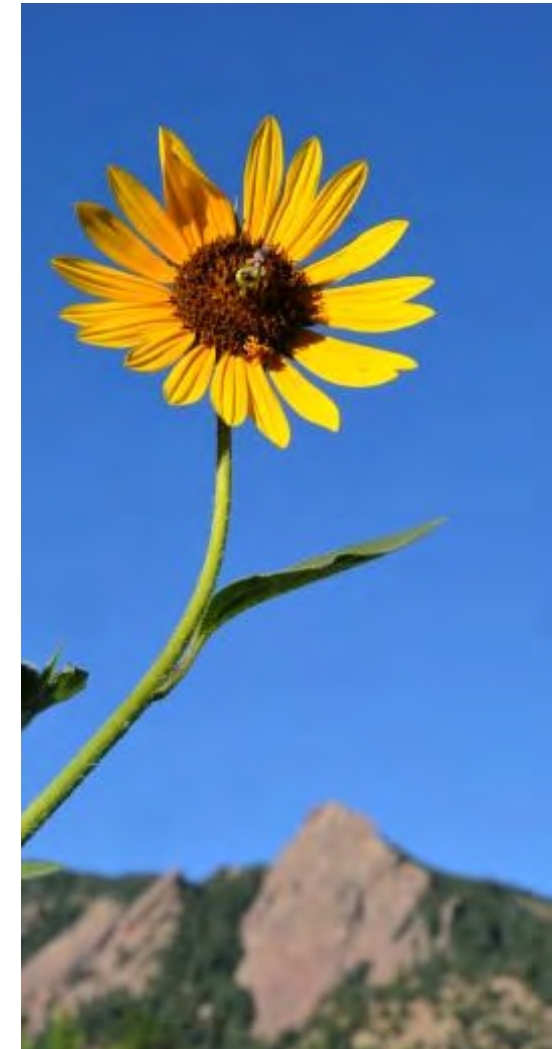
Many modes of transportation serve the Grandview

area. Pedestrian access is safer due to improved crossings of University Avenue developed during 2000 in a joint city and university effort. In the future, a new pedestrian overpass of 17th Street is envisioned to provide an improved link to Macky Auditorium and the Main Campus. As part of the Grandview Agreement, the city has vacated 13th Street from its intersection with University Avenue north to the southern boundary of Grandview Avenue and from the northern boundary of Grandview Avenue north to the northern boundary of the Grandview area. Certain public alleyways in the Grandview area have also been vacated. This permits an increase in the size of building footprints and facilitates the conversion of some land from vehicular-oriented use to pedestrian-oriented use. Where there is now an unsightly alley between Grandview and University Avenues, a new west-to-east landscaped pedestrian spine is envisioned.

There have been a maximum of 470 parking spaces in the Grandview area between Broadway and the Armory, including non-university spaces, but not including spaces along University Avenue. With the vacation of portions of 13th Street and adjacent alleys, along with demolition of smaller structures, it may be advantageous to reconfigure some surface parking and roadway areas to provide better utilization of the land and increase availability of parking in the area. Long-range development plans indicate that some of the parking will need to be in structures as parking demand grows and as surface parking is eliminated by development. Parking will be integrated into academic or housing development where feasible to minimize its visual impact.

d. Phasing

Some structures will be removed. Where buildings are removed, there may be interim land uses such as parking lots and/or landscaped spaces. The university likely will continue to acquire some of the remaining privately owned buildings shown in Exhibit V-B-6. The pace of redevelopment will depend on many things: acquisition of land, usage of existing buildings, timing of demolitions, identification of space needs, consideration of site suitability for identified needs, and availability of funding.



7. Other Micro-Master Plans

Periodically, other micro-master plans are prepared for campus areas, such as the five discussed in this section, and campus topics, such as outdoor lighting. Micro-master plans have a narrower focus and greater level of detail. Micro-master plans are usually adopted by CU-Boulder, rather than by the Regents representing the entire university, but some have been approved by the Regents.

Some of the following micro-master plans are referenced in this plan, and have links to the existing plans.

Other still applicable micro-master plans as of this writing include:

- Fischer Field Physical Sciences Micro-Master Plan, 1989, by Peter Heinz Architects
- Mary Rippon Theater Micro-Master Plan, 1991, by Midyette / Seieroe & Associates
- The Norlin Quadrangle Historic Area Micro-Master Plan, March 1999, by Design Concepts Landscape Architects
- Lighting Master Plan, October 2008, by Clanton & Associates, (Updated by Facilities Management in 2007)

C. Open Space Development Plan

1. Overview and Background

The University of Colorado Boulder rests against the Foothills of the Rocky Mountains, which created the inspiration for the architectural style and the backdrop for today's campus landscape; a set of spaces and places carefully designed to unify the surrounding buildings in a subtle manner creating psychological and sociological connections. These outdoor spaces help shape institutional image and play a role in student recruitment and retention; create safe and welcoming environments, and provide a consistent canvas for the buildings to sit. This portion of the Campus Master Plan is meant to guide the preservation, creation, and management of the campus landscape and open space.

a. Correlation to Other Plans

Previous master plans provided primary focus for the 313 acres that make up the Main Campus; this open space development plan is a broader framework to include land use issues for north of Boulder Creek, the East Campus, and Williams Village. It will augment but not replace the Williams Village Master Site Development Plan created in 2006 by Design Workshop. The plan is meant to build upon the work started by William R. Deno FAIA, Campus Architect Emeritus, as guided by Hideo Sasaki of Sasaki Associates, Inc. in the Campus Open Space Development Plan (final revision, 1990). The plan also derives information from the report of the Task Force on Recreation, Open Space, and Athletics, and the University of Colorado Research Park Design

Guidelines prepared by Downing/Thorpe/James & Associates, January 29, 1988.

b. Purpose of the Open Space Development Plan

This plan is meant to provide a framework for determining appropriate levels of development, management of the existing landscape, and guidance for land protection efforts in the future. It is written to provide objectives and achievable guidelines to aid campus administrators and consultants seeking to add new projects within the existing framework; to ensure that the additions to the landscape are part of a consistent whole; and will allow for flexibility, growth, and expansion while protecting current natural resources. Finally, the plan will outline landscape guidelines and standards for those that will be maintaining the existing and new improvements.

c. Guiding Principles

- Preserve and maintain existing open spaces, including recreational fields, from development and detrimental activities.
- Identify the appropriate amount of passive and active open space to correspond with total campus population and building ratios.
- Strengthen connections between the Main Campus and other developing areas, including North of Boulder Creek, East Campus, and Williams Village.
- Protect and restore historic landscapes within the Main Campus.
- Promote sustainable design for existing and new developments that complement the architecture. Create safe and accessible campus environment.
- Designate safe and understandable circulation routes for all modes of travel, including service vehicles.
- Apply universal accessibility standards in all exterior design.
- Provide adequate wayfinding and lighting.

2. The Campus Landscape: A Sense of Place

It has been said that “walking across a campus landscape can be one of the most memorable experiences of a place that people ever encounter”. The University of Colorado, fortunate with the architectural richness of the Klauer buildings, makes use of the landscape as a final detail to ground each building knitting the exterior spaces together. Students, visitors, and alumni have fond memories of their experiences on campus. Not all will mention the landscape in particular, but almost all will have mentioned the landscape combined with a favorite space they recall providing quiet study or gathering to meet friends.

a. Regional Influences

Colorado enjoys over 300 days of sunshine per year, creating a desirable destination for many. The city of Boulder sits at the base of the foothills, at an elevation of 5,430 feet. One can walk from the campus and be

hiking a trail in the foothills within 20 minutes, making the Boulder campus a very popular place for outdoor enthusiasts. These same foothills reveal a harsher side, bringing wind gusts up to 100 miles per hour which can uproot trees and create challenges for landscape establishment. The beautiful canyons which provide the waterways that supply the campus landscape can also cause flash flooding during the spring and summer, making it tough to understand that water is one of the state's greatest resources. Boulder receives only 19 to 21 inches of rain per year, requiring careful selection of vegetation and judicious irrigation management. The campus enjoys an abundant variety of wildlife from red squirrels to deer, foxes, and an occasional bear that have been found to roam and live within the landscape. Sections of the Boulder Creek Path provide homes to abundant birdlife, creating one of the most popular spots in the city for Audubon Club members to visit.

b. Historical Background

Old Main was the first building on a barren landscape consisting of dryland grasses and cactus. Ann Sewall, the wife of the first president, is credited for planting the first lawn, in the area now known as Norlin Quadrangle. Armed with bed sheets and grass seed, she elicited assistance from a janitor and two students to spread 50 wagon loads of topsoil and plant the seed which was covered with the bed sheets anchored by rocks. In the spring they were rewarded with a “lawn of matchless green.” The campus held annual celebrations in the spring the first few decades of the 20th Century which included digging of weeds and planting of trees by students.

The Colorado legislature supported an increase in student population in 1917 from 1,200 to 3,000 students prompting the Board of Regents to instruct President George Norlin to begin a search for an architect to do a master plan for the development of the campuses. This resulted in the commissioning of the firm of Day & Klauer of Philadelphia. Charles Klauer's use of natural materials in his “Rural Italian” style provides the rich backdrop against which the landscape is set today.

The landscape against the Klauer buildings includes high tree canopies and informal foundation plantings that soften the stone edges and frame entrances. The landscape layout is informal, providing a simple contrast to the formality of the architecture. By 1957 enrollment had reached 10,000 with a prediction of doubling that amount by 1970. Anticipating this growth, the firm of Sasaki, Walker & Associates were hired to assist in campus planning. The 1963 Master Plan removed Klauer's proposed administration building at the west end of Norlin Quadrangle and created two new malls, one south of Duane Physics and the other south of the Engineering buildings along with a variety of open spaces surrounded by buildings connected by axis of streets, walkways, and passageways laid out in a formal fashion. The 1963 plan began to address the pedes-

trian campus stating that “an effective environment for education cannot permit through-traffic in the campus”. Recommendations were made to close Folsom Street between Regent Drive and Colorado Avenue, which was done in 1976.

The 1979 Master Plan addressed pedestrian connectivity and improved definition of campus edges and entrances to define the campus and upgrade its image. This plan was the first to address natural resources including flood water, irrigation water and energy conservation. In 2001, the Campus Master Plan continued to address improvements to be made to the open space, exterior lighting, signage, and wayfinding. Looking towards the future, the Main Campus will soon reach build out with development spreading to East Campus, areas north of Boulder Creek, and Williams Village. Continued growth requires a persistent management of existing resources and protection of existing assets.

c. Landscape Management

The care and management of the campus landscape affects not only aesthetics but also the health and vigor of the ecosystem. Careful attention to design details, plant species, and material selection will assist those in charge of caring for the outdoor spaces. Advancement of the current Turf Task Force (TTF) and Integrated Pest Management (IPM) plans will support programs to increase soil health and plant health while reducing the amount of synthetic chemicals applied to the turf and landscape beds. Proper site design of new capital projects must include Low Impact Development (LID) techniques to control storm water runoff at each site instead of removing the water by piping directly to the storm sewer system. These best management practices (BMP's) include reducing the amount of impervious surfaces, using bio-swales, retention, detention and the landscape to filter and treat stormwater, and taking advantage of natural runoff in the landscape recharging ground water. Proper soil amendment and soil depths for the landscape ensure robust plant growth and increases carbon sequestering.

3. Boulder Campus Properties

The physical separation of the Main Campus, the East Campus, and Williams Village allows separate but similar landscape styles with natural features and topography assisting the effort. The separation allows for slight interpretation of the rules. The Main Campus is part of the pinion juniper ecosystem, one of the six ecosystems found within the Boulder Campuses with its visual proximity to the Foothills. The transition to the East Campus and Williams Village provides a different topography with larger open spaces, riparian landscapes, and varied views to the back range of the Rocky Mountains. While it is important to maintain an integrated campus feel, it is also important to acknowledge the special differences that make up each individual campus. As CU-Boulder moves into the 21st Century, stewardship for the exist-

ing landscape is paramount while developing landscapes for the future.

a. Main Campus

Today's Main Campus has changed quite dramatically from the solitary buildings and sapling trees of last 130 years. The abundance of canopy trees and mature gardens has transformed a barren windswept hilltop into a park-like setting in which the stone buildings sit. The 313 acres of the Main Campus include large quadrangles, recreation and athletic fields, plazas, and gathering spaces as well as intimate courtyards and gardens connected by a series of pathways and streets. This diversity of outdoor spaces contributes to the positive experiences of those on campus. Trees have been chosen and situated to allow the sun to warm, while blocking the winds. Micro climates created by the stone buildings have allowed specialty plants that normally would not grow well in Colorado's climate to thrive, and maintenance crews take pride and ownership in the grounds and strive to keep the first images of the Main Campus impressive.

There are, however, challenges to be faced with the growth the campus has seen in the last 10 years. Campus population has reached a point where there is strain and conflict on the existing walkways between various travel modes, service, and emergency vehicles. Sidewalk widths that were generous are now congested and dangerous. The few building sites left on the Main Campus are primarily located within existing parking lots, creating challenges to replace the loss of parking without compromising other open spaces and while maintaining current open space ratios for health and well being. Aging infrastructure and lack of coordination between early utility planning and the landscape has left utilities in need of repair located under century old trees, causing difficult decisions to be made with a higher level of frequency.

Planning for the future will require innovation, creativity, and forethought to address all of these issues, although there are exciting and sustainable opportunities to be realized in each solution. As planning is completed to create a safer pedestrian environment on the Main Campus, there is the potential to close streets and incorporate additional bike lanes and bike parking while increasing connectivity to the East Campus, Williams Village, and north of Boulder Creek. Widening of sidewalks to handle pedestrian loads should include site furnishings, wayfinding, lighting, and the use of pervious materials relieving pressure on the campus storm sewer systems. Replacement of aging utilities in open corridors provides protection to the open space and trees for the future. Careful evaluation of the Main Campus landscape will allow for restoration and renovation of historic gardens while applying today's techniques for water conservation and the reduction of chemical applications. The century old landscape on the Main Campus is now a valuable asset to the University, and

should be protected as such. Early action to declare the 313 acres of Main Campus an arboretum should be encouraged with policies to preserve and protect the existing green spaces.

b. Boulder Creek and North of Boulder Creek

The northern edge of the academic Main Campus is a bluff, dropping 60 feet down to Boulder Creek, bisecting the Main Campus and separating the 50 acres to the north. The bluff and creek provide a unique riparian area featuring abundant wildlife and birds. This area from the 19th Street Bridge to Folsom Street has been designated as a Zone 1 natural area protected by LEED requirements that the area will remain in a natural, non-irrigated state with improvements limited to issues related to safety. Currently, there are three bridges crossing Boulder Creek, allowing access to the campus from the northern properties and the city of Boulder. These are the Stadium Bridge, the 21st Street Bridge, and the 19th Street Bridge. Stadium Bridge, built in the 1970's, is rated for 36 ton gross vehicle weight (GVW). It has recently been evaluated by structural engineers to have 10-20 more years of service life. The bridges at 19th and 21st Streets are in disrepair and need replacement. A recent design has been completed to renovate the 19th and 21st Street trails allowing for an accessible path to the stadium. When finished, this path will be the only ADA accessible path from the city of Boulder to the campus and will offer a much desired pedestrian connection to future development north of Boulder Creek. Any additional work to the riparian area should be limited to the replacement of non-native invasive plant species with native plantings and protection of the CCC era stone walls and fireplace at the foot of the 19th Street trail. Consideration should be given to the relocation of the Outdoor Services bone yard located at Folsom with restoration back to native habitat.

The property north of Boulder Creek is not as heavily vegetated as the rest of the Main Campus, although it is home to a variety of mature trees that need evaluation prior to development efforts. Aside from the mature trees, the parcel of land is a blank slate for future development. Care should be taken to meld the landscape north of Boulder Creek into one that compliments the Main Campus while adding an urban feel that respects the surrounding neighborhoods and maintaining the Open space development guidelines applied to development within each building pod. All of this property lies within the flood plain of Boulder Creek. Framework plans show an increase of recreation fields located within the flood plain, and development of residential neighborhoods. One should not ignore the natural beauty of the hillside and the creek to the south by designing with an inward focus; instead, efforts should be made to capitalize on the opportunity to use biophilic design principals to include the ecosystem into any new development. The integration of the property

north of Boulder Creek to the hillside trails will provide a connectedness and strengthen the University image. Additionally, discussions with the City of Boulder should look toward increasing the width of the Boulder Creek Path from the current 10 feet to a size that can accommodate the large volume of users on the multi-use path and encourage alternative modes of transportation to the East Campus by campus affiliates.

c. East Campus

The CU-Boulder East Campus is an easy 10-20 minute walk from the Main Campus along Colorado Avenue, the Boulder Creek Path, or Arapahoe Avenue. The topography of the East Campus drops very gently from the southwest corner to the northeast corner as the Boulder Creek multi-use path continues through the northern third, intersecting Skunk Creek and Bear Canyon Creek to the east. Large willows and cottonwoods line the creek banks extending the natural riparian area and wildlife habitat. In 1990, flood mitigation was done on the northeast section of the property creating a series of drainage ways and retention ponds. This area offers great potential to connect building and open spaces to a vibrant natural ecosystem. This work notwithstanding, a large portion of the East Campus still sits within the floodplain. Views of the Rocky Mountain back range are visible from most of the 201 acre site, offering a challenge to architects to capture and frame. The relatively open area and level ground plain provide opportunities to create a landscape that differs from Main Campus, using more native plains plant species and the ability through the topography to capitalize on the riparian areas of Boulder Creek and attached ponds. Additional design elements should focus on a pedestrian campus that includes separate routes designed for pedestrians and service vehicles, a shared street system to accommodate and encourage alternative modes of travel, the use of pervious materials for paved surfaces, and careful design of utility infrastructure allowing for tree protection in the future.

c. Williams Village

Williams Village, a primarily residential campus property, sits just off US 36 two blocks east of the Main Campus. This 66-acre property is bordered by an urban shopping center to the west, US 36 on the southwest and residential neighborhoods to the north and east. Bear Canyon Creek flows through the area on the eastern third with the Bear Canyon Creek multi-use trail creating a pedestrian/cycle connection through the neighborhood to the East Campus. Views from the property can also capture the back range, particularly on the eastern edge. Cottonwoods, willows, and native plantings line the creek and federally protected wetlands located on the western edge of Bear Canyon Creek. Goals for the most current residential addition, Williams Village North, include a desire for better connection to the Main Campus physically and programmatically. Physical connections still need attention primarily with bus routes and better

wayfinding for bicycle and pedestrian routes. Programmatic connections include a RAP program focusing on sustainability. The landscape for Williams Village North includes a palette consisting of 100 percent native plant materials, as well as bioswales within the parking lots. These pilot projects will allow educational opportunities for students and staff to observe and maintain new varieties not found on other campuses, while providing guidance for new development.

e. Mountain Research Station

The Mountain Research Station is located in the mountains west of Boulder. The 192 acre property sits at an elevation of 9,500 feet and is largely undeveloped. The landscape is native to the rocky mountain region. Any plans for development in the area will include restoration to the native habitat.

f. CU-Boulder South

CU Boulder South is 310 undeveloped acres in unincorporated Boulder County, south and east of the city of Boulder. The property is currently land banked by the university with no plans for development in the near future and is not considered within this master plan process.

4. Landscape Typologies

a. Built Systems

Within each part of campus there exists a series of built systems that include quadrangles and lawns, courtyards, terraces and plazas, fields, entrances, streetscapes, and edges. Each system is identified below with suggestions to further enhance existing areas, and direction for future development. Additional information can be found in the Landscape Guidelines.

b. Quadrangles and Lawns

The large open green spaces around which the buildings are arranged creates the park like setting that gives the campus its unique and memorable character. These areas include formal quadrangles, malls and informal lawns used for large gatherings and quiet passive recreation, require careful management to keep these important properties available for use.

Norlin Quadrangle is located on the western edge of Main Campus, yet is considered to be the "heart" of the historic campus. It is enclosed on three sides by academic buildings and on the west by large evergreen trees forming a green enclosure still allowing views to South Arapahoe Peak and the Front Range. The large green lawn is lined with century old trees, providing a spot for passive recreation, and is one of the largest outdoor rooms on campus. Strong emotional attachments are associated with the Norlin Quadrangle. Each spring the graduation walk proceeds through the quadrangle on its way to the stadium. It is a favorite gathering spot for many campus activities. More attention has been placed on the maintenance in the past 10 years,

increasing the quality of turf and landscape, although it continues to be used for construction staging and other damaging activities. The quadrangle is part of the Norlin Quadrangle Historic District (NQHD) and should continue to be upgraded using the NQHD guidelines as well as have the protection afforded to this type of area with stronger written policy.

Other important open spaces in the historic district include the quadrangle cross axis between Macky and Hellems and the park-like space near Varsity Lake, Fischer Field, and the ponds at Kittredge. These areas need to be preserved in their location or replaced in close proximity to retain the spaces needed for passive and active recreational use.

Additional campus quadrangles and lawns include the newly installed Engebretson Quadrangle located on the west side of the Leeds School of Business, the Recreation Center Lawn, and the Housing Quadrangle located between Brackett, Hallett, Reed, and Farrand Halls. Both the Recreation Center Lawn and the Housing Quadrangle will be in the center of green space redevelopment as these properties are renovated or replaced.

New quads proposed for the East Campus will be similar in scale and developed with the same traditional feel as the Norlin Quadrangle, with large expanses of lawn and large tree canopies that allow protection from wind and sun while allowing extended views. Quads will relate to surrounding architecture that helps define and enclose the space. Pedestrians need to be accommodated at the edges with pathways and site furniture as well as connections through the quad to avoid social trails. Designers will have unique opportunities to create a collegiate campus feeling within these large expanses while keeping in mind the high levels of use, correct climatic plantings and innovative ways to address storm water management. Quadrangles and lawns can be found in Exhibit V-C-1.

c. Terraces, Plazas, Courtyards and Gardens

Terraces, plazas, and courtyards create the social spaces between the buildings and the landscape. They are meeting places, gathering spots, and destinations for quiet study. The sizes range from those large enough for a public rally to small intimate gardens with a bench under a shady tree. If designed with care they become vibrant memorable places on campus that build community. They can also be unfriendly open air voids that are hardly inhabited. Designs for these social spaces need to address the desired function for the space. Is the area a large gathering spot or a quiet study area? How many activities will be or can be accommodated in the space? Successful social spaces will require design to be somewhat flexible to allow for a variety of activities. They need to include adequate paving and seating using a variety of materials placed around the edges, as well as adequate lighting and

accessible pathways. Designers should address today's student, allowing for laptop accommodations to plug in and connect to wireless networks. Designs should be scaled appropriately for pedestrian use, which may require providing horizontal enclosure using trellis or tree canopy elements. Plant materials can soften the transition space between building and exterior floor and should be placed appropriately for wind and sun protection as well as visual interest. Often times a unique micro-climate is created by the building orientation allowing for special plantings to occur within a plaza or courtyard. Water features or sculpture can help to create a focal point and add identity to the space.

Several significant areas have been improved since the last master plan. The Dalton Trumbo Fountain Court has received tables and an upgrade to the fountain. Additional improvements to the surrounding planted areas are still needed. Herbst Plaza was created as part of the Discovery Learning Center project in 2002. Overlook Plaza was created between McKenna and Macky, thanks to the Class of 1950. Library Circle, east of Norlin, has been renovated to include upgrades to the sundial area, pervious paving, water features, an outdoor classroom, and site furniture with electrical accommodations for exterior study opportunities. The construction of the pedestrian underpass at Regent Drive included an upgrade to the area west of Fiske Planetarium. The Dirks Family Plaza on the east side of the Center for Community provides another large paved plaza for public gatherings and the Dirks Courtyard provides a quiet, enclosed courtyard to enjoy a meal and the beauty of the Flatirons backdrop. The restoration of the Lilac Garden originally designed by Irvin McCrary of Denver in 1949 will be completed with the construction of the Broadway Euclid Underpass with assistance of a gift from the Class of 2008. Opportunities still exist at Duane Plaza, within the Engineering Courtyards, Fieldhouse Plaza, Fine Arts Green, and the UMC Terrace to add amenities and landscape to improve exterior quality and functionality. Plazas, terraces, courtyards, significant gardens are mapped in Exhibit V-C-2.

d. Recreation and Athletic Fields

Recreational fields provide a much needed release to the stresses of campus life. The Task Force Report on Recreation, Open Space, and Athletics documented the health benefits of active and passive recreation while listing a concern for the amount of recreational field space available to the students. It is important to provide quality fields in close proximity to recreational programs and residential living space. The Boulder campus can take advantage of the flood plain space available north of Boulder Creek and on the East Campus as prime spaces for recreational fields. These areas are to be open and built to meet the highest standards, which may include the use of permeable synthetic turf systems. Maintenance standards are higher for fields that receive high traffic keeping the turf in top shape

to prevent injuries. A map of these areas is identified in Exhibit V-C-3.

Recreation Fields on the Main Campus include the newly renovated Farrand Field redesigned as a major student space with a stage, seat walls, and upgraded drainage system allowing for high use without damage to the turf; Kittredge Fields; and the Coors Events Center Basketball Courts. Smith volleyball courts and the Williams Village volleyball courts will be completed in the summer of 2011. Fields in need of upgrade to accommodate high use include Business Field and Sewall Field on the Main Campus.

e. Natural Areas

Natural areas include portions of the campus that are not subject to development for academic, recreational, or service use. The natural areas are divided into two zones: Zone 1 natural areas include the quadrangles and lawns; open green spaces set aside for passive recreation; portions of the campus that are historically significant such as Norlin Quadrangle; and Varsity Lake. These spaces are to be preserved and managed following established guidelines and management practices. Zone 2 areas include wetlands and waterways, various ponds, and green spaces left in a natural state, such as the bluff that separates the Main Campus from Boulder Creek or the Bear Creek natural area. Zone 2 natural areas may provide significant wildlife or riparian habitat, include rare plant sites, or create noise buffers, currently including the bluff along Boulder Creek, East Campus ponds, and the buffer zone along 28th Street. A map of natural areas can be found in Exhibits V-C-1 and V-C-4.

f. Gateways, Campus Edges, and Streetscapes

Campus entryways act as the threshold to the campus proper, adding identification and image to the institution. The campus has started a Gateways Initiative at Baseline and Broadway to identify the Boulder campus and welcome visitors. The system is a kit of parts, using low stone walls done in the university style and blending in with a simple landscape. At a pedestrian entry, the walls are combined with pedestrian walkways, plaza areas, and seating. Vehicular entrances may include larger scale trees and landforms. Each entrance is marked with a wall that identifies the Boulder campus using engraved limestone and bronze seals. All entrances are safe, well lit and welcoming. Gateway opportunities exist at all campus entry points replacing old and outdated signage.

Campus gateways tie into campus edges and should be thought of together. The edges extend the gateway image to the visitor while providing a tie to the surrounding community. Edges provide the first impression of greenery to visitor and should be maintained at a consistent level. Plantings at the edges should reflect the surrounding area, yet be consistent with the overall campus landscape. In some instances there are

opportunities to use plant materials as an educational opportunity, showcasing adaptable plant species in new arrangements.

Campus planning is focused on creating a pedestrian environment on all properties. The street systems should be designed with pedestrian and alternative transportation in mind. Streets should safely accommodate vehicle at slower speeds. Wherever possible, separating the bike lane and pedestrian zone from the vehicles should be created using street trees, site furnishings, and lighting. The overall look should be one of a well designed avenue.

g. Circulation

The circulation network of a campus ties the campus community to their day-to-day activities. Routes for pedestrians, bicyclists, skateboarders, and service vehicles need to be safe, direct, and well maintained. As campus population increases and land becomes scarce, the challenge becomes greater to maintain safe routes for all who travel through the campus. The topic of transportation demand is more fully addressed in the Transportation section (Section V.E) and in the more detailed Transportation Master Plan (Appendix VII.B). The information in this section will give guidance to circulation patterns and recommendations as it relates to the landscape.

- **Pedestrian Routes.** Each master planning effort makes reference to enhancing the pedestrian feel of the campus. The Boulder campuses are challenged with a growing campus population traveling in limited spaces. Major walkways on the Main Campus are not wide enough, causing travel along the edges to damage the landscape. The current mix of pedestrians, cyclists, and skateboarders within the same travel routes is causing conflict and accidents. Main pedestrian routes need to be re-examined allowing for separation of travel modes, introduction of more pervious materials, and widths adjusted to accommodate traffic as well as a 12-24" landscape buffer on the edges as walks are replaced. The Campus Open Space Development Plan in 1990 stated: "Designers and planners need to keep in mind that pedestrians follow the shortest path, are often preoccupied, and do not always follow vehicular traffic rules when on a sidewalk (that is they tend to walk on the right, but will stop in the middle to talk)." A large amount of effort has been initiated to create better ADA access through the campus, although more can be done to make travel for all an improved experience.
- **Multi-Modal Travel.** Today's students are as likely to jump on a skateboard or bicycle as they are to walk. The Boulder campus was recognized by the Sierra Club in 2009 as one of the most sustainable campuses in the nation. When representatives came to visit, they had many positive remarks about the number of bicycles on the Boulder campus, which

reinforces the institution's goal to encourage multi modes of transportation. At the same time, the campus is facing a safety crisis with the number of bicycle/skateboard conflicts growing each day. Working in conjunction with the Transportation Master Plan, bicycle and skateboard routes through campus have to be identified along with the pedestrian routes. They need to be clearly marked using wayfinding techniques. Congestion is such that all wheeled travelers need to understand that the core of campus will be pedestrian friendly and be respectful of their travel habits.

- **Vehicular Travel.** Vehicular travel on campus is made up of campus commuters and those that travel the campus as part of their workday including staff, service vehicles, vendors, and emergency vehicles. Emergency routes have been designated and can be found on Exhibit V-E-18.. Vendors and service vehicles are required to attend to various needs on campus and can often be found traveling on the sidewalks. In the last ten years, an attempt has been made to limit the number of vehicles that travel on sidewalks. Service stalls have been added and permits changed for vendors allowing them time to load and unload without parking privileges. Construction access is limited, allowing 1-2 vehicles onsite; the remainder of the construction crews park in remote areas. Facilities Management has mandated no travel on sidewalks by campus vehicles during class changes, providing alternate routes. The practice, however, has not been universally accepted by the campus community and external vendors, leaving room for improvement. Despite requests to outside vendors to curb driving and parking activities on the sidewalks, there is not a class change that does not include a Pepsi, FedEx, or UPS truck travelling on the busiest of walks alongside the students. If the campus is to increase pedestrian safety, stronger rules and enforcement need to apply to all who travel the walkways. In the most congested areas, hours of operation should be instituted similar to large cities that allow early morning and evening deliveries only. Vehicle fleets should be evaluated to determine if smaller vehicles or electric carts could be used for service. A bicycle messenger service could be implemented for small deliveries during all but a few inclement months. Construction access can be further limited to no onsite parking, instead providing these 1-2 spaces in a nearby lot, thereby reducing sidewalk trips.
- **Parking Lots.** Surface parking lots are necessary for daily campus business and require attention within the campus landscape. There are a few good examples of landscaped parking lots completed with newer buildings. The remainder of the lots are often barren, with weeds growing around rocks or planting islands that have been filled in with asphalt paving. Parking lots are exterior rooms, which need canopy

trees, permeable surfaces, and improved wayfinding.

- **Wayfinding.** Campus wayfinding is a critical component of the campus landscape. A consistent, clear signage program that includes appropriate lighting is part of the overall image of the institution. The current wayfinding system on the Boulder campus includes campus directory maps in various locations and building identification signage. A missing component in the wayfinding program is directional signage. Directional signage should be added to identify routes to key campus locations, as well as the identification of bike/service routes through campus, which will further pedestrian safety efforts. Any additions to the system should be designed in tandem with the existing graphics program. The signage system needs to be addressed as a whole to remain consistent projecting a positive institutional image.

5. Landscape Design Guidelines

a. Introduction/Correlation to the Campus Master Plan

This document is meant to work in conjunction with the Campus Master Plan, providing details for the design and character of the campus landscape. It is a compilation of the Campus Open Space Development Plan written by Campus Architect Emeritus William R. Deno, FAIA, in consultation with Hideo Sasaki (final revision June 1990), the Williams Village Master Site Development Plan, Research Park Design Guidelines, and the Department of Housing Landscape Master Plan. The information listed in this document is fluid and adaptable to change realizing economics, available resources, and academic needs.

b. Purpose of the Landscape Design Guidelines

Buildings on the Boulder campus are aligned along the edges of open spaces forming architectural walls to create a series of outdoor rooms that include quadrangles, plazas, and courts. These rooms, along with the circulation pathways, supporting amenities, and planted landscape, create the whole that becomes the park like setting in which the university community resides. Changes to the landscape will work within the framework established by past master plans, with guidance from the current plans and an eye toward the future.

The goal of the landscape guidelines is to provide direction for design consultants, university staff, and maintenance personnel working within campus architecture and associated exterior spaces. These guidelines will focus on the elements that make the University of Colorado Boulder a special and unique place, including site planning, vegetation, and sustainable practices. They will offer guidance for future development, along with restoration and preservation of our existing green spaces. All of these factors add to the character of the campus. As they evolve, there will be opportunities to respond with changes to the built environment while preserving the established character of the landscape.

c. Landscape Preservation

The variety of native and introduced plantings that fill the outdoor areas of CU-Boulder's campus require a strong commitment to protect, preserve, and rehabilitate. The century old landscape is under consistent threat from construction, infrastructure repair, and upgrade as well as overuse from campus activities.

- **Goal.** To preserve and protect the established landscape that makes up CU-Boulder.
- **Guidelines.**
- The Main Campus should undergo an evaluation to inventory the historic landscapes in order to set up preservation and renovation strategies.

- Arboretum status should be pursued and obtained for the Main Campus.
- Development sites on the East Campus, Williams Village, and the area north of Boulder Creek should include site evaluations during initial design phases to map important landscape and natural features.
- Policy to protect landscape from construction impacts should be adopted.
- A program for tree and significant plant protection and replacement should be formalized for the campus.
- Formal guidelines to protect natural areas should be written and followed by all who maintain these areas.

i. View Corridors

- **Goal.** Views of the Flatirons, Boulder Creek, and the Continental Divide are amenities that need consideration when siting buildings and other open spaces.
- **Guidelines.**
- View corridors should be protected or enhanced during the planning process for buildings, open greens, roads, and walkways.
- Show view corridors on landscape plans and design landscape to take advantage of long range views.

ii. Floor Area Ratios

The ratio of building gross floor area as established in the Campus Master Plan for each campus will monitor overall density and protect open spaces.

- **Goal.** Maintain and create open spaces identified in the Campus Master Plan.
- **Guidelines.**
- Total building floor area ratio to overall land area for Main Campus should be no more than 0.60 with new projected development including north of Boulder Creek.
- The overall East Campus FAR will be .46 at buildout. The goal will be to match the Main Campus FAR of .60 in areas not subject to flooding Areas subject to flooding will have an FAR of 0.25.
- Williams Village: The maximum floor areas for each developable pod are found in the Williams Village Master Site Development Plan.

d. Outdoor Places

I. QUADRANGLES AND LAWNS

Large open greens on campus become symbolic places that the buildings surround, creating space for social gatherings and passive recreation.

- **Goal.** Preserve and protect campus quadrangles and open lawns, renovating as needed to make certain surfaces can withstand high pedestrian use.
- **Guidelines.**
- Scale plant materials to the size and scale of the space, while maintaining view corridors.
- Locate the appropriate open space adjacent to residence halls for maximum health benefits.

- Use plant materials to assist in creating windbreaks and shade, locating large canopy trees around the edges.
- Large-scale renovations of fields should include drainage systems and turf design for high use.
- Size walkways appropriately for current and future pedestrian use, snow removal, and service traffic requirements.
- Design for snow storage areas to take advantage of storm water drainage into landscape or permeable plaza areas.

II. TERRACES, PLAZAS, COURTYARDS, AND GARDENS

The intermediate exterior rooms of the campus are the terraces, plazas, courtyards, and gardens. These areas define building entrances and exits, providing a transition from public to private using architectural and landscape elements.

- **Goal.** Plan exterior building spaces to take advantage of Colorado's climate and design for a variety of activities.
- **Guidelines.**
 - Design these outdoor rooms focusing on the programs within the buildings, adding the appropriate amount of site furnishings, amenities, and landscape.
 - Plazas, terraces, and courtyards are pedestrian spaces. Limit access to vehicles by the use of bollards, site walls, and landscaping. Bicycle storage is not an appropriate use for these spaces.
 - Each area should incorporate unique design character and focal points from other areas, i.e., fountains, sculpture, study spaces, food vendors.
 - Larger plazas and terraces should have flexibility to accommodate different types of events.
 - Enclosed courtyards can consider movable furniture creating flexibility. Moveable furniture has not been acceptable for open campus areas.
 - Paving should be permeable whenever possible and include snow storage areas if appropriate.
 - Provide structural soil systems within hardscape surfaces for plant materials to avoid planting in native compacted soils.
 - Use tree grates for trees planted in terraces and plazas.
 - Design areas to be sheltered from northwest and westerly winter winds and hot southern sun, while taking advantage of gentle southeast and southwest winds.
 - Provide adequate lighting without creating light pollution, and limit landscape that could become overgrown providing security concerns.
 - Make note of micro climates created by buildings when choosing plant palette.
 - Use landscaping to enhance transitions between exterior spaces.

- Smaller intimate gardens are areas that can include more intricate landscaping if acceptable to those who maintain them.

III. RECREATION AND ATHLETICS FIELDS

Outdoor recreation is essential to maintain physical and mental well-being. Recreation fields are interspersed within the campus, contributing to productive use of leisure time and lower stress levels in students.

- **Goal.** Continue to provide adequate space for recreation fields within close proximity of student population centers for student access, student zones, and central locations
- **Guidelines.**
 - Planning of new fields and facilities will be done with a commitment to sustainability goals, including the latest design technologies to reduce turf stress, lower water usage, encourage recycling and composting, and reduce pesticide applications.
 - Protect prime play fields from detrimental activities that add to soil compaction, such as event parking.
 - Provide amenities for spectators including adequate seating, shade trees, and structures as well as trash receptacles.
 - Design equipment storage space into campus-approved accessory structures to eliminate renegade storage boxes.

IV. NATURAL AREAS

The Boulder campus properties include two types of natural areas. Natural areas in Zone 1 include areas that can contain fragile or endangered species and are to be left in a native state, providing maintenance only as needed for removal of dangerous tree limbs and refuse clean up. Zone 2 natural areas are defined as spaces on campus where landscape is planned as a park, inclusive of adaptive plantings, ponds, and waterways. A map of each zone is located in Section V-C.

- **Goal.** Preserve and protect natural areas from disturbance and development, and restore and renew as directed by the following guidelines.
- **Guidelines.**
 - Management criteria for these zones will account for the rare or unique attributes of each zone, allowing for specific enhancements deemed appropriate.
 - Restoration of Zone 1 areas will include replacement of non-native invasive species and plantings at the end of their lifespan with native plantings suited to their biotic zone.
 - Plantings will encourage wildlife within Zone 1 natural areas.
 - Maintenance within Zone 1 areas will include the removal of dead and dangerous tree limbs, trash removal, and limited clearing for safety (Boulder Creek).
 - Restoration of Zone 2 areas will include enhancement of the natural area using native and adaptive plantings and removal of invasive species.

- Maintenance within Zone 2 will be dictated by location of the zone within campus.
- Guidelines for federally protected wetlands located in Williams Village will be followed.

f. Types of Space

I. NATURAL PONDS AND WATERWAYS

There are a variety of waterways on the Boulder campus properties. These include historic ditches on the Main Campus that were used to flood irrigate the campus, ponds that were built to enhance the landscape or mitigate storm water, and natural creeks.

- **Goal.** Protect and enhance natural ponds and waterways.
- **Guidelines.**
 - Provide regular maintenance to established ponds on campus—Varsity Lake, Kittredge Ponds, and the 28th Street Ponds to keep them healthy, safe, and aesthetically pleasing.
 - Monitor bank erosion around ponds, planting grasses and trees to stabilize soils.
 - Maintain the ditches used for flood irrigating that are located within the historic district.
 - Enhance existing storm water retention areas with landscape to create amenities rather than detractions from the landscape. Consider retaining, restoring, and maintaining the natural streams and ponds when adding new storm drainage and detention/retention areas.

II. CAMPUS EDGES AND GATEWAYS

The edge of the campus creates a boundary between the university “city” and the surrounding community. These spaces help to define image while reinforcing entrances. The boundaries of the Boulder campuses are somewhat amorphous depending on location, due in part to campus growth or lack thereof. As the Main Campus reaches build-out and other campuses begin to develop, it is important to define and enhance the image of the Boulder campus.

- **Goal.** Use landscape and wayfinding to clearly define the extent of the Boulder campus properties.
- **Guidelines.**
 - Gateway approaches should enhance the image of the university while providing a welcoming entrance and exit for all students, staff, faculty, and visitors. Entrance design should be the proper scale for the type of entrance
 - Designs should follow established gateway “kit of parts” provided for the initial location at Baseline and Broadway including low masonry walls, limestone panels with engraved signage, and lighting.
 - Use mass plantings at campus entrances, limiting the plant palette to a few varieties taking advantage of adaptive plant species where appropriate.
 - High maintenance specialty gardens are not appropriate for gateway entrances.

- Consider low masonry site walls to accent the entrances and define the edge between the campus and the city, maintaining the appropriate scale for the type of entrance.
- Entry walls and landscaping should be placed so that there are unobstructed sight lines for safe entrance and exit.
- A formal street tree plan using approved street and canopy trees should be developed for new campus expansions. Existing street tree plans for the East Campus should be adjusted to minimize monocultures.

III. PARKING LOTS

The design for surface and structured parking requires careful attention to placement, materials, and screening. If not designed properly, lots will detract from the overall site development. Parking for the campus should be located on the periphery, convenient to major arterials and campus bus circulators.

Goal. Place the appropriate number of parking lots working with current transportation demand management programs and campus sustainability guidelines. Design parking lots to blend with the surrounding landscape so as not to detract from architecture and campus open spaces.

Guidelines.

Use grading, sitework, and site walls with landscaping to buffer and screen parking from off-site views.

Parking lots should be considered as exterior rooms. Add internal landscaping to provide shade and break up large lots, using shade trees for entrances, exits and perimeter plantings. Avoid messy trees.

Use pervious paving and bioswales for water quality, snow storage, and supplemental irrigation to landscaped areas.

Parking spaces will be 8'-6" minimum width by 19'-0" long.

Include spaces in each lot for car share programs.

Bicycle parking should be considered along one edge of a lot if the lot is in close proximity to buildings.

Interior landscaped islands are to be at least five feet wide with one shade tree planted every 40 feet in a structural soil system that includes a root barrier.

IV. SERVICE, DELIVERY AND STORAGE AREAS

Areas defined for service include loading docks, waste storage areas, and snow storage.

- **Goal.** Plan for service and storage areas away from major entrances or social areas, allowing accessibility without compromising views.
- **Guidelines.**
 - Use site walls, green walls, and plant materials to

screen service and delivery areas.

- Co-locate temporary construction staging in selected areas on campus periphery zones, allowing for storage of materials and equipment to be removed from central areas of campus.
- Co-locate waste collection sites with building uses and collection times.
- All waste collection sites must be screened with campus standard materials and closures.
- Site planning will include snow storage sites using permeable materials.

f. Outdoor Systems

I. WATER QUALITY, STORM WATER MANAGEMENT/DRAINAGE DESIGN GUIDELINES

The university strives to improve water quality of storm water by reducing pollutant loads to protect existing streams and creeks, improve drainage, and maintain ground water recharge.

- **Goal.** To avoid an increase in storm water runoff on campus, all new designs and renovations should apply Low Impact Development (LID) design techniques that look for new opportunities that mimic natural systems to infiltrate or retain onsite storm water.
- **Guidelines.**
 - New building site plans will reduce the storm water runoff rate and volume by 25 percent of pre-construction conditions.
 - Improve water quality of storm water by using bio-retention and bio-detention, landscape infiltration, and reduction of permeable surfaces
 - Consider using green roof technology in appropriate locations to minimize runoff and reduce heat island effect.
 - Ensure that all construction uses Best Management Practices (BMPs) by submitting storm water mitigation plans for approval prior to building permit issuance.

II. WATER RESOURCES AND WATER AMENITIES

The majority of the campus landscape is irrigated with fully automated systems using raw water. This water augments the 15 inches of annual precipitation received naturally. It is imperative the university constantly monitor its water use judiciously while following current Colorado water law.

- **Goal.** Use of water for landscape and water amenities is to be done efficiently, while applying water conservation techniques.
- **Guidelines.**
 - New landscape will be designed using the design principles to conserve water by appropriate plant

selection and efficient irrigation design.

- Campus landscape that is currently watered with domestic water should make improvements to connect to the raw water system.
- Water features should be designed using newer technology allowing for conservation or use of raw water without violation of Colorado water law.

III. UTILITIES

Utilities include underground lines and aboveground support structures. Both can have a detrimental effect on the landscape.

- **Goal.** Minimize visual impacts of aboveground utility structures and long range impacts of belowground utility lines.
- **Guidelines.**
 - Locate underground utility corridors in streets or through the center of large quadrangles whenever possible to reduce future landscape conflicts.
 - Locate structures at ground level away from major social spaces and building entrances.
 - Screen aboveground structures with plant material or add them to the transformer art program.
 - Consider noise implications when locating transformers and place them out of the way of major pedestrian areas.
 - All structures at ground level, such as manholes and inlets, need to be designed into the paving patterns of plazas if possible and placed flush with the pavement. All grates are to be spaced one-half inch apart or less to allow bicycle and wheelchair accessibility.

IV. LIGHTING

Campus activities—including classes, performances, and evening sporting events—occur at all hours. Lighting is a critical component of the landscape creating ambience as well as a safe environment for all to travel in.

- **Goal.** Suitable lighting will create a welcoming nighttime landscape while providing a safe, secure environment.
- **Guidelines**
 - Evaluate campuses routinely to verify that the exterior lighting is continuous without dark areas.
 - Use sustainable fixtures that cast a warm white, instead of orange or bright white, light.
 - Highlight campus gateways and entry signage.
 - Provide accent lighting on significant building facades.
 - Design lighting to accommodate light sensitive areas, keeping the night sky from being over-lit.

g. Circulation

Travel through the campus must be a safe, efficient, and convenient system that puts pedestrians first, while acknowledging that vehicular travel will always be a part of campus business. The Main Campus now requires

evaluation of all modes of travel to ensure pedestrian safety. Developing campus properties, including the area north of Boulder Creek and on the East Campus, become opportunities to plan circulation that includes all modes with a focus on the pedestrian experience.

I. VEHICULAR CIRCULATION DESIGN GUIDELINES

- **Goal:** Design new streets to accommodate travel through campus in a safe, efficient manner while accommodating all modes of travel.
- **Guidelines:**
 - Primary streets considered as the main thoroughfares through campus should be designed to accommodate all modes of travel, incorporating separate bikeways (cycle track) when spatially possible.
 - Secondary streets may be targeted as intercampus bike routes, and should incorporate bike lanes if direction of travel connects through campus.
 - Eliminate on street parking where practical, using additional space for bike lane or pavement width reduction.
 - Many campus sidewalks serve as emergency access routes. Design of sidewalks should be of adequate width to accommodate their intended use, including a 1-2' buffer at the edges for landscape.
 - Policies regarding vehicle traffic on sidewalks should be written and enforced.
 - All street design should include a landscape plan that contains appropriate street tree planting, lighting, and associated landscape including furniture, fixtures, and equipment.
 - Design a pedestrian friendly circulation system that accommodates all forms of transportation in a safe, efficient way.

II. PEDESTRIAN CIRCULATION DESIGN GUIDELINES

The 1979 Campus Master Plan reaffirmed the notion that the campus is “first and foremost a pedestrian environment.” As the population increases within the Boulder campus, it is paramount to design for the future providing safe, accessible routes. Planning efforts must include retrofits to the Main Campus walkways along with new planning ideas for properties yet to be developed.

- **Goal.** The campus should be designed for pedestrians creating a safe, identifiable, walkable campus with safe connections throughout.
- **Guidelines.**
 - All pedestrian routes must meet and/or exceed the current Americans with Disabilities Act (ADA) design criteria for safety and accessibility.
 - Identify major pedestrian corridors with changes in width, pavement design, lighting, and wayfinding along with site furniture.
 - Provide pedestrian linkage to all parts of campus,

with enhancement of aging trails becoming a priority as funding is available.

- Provide clear, well lit, safe routes through parking lots to building entrances.
- Delineate pedestrian crosswalks with a consistent paver design, raised in areas of high vehicle traffic.
- Provide lighting for safety on all walkways and add wayfinding and site furniture where necessary. Use of permeable paving surfaces is encouraged.
- Use railings as a last resort when landscape or site furnishings will not be sufficient to deter cross cutting. Railings tend to be used as unauthorized bike racks requiring enforcement.

III. BICYCLE/SKATEBOARD CIRCULATION DESIGN GUIDELINES

Studies of bicycle/skateboard commuters to and through campus have shown a consistent increase in non-motorized travel from previous master plans, sharing the same spaces as pedestrians in most places on campus. As campus population increases, so does the safety risk. It is time to separate modes of travel by creating travel routes through each campus for wheeled commuters.

- **Goal.** Encourage alternate modes of transpiration while protecting the safety for pedestrians by careful evaluation and design of travel routes through campus and safe routes to other campuses.
- **Guidelines.**
 - Design routes for bicycles and skateboards that are separate from pedestrians where possible.
 - Review current legal statutes to allow skateboards to travel the same routes as bicycles without legal consequence.
 - Continue partnerships with the City of Boulder as opportunities arise to create bicycle routes along city streets and pathways to connect all campuses and city amenities.
 - Provide enhanced bike parking at entrances of pedestrian zones to increase compliance. Enhancements may include secure or covered spaces.

IV. SERVICE ROUTES

Campus planning cannot ignore the need for service routes throughout campus. Service includes departmental vehicles, university maintenance vehicles, and outside vendors. The Main Campus has reached a point where additional controls should be added to vehicle deliveries to ensure safety on campus. The East Campus and Williams Village have opportunities to design for service routes.

- **Goal.** Service vehicles are a necessary function of the university and should be accommodated into the circulation network in a safe, effective manner.
- **Guidelines.**
 - Evaluate Main Campus and establish service routes and regulations for all vehicles making trips during

the business day.

- Consider the use of alternative modes for delivery of small packages during peak travel times on dry weather days.
- Develop service ring roads around each campus, helping to eliminate vehicles from the core of campus.

H. SIGNAGE AND WAYFINDING

Signage systems include a hierarchy of information and if well designed can add a visual connection to the exterior spaces, providing direction and creating a positive campus image. Signage is informational, directional, and regulatory and a necessary component to the campus landscape. The way information is portrayed can either be a positive or negative experience. Too many signs cause information overload, resulting in “message ignore.” Campus wayfinding should be expanded from the current campus maps to include markers that direct the visitor to main buildings and areas. Types of signage addressed in this section include campus gateways, primary identification, and wayfinding.

- **Goal.** Reinforce a positive campus image by creating a consistent signage program to include campus gateways, primary identification, wayfinding, and regulatory signs.

I. GATEWAY

• Guidelines.

- Main campus entry points should be identified with the “kit of parts” created for the monument signage at Baseline and Broadway. Materials will include masonry walls with limestone panels to identify the campus.

- Wood is not a suitable material to be used for signage.

II PRIMARY IDENTIFICATION

• Guidelines.

- Primary building identification will be consistent on all campuses, located at main building entrances. Larger buildings with multiple entry points may require multiple signs.
- Building identification will follow Building Identification Sign Guidelines (January 20, 2004) located within facilities Planning Design and Construction, using adopted campus branding (2011) for typestyles and university graphic.
- Background colors will remain consistent on all campuses.
- Individual logos will not be applied to building signage.
- Signage height will be sufficient to clear moderate snowfall without creating a safety obstruction.

III. WAYFINDING

- Guidelines.
- Expand campus wayfinding from campus maps to

intermediate directional signage with appropriate lighting at key points on campuses to identify noteworthy buildings or areas.

- Update campus maps as new buildings are built.

I. SITE FURNISHINGS DESIGN GUIDELINES

Site furnishings for the campus provide design consistency in the relationship between the exterior spaces and architecture, acting as a functional accent to the landscape. The campus has chosen site furnishings and accessories that are listed in current campus standards. Any changes to the existing site furnishings will be reviewed and approved by facilities planning. Materials should consider safety, durability and maintenance, and economy. The furnishing group includes shelters and kiosks, seating, and miscellaneous site accessories. Signage and wayfinding are discussed in the Signage section.

II. SHELTERS AND KIOSKS

Shelters include those that are used for weather protection on recreational fields, bus stops, and covered bike parking. Kiosks include the small structures used for ATMs and parking equipment protection, as well as informational kiosks for posting of campus events.

- **Goal.** Shelters and kiosks shall be placed in areas with high pedestrian activity, with careful consideration of open space use, and protection of views.

• Guidelines.

- All shelters and kiosks will be consistent in design, materials, and forms that relate to current site furnishing family.

III. SEATING

- Goal. All site furnishings should be consistent and complementary to the building style and surrounding landscape.

• Guidelines.

- Include a variety of seating options in plazas and terraces to accommodate different uses and groupings.
- The extension of campus-wide WiFi has created additional opportunities for outdoor study. Additional tables should be added for this use. Exterior study spaces should include a few exterior outlets for laptops.
- Provide adequate number of furnishings for the anticipated use for all outdoor areas including plazas, pathways, and recreation fields.
- Congregate seating for conversational purposes, adding space for wheelchair parking in bench layouts.
- Consider space for feet to rest when placing benches along walkways.
- Maintain consistency of furnishings within individual building sites, using established campus standard selections.
- Black metal furnishings will be used to maintain campus consistency.

- Wood is not a reliable material in the Colorado climate and should be avoided.
- Masonry seat walls provide alternatives to individual benches along borders and edges. Masonry should match campus buildings and include skateboard deterrent detail engraved in the capstone.

IV. MISCELLANEOUS SITE FURNISHINGS

Accessory site furnishings provide additional amenities to the outdoor space.

IV. TRASH RECEPTACLES AND ASH URNS

Trash receptacles, including recycling stations, are located in tandem in select areas around campus. Ash urns are necessary for the safe disposal of cigarettes.

• Guidelines.

- Trash and comingled recycling stations are located by the Outdoor Services staff in high traffic areas. Two cans are located together on a concrete slab just off main sidewalks for ease of disposal, ease of collection, and out of snow removal routes.
- Trash collection should be located away from building entrances to eliminate access for pests to enter the building.
- Locate ash urns using current state statutes for health and welfare. Current statutes require ash urns to be 25 feet from any building entrance.
- Do not locate ash urns in front of air intakes.
- Plan the locations carefully to avoid ash urns next to mulched garden beds.

j. Site Amenities

i. Planters

Planters can help to direct pedestrian traffic and accentuate buildings and plazas while providing a spot for seasonal color.

• Guidelines.

- Materials chosen for planters should complement the surrounding architecture, be durable, and be sized to withstand Colorado’s harsh climate.

II. BICYCLE RACKS

Bicycle racks are an important feature to the campus landscape that enhances multi-modal transportation.

• Guidelines.

- Integrate layout and configuration with campus circulation system, plaza design, and building entrances.
- Provide adequate lighting and place racks in locations where they can be viewed from buildings.
- Areas that are more removed from main entrances should be covered to encourage use.
- Maintain consistent installation standards.

III. TREE GRATES

• Guidelines.

- Tree grates are to be provided for all trees that are located within paved areas to ease soil compaction and provide protection from equipment.

IV. Newspaper Vending Machines

- Guidelines.
- Congregate newspapers in select approved locations on campus to reduce the visual clutter of numerous boxes.
- Provide three-sided screening using appropriate campus building materials.
- Materials and finishes should be consistent with surrounding site furnishings.
- Installation of boxes must meet current ADA standards.

k. Fencing and Screening

Fences placed on campus are used as a pedestrian intervention or for screening purposes. The placement of a fence is carefully guided by facilities planning. Fencing will not obstruct quads or separate recreational spaces from public use unless approved. The fencing appropriate for campus includes steel picket, metal screening, and vinyl coated chain link with privacy panels.

- **Goal.** Use fencing judiciously for screening and barriers if necessary for protection of athletics fields.

I. STEEL PICKET

• Guidelines.

- Steel picket fencing is found around Franklin Field and Farrand Field. This type of fence has been installed to modulate pedestrian traffic around and through these venues. A 42-inch pedestrian scale height is preferred. This type of fencing is also used as crowd control for large events at the stadium instead of less permanent jersey barriers. All steel fencing is black in color.

II. VINYL COATED CHAIN LINK

• Guidelines.

- Vinyl coated chain link fencing has been approved for screening of less visible areas such as utility areas or trash enclosures. This type of fencing must include black privacy slats to create a completely opaque screen. Non vinyl coated chain link is not an approved material.

III. METAL SCREENING

• Guidelines.

- Metal posts with two panels of metal screening are appropriate for screening of transformers, and trash enclosures in visible areas on campus. Metal for screening should be chosen for its opaque nature. All metal screening is black in color.

I. Planting Design Guidelines

The landscape concept for the Boulder campuses will enhance and add to the existing park-like setting created for the Main Campus a century ago without creating major shifts in design. New landscapes for buildings will be required to become part of the “consistent whole” while applying technology to preserve and conserve materials.

- **Goal.** Plant selection for the campus is to be diverse and appropriate to the climate of Colorado. Native

plants are to be used when possible and where appropriate. Avoid plants that require excessive maintenance.

- **Guidelines.**
- Plant pallets should be chosen with consideration of micro climates created by masonry buildings.
- Plants should be massed in general to avoid creating high maintenance bed requirements, and of proper scale to match the setting. For example, the mature canopy trees in the Norlin Quadrangle lend a sense of history, permanence, and tradition. Smaller ornamental trees in bordering courtyard entrances help bring the scale to a pedestrian level.
- Plant pallets should be selected with the idea that the main “season” for the majority of university population is August through May.
- Spacing for plant materials should be determined on individual growth habits of each species within the Colorado climate.
- Existing beds should be evaluated to remove plants at the end of their lifespan, replacing them with materials that are climatically appropriate, and do not increase maintenance or pest infestations.
- Mulch beds should be filled with shrubs or ground cover to reduce constant yearly cycle of mulch replacement.
- Group plantings with similar water requirements allowing for efficient Irrigation design.
- Planting within historic districts should maintain existing historic patterns.

See Appendix B for Plant Material List

m. Design Guidelines for Construction Sites and Temporary Facilities

Construction is an ongoing activity on campus, causing detours for pedestrians and detriment to the campus landscape. The following guidelines apply to all construction sites and temporary facilities installed during construction.

- **Guidelines.**
- Locate construction staging away from landscaped areas whenever alternatives are present.
- A site survey is required to list all plant material, site furnishings, or accessories that may be impacted by construction. Plant materials may be subject to an outside appraisal prior to start of construction.
- Access, traffic control, and storm water management plans will be approved by authorized campus personnel prior to start of construction.
- Staging areas will include limited parking. Crew parking will be found in nearby parking lots or off-site with the use of shuttles for larger capital projects.
- Chain link fencing will be used for all construction perimeters.

n. Campus Standards

Campus Standards can be found on the Facilities Man-

agement web site. These materials include all site amenities and planting requirements for the Boulder campus to be used for all projects affecting the landscape.



D. Environmental Management Plan

1. Outdoor Air Quality

Actions taken by CU-Boulder can impact outdoor air quality to some degree. Among CU-Boulder's existing and ongoing efforts to help assure air quality:

- Leading-edge research conducted regarding air quality, including studies at the Mountain Research Station, which affords a unique opportunity to assess atmospheric conditions.
- Cogeneration of electricity and steam (used for heating and cooling buildings), in a natural-gas-fueled power plant. The use of natural gas is cleaner but more expensive than coal, which is used as a fuel source at many Colorado power plants.
- Initiatives to encourage the use of varied transportation modes, including the non-motorized modes of walking and bicycling when these are feasible, reducing vehicular emissions.
- In winter road and walkway ice abatement operations, the shift from use of a sand/salt mixture to a magnesium chloride liquid de-icer. Sand application has been reduced by approximately 70 percent in the five years prior to writing this plan, helping limit suspended airborne particulates, a significant component of visible air pollution.
- CU-Boulder should endeavor to minimize pollutants that degrade air quality or that contribute to worldwide environmental concerns such as the "greenhouse effect."
- **Goal.** CU-Boulder will identify and implement institutional actions that help address air quality concerns.
- **Guidelines**
- Add new student housing at Williams Village and Main Campus, which helps limit the need for vehicular trips.
- Improve pedestrian routes, bicycle routes, transit service, and transit vehicles.
- Mitigate congestion and idling in traffic through roadway construction and improvements, improved directional signage, and parking management.
- Reduce hazardous waste generation (avoiding the need for waste disposal companies to incinerate it).
- Upgrade institutional fleet vehicles with new cleaner-burning diesel buses and (where feasible) with vehicles using innovative technologies for propulsion such as electric and hybrid-electric.
- Environmental Health and Safety and Facilities Management will continue to coordinate efforts to comply with new EPA Greenhouse Gas rules issued in 2009.

2. Indoor Air Quality

Indoor air quality is affected by many factors in building design, site design, and location of air intakes. Concentrations of potentially toxic materials in the air tend to

be much higher indoors than outdoors, in part due to the use of paints, stains, adhesives, and other modern building materials. One way to lower these concentrations is through the use of materials that do not off-gas as much formaldehyde, volatile organic compounds (VOCs), or other potentially hazardous chemicals. CU-Boulder has successfully built with the LEED for New Construction requirements of using low VOC materials. This practice will continue in all new buildings and major renovations.

Regularly auditing and monitoring indoor air quality is a criterion brought forth by STARS. In order to meet the campus commitment of achieving a minimum of LEED Gold Certification on all new buildings and major renovations, air quality monitoring devices should be included in the design of buildings. Likewise, the latest STARS report addressed the need for similar monitoring devices in all existing buildings. As resources become available, CU-Boulder should add indoor air quality monitoring devices in all existing buildings on campus and create a mechanism for building occupants to register complaints.

- **Goal.** CU-Boulder will continue to implement practices and procedures that help assure indoor air quality.
- **Guidelines**
- Continue to implement processes to identify and mitigate the potential for mold growth.
- Continue to locate vehicular loading areas and air intakes at separate locations in new building design.
- Continue to respond to concerns regarding smoking near entryways and air intakes and to support a culture of smoking courtesy.
- Use low- or no-VOCs materials in construction and maintenance activities.
- Continue to utilize a "purging" time to ventilate a new building with outside air for a reasonable time before people move in. This will help remove airborne contaminants left over from the construction process, and will better accommodate the initial off-gassing of VOCs. LEED requires an approximately two-week flush-out process.
- Continue to balance adequate indoor air quality measures with energy efficiency.
- Provide IAQ monitoring devices in new buildings and retrofit devices into existing buildings during renovations.

3. Water Quality

Potable water originates in the mountains and is treated by the city of Boulder treatment plants before distribution to the campus. The city of Boulder is responsible for the quality of this potable water.

Wastewater leaving the campus in sanitary sewers is delivered to the city of Boulder wastewater treatment plant. The city of Boulder regulates CU-Boulder waste-

water discharge to comply with Colorado Department of Public Health and Environment, and Federal EPA regulations. CU-Boulder's wastewater discharge permit limits allowable discharges of organic pollutants, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, silver, and zinc, and limits allowable levels of biological oxygen demand. Wastewater discharges are periodically sampled from several sampling stations on campus.

Compliance with water quality regulations has improved, with guidance from the Environmental Health and Safety Department (EH&S) that includes increased education of laboratory users to prevent drain disposal of hazardous materials.

EH&S has also increased training efforts toward general contractors and other vendors to address the impact of their activities on the CU-Boulder campus and neighboring environment.

EH&S will be instrumental in the installation of an interceptor system being constructed at Basin C to address issues of illicit discharges to Boulder Creek.

Water collected from storm sewers and ditches runs into local creeks. This would allow chemicals used on irrigated areas, and oils from streets and parking lots, to enter creeks. In the East Campus Research Park, there was sufficient land to create a series of ditches, ponds, and wetlands that allows water quality to naturally improve before water is discharged into Boulder Creek.

The Mountain Research Station and CU-Boulder South have their own water and wastewater systems. The Mountain Research Station wastewater treatment plant has been upgraded to increase compliance with Colorado Department of Public Health and Environment regulations.

- **Goal.** CU-Boulder will meet or exceed water quality requirements in campus discharges to streams and to storm and sanitary sewer systems.
- **Guidelines.**
- Continue to maintain the East Campus wetland ponds that accommodate flood protection, nature study, and cleansing of drainage runoff.
- The Department of Environmental Health and Safety will continue to oversee the campus community to avoid accidental discharges of illicit materials into storm or waste water systems.
- New campus construction guidelines include design criteria that incorporate best management practices and structures that work to improve overall campus water quality. Also identified in LEED SSc6.1 & 6.2.
- Continue utilizing the integrated pest management system, which helps reduce the use of pesticides in landscaping and drainage runoff. CU-Boulder is finalizing a plan to significantly reduce pesticide use with a goal of chemical free turf within the next few years.

- Continue to locate and appropriately label storm drains to help avoid accidental spills into creeks.

4. Flood Mitigation

The University of Colorado Boulder has approximately 30 percent of its land assets located within the 500-year floodplain. Reducing the likelihood of flood damage through appropriate building modifications, land use planning, building design, and siting are important components of planning, design, and construction on the campus. The campus has had consultants study the impacts of a major flood event to the campus to assess areas of vulnerability and provide recommendations to improve the flood risk. The city of Boulder has also placed flood-warning sirens on and near the campus, which will alert people in the vicinity of an impending flood so they may move to higher ground.

- **Goals.**
- Ensure flood evacuation plans are in place for all facilities located within the 500-year floodplain. These evacuation plans should be periodically reviewed by Facilities Management staff and distributed to the building occupants annually before each flood season.
- Continue to perform building modifications that reduce the risk of flood damage within the building.
- Continue planning to mitigate the flood hazard for the existing campus residential units north of Boulder Creek.
- Remove the overhead steam line crossing Boulder Creek, which feeds the residential properties on the north side of the creek.
- Continue to work with the city of Boulder and the Urban Drainage and Flood Control District to address floodplain concerns on the campus. This includes the possible replacement of existing bridges over Boulder Creek with "breakaway" type bridges.
- Continue to minimize the flood risk to areas on the campus that may be subject to localized flooding.
- **Guidelines.**
- Do not locate critical facilities (as defined by the Colorado Water Conservation Board) in the 500-year floodplain, unless the requirements of the CWCB's Floodplain Rules and Regulations are met.
- Elevate the first-floor elevation of new buildings to be located in the floodplain to 2.0 feet above the FEMA regulatory floodplain.
- Athletics playing fields and recreational facilities, e.g., soccer fields, are preferably located in floodplains and floodways.

5. Hazardous Materials

The Department of Environmental Health and Safety administers the policies for radiation safety, biohazardous materials, hazardous wastes, indoor air quality, water quality, industrial hygiene, and asbestos/lead abatement. Campus safety remains a responsibility shared

by every member of the university community. Program areas within EH&S are designed to focus on preventative, remedial, and emergency response measures to hazardous materials used on campus.

The Environmental Health and Safety Center (EHSC) was completed in 2000. The facility houses all EH&S staff and facilitates services and waste methodologies intended to reduce the amount and costs of hazardous wastes for disposal for the Main Campus. A waste treatment facility was incorporated into the EHSC and became operational in 2001. The treatment facility allows EH&S to treat certain hazardous wastes, thereby reducing costs and liabilities associated with their disposal. Research continues within the treatment facility to find ways of expanding opportunities for waste treatment.

The continued growth in research activities at CU-Boulder has produced a corresponding growth in activities performed by EH&S related to hazardous materials management. The additional research space that is currently under construction, especially the expansion of research facilities on the East Campus, will result in an even greater need of these activities performed by EH&S to safely manage the hazardous materials used and generated.

- **Goal.** EH&S will help the campus community continue to nurture an environmental and safety consciousness and maintain compliance with local, state, and federal environmental standards and regulations.
- **Guidelines.**
 - Minimize the production of hazardous waste through education, inventory management, and waste treatment efforts.
 - Conduct on-site inspections, training and program reviews, and investigations of incidents.
 - Oversee safe use of radiation producing machines and the safe use and disposal of radioactive materials.
 - Handle, transport, and appropriately dispose of hazardous waste materials.
 - Oversee safe use and disposal of biohazardous materials.
 - Test, detect, abate, and dispose of materials containing asbestos or lead.
 - Develop contingency plans and procedures.
 - Develop appropriately scaled waste handling facilities on the East Campus as the campus develops and more waste is generated.



E. Transportation Plan

1. Overview

This section summarizes the efforts of a larger document that is to be appended to the Master Plan once complete. The Campus Master Plan Transportation Element addresses the policy and direction by which transportation planning will be developed. The larger Transportation Master Plan will address these issues as well as implementation strategies, financial considerations, and operational opportunities and constraints.¹

The Transportation Master Plan of the 2011 Campus Master Plan must meet the goals of the Flagship 2030 Strategic Plan which will increase enrollment by 5,300 students and tenure-track faculty by 300 positions. At the same time as growth is forecast, broad sustainability goals set high aspirations for the university:

- Reduce greenhouse gas (GHG) emissions 20 percent by 2020.
- Become carbon-neutral by 2050.

The Master Plan adopts the goals listed in the Sustainability Task Force document, which are to:

- Move toward a higher proportion of transportation fuels derived from renewable resources
- Increase the number of passenger miles traveled
- Reverse the growth in the average length of trips taken
- Work to reduce the growth in the number of trips taken while retaining the current modal hierarchy of pedestrians, bicycles and skateboards, transit, car share/carpool, and single occupancy vehicles (SOV)

2. Transportation Accomplishments and Future Challenges

a. Accomplishments

The Transportation Master Plan is being completed on the 20th anniversary of the first comprehensive transportation demand management program for CU-Boulder. Those efforts were initiated in fall 1991 and today this document continues the commitment. The following summarizes what it has taken to accomplish today's celebrated successes:

- Collaborative transportation demand management actions, including those at CU-Boulder, have meant that traffic volumes in Boulder decreased approximately 13 percent from 2001 to 2009 while metropolitan Denver traffic volumes increased 12 percent over the same time period. The result is a total 25 percent reduction in traffic volumes because of these actions.
- Survey data of students and faculty/staff suggest that had CU's mode split patterns in 1990 continued, CU-Boulder would have needed an additional 2,863 parking spaces today.

¹ Table references in this section are references to chapters contained in the Transportation Master Plan that have been excerpted for use in this section.

- CU-Boulder has one of the lowest single-occupant vehicle (SOV) modal splits among major universities.
- CU-Boulder is in the top 9 percent of universities in the nation with regard to campus transit service, with over 28 transit routes now providing access to campus and an increase in CU-Boulder student transit of over 300 percent since 1991.
- CU-Boulder compares favorably with its peer universities and is rated "excellent" with regard to bicycle and pedestrian facilities.

b. Future Challenges

As CU-Boulder plans for the next 20 years, it faces many issues that will challenge its ability to both physically and financially meet its projected growth and its sustainability goals, including:

- Parking & Transportation Services' (PTS) revenue streams are currently strained to offset its existing operating costs, which include the new debt service for the recently completed Center for Community parking structure.
- CU-Boulder's Travel Demand Management programs have been very successful, but unless these programs continue to expand the university will need to build additional parking to address future parking demand. Building new parking is significantly more expensive than TDM. The university will need to off-set projected growth in travel demand as well as reduce green house gas emissions to achieve its sustainability commitments.
- The university's parking system currently has limited supply in the high demand areas of Main Campus and an under-utilized supply at East Campus and the current price of parking does not reflect the cost of providing that parking. Excess supply and under-priced parking are major deterrents to successful TDM programs.
- The Main Campus of the university is nearing build-out. Although there are a variety of viable alternative transportation options offered on Main Campus, there are still enhanced and new pedestrian, bicycle, and transit infrastructure and services needed.
- Approximately 35 percent of the university's total parking supply is not within the management and control of PTS (over 4,000 parking spaces). Much of this parking is provided with no direct permit or other fee charged to users. Without centralized oversight of the parking supply, the university will not have consistency in its approach to parking management and will not be as successful as it can be in achieving a change in travel behaviors and in reducing parking demand.
- If no improvements are made to current travel demand management programs, rather than reducing vehicle miles traveled and GHGs by 20 percent, CU-Boulder's VMT will increase by 17 percent by 2030.
- If no improvements are made to current travel demand management programs, campus parking

demand will increase by 1,700 spaces by 2030.

c. Travel Demand Management Response to Future Challenges

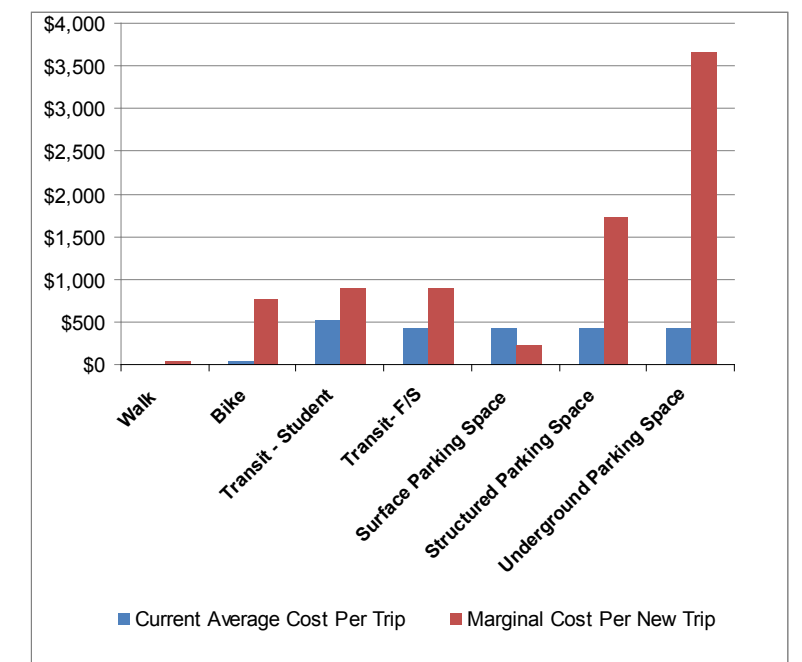
The CU-Boulder response to these future challenges is to manage parking; improve pedestrian, bicycle, and transit access to campus; and thereby achieve VMT and GHG goals. The tools and techniques that will be applied and expanded include the following:

Reduce the need to travel	<ul style="list-style-type: none"> • Land use – intensification • University villages with housing, academic, retail, and service facilities • Tele-working, video conferencing
Provide for travel choices	<ul style="list-style-type: none"> • Allocation of street space (to public transit, walking, bicycling, high occupancy vehicles) • Improved public transit services • Construction of walking and bicycling networks • University villages with housing, academic, retail, and service facilities
Influence travel choices	<ul style="list-style-type: none"> • School, business, and community travel TDM plans • Improved travel information • Pricing of parking and roads (i.e., US 36) • University villages with housing, academic, retail, and service facilities

CU-Boulder's experience shows that TDM costs approximately five times less than providing parking. This least-cost planning approach is the best approach to help the university address the challenges it is facing.

Figure 1 summarizes an analysis of the average and marginal cost per trip for various modes at CU-Boulder. The current average cost per trip reflects actual costs to the university of providing this mode per commuter per year. The marginal cost per new trip is an estimate of what it could cost the university per commuter per year to provide this service in the future and reflects the cost of needed capital improvements, programs, and services needed to provide this new trip.

Figure 1
Annual CU-Boulder Cost of Commuting By Various



Goal

- * Encourage the expansion of TDM programs to increase the use of alternative transportation modes and reduce the use of single-occupancy vehicles.

Guidelines

- * TDM should be implemented first before considering street capacity improvements and adding parking.
- Land is a scarce and valuable asset at CU-Boulder; planned land uses should discourage vehicular use and encourage the use of alternative modes.
- The supply and price of parking are two key factors in choice of travel mode and the university should use these variables to achieve financial sustainability and to encourage use of alternative modes of transportation.
- Consistent parking management and pricing throughout CU-Boulder can address inequities that currently exist.
- Transportation investments to improve commuting to campus by affiliates should consider the costs of accommodating each type of trip to campus (i.e., bike, pedestrian, transit, carpool/vanpool, etc.).
- Transportation options should consider the needs of people with disabilities during the planning and implementation of TDM strategies.

3. Transportation Master Plan Vision and Goals

a. Transportation Vision Statement

During the Campus Master Plan process, a vision emerged for the Transportation Master Plan that describes the aspirations of the Boulder campus. The vision is one where:

- Mobility and accessibility are ensured for all CU-Boulder faculty, staff, students, visitors, and vendors regardless of race, age, income, or disability.
- CU-Boulder bicycle and pedestrian facilities, public transit systems, campus streets, and surrounding community streets are all safe and well-maintained and take users when and where they need to go.
- An integrated, market-based pricing system for the parking supply helps to not only manage the demand on the transportation and parking system but also helps to pay for its improvements and for programs and services to reduce travel demand.
- The impacts of travel activities are recognized and CU-Boulder functions as a good neighbor to mitigate the negative impacts on surrounding communities.
- The CU-Boulder campuses are transformed by a growth pattern that creates complete campus communities with ready, safe, and close access to classrooms, research and laboratories, jobs, shopping, and services and are connected by reliable

and cost-effective transit and alternative travel mode facilities.

- Technology is implemented including:
- clean fuels and vehicles
- traffic operation systems that manage traffic flow and reduce delay and congestion on nearby roadways
- advanced and accessible traveler information that allows for informed travel choices
- transit systems and strategies that synchronize schedules and routes to speed travelers to desired destinations
- There is a viable choice to leave autos at home and take advantage of a seamless network of accessible pedestrian and bicycle paths that connect to nearby bus, rail, and other alternative travel modes that can carry users to school, work, shopping, recreation, and services.
- CU-Boulder works with regional and local agencies and stakeholders to take effective action to protect the earth's climate and to serve as a model for national and international action.
- CU-Boulder's transportation investments and travel behaviors are driven by the need to reduce the impact on the earth's natural habitats.
- All who work, learn, and teach at CU-Boulder and those who visit enjoy a higher quality of life.

b. Flagship 2030 Strategic Plan Long Range Goals

This plan continues themes from the previous plan, including the modal hierarchy, density, and mixed land uses as key components that support efficient transportation and conveniently located campus services. In addition, the Flagship 2030 Strategic Plan proposes several long-range goals that will impact campus transportation needs:

- Increasing enrollment at historic rates resulting in 5,300 more students by 2030 (2,650 by 2020).
- Developing the East Campus as a full campus, possibly with academic and residential uses.
- Developing residential colleges where students can live with faculty in a living/ learning environment.
- Increasing the number of non-freshmen residents in residence halls from 2 percent (2008) to 20 percent by 2020.
- Redeveloping the area north of Boulder Creek between 17th Street and Folsom Street.
- Increasing the tenure-track faculty by 300 positions (of which 100 faculty have already been hired).
- Internationalizing the institution as a part of the global economy, including seeking more international students.

As noted above and in Section 3 of the Campus Master Plan, the state of Colorado and the University of Colorado Boulder have adopted broad sustainability goals to:

- Reduce greenhouse gas (GHG) emissions by 20

- percent by 2020.
- Become carbon neutral by 2050.

c. Transportation Goals

The Transportation Master Plan, as an element of the CU-Boulder Campus Master Plan, will work in conjunction with the Flagship 2030 Strategic Plan and provide guidance on how to address these challenges and recommendations to:

- Provide a framework and guidance for transportation planning and management over the next 20 years in order to help the university achieve a sustainable transportation future.
- Reduce congestion in and around the campuses and reduce the total number of motor vehicles driven to campus, which will result in reduced parking and travel demand.
- Provide convenient and viable alternative mode options to the campus community in order to encourage the use of transportation modes other than the single-occupant vehicle.
- Better manage the available parking supply and price it to ensure financial sustainability and to encourage alternative mode use.
- Ensure TDM and parking management strategies are considered and incorporated into projects as the campuses develop and to use other methods, such as providing more on-campus housing and building university villages (which integrate student, faculty, and staff housing along with education, retail, and service facilities), to minimize or eliminate the need to build new parking.
- Achieve greenhouse gas emission (GHG) reductions in campus transportation by 2020 in comparable proportion (about 20 percent) that the transportation sector contributes locally to campus GHG.
- Develop viable financial strategies to address current financial deficits of Parking & Transportation Services as well as identify funding for new and expanded efforts to achieve a reduction in travel and parking demand.
- Develop both long-range and short-term strategies to move people between the various properties that compose CU-Boulder.
- Align the university's transportation planning goals with regional transportation efforts.

4. Current Conditions

a. Existing Mode Share

In the spring of 2008, 3,078 faculty, staff, and students participated in an online commuter survey hosted by SurveyMonkey.com. This survey was intended to determine the "modal share" (the proportion of commute trips made using each method of transportation) of trips made to and from the University of Colorado Boulder by faculty, staff, and students. During 2010, a similar survey was conducted four times—winter, spring, summer and fall—with 6,384 affiliate participants. Existing mode share was obtained from a weighted average of the four. The results of the 2010 survey are shown in Table 1 along with the results from the University of Colorado 2008 Commuter Survey.

As shown in Table 1, the 2010 drive alone share is approximately 47 percent for faculty/staff and 19 percent for students. Carpools and vanpools account for another 7 percent of faculty/staff trips and 4 percent of student trips. Compared to 2008, the faculty/staff vehicular use has increased slightly while student use of single-occupancy vehicles (SOV) is about the same.

In addition to looking at overall mode share, the 2010 data were evaluated to determine if there are any differences in mode share between faculty and staff working on the Main Campus and those primarily working on the

Table 1		
CU-Boulder Mode Share		
Faculty/Staff	2008 ⁽¹⁾	2010 ⁽²⁾
Telework/Didn't Come	2.3%	6.2%
Walk	3.8%	6.0%
Bike	8.5%	9.4%
Skateboard	0.1%	0.0%
Bus	25.9%	20.8%
Car/Vanpool	8.9%	7.4%
Motorcycle/Scooter	0.6%	0.5%
Drive alone	45.3%	47.0%
Other	4.6%	2.7%
Students	2008	2010
Telework/Didn't Come	2.2%	5.6%
Walk	22.2%	25.3%
Bike	14.9%	15.9%
Skateboard	1.2%	1.5%
Bus	32.0%	27.6%
Car/Vanpool	2.8%	3.5%
Motorcycle/Scooter	4.2%	0.5%
Drive alone	18.5%	18.9%
Other	2.1%	1.1%
Source		
1. University of Colorado 2008 Commuter Survey		
2. University of Colorado 2010 Commuter Survey		

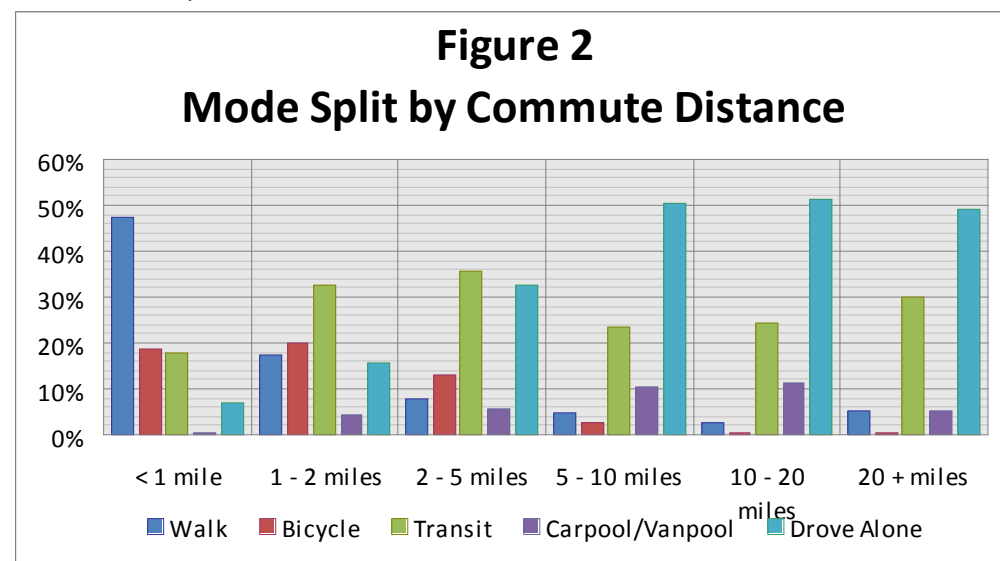
East Campus. Table 2 shows the results of the analysis.

**Table 2
CU-Boulder Mode Share
Faculty/Staff**

Faculty/Staff	2010	Main Campus	East Campus
Telework/Didn't Come	6.1%	6.0%	5.0%
Walk	5.9%	7.0%	5.0%
Bike	8.4%	9.0%	6.7%
Skateboard	0.0%	0.1%	0.0%
Bus	21.7%	24.0%	17.0%
Car/Vanpool	7.7%	7.6%	9.0%
Motor cycle/scooter	0.3%	0.3%	0.3%
Drive alone	47.3%	44.0%	55.0%
Other	2.7%	2.0%	2.0%

As shown, vehicular use is significantly higher for faculty and staff working at the East Campus. This is most likely due to a combination of the lower level of transit service and bicycle/pedestrian facilities at the East Campus and more widely available parking. Since a majority of the future growth at the university is planned to occur on the East Campus, the higher vehicle use and lower transit use could pose a challenge to the university in meeting its sustainability goals.

Finally, an additional analysis was performed on the 2010 data to determine mode share by commuting distance. As shown in Figure 2, vehicle use is very low (less than 10 percent) for affiliates who live within a mile of campus and increases to almost 60 percent for affiliates who live more than five miles from campus. As a result, significant shifts away from vehicle use can be obtained by providing additional housing near campus.



b. Existing TDM Programs

CU-Boulder has developed and funded a comprehensive package of TDM programs since 1992. These programs are jointly managed by Parking & Transportation Services (PTS) and the Student Environmental Center through a Sustainable Transportation Partnership (STP) agreement. PTS has two full-time equivalent employees dedicated to TDM while the Environmental Center has one full-time staff member and several student employees involved in TDM programs.

Existing TDM programs at CU-Boulder include:

Transit:

- Student Bus Pass Program – available to over 30,000 students. Includes regional coverage, Regional Transportation District (RTD) SkyRide to Denver International Airport.
- Faculty/Staff EcoPasses – available to full and part-time continuing employees working at a 20 percent or greater full-time equivalent appointment.
- Late-night transit.
- CU Ski Bus.
- Buy up of additional off-peak frequency on the STAMPEDE route.
- Guaranteed Ride Home with EcoPass.

Automobile:

- Ridematching through Zimride.
- Reserved priority parking spaces are set aside for carpools at Wolf Law, Leeds School of Business, and the Center for Community.
- Car sharing through eGo CarShare with six vehicles.

Bicycle:

- Bike racks around most buildings and in heavily used areas.
- Regular surveys of bike parking.
- Bike Station located near the UMC with staffing during fall and spring, providing maintenance and repair services.
- Mobile Mechanic.
- Buff Bikes – bike sharing and semester rentals.

Marketing, Outreach, and Web Services:

- Periodic commuter surveys to monitor auto and alternative mode use.
- Website “connection” programs to link individuals to various modes of transportation.
- Maps, brochures, and pamphlets on the various programs.

This comprehensive approach to TDM has been successful in reducing the travel and parking demand at CU-Boulder. A comparison of cordon counts on the Main Campus indicates an increase of 62 percent in bicycle use on the Main Campus and 23 percent in pedestrians entering campus from 1998 to 2010.

c. Existing Non-Motorized Travel and Facilities

Non-motorized modes will always be the preferred forms of travel to campus and on campus due to zero energy use and zero carbon emissions. The Main Campus is a walking environment because of its modest size; efficient land use encouragement; extensive system of pedestrian walkways; and pleasant, park-like atmosphere. As East Campus and Williams Village build out, similar pedestrian and bicycle-oriented environments will be developed.

i. Non-Motorized Demand

As previously indicated in Table 1, over 15 percent of faculty and staff and over 42 percent of students use a non-motorized mode of travel to reach campus. The closer affiliates live to campus, the higher the non-motorized mode share.

To quantify non-motorized travel to Main Campus, a cordon count was conducted in 2010. In total 11,417 individuals were counted walking, biking, or skateboarding to campus on Wednesday October 6,, when the weather was clear/partly cloudy with temperatures in the low to mid 50s. This number represents a significant percentage of individuals travelling to campus by non-motorized transportation. Some basic assumptions were made about individuals travelling to campus, as displayed in Table 3.

**Table 3
Count Figures/Mode Share Estimates**

Off-Campus Students	25,600
Faculty/Staff	6,730
Total Potential Commuters	32,330
Total Inbound Count (bike/ped/skate)	11,417
Pedestrians (7,426)	23.0%
Bicyclists (3,764)	11.6%
Skateboarders (227)	0.7%
Total est. Non-Motorized Mode Share	35.3%

The 2010 counts were a thorough, but not exhaustive, summary of all non-motorized travel to campus. There are individuals who access campus at numerous places, whether at an officially designated crossing or at an informal crossing of convenience, who did not fall under count supervision. Furthermore, the CU-Boulder campus plays an integral role in the greater City of Boulder bicycle and pedestrian network; therefore it is likely that people were included in the counts who use the CU-Boulder network to get to their destination, though CU-Boulder might not be their destination.

Despite these factors, the counts still allow some general interpretations to be made about non-motorized

traffic in and around campus. As shown in Table 3, from the 2010 counts it was estimated that nearly a quarter of all individuals coming to campus do so by foot. Additionally, about 12 percent came to campus by bicycle. The results also tell us where more bicyclists, pedestrians, and skateboarders are accessing campus. Understanding these data will allow the plan to address the areas of greatest significance to CU-Boulder's connectivity with the greater City of Boulder bicycle and pedestrian network.

The count results were compiled in 15-minute increments, allowing for peak hour data to be tabulated. Campus-wide, the busiest times for non-motorized activity were between 10:00 and 11:00 a.m., with the highest 15-minute peak beginning at 10:45 a.m. These results coincide with the class schedule on Monday/Wednesday/Friday, where classes end at 10 minutes to the hour, and new classes start at the top of each hour. The count results in Table 4 break out the count totals by aggregated skateboard, bicycle, and pedestrian activity.

The 2010 results show high levels of walking and bicycling. Skateboarding was not recorded in significant levels and represented approximately 2 percent of non-motorized travel. Helmet use, while not officially recorded, was informally noticed by count volunteers as low.

The count data shows the importance of Broadway as a pedestrian and bicycle access point and corridor. Ongoing efforts to enhance non-motorized utility should focus on Broadway and its connection to the greater City of Boulder network. As the East Campus is developed, bicycle and pedestrian access should be considered and linkages improved between the two. Currently, the Boulder Creek path serves both Main and East Campus—and access points to Boulder Creek should be re-examined to strengthen its connection to campus and its utility as a bikeway.

**Table 4
Count Locations Ranked by Activity**

	Skates	Bikes	Peds	Total
Folsom & Colorado	26	738	977	1,741
16 th & Broadway	19	405	1,030	1,454
Broadway & College	40	199	1,123	1,362
Broadway & University	28	403	711	1,142
28 th & College	21	500	492	1,013
Lot 169 & Stadium	0	151	493	644
17 th & University	8	217	478	703
Broadway & Pennsylvania	12	80	568	660
Athens Court	7	49	481	537
18 th & Broadway	33	96	379	508
Baseline & Broadway	2	366	105	473
28 th & Aurora	4	213	295	512
South Broadway Tunnel	7	296	54	357
Broadway & Regent	20	51	240	311
TOTALS	277	3,764	7,426	11,417

ii. Non-Motorized Supply

Discussion and analysis of non-motorized facilities were broken into pedestrian and bicycle components. This distinction is made due to the relative difference in travel speeds between the two modes. There are also some multi-use facilities.

(1) PEDESTRIAN FACILITIES

Pedestrian facilities on the CU-Boulder campus are divided into three sub-categories: corridors, crosswalks, and sidewalks.

Pedestrian corridors are areas of campus where pedestrian movement is prioritized and given preference to other forms of transportation.

Crosswalks are found where pedestrian facilities intersect streets. The major crosswalks on campus are located along Broadway, University Avenue, the 18th/Colorado Avenue corridor and Regent Drive.

Sidewalks are the most ubiquitous pedestrian facility available on campus. During passing periods (times of peak travel) sidewalks can experience heavy amounts of activity, making them suitable only for pedestrians. When skateboarders and bicyclists attempt to use sidewalks during passing periods, they must travel at the speed of pedestrians or use another facility.

(2) BICYCLE FACILITIES

According to the Pedestrian Safety Committee Final Report from April 2010, there are currently two on-street bike lanes that run through the campus. One lane is along Colorado Avenue and the second is along Pleasant Street. The Pleasant Street bike lane is a contra-flow bike lane, meaning that it runs against the one-way (westbound) traffic. The existing bike lanes connecting or near to campus are designated in Exhibit V-E-1.

Sufficient bicycle parking is necessary to support a thriving bicycle network by providing a safe place for bicyclists to lock or store their bikes while on campus. Currently, CU-Boulder houses an extensive bicycle parking system, though there is no dedicated funding source for bike parking and localized parking shortages exist.

According to the 2009 Bicycle Parking Assessment, conducted by the university, there are 9,433 parking spaces in 1,159 racks across campus. Roughly half of this parking is available to the full campus community of 37,334 (30,074 students and 7,260 faculty/staff), or enough parking to serve 13 percent of potential users versus 14 percent of estimated demand. The other half of existing bike parking is provided for on-campus residents at their residential locations on Main Campus, and at Family Housing, Williams Village, and Bear Creek.

(3) MULTI-USE FACILITIES

Multi-use or shared-use facilities are generally of two types: paths and structures. Structures are almost, but not always, multi-use due to the cost to construct them. Structures include bridges, overpasses, and underpasses.

The primary multi-use path serving the campus is the Broadway path. This path plays a critical role in the CU-Boulder and City of Boulder bicycle transportation system. The Broadway facility is striped for bicyclists to travel in opposite directions, and also has a designated space for pedestrian travel. Despite these delineations, crossover interference (pedestrians in the bicycle areas and vice versa) is common.

Another important multi-use path for the city and CU-Boulder is the Boulder Creek Path. The Boulder Creek Path runs just north of Main Campus and runs directly through East Campus. Boulder Creek access will play an important role in the non-motorized travel between East and Main Campuses as CU-Boulder grows.

The other clearly marked path on campus is called the "East-West Corridor" located along Pleasant Street east toward Folsom Field. This section does not function well, as pedestrians and bicycles often ignore the lane markings. Physical dividers would help define the paths more clearly but are impractical due to the service requirements and large volumes of pedestrians during class change periods.

Other areas are designated as bicycle paths on campus; however, the painted designations are often ignored as was discovered during field visits. Other observations included that "paths" were not clearly identified as such on campus, and resembled sidewalks or unmarked, paved areas.

Bridges, overpasses, and underpasses allow for the uninterrupted flow of pedestrian and bicyclist movement separate from vehicle traffic, and are therefore much safer than at-grade crossings. These are similar in some ways to crosswalks, where safety concerns are high inside under- and overpasses and at their entrances/exits. According to the City of Boulder 2008 Management Plan, there are approximately 24 underpasses and 12 bridges within or supporting the CU-Boulder campus.

d. Existing Transit Travel and Services

Bus transit service has continued to play a pivotal role in working to meet CU-Boulder's vision and goals for an efficient, sustainable, carbon-neutral university. The amount of transit service to CU-Boulder places it in the top nine percent of universities nation-wide. The City of Boulder, Boulder County, RTD, and CU-Boulder have collaborated in extensive planning together to achieve this level of transit service.

Mode share data indicate transit to be best serving the 2-5 mile distance with local service and the >20

mile distance with regional service. The intermediate distance will need to be a focus to capture the dispersal of trips and housing locations unless housing location trends change.

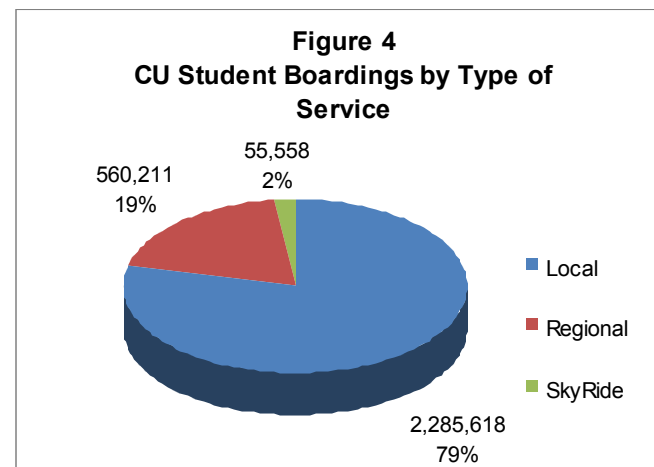
The mode share data also indicated strength in service to Main Campus and Williams Village. As the East Campus is built out, transit service to this location will need to be a future area of focus.

ii. Demand for Transit Service

Compared to the 740,000 CU-Boulder student boardings on RTD buses recorded in 1992, student boardings had almost doubled to 1,427,000 in 2002, and had tripled to 2,328,000 by 2009. Of the 2.3 million student trips made in 2009, 74 percent were served by local routes, 24 percent by regional routes, and 2 percent by skyRide routes.

Additional analysis was completed to understand the share of riders who board routes that directly serve one of the CU-Boulder campus locations. This gave an indication of the preference for one-seat rides versus rides requiring a transfer. The data show that 93 percent of CU-Boulder student boardings are on routes with direct service (one seat ride) to campus, while 7 percent are on routes requiring a transfer to reach campus. Direct-service routes average 30 percent CU-Boulder student ridership while indirect routes average 6 percent. This important finding is reflected in recommendations.

The average annual growth rate in CU-Boulder student boardings of RTD transit services over the 17-year period from 1992 to 2009 has been 7.0 percent per year. CU-Boulder student enrollment averaged 1.1 percent growth per year over the same period.



Using five-year rolling averages to look at smoothed trends, the average annual growth rate for all routes has been gradually slowing since 2005, from a peak of 11.7 percent per year (2000-2005) to a more recent 5 percent per year (2004-2009). In contrast, rolling average growth rates for regional trips have been increasing in recent years. This suggests that there have been an increas-

ing number of longer-distance trips by CU-Boulder students.

Separate demand estimates for the three campuses of CU-Boulder were prepared. These were prepared using a variety of estimates and methods including trend line growth, population and employment forecasts by local government (City of Boulder) and regional government (DRCOG), and forecasts by CU-Boulder of student, faculty, staff, and facilities growth (buildings and classrooms). For each, a range and an average growth rate are presented for the baseline growth. The lower end of the range represents a continuation of existing mode split. The upper end of the range represents some progress in shifting travel from other modes to transit. An aggressive growth rate is also presented, reflective more robust growth and policy choices which might more strongly favor transit. Demand estimates are shown here, existing and forecast transit supply follows, and then recommendations are made to address identified gaps between demand for and supply of transit service.

Williams Village Transit Demand

- Base Demand: Average of 2.6 percent per year base growth (Range: 1.7 to 3.5 percent per year).
- Aggressive Demand: 5.0 percent per year.

East Campus Transit Demand

- Base Demand: Average of 2.5 percent per year base growth (Range: 1.3 percent to 3.6 percent per year).
- Aggressive Demand: 6.0 percent per year.

Main Campus Transit Demand

- Base Demand: Average of 1.7 percent per year base growth (Range: 1.1 percent to 2.4 percent per year).
- Aggressive Demand: 4.8 percent per year.

ii. Supply of Transit Service

CU-Boulder is served by 28 different routes, with different combinations of those routes serving one of the three campus locations: Main, East, or Williams Village. The bus routes are provided by RTD, Special Transit, and CU-Boulder, and are funded by many sources.

Main Campus

The CU-Boulder Main Campus is directly served by 16 RTD routes, the HOP, and the Buff Bus. Of the 16 RTD routes, eight are local routes and eight are regional/skyRide. Of the eight RTD routes serving Main Campus, five serve the west edge of the Main Campus and are oriented north-south along the Broadway corridor (203, 204, 225, Dash, and Skip). Two routes are oriented east-west along the 18th Street/Colorado Avenue corridor (209 and Stampede). The eighth local route touches the south edge of the Main Campus along Baseline Road (Bound).

Of the five RTD routes serving the west edge of campus along Broadway, four also serve as the connecting

routes for many other routes that converge at the Boulder Transit Center (203, 204, 225, and Dash). The Skip provides connections with a two-block walk from the Boulder Transit Center to Broadway and provides transfer opportunities to other routes it intersects. The HOP provides connections from CU-Boulder to the Boulder Transit Center, but not in the opposite direction.

Seven routes serve the Boulder Transit Center and require transfers to reach the CU-Boulder campus. Those seven routes are: 205, 206, 208, Jump, Bolt, N, and Y. These routes provide important connections to the Boulder County locations of Gunbarrel, East Boulder, Valmont/55th/East Arapahoe, Lafayette and Louisville, Longmont, Nederland, and Lyons, respectively.

Of the eight regional/skyRide routes serving Main Campus, five are oriented north-south along the Broadway corridor (AB, B/BX, DD, DM, GS). Route J passes east-west through the Main Campus via the 18th Street/Colorado Avenue corridor. The remaining two regional routes touch the east edge of Main Campus along 28th Street (HX and S).

East Campus

The CU-Boulder East Campus is directly served by six routes, of which four are local routes and two are regional. Of the local routes, the Stampede passes along the four edges of East Campus, while the 209 touches the 30th/Colorado corner. The Bound serves the western, 30th Street edge. The other local route, the Jump, serves the northern Arapahoe Avenue edge. The local routes provide all-day service.

The two regional routes serving East Campus both pass along the northern, Arapahoe edge. They are the J and S routes. The J route also runs along the western, 30th Street edge of East Campus on its way to and from Main Campus. Both routes have very limited peak-only service, with no off-peak service. Each provides a handful of trips to Boulder in the morning and out of Boulder in the evening.

The East Campus is also indirectly served by two local routes and two regional routes that come within several blocks of East Campus. These routes pass through the Arapahoe/28th (Regional Route HX) and Canyon/28th Street intersections (205, 206, Bolt).

Williams Village

The Williams Village Campus is served by three local routes, two on Baseline Road and one on 30th Street. The 203 and 225 pass east-west along Baseline Road and then travel north-south along Broadway. As such, they connect both campuses. Because neither route enters the Williams Village Campus or the Main Campus, these routes are less convenient than the Buff Bus at making this connection. The Bound route travels north-south along 30th Street, passing by the 30th/Baseline corner of Williams Village Campus and continuing west

on Baseline.

The Buff Bus shuttle connects students who live in Williams Village with the Main Campus. It operates between 6:48 a.m. and midnight on weekdays and 10:00 a.m. and midnight on weekends. Late-night service is also provided Tuesday through Sunday mornings between midnight and 3:30 a.m. The buses run most often, at four-minute frequencies, between 7:19 a.m. and 10:35 a.m., approximately on five-minute frequencies from then until 4:16 p.m., with decreasing frequencies thereafter.

e. Existing Vehicular Travel and Facilities

The CU-Boulder campuses are located within the City of Boulder and served by the city's street network which is displayed in V-E-3. The street network is the primary transportation system and serves a variety of modes and vehicular types, including automobile, truck, transit, bicycles, and pedestrians. Boulder's street system is largely built out and constrained by Boulder being a mature community, so the emphasis is to operate the system as safely and efficiently as possible. The street system is defined by a Street Functional Classification, consisting of a hierarchy of streets from the local streets to collector streets to freeways. These functional classes establish a common understanding of the use of the street and its character, regulate access from adjacent properties and determine how the costs of new street construction are shared between the city and surrounding properties.

I. 2001–2009 TRAFFIC VOLUME COMPARISON

To determine the traffic volumes patterns in the last decade, the Colorado Department of Transportation (CDOT) traffic volumes along State Highways (SH) in the City of Boulder were obtained and compared. Traffic data from 2001 along US 36, SH 7, SH 93, SH 119, and SH 157 was compared to 2009 traffic data. The results are shown in Figure 7. Data for a total of 14 locations were compared. Traffic volumes decreased from 2001 to 2009 at all but one location (Arapahoe Avenue east of Broadway Street). Overall, traffic volumes decreased by approximately 13 percent from 2001 to 2009.

To determine if this reduction is due to the Travel Demand Management (TDM) practices that the university and City of Boulder have implemented, or due to the overall reduction in traffic volumes that has occurred in the last couple of years, a volume comparison was performed along US 36 at Wadsworth Boulevard. CDOT has an automatic traffic recorder (ATR) along US 36 at this location that is continuously collecting traffic. An analysis of the data shows that the traffic volumes along US 36 in the vicinity of Wadsworth Boulevard have decreased by 2 percent from 2001 to 2009. In addition, according to the 2009 Annual Report on Traffic Congestion in the Denver Region, published by the Denver Regional Council of Governments (DRCOG), total vehicle-miles traveled in the Denver Region has increased by approxi-

mately 12 percent from 2001 to 2009 with most of that growth occurring between 2001 and 2005. However, it should be noted that some of that growth in vehicle-miles is due to the construction of new roadways. As a result, the growth in vehicle-miles of travel on existing roadways should be lower. Regardless, it appears that the reduction in traffic volumes experienced in the City of Boulder and the areas surrounding the university is not consistent with the rest of the Denver Region and indicates that the various TDM practices that have been implemented are being effective. This is a very important finding given that CU-Boulder is the largest employer in both the City of Boulder and within Boulder County.

II. INTERSECTION LEVEL OF SERVICE

Level of service (LOS) is a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Six LOS are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Each level of service represents a range of operating conditions and the driver's perception of those conditions.

The City of Boulder evaluated all its signalized intersections in 2009. Levels of Service for the intersections surrounding CU-Boulder are illustrated in Exhibits V-E-5 and V-E-6 for the morning and evening peak hours, respectively. In general, operations are better during the morning peak hour, with all nearby intersections operating at LOS D or better, with the exception of the 28th/Colorado and Baseline/Foothills Parkway intersections, which operate at LOS F. These two intersections also operate at LOS F during the evening peak hour along with Broadway/Baseline, 28th/Arapahoe and Colorado/Foothills Parkway. In addition, the two Baseline/US 36 ramp intersections along with Arapahoe/Foothills Parkway operate at LOS E.

The City has improved the 28th/Colorado, Arapahoe/Foothills Parkway, and Arapahoe/30th Street intersections in recent years. Improvements are planned at Broadway/Baseline, Baseline/30th, and Baseline/Foothills Parkway.

f. Existing Parking Management, Supply, and Demand

I. EXISTING PARKING SYSTEMS OPERATION

Parking & Transportation Services (PTS) is an auxiliary (i.e., self funding) department of the university and uses revenues generated from parking user fees to offset parking administration, maintenance, and development costs. No general fund (i.e., tax or tuition) dollars are allocated to support parking operations. Parking & Transportation Services is responsible for administration, maintenance, and enforcement of most campus parking facilities, and coordinating parking arrangements for sporting and special events. PTS controls the distribution of parking permits for about 65 percent of the Main

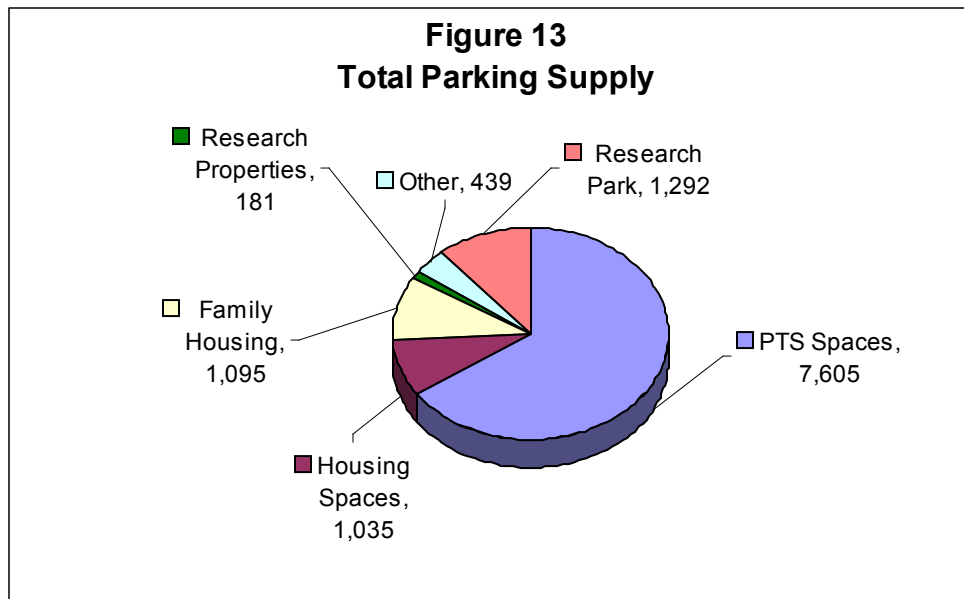
Campus, East Campus, and Williams Village Campus parking supply. The remaining 35 percent of this supply is controlled by Housing and Family Housing (19 percent),

the Research Property System on East Campus (13 percent), the Athletics Department (2 percent), and a variety of other departments (2 percent). These non-PTS controlled spaces, which are generally underutilized, offer an opportunity to supplement the campus parking supply without building new parking, and to delay the costs of new parking development.

(1) EXISTING PARKING SUPPLY

PTS-managed parking facilities are located throughout the Main, East, and Williams Village Campuses as shown in Exhibits V-E-7, V-E-8 and V-E-9. Family Housing and Research Properties spaces are situated primarily on East Campus, with some Family Housing spaces located north of Main Campus. Housing controlled spaces are located on the Williams Village Campus and family housing areas while Athletics controlled spaces are located around the stadium. This distributed pattern of parking resulted from the expansion of the campus over a number of decades and the placement of parking in locations where land was available after building construction. The most concentrated campus parking

supply, including roughly 24 percent of all Main Campus parking, is provided in three structured garages, the Regent AutoPark, Euclid AutoPark, and the Center for Community underground garage. Surface lots on Main Campus vary in size from just a few spaces to several hundred spaces and provide about 76 percent of the Main Campus parking supply. Meters control short-term parking along streets and within some parking lots. In addition to traditional single space meters, PTS has installed computer-based multi-space meters in nine parking lots using “pay-by-space” or “pay-and-display” formats. These devices provide users with a broader range of payment options, including currency, coin, credit cards, and “smart chip” based cash cards sold by PTS.



There are a total of 10,355 parking spaces on Main Campus, East Campus, and Williams Village. In addition, there are 1,292 spaces at the Research Park for a combined campus

total of 11,647 spaces. Of the Research Park spaces, 1,027 are leased and used by Sybase² and the Advanced Technologies Center. The remaining 265 are used by CU employees of the Laboratory for Atmospheric and Space Physics (LASP) and the Center for Astrophysics and Space Astronomy (CASA).

Of the total parking supply available at CU-Boulder, PTS manages approximately 7,605 spaces. This means that departments other than PTS manage at least 4,042 spaces, comprising about 35 percent of the total supply. These include 1,095 Family Housing spaces, 1,035 Housing spaces, 1,292 Research Park spaces (East Campus), 181 Research Properties spaces, and 439 spaces controlled by Athletics and other groups. This fact is important for purposes of policy and pricing consistency.

(2) EXISTING PARKING DEMAND

Previous parking studies conducted for CU-Boulder estimated parking demand by multiplying the percent-

² Acquired by CU-Boulder in 2011, the parking is now a part of the Research Properties.

age of each user group expected to be traveling to campus each day by the percentage of drive alone (SOV) users and carpool drivers. For this analysis, the percentages derived from the 2010 CU-Boulder Commuting Spring and Fall Survey and the current population estimates were used and are shown in Table 5. The faculty/staff driving ratio is the drive alone plus motorcycle percentage (47.5 percent) plus the carpool percentage (7.67 percent) divided by two (assuming two-person carpools), which results in a 0.514 driving ratio. The Commuter Survey also had a question asking those who drive where they parked. This percentage was used in the analysis. The presence factor takes into account varying schedules of faculty/staff

	Driving Population	Driving Ratio ⁽¹⁾	Parking On-Campus ⁽²⁾	Presence Factor	Parking Demand Ratio	Campus Total Space	Campus Parking Demand
Faculty/Staff	7,260	0.514	0.72	0.97	0.359	2,606	1,013
Commuter Students	22,389	0.246	0.71	0.65	0.114	2,552	1,038
Resident Students Driving to Campus	7,021	0.101	0.79	0.65	0.052	365	97
Family Housing Students Driving to Campus	666	0.101	0.79	0.65	0.052	35	9
Subtotal	37,336					5,558	2,157
Resident Students	7,021		0.25	0.97	0.238	1,669	
Family Housing Students	666		0.25	0.97	0.238	158	
Faculty/Staff in Family Housing	150				1.5	225	
Total						2,052	
Retirees Parking on Campus						150	
Vendors & Contractors						89	
Daily Lot Parking Passes						46	
University Vehicles						465	
Visitors						776	
						1,526	
							9,136

Notes:
 (1) Driving ratio is a weighted combination of drive-alone (SOV) users and car/van pool users (HOV) assuming an occupancy rate per HOV vehicle of 2.0 for faculty/staff and students
 (2) Obtained from 2010 Spring/Fall Commuter Survey

Because resident hall demand is based on students who want to park their cars on campus (not how much they drive them), the parking demand ratio for this group is based on the ratio of the number of permits sold, divided by the number of students. This was then multiplied by a presence factor estimated by PTS.

For commuting students, the driving ratio was derived from the 2010 Commuting Survey drive alone/motorcycle/carpool mode shares as was the percentage parking on-campus. The presence factor was taken from the previous parking studies. It is lower than the faculty staff presence factor since students tend to be on campus

for shorter periods than faculty/staff.

In addition, PTS provided estimates of daily parking by retirees, vendors and contractors, university vehicles, and visitors. Table 5 indicates that the 2010 affiliate population generates an average daily parking demand of about 9,136 spaces. To compare this with CU-Boulder's parking supply, current parking data are shown in Table 6. PTS provided the number of regular, short-term, disabled, and reserved spaces available for faculty/staff and student parking on the Main Campus, East Campus (including the Research Park), and Williams Village.

To reduce time and energy spent on finding a parking space, it is good practice to provide a supply that is somewhat more than the projected demand. The effective factors take this into account. These factors are the same as used in previous studies. For short-term spaces, the effective supply was assumed to be the current utilization, which was estimated by PTS to be 0.70 percent.

The effective parking supply for the resident and commuter population is estimated at 9,576 spaces. Based on a comparison of the estimated demand and supply, it appears that CU-Boulder has a surplus of about 438 spaces. However, most of the surplus is on the East Campus and Williams Village, with Main Campus lots having a high utilization rate. The tight Main Campus supply results in many vehicles being parked off-campus. Over 2,100 vehicles are estimated to be parked off-campus.

	Faculty/Staff Commuter	Student Commuter	Resident Hall	Family Housing	ADA	Reserved	Other(1)	Motorcycle	Short Term(2)	Research Park(3)	Service(4)	Total
Total Spaces	3,359	2,553	980	983	223	103	519	259	1,108	1,292	268	11,647
Effective Factor	90%	90%	95%	90%	60%	95%	90%	90%	70%	40%	80%	
Effective Spaces	3,023	2,298	931	885	134	98	467	233	776	517	214	9,576

Notes:
 1. "Other" - includes Alumni, Athletics, Facilities, Foundation, Jila, Transportation Center & President's office
 2. Short Term - includes 864 spaces that would be generally at \$1.50/hr, 398 spaces at Euclid AutoPark at \$1.75/hr (first 3 hours) and \$3/hr (additional hrs till 5pm M-F), and 46 other spaces
 3. Effective Factor calculated based on current use by CU affiliates
 4. Service spaces are not available for commuter parking

5. Assessment of Data and Demand Projections

This section presents the Flagship 2030 projections of student enrollment, faculty/ staff projections, and other forecasts affecting travel and parking at CU-Boulder. Based on these projections, forecasts of commuting vehicle miles of travel, transit ridership, and parking demand are developed.

a. Campus Population Projections

The office of Planning, Budgeting, and Analysis (PBA) provided projections of student enrollment through 2030 as shown in Table 7. PBA also provided projections of faculty/staff through 2030 as shown in Table 8. Using PBA's mid estimate and carrying the same growth rate of approximately 0.86 percent per year through 2030 yields the affiliate population projections shown in Figure 14.

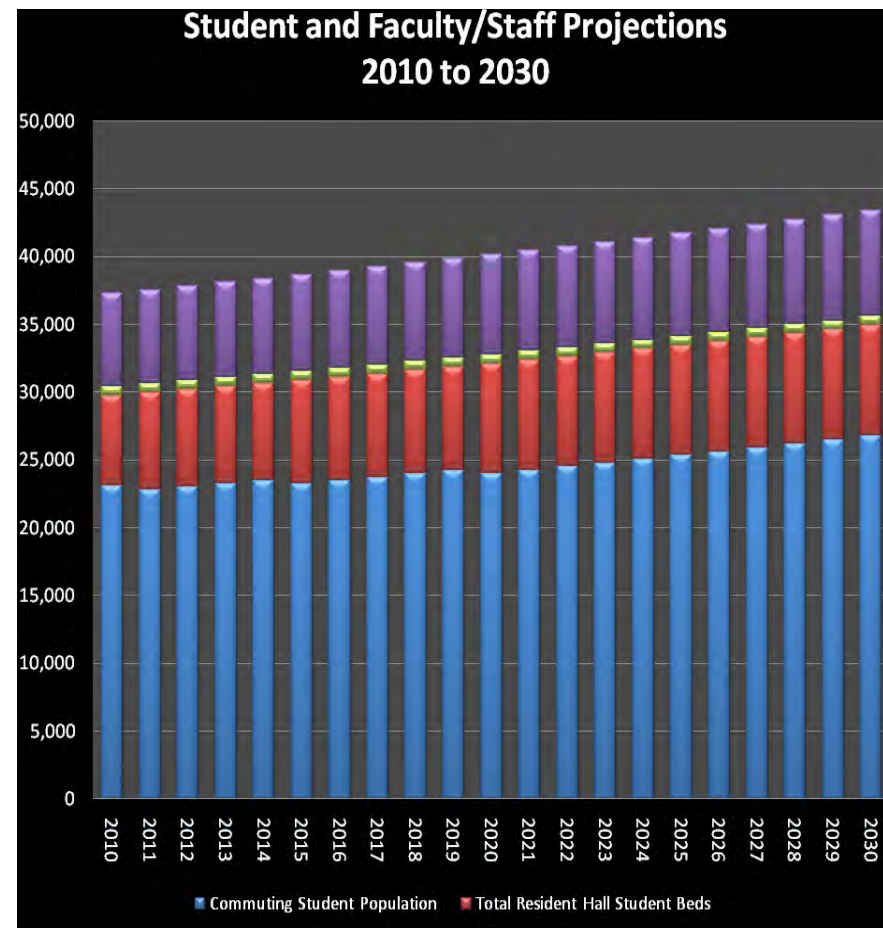
	Fall of:	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030
Graduate		4,854	5,013	5,175	5,338	5,503	5,671	5,840	5,947	6,056	6,168	6,281	7,550
Total					31,040	31,359	31,680		32,198			32,797	

**Table 8
Projections of Faculty/Staff**

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030
Instructional	2,207			2,279		2,315		2,351			
Non-Instructional/Research	1,773		1,877	1,912	1,947	1,981	2,016	2,051		2,120	
Classified/Unclassified Staff	3,280									3,414	3,715
Total	7,260	7,326	7,392	7,524	7,590	7,656	7,722	7,788	7,854	7,907	

* Actual employment

Figure 14



b. Existing Commuting Travel Estimates

Estimates of commuting vehicle miles of travel were developed by taking the affiliate population, applying current mode use percentages (see discussion on the University of Colorado 2010 Commuter Survey and Table 1) and multiplying by average commuting trip length. The calculations for VMT include the calculation of all commuting vehicles traveling to and from campus, including all vehicle-miles (both auto and transit) attributed to the university's commuting affiliates. Transit VMT includes both RTD buses as well as the university-operated Buff Bus. Carpool/vanpool occupancy was assumed at 2 persons per vehicle while bus occupancy (with the exception of Buff Buses) was assumed at approximately 8.9 persons per vehicle. The VMT was then obtained by multiplying the resulting vehicles by an average commuting trip length. A one-way trip distance of 11.0 miles for faculty/staff and 13.9 miles for students was used for vehicle commuter trips. For transit commuter trips, a one-way trip distance of 14.3 miles for faculty/staff and 6.8 miles for students was used. These distances were obtained from the University of Colorado 2010 Commuter Spring Survey (with the exception of the faculty/staff vehicle distance which was based on fall 2010 PTS permit data). The results of the 2010 VMT calculation are shown in Table 9. As shown, existing VMT associated with the university's commuting trips is approximately 252,760 miles per weekday.

Table 9 2010 Vehicle-Miles Traveled Calculations						
Affiliate Breakdown						
Commuting Students			22,389			
Resident Students			7,021			
Family Housing			666			
Faculty/Staff			7,260			
Total Campus Population ⁽¹⁾			37,336			
Family Housing Units			816			
Mode Share ²		Trips		Average Round Trip Length ⁽⁴⁾		Weekday Vehicle Miles Traveled
		Trips	Occupancy ⁽³⁾	Vehicles		
Commuting Students	Bike	14.9%	3,338			
	Transit	30.1%	6,730	8.9	756	10,284
	Drive Alone	22.2%	4,975	1	4,975	138,305
	Car/Van Pool	3.4%	752	2	376	10,453
	MC/Scooter	0.7%	157	1	157	4,365
	Walk	20.4%	4,574			
	Other	8.3%	1,863			
	100.0%	22,389				163,406
Resident Students	Bike	12.8%	980			
	Transit	23.0%	1,771			695 ⁽⁵⁾
	Drive Alone	6.8%	520	1	520	1,040
	Car/Van Pool	5.1%	390	2	195	390
	MC/Scooter	0.8%	59	1	59	118
	Walk	43.3%	3,330			
	Other	8.3%	637			
	100%	7,687				2,243
Faculty/Staff	Bike	8.4%	608			
	Transit	21.7%	1,575	8.9	177	5,061
	Drive Alone	47.3%	3,431	1	3,431	75,482
	Car/Van Pool	7.7%	557	2	279	6,127
	MC/Scooter	0.3%	20	1	20	440
	Walk	5.9%	428			
	Other	8.8%	641			
	100.0%	7,260				87,110
Total Weekday Vehicle-Miles Traveled						252,760

Notes:
 (1) Population estimates based on 2010 data from the Office of Budget, Planning and Analysis and growth rates from the *Flagship 2030 Strategic Plan*.
 (2) Mode split based on data found in the *Spring 2010 Commuter Survey*. Other category includes, skateboard, working from home, not working, and other.
 (3) Assumes an average occupancy of 2.0 for student car/van pools and 2.0 for faculty/staff car/van pools. Projected number of buses calculated by assuming an average bus occupancy of 8.9 based on RTD data.
 (4) Calculated based on average trip distance. Trip distance for commuting students is based on *Spring 2010 Commuter Survey* while trip distance for Faculty/Staff is based on geocoded PTS permit address information.
 (5) Buff Bus annual VMT obtained from CU. Daily VMT calculated by assuming 9 months of service, 4.33 weeks per month, and 5.45 weekday-equivalents per week based on the existing weekday and weekend schedule.

c. Future Commuting Travel Projections

Estimates of future commuting travel for university affiliates were projected based on projected population growth and the continuation of the current set of TDM programs.

As discussed in Section 4-a (see Table 3), vehicular use is significantly higher for faculty and staff working at the East Campus. This is most likely due to the lower level of transit service and bicycle/pedestrian facilities at the East Campus. Since a majority of the future growth at the university is planned to occur on the East Campus, the Drive Alone and Carpool/Vanpool mode shares were assumed to be higher in 2020 and 2030 compared to the 2010 shares for these modes.

Using the same methodology as Section 5-b, VMT was estimated for 2020 and 2030 using the affiliate population estimates discussed for 2020 and 2030. The results are shown in Table 10 along with estimates for 2010. As shown, existing VMT associated with the university's commuting trips is approximately 252,760 miles per weekday. With no changes in the university's TDM programs, VMT is expected to grow to approximately 296,954 by the Year 2030 due to population growth and slight shifts in mode type due to growth at East Campus. This means there will be an additional 44,194 miles per weekday of travel to and from the campus. This demand will also result in a demand for an additional 1,700 on-campus parking spaces to accommodate this increased travel demand.

Table 10			
Commuting Vehicle-Miles Traveled			
Faculty/Staff	2010	2020	2030
Bicycled	8.4%	8.0%	8.0%
Carpooled/Vanpooled	7.7%	8.0%	8.0%
Drove Alone	47.5%	49.6%	49.6%
Transit	21.7%	20.2%	20.2%
Walked	5.9%	5.4%	5.4%
Worked at Home/Didn't Come/Other	8.8%	8.8%	8.8%
Commuting Students			
Bicycled	14.9%	14.9%	14.9%
Carpooled/Vanpooled	3.4%	3.4%	3.4%
Drove Alone	22.9%	22.9%	22.9%
Transit	30.1%	30.1%	30.1%
Walked	20.4%	20.4%	20.4%
Worked at Home/Didn't Come/Other	8.3%	8.3%	8.3%
Weekday SOV VMT	219,750	237,512	258,857
Weekday HOV VMT	33,009	35,040	38,097
Total Vehicle-Miles Traveled	252,760	272,552	296,954
Fuel Consumption (gal.) ⁽²⁾	13,414	12,346	11,778
CO2 Emissions (mt. tons)	118	109	104
On-Campus Parking Demand	9,125	10,203	10,826
Off-Campus Parking Demand	2,157	2,369	2,570
Total Parking Demand	11,281	12,572	13,396
1. Assumes 1,500 student housing beds that are currently planned. Faculty/staff SOV split increases due to most new growth occurring at East Campus where the SOV split is higher than Main Campus.			
2. Year 2030 fuel consumption assumes a 25 percent reduction which is consistent with current EPA goals.			

Table 10 also shows calculation of daily fuel consumption and metric tons of CO2 emissions for each alternative. The fuel consumption was calculated using the VMT estimates, the current affiliate vehicle mix obtained from PTS, and the Environmental Protection Agency (EPA) fuel consumption estimates for each vehicle class. The specific mix used and miles-per-gallon (MPG) estimates for each class are shown in Table 11.

Table 11		
Vehicle Type	Percent	MPG
2-Door Sedan	8%	28
3-Door Hatchback	1%	28
4-Door Sedan	42%	26
5-Door Hatchback	2%	26
Station Wagon	8%	22
Van	5%	21
Sport-Utility	19%	19
4-Wheel Drive Utility	4%	16
Truck	10%	16
Motorcycle/Moped	0%	50

The daily CO2 emissions for each alternative were calculated assuming 19.4 pounds of CO2 per gallon of fuel. Please note that fuel consumption and emissions are expected to decrease from Year 2010 to Year 2030, even with a growth in VMT, due to improvements in vehicle fuel consumption of 25 percent as set forth by recent federal standards.

6. Transportation Master Plan Goals

a. Mode Share Goals

Analysis of CU-Boulder mode share scenarios demonstrates that zero growth in campus-related travel (vehicle miles of travel) is possible even with a projected 18 percent growth in student enrollment and faculty/staff. If TDM programs and services are implemented they can achieve the following target mode shares by 2030 as shown in Table 12:

Mode of Travel	Existing 2010		Goal for 2030 ¹	
	Students	Faculty/Staff	Students	Faculty/Staff
Bicycle	14.9%	8.4%	16%	9%
Carpool/Vanpool	3.4%	7.7%	3%	9%
Drive Alone (SOV)	22.9%	47.5%	19%	44%
Transit	30.1%	21.7%	33%	23%
Walk	5.9%	5.9%	20%	6%
Work at Home/ Don't Come/ Other	8.8%	8.8%	8%	9%

¹Assumes 1,500 student housing beds that are currently planned.

Goal

Implement a TDM plan to meet the stated objectives of the Flagship 2030 Strategic Plan and its greenhouse gas emissions goals.

Guidelines

Reduce Travel

- Add 1,500 beds by 2030
- Promote telecommuting, flexible work schedules & flexible start/end times
- Implement staggered class times.
- Propose reduced parking standards for new construction
- Create and implement bike parking standards for new construction
- Create and implement transit standards for new construction

Provide for Travel Choices

Bike/Pedestrian

- Monitor campus bike racks/Provide additional bike racks as needed where space is available
- Maintain the bike station located near the UMC
- Provide 200 more covered spaces
- Expand bike sharing programs
- Add bike stations at Williams Village and Engineering Center
- Add bike share stations at East Campus and Williams Village, and at UMC
- Add 4.5 miles of bike/pedestrian facilities around and through campus

Transit

- Regional Coverage
 - SkyRide
 - Late-night transit
 - CU Ski Bus
 - Supplement Stampede with additional overlay/shuttle route between EC and MC
 - Buy up additional off-peak frequency or make service changes on two other routes
 - Implement the Orbit bus route
 - Enhanced amenities at transit stops including real-time departure information at major stops
 - Williams Village: Move from 2 articulated and 4 standard buses to 10 articulated buses on the Buff Bus
 - East Campus: Add significant capacity. Move from 3 standard to 4 articulated buses
 - Main Campus: Implement first **phase traffic/bike/ped design changes on 18th/Colorado corridor**
 - Main Campus: Modest improvements in marketing downtown Boulder – Main Campus transit option
 - Williams Village: Work with the City of Boulder to add a US 36 slip ramp stop at south edge of the WV Campus
- #### Ridesharing
- Add 60 carpool spaces on Main Campus

- Add 30 carpool spaces on East Campus
- Consider reduced carpool permit fees (50 percent)

Vanpools

- Form 10 vanpools

Carsharing

- Add 20 carshare vehicles as funding becomes available

Fleet Vehicles

- Provide pick-up locations on Main Campus

Influence Travel Choices

Transit

- Continue Student Bus Pass Program
- Continue Faculty/Staff EcoPasses
- Guaranteed Ride Home with EcoPass

Marketing and Incentives

- Find options to increase funding to monitor programs
- Conduct periodic commuter surveys
- Create an Incentives Program (bike discounts, bike/ped challenges & rewards, carpool incentives/rewards)
- Implement “Buddy” programs to show how to use transit, bike, etc. connect students to TDM. 2 part-time students.
- Develop social network apps for transit, bikesharing, carpooling, etc.

Parking

- Consider a zone permit structure with core permits 40 percent more than peripheral permits.
- Propose a Flexible Permit Program to allow fewer than 5 days use.
- Install access control (gates) at larger lots and implement parking management technology with the capability of monitoring parking use and charging demand-based parking rates.

c. Pedestrian Improvements and Goals

The suggested Campus Pedestrian Corridors are shown in V-E-10. There are two types of pedestrian-oriented designations on the CU-Boulder Campus. Major Pedestrian Corridors, and Pedestrian Only Corridors. Together, these facilities comprise the pedestrian network on campus and lay the groundwork for CU-Boulder’s attractive and safe pedestrian environment.

The purpose of identifying a pedestrian network on campus is to prioritize current/future improvements, maintenance, and other issues that face the pedestrian environment on campus. There are many paths, rights of way and sidewalks that are used every day on campus, but are not major corridors. The purpose of this discussion is to identify key pedestrian corridors on campus and acknowledge them for planning and development purposes.

	Continue Existing Programs	Moderate Expansion	Aggressive Expansion
Reduce Travel			
On-Campus Housing	* Add 1,500 beds by 2030	* Add 1,500 beds by 2030	* Add 1,500 beds by 2030
Integrated Trip Reduction	* Promote telecommuting, flexible work schedules & flexible start/end times	* Promote telecommuting, flexible work schedules & flexible start/end times	* Promote telecommuting, flexible work schedules & flexible start/end times * Implement staggered staggered class times
New Construction		* Reduced parking standards * Implement bike parking standards	* Reduced parking standards * Implement bike parking standards * Transit standards
Provide for Travel Choices			
Bike/Pedestrian	* Bike racks around most buildings * Regular surveys of bike parking * Bike Station located near the UMC * Mobile Mechanic * Buff Bikes-bike sharing/semester rentals * Covered Parking near Annett Hall	* Bike racks around most buildings * Regular surveys of bike parking * Bike Station located near the UMC * Mobile Mechanic * Buff Bikes-bike sharing/semester rentals * Provide 100 more covered spaces * Provide additional bike racks as needed * Expand bike share programs * Add bike station at Williams Village * Add bike Station at Engineering Center * Add bike Station at UMC * Add 2 miles of bike/pedestrian facilities around and through campus	* Bike racks around most buildings * Regular surveys of bike parking * Bike Station located near the UMC * Mobile Mechanic * Buff Bikes-bike sharing/semester rentals * Provide 200 more covered spaces * Provide additional bike racks as needed * Expand bike share programs * Add bike station at Williams Village * Add bike Station at Engineering Center * Add bike Station at UMC * Add bike share Station at Williams Village * Add two bike share stations on East Campus * Add 4 miles of bike/pedestrian facilities around and through campus
Transit	* Regional Coverage * SkyRide * Late-night transit * CU Ski Bus * Buy up of additional off-peak frequency on the STAMPEDE route * WV: move from 2-artic + 4-std buses to 4-artic + 2-std buses on Buff Bus * EC: no change needed to STAMPEDE through 2020. 3-std buses * MC: transit service growth is incremental and paid through EcoPass and Student Pass. * MC: conduct traffic operation + simulation study of 18th/Colorado corridor.	* Regional Coverage * SkyRide * Late-night transit * CU Ski Bus * Buy up of additional off-peak frequency on the STAMPEDE route * Supplement Stampede with additional overlay/shuttle route between EC + MC * Buy up of additional off-peak frequency on one other route * WV: move from 2-artic + 4-std buses to 7-artic on Buff Bus * EC: Add some capacity. Move from 3-std to 3-artic buses (RTD) * MC: transit service growth is incremental and paid through EcoPass and Student Pass. * MC: Modest improvements in marketing downtown Boulder - Main Campus transit option.	* Regional Coverage * SkyRide * Late-night transit * CU Ski Bus * Buy up of additional off-peak frequency on the STAMPEDE route * Supplement Stampede with additional overlay/shuttle route between EC + MC * Buy up of additional off-peak frequency or make service changes on two other routes * WV: move from 2-artic + 4-std buses to 3-artic on Buff Bus * EC: Add significant capacity. Move from 3-std to 4-artic buses (RTD) * MC: Implement full traffic/bike/ped design changes on 18th/Colorado corridor. * MC: Modest improvements in marketing downtown Boulder - Main Campus transit option. * WV: US 36 slip ramp stop at south edge of the WV Campus * Implement the Orbit bus route * Enhanced amenities at transit stops including real-time departure information at major stops.
Ridesharing	* Ridesharing through Zimride * Reserved priority carpool spaces at Wolf Law, Leeds Business & C&C * Add 60 carpool spaces on Main Campus	* Ridesharing through Zimride * Reserved priority carpool spaces at Wolf Law, Leeds Business & C&C * Add 60 carpool spaces on Main Campus * Reduced carpool permit fees (50%)	* Ridesharing through Zimride * Reserved priority carpool spaces at Wolf Law, Leeds Business & C&C * Add 60 carpool spaces on Main Campus * Add 30 carpool spaces on East Campus * Reduced carpool permit fees (50%)
Vanpooling		* Form 5 Vanpools	* Form 10 Vanpools
Carsharing	* Six CarShare vehicles	* 10 CarShare vehicles	* 20 CarShare vehicles
Fleet Vehicles	* Fleet vehicles available on East Campus	* Fleet vehicles available on East Campus * Provide pick-up location on Main Campus	* Fleet vehicles available on East Campus * Provide pick-up location on Main Campus
Influence Travel Choices			
Transit	* Continue Student Bus Pass Program * Continue Faculty/Staff EcoPasses * Guaranteed Ride Home with EcoPass * Increase funding to monitoring programs	* Student Bus Pass Program * Faculty/Staff EcoPasses * Guaranteed Ride Home with EcoPass * Increase funding to monitoring programs	* Student Bus Pass Program * Faculty/Staff EcoPasses * Guaranteed Ride Home with EcoPass * Increase funding to monitoring programs
Parking Management	* Proximity permits 20% more than peripheral permits	* Implement Zone permit structure with Core permits 40% more than peripheral permits * Implement Flexible Permit Program to allow fewer than 5 day use	* Implement Zone permit structure with Core permits 40% more than peripheral permits * Implement Flexible Permit Program to allow fewer than 5 day use * Install access control (gates) at larger lots and implement parking management technology with the capability of monitoring parking use and charging demand-based parking rates
Marketing and Incentives	* Periodic Commuter Surveys * Website "connection" programs to link individuals to various modes of travel	* Enhanced Website "connection" programs to link individuals to various modes of travel * Incentives Program (bike discounts, bike/ped challenges & rewards, carpool incentives/rewards) * FTE & incentives budget * "Buddy" programs to show how to use transit, bike, etc., connect students to TDM. 1 Part-time student	* Enhanced Website "connection" programs to link individuals to various modes of travel * Incentives Program (bike discounts, bike/ped challenges & rewards, carpool incentives/rewards) * FTE & incentives budget * "Buddy" programs to show how to use transit, bike, etc., connect students to TDM. 2 Part-time student * Develop social network apps for transit, bikesharing, carsharing, carpooling, etc.

I. MAJOR PEDESTRIAN CORRIDORS

Major pedestrian corridors are thoroughfares heavily used throughout the day, and support large volumes of pedestrian traffic during peak-travel times. Because of their significance to the greater pedestrian network, service vehicles, bicycles and skateboards would ideally refrain from using these parts of campus during peak travel times. For planning purposes and future development, Major Pedestrian Corridors (MPCs) should take priority with respect to maintenance and snow removal. As Main Campus develops and East Campus continues to grow, designating additional MPCs will ensure that CU-Boulder continues to be a pleasant place to walk.

II. PEDESTRIAN ONLY CORRIDORS

Pedestrian Only Corridors (POCs) are special areas on campus. These areas combine thematic and physical design that prioritizes pedestrian movement and enhances the overall beauty of the campus. There are currently two POCs in development stages. The Central Campus Walkway and the University Memorial east pathway through Fine Arts Green are scheduled to be the first POCs on campus. POCs will be designated and designed for pedestrian use only. Service vehicles and bicycles will be discouraged from utilizing these areas of campus. In the future, CU-Boulder may want to designate other areas of campus as POCs as growth and need warrant.

d. Bicycle Improvements and Goals

I. ON-CAMPUS BICYCLE IMPROVEMENTS

To encourage bicycle/skateboard use off Major Pedestrian Corridors and restrict their use on Pedestrian Only Corridors, a connected, viable network must be implemented for bicyclists and skateboards to travel throughout campus. The guidelines in this plan establish a network of varying facilities to provide enhanced convenience and connectivity for non-motorized travel to, from and between campuses. The recommendations are listed in Table 14.

Exhibit V-E-11 outlines the additions to the existing bike network. It is important to note that some of these projects will take longer to fund and build. This network is designed to provide bicyclists a viable, uninterrupted system of routes to get through campus. A primary component to improving the bikeway network will require that off-street facilities provide separation from pedestrian use if/when space permits. In areas of new development/facilities, all off-street bicycle and pedestrian facilities should be separated.

Separation can be provided via elevation changes, landscaping, fencing, bollards and other design features. This is most relevant to the East-West Bikeway and to the path that runs north and south from the Engineering Complex towards the Kittredge Loop.

Project ID	Corridor	Facility Type	Limit 1	Limit 2	Length (miles)
1	19 th St. Path	Multi-Use Path	Boulder Creek	Rec Center	0.05
2	18 th St./Colorado	Cycletrack	Euclid Ave.	Colorado Ave. Bike Lanes	0.2
3	UMC/Bike Station	Bike Route	18 th St.	Broadway	0.12
4	Baker Drive	Shared Lane Marking	SE Corner of Libby Hall	SW Corner of Baker Hall	0.2
5	Wardenburg Dr.	Shared Lane Marking/ Multi-Use Path	18th St.	North-South Bikeway	0.34
6	Leeds-Engineering	Multi-Use Path	North-South Bikeway	Regent Dr.	0.13
7	Williams Village	Bike Path	Bear Creek Apartments	Caddo Pkwy	0.2
8	35 th South	Cycletrack/Multi-Use Path	Baseline Road	Bear Creek Apartment Path	0.5
9	Discovery Dr.	Cycletrack	Colorado Ave.	Innovation Dr.	0.36
10	Innovation Dr.	Bike Route	Colorado Ave.	Shadow Creek Dr.	0.12
11	33rd St.	Bike Lanes	Shadow Creek Dr.	Arapahoe Ave.	0.16
12	Shadow Creek Dr.	Bike Lane	30 th St.	Discovery Drive	0.4
13	North-South Bikeway	Multi-Use Path	Colorado Ave.	Broadway Multi-Use Path	0.42
14	Libby Drive	Shared Lane Marking	Duane Physics/ Colorado Connector	Cockerell Dr.	0.12
15	Stadium Dr.	Shared Lane Marking/ Multi-Use Path	Folsom St.	17th St.	0.53
16	Lot 169 Path	Multi-Use Path	Lot 169	Stadium Dr. Multi-Use Path	0.2
17	22nd St.	Shared Lane Marking	Arapahoe Ave	Athens St. Bike Path	0.08
19	Athens St.	Shared Lane Marking	17 th St.	Folsom	0.42
20	19 th St.	Shared Lane Marking/ Multi-Use Path	Arapahoe Ave,	Boulder Creek Path	0.18

II. OFF-CAMPUS BICYCLE CONNECTIONS

An important facet of the guideline network is it how it synthesizes with the greater City of Boulder network. To maximize the convenience of bicycle travel to campus, it is important that the campus network provides convenient and multiple connections to bikeways in the City of Boulder. In the development of the proposed CU-Boulder bikeway network, connections to the City of Boulder's bikeway network were examined to ensure that the CU-Boulder bikeways were integrated with Boulder. Table 15 lists the proposed CU-Boulder bikeways and their connections to the Boulder bikeway network.

substantially impacts bus operations and time tables and bicyclists are left to operate in the same space as buses and pedestrians crossing at other places than the crosswalk. The fundamental ideals behind the following design options were to provide designs that increased the utility of the corridor for bicyclists, minimized transit conflicts, and prioritized pedestrian crossings.

**Table 15
Proposed Bikeways Connecting to Boulder Bikeways**

Proposed CU Facility	Proposed Facility Type	Connecting Boulder Facility	Connecting Boulder Facility Type
University Ave	Shared Lane Marking	University Ave	Bike Lane
Stadium Dr	Shared Lane Marking	Folsom St	Bike Lane
Athens Ct	Multi-use Path	Boulder Creek	Multi-use Path
Lot 169 Path	Multi-use Path	Boulder Creek	Multi-use Path
Regent Dr	Shared Lane Marking	Broadway Path	Multi-use Path
Regent Dr	Shared Lane Marking	Colorado Ave	Bike Lane
Libby Dr	Shared Lane Marking	Colorado Ave	Bike Lane
Discovery Dr	Cycletrack	Boulder Creek	Multi-use Path
Innovation Dr	Bike Route	Colorado Ave	Multi-use Path/ Bike Lane
Innovation Dr	Bike Path	30 th St	Bike Lane
Extension	Bike Path	30 th St	Bike Lane
Marine St Connector	Multi-use Path	Boulder Creek	Multi-use Path
Marine St	Shared Lane Marking	30 th St	Bike Lane
Marine St	Shared Lane Marking	Arapahoe Ave	Multi-use Path
35 th St	Bike Route	Boulder Creek	Multi-use Path

The proposed CU-Boulder bikeway network seeks to increase bikeway connections to the existing and proposed City of Boulder bikeway network. The completion of the CU-Boulder bikeway network will greatly increase the convenience of biking in and through campus.

III. SPECIAL NON-MOTORIZED NETWORK LOCATIONS

In the development of this plan, two campus locations received specific attention because of their importance to the movement of non-motorized users connecting with the City of Boulder network, and moving within the greater campus network. The 18th Street/Colorado Avenue corridor and the College Avenue underpass beneath Broadway were examined to heighten the safety of pedestrians, bicyclists and skateboards and minimize any conflict that may exist between the various user groups. Out of several concepts which evolved, specific recommendations are made for each site.

18th Street & Colorado Avenue

The 18th/Colorado corridor is the primary artery for transit and motorized traffic within Main Campus. As such, it is the point of convergence for pedestrians, bicyclists, service vehicles and others who use the corridor on a daily basis. During passing periods, the corridor supports heavy amounts of pedestrian activity as students cross 18th and Colorado. Passing periods

The recommended concept is called the "Hybrid" (following page), acknowledging that at this point completely restricting transit access through the corridor is not an option, but providing a transformative environment that emphasized bicyclist and pedestrian safety was a top priority.

A dedicated and separated cycle track is located on the west side of 18th and north side of Colorado as it runs east towards Folsom. The median separates the dedicated traffic lane with green space, permeable surface for rainwater collection, and additional bike parking facilities. This concept would substantially increase the convenience of intra-campus bicycle travel, by separating it from bus/vehicle traffic. It would also allow transit vehicles to have their own lane(s) and enhance safety by channeling pedestrian crossings at officially designated points along the corridor (at present, the open "feel" of the corridor permits crossing at any point of convenience for pedestrians.

The hybrid concept also addresses vehicular access/ travel, as well as transit routing. The hybrid model recommends limiting vehicular access to only transit vehicles, and private ADA access. All other private use/ service vehicles would be restricted from this corridor.

The transit lane of the hybrid model is currently recommended with three scenarios for further study:

1. Transit access can travel in both directions, with "pull out" areas located within the median to allow buses to yield to each other when traveling within the corridor.
2. Peak-hour model, wherein transit flow is reversible along the one lane corridor, depending on the time of day.
3. Transit access limited to north on 18th, east on Colorado via a one-way travel lane.

College Avenue/Broadway Underpass

The College Avenue/Broadway underpass is one of the major access points for pedestrians and bicyclists coming from "the Hill" and western Boulder and travelling to the CU-Boulder campus and the Broadway Multi-Use Path. It is the convergence of bicyclists and pedestrians coming from the underpass and crossing through or utilizing the Broadway Multi-Use Path. Because of the design of the underpass, it can present a challenge for bicyclists traveling on the Broadway Multi-Use Path to see individuals coming out from the underpass. The Broadway Multi-Use Path slopes down towards this point on campus, increasing speeds of bicyclists and pedestrians. This location was the only count location that experienced a decrease in pedestrian and bicycle



Hybrid Design Concept

activity. Designs to improve sight lines and safety were considered to help the large numbers of bicyclists, pedestrians and skateboarders accessing/leaving campus at this location. Two designs are recommended for further consideration and subsequent implementation.

iv. Bicycle Parking

Goal

Bicycle parking will be improved through a tiered investment strategy which considers both existing facility standards and new facility standards.

Guidelines

- **Campus Core Bicycle Parking Standard** – Develop and adopt bicycle parking standards for the core campus area.
- **New Development Bicycle Parking Standard** – Develop and adopt a bicycle parking standard for new development on campus to ensure that adequate bicycle parking is provided.
- **Covered Bicycle Parking** – Develop and adopt a standard for providing covered bicycle parking to encourage bicycling year round – even on rainy or snowy days. CU-Boulder’s initial covered bicycle parking installation has been well received by the cycling community. Utilization of this covered bicycle parking suggests that additional covered bicycle parking installations are warranted. Over time as funding is available, CU-Boulder should strive to provide 1-2 percent of total bicycle parking as covered bicycle parking.



Secure Bicycle Parking

Goal

Provide more secure bicycle parking options as a means of providing a safer, bicycle parking option on campus.

Guidelines

CU-Boulder should begin providing more secure bicycle parking options, such as the following:

- Bicycle Lockers

- Indoor bicycle storage rooms
- Bicycle cages in parking structures
- Bicycle Garages (see photo from PSU)
- Consider design changes to allow bicycle parking within offices and residence halls.

Secure Bike Parking/Bike Station/Bike Share Locations

Exhibit V-E-12 illustrates proposed locations for new bike stations, bike sharing stations, secure bike parking, and covered parking.

e. Transit Improvements Goals & Guidelines

Goal

Provide public transit systems that are safe, well maintained and take users when and where they want to go.

I. MAIN CAMPUS TRANSIT SERVICE GUIDELINES

BROADWAY CORRIDOR

- The Broadway corridor has well-established local and regional bus routes with well-established transit infrastructure including pedestrian underpasses and the under-construction Broadway/Euclid project.
- Transit services will primarily expand based on RTD service standards for loading and frequency. CU-Boulder's funding share will expand with Student Pass and Eco Pass pricing for students and faculty/staff, respectively.
- Transit services are expected to expand incrementally based on load standards and overall ridership for the next ten years. FasTracks plans over the longer-term may provide additional increases, but will be beyond the ten-year horizon of this plan.
- Market, educate, and otherwise increase the level of understanding about the existing services between the Boulder Transit Center and the Main Campus.
- The Orbit (see Exhibit V-E-13) is identified in this analysis as having a high priority among CTN recommendations for implementation, to increase connectivity to Main Campus with convenient transfers, for routes like the Bolt and 205.
- Extension of routes from the BTC to Main Campus should be pursued only after the marketing/education actions and CTN actions above, and then only done selectively with additional data collection to support it.

EUCLID/18TH STREET/COLORADO AVENUE CORRIDOR

- Based on transit alternatives, both baseline and aggressive, bus volumes in this corridor are expected to increase 4 to 14 buses per hour by 2020 and 14 to 22 buses per hour by 2030. This is on top of 42 buses per hour currently. More buses means that more people will be using transit and meeting the goals of the plan (VMT, carbon emission reductions), and that there will be more opportunity for motorized and non-motorized conflicts. Safety and incident monitoring in this corridor is recommended to document trends and identify the appropriate phasing for more comprehensive actions and solutions.³
- Through iterative development and evaluation of design alternatives, the preferred option is to increase overall safety in this corridor by reducing the transit-way to one lane in a significant segment

³ A combination of Public Safety (actual accidents) and PTS (operational observations from drivers or by PTS staff) is recommended.

of 18th Street and Colorado Avenue, likely between Euclid and the guard house near Folsom Field. A more thorough traffic operations evaluation, possibly simulation, is recommended to complete the evaluation of this preferred concept.

- Traffic analysis and simulation will need to consider three locations for bus queuing: Euclid/18th, 18th/Colorado (Engine Alley), and the Folsom Field guard station. Two of those, Euclid/18th and Folsom Field guard station, should also be considered for turn-around locations.

28TH STREET CORRIDOR

CU-Boulder and RTD should jointly monitor the HX and S services to ensure there is alignment between funding increases, especially student and faculty/staff pass sales, and service enhancements.

CU-Boulder and RTD should verify that services in this corridor continue to meet customer expectations as connecting services, like the Stampede, are modified.

II. EAST CAMPUS TRANSIT SERVICE

Guidelines

- Monitor East Campus growth in terms of both campus population and transit utilization. Ensure that transit utilization and mode split is at least keeping pace with transit growth.
- Reconfigure the current Stampede route to provide two-way service along the full length of Colorado Avenue along the south edge of east campus, and maintaining the service along Arapahoe and Marine Streets. Two-way service along Arapahoe will also benefit the Center for Innovation and Creativity (CINC) to the north by providing a closer stop.
- Plan for demand on the Stampede to grow between 1.3 percent and 3.6 percent per year as a base forecast. By 2020 supply additional capacity by either providing articulated buses or increasing the frequencies of service. Increased frequency will do more to attract ridership. A short-turn route pattern of the Stampede is recommended to achieve this objective (see Exhibit V-E-14).
- With RTD, plan to extend the Bound along Iris to provide a direct connection to more of North Boulder, and a one-transfer connection with the Skip.
- Complete a design study to more fully evaluate the potential for a US-36 slip ramp stop at the south edge of the Williams Village/Bear Creek Campus and its concomitant site impacts.
- If a Boulder Creek crossing allows north-south vehicular access through East Campus, re-align the regional route J to make the most of this opportunity to provide direct transit access (see Figure 20).

III. WILLIAMS VILLAGE TRANSIT SERVICE

Guidelines

- Monitor demand and utilization carefully with the opening of Williams Village North which will take the

student and faculty/staff population from 2,400 to 3,600.

- Make short-term, incremental shifts in fleet mix to increase the proportion of service delivered with articulated buses (two have been ordered for 2011-12).
- Make long-term Buff Bus fleet mix decisions after Main Campus design decisions have been made and implemented, i.e. 18th/Colorado. There is expected to be a 2-year lead time between any such decision and actual implementation.
- Make design decisions at Williams Village which are aligned with Buff Bus operating investments.
- If the choice favors RTD service supplying some of the needed transit capacity, Williams Village North building and site design should improve upon recommendations in this report for a traffic and pedestrian signal at 35th street and collaborate with the City of Boulder, Boulder County, and RTD to implement transit hub/superstop/FastConnect facilities along Baseline Road.
- Adjust Buff Bus operating budgets or RTD service buy-up budgets according to the above decisions.
- Complete a design study to more fully evaluate the potential for a US-36 slip ramp stop at the south edge of the Williams Village/Bear Creek Campus and its concomitant site impacts.

f. Roadway Improvement Development Plan

With the Main Campus almost built out, street improvements will focus on improving bike, pedestrian and transit access, as well as reducing modal conflicts.

Exhibit V-E-16 displays the recommended street improvements for the CU-Boulder campus. These include:

NORTH OF BOULDER CREEK

1. Athens Street: construct connection between 20th and Folsom Streets as a low speed local street.
2. 22nd Street: construct connection between Arapahoe and Athens Street extension as a low speed local street.

These connections will improve connectivity in this area for vehicles, bikes and pedestrians. Athens Street will have continuity between 17th and Folsom Streets, thus providing some relief for heavily congested Arapahoe Avenue.

MAIN CAMPUS

3. Stadium Drive: realign if new parking structure or fieldhouse is built.
4. North Service Road: construct service road connection from parking lot north of the Recreation Center to the loading dock behind Sewell Hall.

EAST CAMPUS

5. 33rd Street: construct connection from Arapahoe south over Boulder Creek to Discovery Drive extension.
6. 31st Street: improve connection between Discovery Drive extension and Colorado Avenue.
7. Discovery Drive: construct extension west to the 33rd Street extension and to 30th Street opposing Shadow Creek Drive.
8. East-west connector: construct local street connecting 38th Street with 30th Street opposing the south access to Scott Carpenter Park. Includes connection to Marine Street.
9. 30th Street/Discovery Drive traffic signal.
10. Colorado Avenue/Discovery Drive traffic signal.
11. Colorado Avenue/Innovation Drive: covert to full movement intersection.

These connections will improve connectivity for vehicles, bikes and pedestrians. The bridge over Boulder creek will provide an internal connection between the East Campus and the Research Park. This will allow rerouting of some bus routes as described above. It will provide another vehicular route from the Research Park to Arapahoe which may provide some relief to the Colorado/Foothills Parkway intersection.

WILLIAMS VILLAGE

12. 35th Street Connector: construct low-speed street from 35th Street southeast across Bear Creek looping back to the Williams Village parking south of the Bear Creek apartments.
13. Baseline Road/35th Street traffic signal when traffic volumes warrant.

This connection will provide access to the faculty/staff housing planned east of Bear Creek as part of the Williams Village Micro-Master Plan. The connection of this road to Caddo Parkway will be designed for emergency vehicles and non-motorized users.

g. Service and Emergency Access

Access to buildings needs to be provided for essential services and in emergency situations.

i. Service Access

Service access and parking should be better managed to avoid the conflicts between pedestrians and vehicles that are currently too prevalent on campus sidewalks. The maintenance and delivery requirements for nine million square feet of building space, and the equipment contained therein, generate a constant influx of service vehicle traffic to the campus. Consistent with planning tenets, many roadways that previously transected the campus have been eliminated in favor of a more contiguous, pedestrian-oriented environment. Given the absence of proximate roadway access to many campus buildings, service vehicles must drive, and park, on campus sidewalks. Fortunately, pedestrian/vehicle collisions that lead to injury have been extremely rare, although pedestrians often complain of sidewalks obstructed by service vehicles. Vehicles associated with new construction, and those associated with projects maintaining or replacing aging facilities, add to the problem. Service vehicles and emergency vehicles sometimes find their paths blocked by other service vehicles parked along sidewalks.

A variety of regulatory strategies has been tried, but has proven ineffective at significantly reducing sidewalk traffic and parking. In fact, most of the vehicles now driving and parking along campus sidewalks are in compliance with CU-Boulder parking regulations, which include the issuance of permits to park on sidewalks.

The Department of Facilities Management has installed some physical barriers to close off vehicular access to the plazas and other pedestrian areas on which vehicles are inappropriate, but many areas cannot be blocked off due to the need to retain emergency access. The campus is also too large for physical barriers to be the principal solution. Permitted sidewalk parking should be reduced. Instead, most maintenance and delivery vehicles could be directed to designated service parking areas. Designating more service parking could help to alleviate the pressure to park on sidewalks along with stronger campus policy. Minimal construction vehicles should be accommodated within staging areas, designating an access point/path for construction sites connecting to the nearest service drive, while encouraging construction employee vehicles to be largely accommodated at remote locations.

ii. Emergency Access

Based on the Uniform Fire Code, as adopted by the

State of Colorado and CU-Boulder, fire apparatus access routes need to be added where any part of buildings are located more than 150 feet from existing fire apparatus access. Access routes are reviewed by the CU-Boulder Fire Marshall, the Boulder Fire Department, and facility planners. Campus emergency access is along a variety of routes: state highways, city streets, university streets, service alleyways, and wide sidewalks serving as fire lanes. Exhibit V-E-18 is a map of the existing and proposed fire lanes, which need to have at least 12 feet in width of clear access.

Non-fire emergencies such as a flood, chemical release, hazardous material spill, or gas leakage are also important concerns on campus. Especially in light of the many laboratory science facilities on campus, the need for adequate access and evacuation routes is pronounced.

Some portions of the Main Campus need to be made more accessible for emergency apparatus. According to the Boulder Fire Department, an existing area with problematic fire apparatus access is "Engine Alley," the central east-west walkway in the academic core of campus, where many service vehicles are parked each day. This has been addressed by prohibition of service vehicle parking in this or any other fire lane, as specified in the Uniform Fire Code, although vehicle travel still remains an issue.

Also of concern is access around large building complexes such as the Engineering Center, high-rise structures, building bridges, and below-grade spaces. These concerns should be addressed through upgrade of building fire protection systems, access improvements and regulation, parking restriction, and by careful design of future development.

Trees can limit emergency access if placed improperly. Trees along emergency routes should be trimmed as not to interfere with access. Placement of new plantings should consider emergency routes and future growth so that Fire Department vehicle access is not adversely affected in the future.

Adequate access by Fire Department vehicles will continue to be included during all phases of new construction and site development. It is the campus practice for the Boulder Fire Department to be invited to provide input for all site and building developments. Boulder Fire Department apparatus requirements with regard to width, height, and turning radius are to be addressed for necessary access in site and building designs.

As the campus continues to grow in density and size, the safety and welfare of all persons and property can be assured by the following: attention to access during design, construction, and operations; provision of an adequate and accessible supply of water; and compliance with adopted building codes.

iii. Service and Emergency Access Goals &

Table 16					
Street Connection Costs					
Map Key	Street/Project	From	To	Description	Cost
1	Athens Street	20th St.	Folsom St.	Construct two-lane low speed street	\$765,000
2	22nd St.	Arapahoe Ave.	Athens St.	Construct two-lane low speed street	\$234,000
3	Stadium Drive	Stadium	Folsom St.	Construct two-lane low speed street	\$300,000
4	North Service Rd.	Rec Center Parking Lot	Sewell Hall	Construct service drive	\$600,000
5	33rd St.	Arapahoe Ave.	Discovery Dr.	Construct two-lane collector street	\$600,000
				Boulder Creek Bridge	\$2,000,000
6	31st St.	Discovery Dr.	Colorado Ave.	Construct two-lane collector street	\$495,000
7	Discovery Dr. Extension	Discovery Dr.	30th St.	Construct two-lane collector street	\$1,000,000
8	East-west Connector	38th St.	30th St.	Construct two-lane collector street	\$1,400,000
9	Traffic Signal	30th St.	Discovery Dr.	Install Traffic Signal	\$300,000
10	Traffic Signal	Colorado Ave.	Discovery Dr.	Install Traffic Signal	\$300,000
11	Traffic Signal	Colorado Ave.	Innovation Dr.	Install Traffic Signal/Pipe Ditch/Add Turn Lane	\$600,000
12	35th St. Connector	Bear Creek Apartments	35th St.	Construct two-lane low speed street	\$1,200,000
13	Traffic Signal	Baseline Rd.	35th St.	Install Traffic Signal	\$300,000
					\$10,094,000

Costs for these connectors are given in Table 16.

Guidelines

Goal

Necessary access will be ensured to service buildings and to provide emergency services.

Guidelines

- Provide more adequate service vehicle parking.
- Evaluate current service and delivery parking and add additional sites for drop-off and pick-up of materials if space allows within reasonable proximity of each building.
- Keep emergency access routes and walkways in general, unobstructed by parked vehicles through better enforcement.
- Continue review of all development proposals to ensure access for building services and for emergencies.
- Coordinate the routes and close-in parking with overlapping requirements to meet needs of handicapped persons. Avoid placing handicapped parking in loading dock areas, which are not appropriate public entries and where conflicts are likely.

h. Parking Management

I. PROJECTED PARKING DEMAND AND SUPPLY

Parking is a major land use on campus. Parking competes with building sites, open space, and athletic and recreational uses for the valuable and limited campus land resource. Approximately 75 acres of campus land are occupied by parking spaces. Of the total 11,647 parking spaces 7,152 are on the Main Campus; 3,081 are on the East Campus, including the Research Park; and 1,414 are at Williams Village.

Based on a comparison of the estimated demand and supply, it appears that CU-Boulder has a surplus of about 438 spaces. However, most of the surplus is on the East Campus and Williams Village, with Main Campus lots having a high utilization rate. The tight Main Campus supply results in many vehicles being parked off-campus. Over 2,100 vehicles are estimated to be parked off-campus.

To project parking demand, the mode share analysis in Chapter 3 was used along with the CU-Boulder parking model to estimate parking demand by commuters to the CU-Boulder campus. Parking supply was increased by 650 spaces which assumed that the underutilized spaces in the Research Park could be used by the commuting population. Comparison of 2010, 2020, and 2030 parking demand and supply is given in Table 17.

**Table 17
Parking Demand/Supply Projections**

	2010	2020	2030
Effective Supply			
Existing	9,576	9,576	9,576
With Research Park (650 spaces)		650	650
Total Effective Supply	9,576	10,226	10,226
Commuter Parking Demand (spaces)	9,125	10,203	10,400
Parking Surplus (Deficit)	451	23	(174)
Off-Campus Parking Demand	2,304	2,369	2,399

II. POTENTIAL PARKING EXPANSION SITES

The recent Center for Community (C4C) project shows how difficult and costly it is to integrate underground parking in a building project. The project contains 376 underground spaces and 52 surface spaces built on lots which once contained 315 spaces, resulting in a net addition of 113 parking spaces. Due to the high cost of underground construction, the construction cost amounted to \$44,124 spread over the 428 spaces. There were many benefits of the C4C project in this location, including convenience, event parking, and wise stewardship of limited land resources, but the cost of this parking structure will be a significant burden on PTS for years to come. Due to the high cost of construction, there will be few if any new spaces added to the Main Campus. New parking structures, however, may be needed to replace existing parking lots needed for new buildings. Several sites on the Main Campus have been identified for potential structures. These sites along with other sites on Williams Village and East Campus are shown in Exhibit V-E-17.

Grandview – Parking development in the Grandview area must be done in accord with the tenets of the Grandview Memorandum of Agreement (MOA) executed between the City of Boulder and the university in January 2001⁴. The Grandview MOA limits the total number of spaces in the area to 470. There are currently 370 parking spaces in the Grandview area. Some parcels of land within the Grandview area are precluded from use as sites for parking development through the course of the “Grandview Preserve Covenant” addendum to the MOA, which will remain in effect through January, 2026. The proximity of this area to Mackey Auditorium makes it attractive, since Mackey attracts many visitors for lectures and concerts and nearby parking is difficult to find. Given the patchwork of buildings, streets and existing parking lots, however, it will be difficult to develop a site of sufficient size with reasonable access to be feasible.



Folsom Street/Stadium Drive - this would be located south of Boulder Creek. A site study sponsored by the Department of Athletics projected that the facility could accommodate up to 1,000 spaces and would serve as the foundation for a new Field House building. Stadium Drive would be relocated north along Boulder Creek to connect to Folsom opposite Taft Drive. All the storage buildings and the Grounds Building would be removed. This opens up a rectangular site at the north end of Franklin Field that is very large and the grade difference allows for a four-level parking structure holding approximately 1,000 spaces. This site is located in a good location to intercept traffic coming from the north and is located relatively close to buildings located on the north end of campus. Its proximity to Folsom Stadium makes it very attractive for stadium events.



Euclid AutoPark was designed to allow the addition of an academic building containing two floors on top of the existing garage. Access in this area is an issue, especially at Broadway, where there is a skewed intersection. The planned improvements at Broadway/ Euclid and 18th Street should improve this situation. In addition, Lot 204, located south of Euclid, could be built on with structured parking, but potential expansion of the University Club for Admissions may likely remove this from consideration.



Regent AutoPark could also be expanded into adjacent lots, but currently congestion on Regent Drive at the AutoPark and parking lot accesses is significant and dangerous for pedestrians, especially during afternoon periods. Adding traffic with more parking would only add to the problem. A High Intensity Warning Signal (HAWK) on Regent Drive was funded for Spring 2011 and will be used as a test pilot for the following year to see how traffic and vehicle/ pedestrian conflicts are affected.



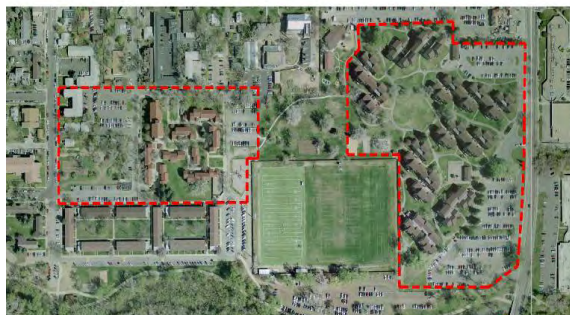
⁴ The Grandview agreement expired in July 2011 however both the university and City of Boulder continue to abide by the general terms until such time as a new agreement can be negotiated.

Lot 304-308 has potential for under-building or underground parking in connection with the planned performing arts building if needed and financially feasible

With the redevelopment of family housing north of Boulder Creek, additional housing on Williams Village, and the development of East Campus, potential other sites for structured parking include:

North of Boulder Creek is currently being studied for replacement of outdated family housing. Since this area is located within walking/ biking distance of the Main Campus, developing as many dwelling units as possible is desirable. In order to achieve higher densities, structured parking may be needed.

Williams Village – the WV Micro-Master Plan Campus area plan includes structured parking in later phases, however, as indicated in Chapter 4 of the Transportation Master Plan, the Williams Village current parking supply of 1,400 spaces should be adequate to accommodate the projected undergraduate and graduate population. New parking should be added for any new family or faculty housing. Constructing structured parking on existing surface lots may be a long range option to provide commuter parking or to enhance the planned transit station. One site could be south of Baseline on Lots 622-24.



III. PARKING MANAGEMENT GOALS & GUIDELINES

Parking management is one of the most effective traffic reduction strategies and that underpriced, abundant and convenient parking can be a major deterrent to alternative mode use. From a land use perspective, devoting land to parking and access drives distracts from the pedestrian-oriented campus setting that is so important to a university environment.

Goal

Parking needs to be priced appropriately and managed to get the highest possible utilization.

Guidelines

1. Install access control (gates) at all larger lots and implement parking management technology (such as Smart Cards) which has the capability of monitoring parking use and charging demand-based parking rates.
2. Consider implementing a higher rate structure in the core of Main Campus (generally bounded by University and College Avenues on the north, Regent Drive on the east and south, and Broadway on the west). The differential between this area and other areas on campus should be at least 30 percent.
3. Provide more short term and visitor parking in the core area of Main Campus.
4. Using the new access control and parking management technology or other system, implement flexible permits which allow fewer than five days a week use to encourage alternate mode use.
5. Continue to provide low cost remote parking on East Campus for affiliates who lack alternative mode options and can't afford higher priced parking. Continue transit service to this parking and provide secure bicycle parking and bike share facilities.
6. The C4C project costs will increase PTS bound repayment costs by \$1,232,000 for the next 25 years. This will be an additional cost for the next four years, but then other bonds are paid off. If the first four years costs of about \$5 million are spread over 25 years, financed at an interest rate of 4 percent, the effective increase is about \$320,000 per year or 8 percent of PTS expenses of \$4 million per year. Effectively, this would increase the existing ~\$17 million 25 year bonding for the C4C project to ~\$22 million by adding a new \$5 million bond for 25 years, to raise an extra \$5 million to be used to cover the four years of double bond payments for both the C4C and EAP/RAP bonds. To offset these expenses, base permit fees (faculty/staff, student, business, gates and events) which currently bring in about \$4 million in revenues, would have to be raised by 7 to 9 percent in addition to normal inflation.
7. Consider consolidation of all parking spaces under PTS management, to administer all CU-Boulder parking spaces more equitably In particular, the Research

Park should come under PTS control, so the current underutilized parking can be used to meet CU-Boulder's parking needs.

8. Propose that costs associated with retirees and X permit holders should be borne by the appropriate departments and not PTS.
9. As redevelopment for family housing occurs, parking spaces should be unbundled from lease rates, with tenants required to purchase parking permits and encouraged to use alternate modes.

No net new parking spaces should be added to Main Campus. New parking structures may be needed to replace existing parking lots needed for new buildings. Since there is a great benefit to the university to utilize existing land with surface parking for campus buildings or other uses, and a great cost to replace this parking, alternative funding sources will be needed so the high costs of replacement structured parking doesn't overwhelm PTS's budget.

i. Transportation Program Financing

Funding for CU-Boulder transportation facilities, programs, and activities comes from many sources, controlled by many agencies and departments with their own specific missions, goals, and objectives. Fortunately, from a transportation perspective, these missions are often aligned in encouraging the use of efficient transportation modes which minimize energy consumption and reduce carbon emissions. While the prospect of increased federal and state funding in the short term is bleak, recent emphasis on transit and alternative modes funding bodes well for joint projects. It is assumed that many of the transit recommendations, especially commuting services, will be cooperatively funded by RTD, the City, Boulder County, and DRCOG. Likewise, bicycle and pedestrian connections to nearby neighborhoods, other City areas and Boulder County will be funded by City, County, State, and federal sources. As it has done in the past, CU-Boulder should work closely with its local and regional partners to plan these programs, services, and facilities, with CU-Boulder providing funding for campus-only projects, and providing limited participation in joint funding for demonstration projects or when federal/state/private sources can be leveraged.

TDM Program expansions include:

- Covered/Secured Bike Parking
- Bike station/bikeshare programs
- Pedestrian & Bike Connections (4.5 miles)
- Stampede Route Changes & Overlay Service
- Buy up additional off-peak frequency or make service changes on two other routes
- Fund 25 percent of new Orbit route (28th/Folsom)
- Carpooling spaces/discount rates
- Expanded car sharing
- Vanpools
- Fleet vehicle pick-up station on Main Campus
- Marketing & Incentives
- North of Boulder Creek Connections
- Stadium Drive
- North Service Road
- East Campus Boulder Creek Bridge
- East Campus Road Connections
- East Campus Traffic Signals
- Williams Village Connections

a. Advantages and Disadvantages of Various Funding Models

Throughout the development of the Transportation Master Plan, ideas and concepts for increasing revenues for transportation improvements were presented and considered for inclusion in the final document. Most of these concepts could be classified as falling into one of two groups: those that increase revenues to the university and those that transfer existing revenues between departments that provide transportation improvements.

Each of these broad categories has their advantages and disadvantages that generally apply across the board to those financing options within the category. There may be minor deviations such as how fees might be enacted or implemented but overall ramifications are similar. An in-depth analysis of each method is not included in the scope of this document but should be considered as transportation funding options move forward.

I. OPTIONS THAT INCREASE REVENUES

Options that increase the overall revenue to the university are the preferred method by which transportation improvements and TDM programs should be funded. In essence, many of the transfer options listed below are also funded through these sources because much of the costs are passed along to the end users. Sources of funds that are new revenues are:

- Student fee increases
- Tuition increases
- Room and board increases
- Transportation fees paid directly by employees (head tax, co-pay, monthly fee)
- Parking fees
- Government grants
- Donations

All of these are advantageous because they represent true increases in funding that can be applied to transportation measures. Revenues derived from these sources can be applied to the programs described in this Transportation Master Plan without negatively impacting other programs or the academic mission of the institution. With the exception of donations, most of these sources have predictable funding patterns and are largely stable, allowing long-term planning for TDM improvements and capital investment in infrastructure once they are implemented. Parking fees are well established and are an expected part of university employment. Assuming that the rate increase balances cost with demand (elasticity), raising parking fees would serve two purposes described earlier in this master plan – reducing parking demand while increasing parking revenue.

The political process of implementing these revenue sources is the most difficult aspect to overcome. The first three sources – student fees, tuition and room and board increases – are all considered as the cost of education. With declining support from the state, the university has increasingly had to rely on student fees and tuition to fund the educational mission of the institution and room and board has had to increase to cover the cost addressing deferred maintenance and enrollment growth in housing. There is political pressure to contain the total cost so that higher education is afford-

able to middle and lower income Coloradans. Thus, fees for transportation infrastructure may be seen as limiting student access by increasing costs unnecessarily.

Transportation fees for faculty and staff would raise issues of equity and may elicit debate about parking and TDM practices. By state statute, benefits and costs paid to or by one state employee must be the same as all other employees. Thus, all employees would need to pay the transportation fee. This has been seen as a burden to low income employees that often work shifts where alternative transportation modes are not available. Faculty and staff might be resistive to implementing a fee where one has not existed before, particularly if they do not use parking or transit. Such fee would likely have to start small and be phased in gradually over time.

In much the same way, parking fees impact students, faculty and staff and would raise many of the issue above. Parking fees would be considered part of a student's cost of education. Faculty and staff have consistently voiced concern over parking fee increases with regards to equity and impacts to the cost of living. This has become more acute as employees have been asked to shoulder more of the burden of health care, retirement and other traditional benefits without pay increases in order to help balance the state budget.

Donations and government grants are less certain than the other sources. Grants must be sought on a regular basis and funding for traditional programs has become more competitive in recent years. Donations require an active fundraising organization and transportation improvements have not been solicited in the past. A dedicated staff person would be required, donors identified and then pursued. This may be seen as competing against academic programs since the potential donor pool is well known and largely finite.

II. OPTIONS THAT TRANSFER FUNDS TO TRANSPORTATION

Options that do not increase the overall revenue of the university but instead transfer existing revenue to transportation providers include:

- General Administrative and Infrastructure Recharge (GAIR)
- Direct subsidies
- Annual budget requests
- Indirect Cost Recovery (ICR) fees
- Departmental transportation fees
- Capital construction fees

CU-Boulder's FY 2010-11 budget was \$1.4 billion. If the institution was truly committed to making transportation a priority, funds could be reprioritized to fund the infrastructure and programs proposed in this document without increasing revenues. The funding mechanisms listed in this category are largely in place and can be adapted readily to achieve the goals and programs without being subject to the political debates and scrutiny

that fee increases would receive.

The primary funding mechanism that exists today is GAIR (also known as GAR/GIR), which is like a tax placed on groups that benefit from university services and support but would not otherwise pay for them. GAR and GIR are calculated separately as a percentage of the monthly expenditures of auxiliaries and self-funded activities. It is used to fund the maintenance and construction of grounds, roads, sidewalks, etc. in support of the auxiliaries and self-funded activities to which it is charged. An increase in GIR would be one logical source of funds for transportation improvements, particularly those that support auxiliaries.

ICR is similar to GAIR and is charged to federal research grants awarded to the university. While the amount received from ICR is tremendous (approaching nearly 50 percent of a grant), there are equivalent restrictions that dictate how ICR revenues can be spent. Additional investigation is needed to determine whether any revenue from ICR can be used to support transportation initiatives proposed in this master plan.

Likewise a direct subsidy from the General Fund would cover costs to support the transportation needs of the academic units. The most likely way that this would occur would be through annual budget requests submitted by PTS and Facilities Management for transportation improvements.

The biggest obstacle to implementing these types of fees is the lack of stability in the funding stream. Because each year is independent and must be requested, funding is subject to competing interests. For example, a failure in a pipe serving an auxiliary might require a disproportionate expenditure for utility improvements that would limit the amount of money that could be applied to TDM funding. Similarly, an academic or research initiative may gain priority over a General Fund subsidy of transportation causing a one-time or permanent reduction to the subsidy. This type of instability would make long-term transportation funding difficult to plan, implement and maintain.

Departmental fees would be a new extension of the concept of GAIR to academic and General Funded units. A fee could be based on the number of employees (departmental head tax) on expenditures like GIR, or on the amount of space occupied by a unit. This would avoid having employees paying directly for transportation infrastructure and programs but would have a direct impact on academic units and their mission.

Capital construction represents another area where revenue could be transferred to transportation infrastructure providers. CU-Boulder frequently constructs and renovates buildings on campus, averaging close to \$120 million per year over the past four years. Municipalities frequently require "growth to pay its own way" and tax new developments in the form of development excise

taxes, use taxes, plant investment fees, permit fees and other charges. To some extent, the university is similar and assesses some plant investment fees, lost parking fees and permit fees on its projects. Unlike a municipality, fees charged a capital project are coming ultimately from the institution and if passed through contractor, will be marked up, costing the institution more than a direct transfer.

University capital construction suffers from the perception that it is too expensive. There is constant pressure to keep costs down and maximize the amount of construction put in place. Transportation fees on capital projects have been rejected in the past because of their impact to a project's bottom line. It would be difficult to do long-term transportation planning to account for this type of funding since it would vary greatly depending on the number of projects being built.

Within all the transfer options, there are state laws and fiscal rules that apply differently to each source. As noted, ICR may not be able to be applied to transportation. State funds are prohibited by law from being applied to internal university charges such as plant investment fees. Other rules likely exist meaning that much additional study is required before all the ramifications of fee transfers are known.

III. FUNDING OPTIONS SUMMARY

It is clear from this discussion that there is no easy solution to funding transportation infrastructure and programs. It is likely that a variety of funding sources will be needed to accomplish the various TDM programs outlined above. New revenue sources are desirable since they do not adversely affect existing programs. Issues of equity and fairness must be addressed in any solution. Existing methods for transferring funds must be understood to avoid running afoul of laws and fiscal rules. This section of the Transportation Master Plan presents ideas and concepts about several possible transportation futures. One can only conclude that additional investigation is needed to develop a viable proposal that ensures financial viability of transportation providers like PTS at a price that is fair to those that use the transportation system.

F. Utilities Infrastructure Plan

The University of Colorado Boulder is served by a variety of utilities that are essential to campus operations. This infrastructure plan identifies the various utility systems, their current status, and the issues that should be addressed. The campus is currently embarking on a utility system upgrade that will replace much of the utility generation and distribution systems on the Main Campus. Much of the material contained in this section summarizes more than 10 years of analysis regarding the power utilities of the campus and outlines the plan to improve campus service. During calendar year 2012, following the scheduled adoption of this Campus Master Plan, the East Campus will be studied to better serve the building needs identified by this plan.

References to “city” in this section mean the city of Boulder, particularly its Public Works Department. Campus properties outside of the city of Boulder are also discussed in this section. Utilities at the Mountain Research Station are addressed separately in the Mountain Research Station Plan (in Section V-B).

1. Utility Systems Overview

a. Fuel

Central campus heating, power, cooling, and compressed air are produced by a cogeneration facility fueled by natural gas, with fuel oil backup. Williams Village also uses natural gas with fuel oil backup. Natural gas is the primary fuel source for heating buildings on the East Campus and CU-Boulder South.

b. Heating

Most Main Campus and Williams Village buildings are heated through district steam heating systems radiating from central plants on the two campus properties. Buildings on the north periphery of the Main Campus, and buildings on the East Campus, have individual building heating systems.

c. Power (Electricity)

Most electricity used by the CU-Boulder campus can be produced at the campus Power House, which also produces steam for heating. Xcel Energy, Inc. currently provides the majority of electricity for the CU-Boulder campus. University supplied power is not available to Grandview, Williams Village, leased buildings on the East Campus, and CU-Boulder South, all of which are supplied by Xcel. A major reconstruction of the Power House is planned for 2012–14 that will change the way in which power is generated and purchased (see section below).

d. Natural Gas

A high-pressure natural gas line provides service to the Power House for turbine operation. Intermediate pressure gas lines serve other campus buildings. With few exceptions, Xcel owns and maintains the natural-gas distribution systems on campus.

e. Cooling

Fourteen buildings comprising approximately 40 percent of the Main Campus building space are cooled by chilled water from the Power House. Other buildings are cooled with individual systems such as building chillers, evaporative cooling systems, or unit air conditioners. A number of buildings, including most residence halls, have no space cooling systems, although the Kittredge Complex is ready for chilled water when it is available from the new cooling plant and other residence halls will be added during the planning period.

f. Compressed Air

The Main Campus is served by a central compressed air system. This system is used for both building temperature control systems and laboratory use. However, some buildings utilize this system only as a backup supply and new laboratory usage is currently not permitted due to limited capacity. The demand for compressed air has decreased and will continue to decrease over the planning period as more of the control systems for the campus are converted to digital systems.

g. Water Supply

Domestic (potable) water is distributed from two city of Boulder water treatment plants to the campus edge. On-campus water distribution is primarily through university-owned and maintained water lines with some city lines. On the East Campus, city water is provided directly to each building.

h. Irrigation

Nearly all grounds are irrigated by sprinkler systems using raw water from irrigation ditches. Areas being converted to raw water use are Grandview, west of Bear Canyon Creek on the Williams Village campus, and portions north of Boulder Creek on the Main Campus

i. Sanitary Sewers

On campus, sewage is collected primarily by university sanitary sewer lines and by some city lines. All sewage is conveyed through city sewer lines from the campus edge to the city treatment plants at 75th Street.

j. Storm Sewers

Storm water is collected by a complex system of on-grade facilities, including retention ponds and university storm sewer lines. Most storm-water runoff is routed to Boulder Creek or other drainage ways.

k. Metering

All campus buildings are metered for electricity use. Most buildings on the Main Campus, East Campus, and Williams Village are metered for domestic water, chilled water and steam usage. Buildings served with natural gas are also metered.

l. Communications and Networking

The campus has its own telephone system and data communications network, connected to worldwide net-

works. The campus currently has fiber-optic cabling in selected buildings. A few peripheral buildings, including some in the Grandview area and some housing, have direct phone service provided by Qwest Communications. Communications and networking are covered in the following section (Section V-G).

2. Infrastructure Principles

Between 2008 and 2011, the university began planning and designing a new heating and cooling system for the Main Campus. The current concept is one that balances conservation, carbon, and cost. The plan is to renovate the existing Power House, to be renamed the West District Energy Plant (WDEP), and construct a second plant near the Coors Events Center, to be named the East District Energy Plant (EDEP). This plan best balances the conservation, carbon, and cost goals with the investment in the existing infrastructure. Analyses confirm that centralizing steam and chilled water production in two interconnected district plants provides more diversity, redundancy, efficiency, and lower life cycle costs than using distributed heating and cooling, which involves production of utilities in many smaller plants scattered throughout the campus.

Likewise, there has been a substantial investment at Williams Village in the existing system. Sustainability enhancements will be made during the planning period on an incremental basis as new buildings are brought on-line.

Developing areas north of Boulder Creek and on the East Campus offer opportunities to plan new types of central utility systems. The university will investigate lower exergy⁵ systems in conjunction with traditional carbon-based systems. These types of systems could offer the ability to transfer heat between buildings as well as integrate renewable sources such as thermal solar and geothermal energy into the supply, furthering the goal of near net zero energy use in buildings.

The following principles should be used as utility systems are improved and expanded:

a. Safety

Of primary concern is safety of the students, faculty, and staff. Utility systems must ensure the safety of the entire campus community.

b. Reliability

Utility systems must be reliable. For many systems, this suggests backup and redundant systems allowing for downtime for equipment failures, maintenance and replacement, and peak-load accommodation.

c. Environmental Protection

Environmental impacts associated with the acquisition, production, and distribution of campus utilities should be minimized. Renewable sources should be examined

⁵ Exergy is defined as the total energy of a system that is available for conversion to useful work.

and integrated wherever possible.

d. Minimization

Utilities operating costs should be minimized, with life-cycle costing that includes capital improvements. System demands should be controlled, where possible, through energy management tools. New buildings and major renovations should be properly commissioned. Integral to this is the accurate metering of utilities for each building.

e. Sustainability

All new and renovated facilities shall strive to be near net-zero carbon facilities, defined as: “A net-zero energy facility collects as much energy from renewable sources as the facility uses on an annual basis while maintaining an acceptable level of service and functionality.” Buildings can exchange energy with the power grid as long as the net energy balance is zero on an annual basis. Integral to this is the accurate metering of utilities for each building.

f. Reliance on Utilities Providers

The university will need to rely on the city for the provision of most potable water service and sewer treatment and conveyance. Natural gas will be provided either by Xcel or third-party suppliers. Most campus buildings will continue to receive electricity from Xcel.

g. Longer Demand Periods

Summer occupancy of campus is increasing, creating higher peak power demand and increased cooling demand. Nighttime and weekend use is also increasing.

h. Information Technology

System demands should be controlled where possible through central utility based Supervisory Control and Data Acquisition (SCADA) system. Optimization of communications, networking, computer, and building controls technologies are increasingly integral to higher education endeavors. The development of a central Operations Control Center (OCC), along with a CU-Boulder campus smart grid, are key components to real-time building optimization and energy management. Utility and building systems planning must account for these emerging technologies. (See also Section V.G.)

i. Utility Development Costs

These costs should be recovered through assessments to the various users based on their proportional demands upon the system as allowed by state law.

3. Fuel Use

a. Power House

The central plant on the Main Campus, the “Power House,” provides electricity, steam, chilled water, and compressed air. Electricity and steam are both produced (cogenerated) through the combustion of natural gas in two industrial gas turbines. Production of electricity

began in 1992, upon completion of an approximately \$42 million construction project to convert the Power House to the production of electricity. Debt on the original project was retired in 2006. A major reconstruction of the plant is planned for 2012-14 that will change the way in which power is generated as described below. Operation and maintenance costs are recovered through the campus utility rates.

b. Natural Gas

Natural gas is the primary fuel for the Power House. Gas commodity purchases are managed through a combination of fixed price contracts and spot market purchases to provide CU-Boulder fuel delivery and pricing stability. In fiscal year 2009–10, the Main Campus Power House used approximately 1.9 billion cubic feet of natural gas. Natural gas is the fuel of choice for several reasons, including its relatively clean burning characteristics, lack of storage requirements, and cost.

The natural gas is transported to the campus through a high pressure pipeline owned by Xcel Energy, Inc. (Xcel). A transportation fee is paid monthly to Xcel for this service.

The Williams Village complex is served by a central steam and chilled water plant. Gas commodity purchases are managed under the same contracts as the Power House with transportation provided by Xcel. Williams Village has #2 fuel oil in reserve on-site if natural gas is curtailed. Buildings on the East Campus, on the Main Campus north of University Avenue, and some of those north of Boulder Creek, have individual building heating systems fueled by natural gas, supplied either commercially by Xcel or through competitively-sourced contracts, and again delivered through Xcel's transportation system. These buildings do not have reserve fuel oil on-site and rely solely upon natural gas for space heating.

c. Backup Fuel Sources

It is possible that the natural gas supply to the Power House could be interrupted for a period of time. Xcel Energy, Inc. has called several restricted delivery days since 1992 where it was unable to deliver sufficient quantities of natural gas to its customers on the Front Range, including CU-Boulder. In those instances, backup fuel oil was used to maintain continuous operations at the Power House. CU-Boulder has fuel oil stored in below-grade tanks adjacent to the facility for immediate use should natural gas become unavailable. This on-site supply will operate the Power House fully for 96 hours before oil deliveries would need to occur to replace the fuel oil. Fuel oil will remain a reserve fuel at the Power House for either electricity or steam production. Williams Village also has sufficient fuel oil in reserve on-site for approximately two weeks of continuous operation should natural gas be curtailed.

The campus also has 22 diesel emergency generators

to back up limited, but key, electrical systems in some buildings.

d. Resource Conservation

Natural-gas-fired cogeneration represents a very efficient use of natural resources and also significantly reduces air pollution compared to coal-based technologies. Because of its lower carbon footprint, the university will be reinvesting in the turbines to extend their use for another 20 years. The turbines will become the base load energy source for electricity and steam on the Boulder campus. The proposed renovation will increase efficiencies and the electrical generation capability by adding an extraction-condensing turbine to the cogeneration system. Also, the addition of the new steam turbine will allow year round operation of the cogeneration system to further optimize the process and reduce carbon.

Additionally, the electricity produced will offset the power and demand requirements of the proposed electrically driven centrifugal chillers to produce chilled water. Absorption chillers in other buildings like Norlin Library will be replaced as they reach the end of their life and be replaced with centrifugal chillers.

The university is also aggressively working to reduce demand. The university has embarked on a major conservation effort to meet the governor's executive order to reduce energy consumption by 20 percent by the year 2012. In 2002, the university established the Office of Energy Conservation and began a campaign to educate the campus community on energy conservation, water conservation, and waste reduction. The key components of the conservation effort have been the re-commissioning of all HVAC equipment in buildings on campus; weather stripping and replacing older building windows; insulating steam and chilled water distribution piping; replacing old steam traps with smart stream traps that are capable of monitoring and indicating proper operation; upgrading campus lighting; installing smart technologies like occupancy sensors, CO2 sensors, and building automation systems; and implementing power management strategies like sleep settings for computers and vending machines, as well as after-hours setbacks in buildings.

As discussed in Section III, all new buildings and major renovations are built to a LEED Gold Standard, plus extra attention is focused on energy and water credits (CU-Boulder's term of LEED Gold "Plus"). This helps ensure that buildings are as energy- and water-conserving as possible and provide the greatest long-term payback for the investments made. In the immediate future, efforts will focus on the large energy consumers on campus—laboratories, data centers and dining centers—to reduce their energy consumption.

4. Heating

a. Steam Production

Centrally produced steam is the heating source for

almost all buildings on the Main Campus and Williams Village. As noted in the previous section, some buildings have independent heating systems served with natural gas. The Power House on the Main Campus produces steam in two boilers and two heat recovery steam generator (HRSG) units capable of 400,000 pounds-per-hour (pph) of redundant capacity. The existing Power House steam system is capable of exporting approximately 250,000 pph to the Main Campus. The current steam load for the campus is 165,000 pph with a maximum peak demand during severe winter weather of approximately 185,000 pounds per hour. Load demands have been falling due to resource conservation efforts.

Production capacity to meet peak demands is currently such that the Main Campus could still be supplied with adequate steam in the event that the largest boiler is out of service. The exhaust gases from the two gas turbine-generators are routed to two HRSGs to produce up to 80,000 pounds of steam per hour each. The HRSGs may also be fresh-air fired with natural gas, providing the Main Campus with the capability of producing steam (derated to 40,000 pph) independent from gas turbine operations, if necessary. When they went into service in 1992, the HRSGs replaced the two old boilers, #1 and #2, that were at or beyond their expected service life. Combined with boilers #3 and #4 that remain in service, the resultant total peak steam capacity of the Power House is 400,000 pounds per hour using natural gas (315,000 pounds per hour with backup fuel oil).

Presently, the steam production capacity far exceeds the demand of the campus, particularly when steam demand is at its minimum. However, steam distribution sizing is a limiting factor for exporting steam to campus. Some of this excess capacity from the heat recovery steam generators is siphoned off to run a one megawatt back pressure steam turbine generator, which reduces the steam pressure from 300 psig to 130 psig for general campus use. A new 2.7 megawatt extraction/condensing steam turbine generator will be installed to increase electrical production and better utilize steam produced by the HRSG. The remaining steam production can be sized to the campus load ensuring the highest level of operational efficiency.

During the study process for the two new utility district plants, the probable campus maximum heating load was developed. This analysis involved looking at the total long-term development potential of the campus and assessing the likelihood that a site would be developed. Then, a probable steam load was developed for the potential building. These were totaled to determine the total potential steam load for the campus. The total potential demand was determined to be 300,000 pph at full build-out and the planned new system will be sized to allow a phased growth to that capacity. The expanded capacity would be developed at the EDEP where two boilers would be installed initially—one with a capacity of 50,000 pph and one with a capacity of

100,000 pph. The new plant will have the capability for expansion to up to 400,000 pph, which would provide n+1 redundancy for the anticipated 300,000 pph peak demand calculated above. Upgrades to the current steam distribution system shall also be made to allow proper export capabilities. In the unlikely event that the campus demand were to grow beyond this point, individual building boilers or other production capability would be required.

The Williams Village Heating Plant currently produces steam in two boilers for the Williams Village complex exclusively. The plant has a total capacity of 60,000 pounds per hour with a current peak demand of 19,200 pounds per hour during severe winter weather. One boiler is always in stand-by mode. The steam is distributed to the various buildings through a utility tunnel system. There is currently underutilized steam production capacity to support some additional buildings. Additional housing and a dining center expansion are planned for the Williams Village campus. As mentioned, the Williams Village Heating Plant should be considered within the overall campus utility planning effort. The boilers are thought to be generally in good condition. The tunnel system is similar to that of the Main Campus. As such, it should be considered for upgrades regarding life safety issues such as asbestos, ventilation, and access/egress, and separations from adjacent buildings.

East Campus buildings are heated by individual systems fueled by natural gas or, in the case of the former Sybase building, inefficient electric heat. As noted above, a unified utility system for the East Campus will be the subject of study after the completion of this Campus Master Plan. Conceptually, the plan will need to unify the disperse systems within each building into a system that eventually can be run from a central location. The current thinking is that a lower-temperature, hot water loop may be the system of choice but that is yet to be determined.

b. Steam Distribution

Steam is distributed on the Main Campus through a utility tunnel system nearly three miles in length, plus shorter sections of both elevated and buried pipe. It leaves the Power House (WDEP) through one of several lines arranged in a radial pattern. It is estimated that about 90 percent of the distributed steam is returned as condensate to the boilers for reuse. This steam distribution system dates back to the early 20th century. These same tunnels are also used to convey other campus utilities, including telecommunications cabling. In the last several years, the condition of the steam tunnel system on the Main Campus has been scrutinized in a variety of areas. The system is generally in fair condition, although some piping has required replacement in the last several years due to corrosion. A 1975–76 program plan for utility system improvements specifically addressed two direct-buried steam lines for replacement. One, a service line for the Fleming Building, was

installed in a new utility tunnel. The other, a direct-buried line serving the Stadium, Grounds Building, and Dal Ward Athletic Center has yet to be replaced. This should be considered when the new Fieldhouse is constructed north of Franklin Field.

Steam velocities in the pipes are increasing as more loads are added, placing increasing demands on the maintenance staff. The radial pattern of the steam distribution piping also adds complexity to maintenance activities, as taking any one piping system out of service affects all buildings downstream from the shutoff point. While improvements have been made, additional work is needed to ensure that pressure drops are minimized, particularly if the full build-out potential of the system is to be realized.

For the past 40 years there has been a recognized need to rehabilitate the utility tunnels on the Main Campus. Two sources of rehabilitation funds are used on campus—controlled maintenance funds from the state of Colorado and renewal and replacement funds generated as a part of the utility rates. Controlled maintenance has been the preferred method of rehabilitation over the years, but has dropped off dramatically as the state has had to curtail spending to meet its budget. This means that going forward more of the cost of maintenance will have to be borne on the users through utility rates.

While providing access for maintenance workers and, thus, extending the life of equipment for many years, new utility tunnels are relatively capital-intensive at \$2,000 a foot or more. Only relatively short sections have been constructed on campus in recent years. In order to provide service to new buildings, the construction of less expensive shallow trench tunnels or the burying of steam lines directly in the ground are being considered as options to full-size service tunnels. The cost to extend steam utility service from a main in the tunnel to a new building is borne by the project. The extension of steam mains is also under consideration with that of increasing production capacity.

c. Heating Systems within Buildings

Older buildings such as Old Main are still heated directly with steam in cast-iron radiators. However, the majority of buildings utilize heat exchangers to heat water from steam, which is then used to condition the building space. Generally, buildings not supplied with district steam are heated with natural-gas-fueled boilers. The newer designs usually feature two boilers per building, each designed to meet from 65 to 70 percent of the peak heating load. In this manner, other than during very severe conditions, the loss of a single boiler will not significantly affect use of the building. Some areas, such as Newton Court, have more than one building served by a single boiler. Other smaller buildings such as those in the Grandview area have natural gas-fueled, residential-type furnaces.

5. Power

a. Electrical Supply and Generation

Electricity for both the Main Campus and East Campus buildings is supplied by the Power House. Exceptions include all buildings in Grandview, some buildings north of Boulder Creek, and privately leased buildings in the former Research Park, which are served by directly by Xcel. Xcel maintains three feeders to the Main Campus that normally convey power to the campus for n+1 reliability.

The two 15.3-megawatt combustion turbine generators (CTGs) and existing one-megawatt back pressure steam generator have a production capacity of nearly 32 megawatts of power. The campus has peak demand of 22 megawatts that cannot be met with full redundancy, thus the need to maintain the PST (Standby) Tariff with Xcel. The campus also has the capacity to do limited load-shedding that allows the university utility to regulate the peak demand and ensure that a major failure does not occur due to too high of demand.

Knowing the patterns of electricity usage and associated power quality requirements for campus buildings is considered critical to this process. The existing building electrical meters do not provide real-time information. Replacing these meters with improved meters is considered necessary and is under consideration.

Recently, electrical generation has begun using photovoltaic arrays on building rooftops. Systems have been installed at the University Residence, Coors Events Center, the Wolf Law Building, the Housing System Maintenance Center, the Center for Innovation and Creativity, and at the Mountain Research Station (including rooftop and ground-mounted systems). Three new systems are in the planning stages: Bear Creek Apartments carports, the Institute of Behavioral Science in Grandview, and the Center for Community.

These installations have been financed through third-party agreements where the university leases the roof and agrees to buy the power produced for a set rate for a number of years. The university has the right to purchase the panels when sufficiently depreciated (typically seven years) for a fraction of the original cost. The third-party retains the renewable energy credits (RECs) that it can sell on the open market for the financing period (typically 20 years). While not offsetting the university's carbon production, these renewable projects do reduce the campus demand for energy and the structure of the transaction means that there are no upfront costs for the institution.

The campus is aggressively seeking more of these installations while the tax structure supports such development. Consideration is being given to very large ground-mounted arrays that may exceed one megawatt or more. These are very land intensive, requiring seven acres or more, and as such, they will likely be reserved for interim uses on the East Campus and will be considered for CU-Boulder South in the distant future.

b. Electrical Distribution

The university owns and maintains the electrical distribution system running through most of campus, although Xcel does own some electric lines. The system is distributed at 13.2 kilovolts (kV) and looped to allow power to be back fed to any particular building in the event of failure in any one distribution cable. The capacity of the distribution system should serve planned campus expansion for the next 10 to 20 years.

On the Main Campus, the electrical distribution system is constantly being improved. Replacing aging transformers and switches is an ongoing process. Upgrading of cables in tunnels may occur in parallel with tunnel work associated with the steam and chilled water distribution system.

Two basic loops are routed around parts of campus to provide service. These loops are largely reaching their load capacity and so a third loop was run to the Center for Community. This new loop may be extended to serve development being considered in the Kittredge area or other parts of the southeast section of the campus.

On the East Campus, a new electrical station is being constructed to support the Jennie Smoly Caruthers Biotechnology Building that will facilitate electrical service to the entire campus. The distribution gear will be located near Greenhouse No. 3 and a new duct bank will run to the Caruthers building. From here, it will be able to be looped to other buildings as the campus develops.

The Williams Village campus is served by a radial 13.2kV feeder from Xcel. With development, looped systems have been extended to the various buildings but some additional work may be required to ensure redundancy is provided.

Xcel is the sole source for CU-Boulder South at this time.

6. Cooling

a. Chilled Water Production

The Power House produces chilled water to air-condition approximately 1.4 million square feet of Main Campus buildings. These buildings are generally located near the core of campus. There are three existing steam absorption chillers in the Power House that have a capacity of 3,200 tons. All other air-conditioned buildings, including the Engineering Center complex, the Koelbel Business Building, the Wolf Law Building, Fleming Building, and Norlin Library are cooled by individual systems.

In the same way that the total long-term steam demand was calculated, the university studied the long-term demand for chilled water. The total connected load for all chilled water was determined to be 9,000 tons. This reflects the carbon and energy strategy outlined above that also includes centralizing all the production of chilled water on campus. Three new 1,500-ton

centrifugal chillers would replace the absorption chillers at the power plant which would provide the base load fixed capacity of 3000 tons with n+1 redundancy. A new plant will be constructed east of Coors Events Center that will house two 1,500-ton chillers (one plus one for n+1 redundancy).⁶ The new plant will initially serve the additional load in the Kittredge Complex, as well as the academic buildings that are off Kittredge Loop Road. Existing chillers like the one in the Wolf Law Building will be shut down and only used to reduce peak load demand.

Like steam production, the capacity of the cooling in the EDEP will be scalable to the demand as the campus grows. The plant will have the ability to add up to three chillers, resulting in a potential firm plant capacity of 7,500 tons. The plant layout can also accommodate the upgrade to five 2,000-ton chillers (or a combination of both). The production of chilled water in the two utility plants has been determined to be the most efficient, lowest cost, and most environmentally friendly production method. It is therefore in the best interest of the campus to retire the existing isolated plants in the various buildings. Absorption chillers in Norlin Library and the Engineering Center should be retired as soon as possible when they reach the end of their useful life. Newer chillers in the Koelbel Business Building and Wolf Law Building should be shut down and only occasionally used to shave the peak load demand. New buildings on the Main Campus will be required to connect to the chilled water plant if they are not capable of using other cooling methods.

The Williams Village plant has a capacity of 1,400 tons of cooling, as a result of the installation of two centrifugal chillers. Currently, the peak demand is estimated to be approximately 400 tons. Eight hundred tons of the 1,400 ton capacity is from an absorption chiller that is only dispatched when an electric chiller is unavailable.

The East Campus is presently served by individual plants within each building or, in the case of the former Sybase building, by a rooftop mechanical unit. Like the heating system discussed above, a lower exergy system could conceivably transport heat from building to building. Heat could be rejected into a loop in one building (cooling) and be drawn from a loop by another (heating). This type of system would serve both needs as long as there is a good balance between the loads.

b. Other Cooling Production and Conservation Efforts

Most university buildings have internally determinant cooling loads, that is, heat produced from the equipment, lighting, people, and other heat generating appliances are a greater factor in design than the heating loads from the external climate. Building design has

⁶ The total number of chiller capacity with the n+1 redundancy will be 10,500 tons of cooling. The location of the redundant chiller has not been determined and it will depend on final design considerations. The WDEP and EDEP will be interconnected so that either plant can back up the other one.

responded to this dynamic throughout the history of the campus. Early buildings like Hellems had narrow floor plates, high ceilings, and transom windows that facilitated ventilation through the building. The Engineering Center was constructed with few externally facing windows and those that were provided were surrounded by a hood to increase the shading coefficient and keep the heat associated with natural light out. New building techniques seek to “right size” windows for the space and minimize heat gain through the use of high-performance glass. In this way, additional external heat gain sources are reduced.

Evaporative cooling is increasingly used to provide the initial cooling for campus buildings. The first stage is direct evaporative cooling where water is added to the air stream. The second stage is indirect evaporative cooling where water is run through a cooling tower, then through a heat exchanger in an air handling unit to cool the air dryly. The third stage of cooling would be to cool using chilled water. In some buildings like laboratories, the tight temperature controls and humidity requirements require chilled water, while in others direct/indirect evaporative cooling can provide most if not all of the cooling for a building. This is the case in the Center for Community where building is exclusively cooled with direct/indirect evaporative cooling. This is likely to be the way of the future for all new campus development.

Beyond normal building cooling, there is a base line demand for cooling to handle process loads from equipment. Many experiments use heat producing equipment that rejects heat to water systems. In many scientific buildings, process chilled water loops have been installed to conserve water while providing cooling. Processed chilled water loads exist year-round and a 750-ton water-side economizer heat exchanger will be installed at the EDEP to provide this cooling in the winter so that the chillers can be taken out of service to conserve energy.

There are also quite a few stand-alone air conditioning systems that are used to cool spaces or equipment in buildings that are not adequately served by the existing chilled water or have unique process cooling loads. As improvements are made to the campus utility system these should be retired. The use of electric-driven window air conditioners is no longer allowed due to their inherent inefficiency, maintenance requirements, and unpleasant aesthetics. As these systems reach the end of their life, they will be replaced with campus chilled water or a split DX system that are more efficient and where the compressors can be hidden.

c. Chilled Water Distribution Systems

The existing chilled water is distributed from the Power House through utility tunnels to various campus buildings. Insulated pipe runs parallel to the steam piping in utility tunnels. As a part of the university’s resource conservation efforts, improvements are being made

to the distribution system to improve the efficiency of the existing system by replacing Delta-P valves. This should increase the temperature differential between the chilled water leaving the plant and water returning from buildings.

The new plan to put all campus buildings on central chilled water will require a large expansion of the distribution system. First, a connection must be made from the EDEP to the WDEP to provide redundancy. Then, lines will need to be extended to the areas that do not have chilled water piping. The first of these areas will be into the Kittredge Complex and then eventually to the Engineering Center and Farrand Field district. The Grandview area and north of Boulder Creek will not be served by the Main Campus system and will need to have their own stand-alone plant(s).

At Williams Village, chilled water is distributed through a series of tunnels and shallow trenches that parallels the steam piping. The radial system will be extended as new buildings are added. It is unlikely that the system will be extended to the east side of Bear Canyon Creek, where individual residential systems are likely to be installed.

7. Compressed Air

Compressed air is produced at the Power House for both plant purposes and for use in many buildings on the Main Campus. Temperature control systems in buildings continuously utilize compressed air for equipment such as thermostats, valves, and air dampers. Compressed air is also used in many laboratories, although the demand for purified compressed air means that many of these systems are stand-alone. Compressed air usage was on the rise for many years; however with the affordability of direct digital control (DDC) systems, the need for compressed air has flattened. It will likely reduce some in the planning period although it will not go away since many systems may have DDC controllers with pneumatic actuators and devices.

Buildings at Williams Village and the East Campus have individual air compressors.

8. Domestic Water

a. Main Campus (excluding Grandview)

The supply of domestic water to all campus areas, including the Main Campus, is from the city of Boulder. The Main Campus is served through four main service meters. The distribution systems on the Main Campus are generally satisfactory, except that some of the older mains on the west side of the Main Campus may require upgrades or replacement within the next five to 10 years. Some pressure loss is being experienced in these areas due to aging effects such as corrosion and tuberculation. There are some dead-end water mains (water supplied from only one direction) to a few buildings such as the Visual Arts Complex, JILA, and Wardenburg Health Center. New construction and renovations may offer opportunities for upgrades in these areas. State

funding may also be required on a multi-year basis to perform the necessary upgrades.

Also, due to the current system pressure and flow criteria, it is likely that fire pumps will be required to provide sufficient flow and pressure at both Gamov and JILA Towers when fire sprinkling systems are retrofitted to them. In order to properly maintain the water distribution system, the ongoing testing of primary gate valves and fire hydrants should continue. The effort to upgrade the documentation of the distribution system on a computerized database should continue. This allows the staff to assess better and repair the equipment and plan for future development.

b. Grandview

Grandview is served by old six-inch looped water mains that are maintained by the city of Boulder. Although they are adequate for the existing properties, the university should extend the Main Campus water lines into this area. The benefits of such an extension are to avoid plant investment fees from the city of Boulder. In addition, the university would benefit from a more reliable water service.

c. East Campus/Smiley Court

The domestic water system on the East Campus is owned and maintained by the city of Boulder. The East Campus north of Boulder Creek is served through two main service meters. Based upon available pressures and flows, the system is generally adequate, but will need reconfiguration or extensions of the system as additional service uses are developed north of the creek. The system serving the Smiley Court area is likely deteriorated in places, and needs to be upgraded, as well as possibly reconfigured.

d. Williams Village

The current water distribution system is set up with two distribution loops: the 30th Street loop, which services the Stearns and Darley areas, and the Bear Creek loop, which services both Bear Creek buildings. Development of Williams Village is expected to increase in the next 10 years. With the construction of Williams Village North in 2011, the existing water distribution loops will be connected along a new master meter at 35th Street. This new distribution system will combine all buildings into one water budget and reduce future PIF to the city (this is in concert with raw water expansion at the campus). The Williams Village water system is considered adequate, but some reconfiguration or extensions will be needed as additional housing is developed there.

e. CU-Boulder South

CU-Boulder South currently is not served by a municipal water and sewer utility. As the university develops CU-Boulder South, it will need to pursue obtaining water and sewer services from the city of Boulder.

9. Irrigation

The automated sprinkler system that uses untreated (raw) Boulder Creek water has proven to be a cost-effective system to irrigate the campus. This system was the topic of a 1983 Campus Irrigation Master Plan. The purchase of over 100 million gallons annually of more costly, treated city water is currently avoided by using this system. This system utilizes a portion of the university’s decreed water rights. Water is diverted from Boulder Creek and routed through irrigation ditches to the campus where it is stored in retention ponds. From there, it is pumped through distribution piping to its point of use. Computer-based technology is employed to apply the proper amount of water to each area served by an individual sprinkler head. This system avoids over-watering that is in the water conservation interests of the campus.

The university is a shareholder in three irrigation companies that collectively manage shareholder water rights and maintain the ditches to adequately deliver shareholders’ water. The university should continue to expand the raw-water irrigation system within the constraints of its water rights.

The current use of treated water in some sprinkler systems on the Main Campus, East Campus, and Williams Village should be phased out. As funds permit, Facilities Management staff should work with others on campus, notably Housing & Dining Services and the Department of Intercollegiate Athletics, to foster the conversion of the existing irrigation systems over to raw water irrigation. CU-Boulder has begun efforts to extend the raw water irrigation system into Grandview, which should be operational in 2011. The decreed water rights at CU-Boulder South should be used in a timely manner.

10. Sanitary Sewers

The current campus system of sanitary sewers routed into the city of Boulder sanitary sewer system is generally considered adequate for the current level of development, although some systems are maintenance intensive. Over the past 10 years, the university has provided processed chilled water systems to several buildings eliminating the need for once-through water, thus reducing the load on the existing sewer system. The university should continue such efforts as it both conserves water and reduces the demand on the sewers. Staff should continue to work with their counterparts in the city in both the management of university-owned sewers and city-owned sewers. The Department of Environmental Health and Safety should continue to work with the city of Boulder in monitoring the effluent within sanitary sewers.

The discharge from food service areas on campus is a concern, particularly with regard to grease and its buildup within sanitary lines. Efforts should continue to bring these areas into compliance through the use of appropriately sized and maintained grease traps and waste minimization practices. The sanitary sewers

in a few campus areas, including the area east of the Engineering Center, may require upgrading as the area is developed.

Grandview is served by city sewers, with some building service lines in poor condition given the age of the service. Williams Village systems will need to be expanded/upgraded as part of future development. The sanitary sewer system on the East Campus is mostly owned and maintained by the city of Boulder and is generally in adequate condition.

11. Storm Sewers

The University of Colorado owns approximately 17.1 miles of storm drainage sewers and open channels on the Boulder campus. These systems have largely been installed as development continues to grow on the campus. Storm water systems are generally designed to accommodate five-year storm events in campus streets and associated piped system. From the 2001 Campus Master Plan, many of the suggested storm drainage improvements have been completed, including but not limited to: Mary Rippon Outdoor Theater, the UMC, and the Visual Arts Complex.

The storm sewer system is largely in good shape in terms of capacity and life expectancy. However, the focus for the next 10 years should be on sustainability and storm water quality, concentrating on upgrades that effect large areas of campus. For sustainability, new projects should focus on reducing storm water runoff by means of porous pavements, infiltration trenches, bio-swales, and soil augmentation.

For new projects with existing imperviousness less than or equal to 50 percent, the university should insure that post-development storm water discharge rate and quantity don't exceed pre-development discharge rate and quantity for the one- and two-year 24-hour design storms. For new projects with existing imperviousness over 50 percent, the university should seek to reduce the volume of runoff by 25 percent over pre-existing conditions for the one- and two-year 24-hour design storms. By accomplishing these goals, new projects become eligible for LEED Sustainable Sites credit 6.1. For storm water quality, the university should strongly focus on installing BMP controls on both a project basis and a storm-basin basis. These BMPs should focus on reducing impervious area by promoting infiltration as well as capturing and treating runoff from at least 90 percent of the average rainfall. They should target achieving an 80 percent reduction in total suspended solids as well as oil separation and litter retention. By implementing these storm water quality improvements, projects will become eligible for LEED Sustainable Sites credit 6.2. Award of LEED 6.1 and 6.2 credits is one of the first steps in the large-scale campus goal of achieving compliance with AASHE STARS Operations Credit 23. While the LEED and STARS certifications only require **systems to be designed for two-year storms, the university should**

design all improvements to five-year 24-hour design storm criteria to heighten its image as a "green" campus and ensure compliance.

In addition, the city of Boulder has found elevated levels of E. coli at campus storm outfalls to the Boulder Creek. Since Boulder Creek is on EPA's 303d list, the campus should also perform water quality testing of the storm sewer systems in an effort to determine the source of E. coli. The university should then take steps to mitigate E. coli in the storm sewer system. Proactive activities such as televised investigation and focused testing of suspected E. coli source areas, development of a TMDL strategy before it is required by the EPA, and pilot projects to ease animal-caused E. coli loading should be the focus of the Boulder campus. Funding for these projects should come from both Plant Investment Fees for capital construction and from rate increases on the city of Boulder water bills to the campus.

Contaminated runoff from construction activities should also be addressed. The campus should implement stringent policies and provide greater oversight to prevent sediment, petroleum, and other chemical releases to the storm sewer system. Education and communication, provided by the campus during pre-construction activities, will ensure that contractors working on campus understand the importance of storm water quality and should be utilized in order to help reduce construction related contamination.

Projects for the next 10 years should include: Campus Storm Basin C Water Quality Facility, 28th Street Pond Outfall Improvements, Business Building Storm Sewer Upgrade, and 18th and Colorado Site Drainage Improvements.

G. Information Technology (IT)

1. Background

Information Technology (IT) at CU-Boulder is facilitated through a centralized organization and numerous decentralized services and offices throughout campus. Information Technology Services (ITS) operates many of the centralized IT efforts on campus by providing support for faculty, students, and staff in three primary service areas: academic computing, research computing, and administrative computing. ITS also works in conjunction with decentralized IT services in academic departments, university offices, and affiliated research institutions.

2. The CU-Boulder IT Infrastructure

The majority of the Boulder campus is served by an internally-operated telephone system and a robust data network that includes connections to Internet2 and LambdaRail, ultra-high performance networks dedicated to research and education purposes. The campus' fiber optic network is a three-tiered structure that begins with a decentralized ring of three nodes, which provide redundancy and thus resistance to catastrophic failure

should any single node fail. While two of the nodes are located on the Main Campus, the third node on East Campus is currently located within the 100-year flood plain (although efforts are ongoing to relocate this facility). Each node is deemed to be in a "well-protected site" that includes physical security and emergency back-up power. Only a handful of peripheral buildings (located mainly in the Grandview area, but also including some administered by Housing & Dining Services) have communications provided by an outside vendor, Qwest Communications. The network architecture includes multiple computer security layers to help protect the university information and computing resources. The campus currently maintains a one-gigabit fiber optic backbone, with distributed access to typical users by way of Cat 5 or higher wiring. Upgrading the network by creating a 10-gigabit research network is envisioned to help the campus meet its 21st century research commitments.

ITS also provides a wireless network that provides coverage to all campus buildings and strategic common spaces. Demand for the wireless network continues to grow as the numbers of mobile devices connected to the campus network also increases. A recent study indicated that of the 89,000 devices supported by the campus network, 61,000 of those devices were connected wirelessly. Increasing the number of personal communications devices using Voice Over Internet Protocol (VOIP), used by the general public and emergency responders alike, will continue to put pressure on the air network in terms of robustness and reliability. Other challenges to the robustness and reliability of the campus' wireless network not only include the campus' large inventory of historic masonry buildings but also recently-constructed, energy-efficient buildings which are tightly sealed and can degrade wireless signal strength. Recently, a wireless carrier coverage study found weak, poor, or no signal coverage within 30 to 50 percent of campus buildings (depending on the wireless carrier).

CU-Boulder is poised to become a leader in research computing based on its commitment to research and close working relationships with national research labs and research institutes, including the National Center for Atmospheric Research (NCAR), the National Snow and Ice Data Center (NSIDC), the Laboratory for Atmospheric and Space Physics (LASP), the Cooperative Institute of Research in Environmental Sciences (CIRES), and the Joint Institute for Laboratory Astrophysics (JILA). In FY 2010-2011 the university received \$454 million in sponsored research funding as one of the country's premier public research universities. Research computing will continue to play an increasingly major role in modern scientific investigation, expanding the IT infrastructure to support a wide range of disciplines.

CU-Boulder has recognized the inherent inefficiency in decentralized computing amongst research and

academic programs and is moving toward more consolidated research computing. It is estimated that over 40 "micro" or "mini" clusters are located across campus, which require large amounts of power for high-performance computing, dissipate large amounts of heat into the air, are prone to higher-than-expected ongoing service and maintenance costs, and consume valuable square footage. Consolidating those resources into an energy-efficient data center using a "condominium-style" model (where faculty obtain shares of a centrally maintained computing resource) will increase both energy-efficiency and resource utilization. The campus already maintains a centralized data center, located in the Computing Center. Originally built in 1973 on the East Campus and located in the floodplain, the Computer Center is a 150 kW secure facility with back-up power and redundant chillers.

Advanced research computing has become essential to the success of faculty research endeavors and has a direct effect on faculty recruitment and retention. Funding agencies now recognize the importance of computing in successful research and tend to assess this component more rigorously when evaluating grant proposals. For instance, the NSF now requires that all proposals include a data management plan, a move that other funding agencies are likely to follow. Participation in national cyberinfrastructure initiatives such as TeraGrid can also greatly enhance the prospects for outstanding research, which increasingly requires collaboration on a national and international level. The network to maintain, access, and integrate these resources is called "cyber-infrastructure", which according to EDUCAUSE, consists of "computational systems, data and information management, advanced instruments, visualization environments, and people, all linked together by software and advanced networks to improve scholarly productivity and enable knowledge breakthroughs and discoveries not otherwise possible." Additionally, the high barriers to entry into high-performance research computing (HPRC) can significantly limit research options. Many departments do not have resources for initial hardware and software costs, ongoing maintenance costs, physical and environmental space requirements, nor the technical knowledge necessary just to get started. Some research areas cannot overcome these barriers, nor provide the specialized support skills, and thus may lag behind.

A committee of research faculty, the Boulder Campus Cyberinfrastructure Board, has been created by the VCR to oversee the development of research computing resources, including the development of sustainable funding models to support centralized research computing. It will also oversee the creation of the Center for Research Computing, which will develop, maintain and promote the campus' research computing capabilities while supporting our research community in the use of these resources.

3. Current and Ongoing Projects

The campus continues to ensure that all classrooms in capital construction projects are technology-enhanced. All new classroom spaces are equipped with distance learning capabilities. By fall 2011, 100% of centrally-scheduled classrooms will be technology-enhanced. Additionally, Flagship 2030 calls for a marked increase in the number of Residential Academic Programs, which will add several dozen technology-enhanced classrooms to the current pool. To ensure standardization of technology, to lower initial and ongoing costs, and to best match technology enhancements with teaching and learning needs, ITS and Facilities Management work closely together from the very beginning of and throughout all capital construction and departmental renovation projects.

Other efforts that directly impact the teaching and learning environment and the campus' physical plant will greatly tax the capabilities of the campus's hard-wired and wireless networks. The use of rich media (audio, video, simulations, classroom capture, etc.), videoconferencing, and mobile devices to access educational content are major data bandwidth uses that impede the delivery of services across the networks. In addition, the use of rich media as evidence of learning will lead to greater needs for faculty and student storage. Finally, a new learning management system (Desire2Learn or D2L) that is more modern, flexible, and robust than the current CULearn will greatly enhance the campus's ability to provide online and distance education opportunities.

In 2010, in collaboration with NCAR (and partially funded with a NSF MRI grant) a \$8-million containerized supercomputer, Janus, was located adjacent to the CINC building. The Janus supercomputer is capable of consuming hundreds of kilowatt hours when it is being fully utilized. However, Janus is housed in a custom-built container that uses water-cooled chillers to provide cooling at levels much more efficient than typical data centers, thereby reducing electrical costs.

ITS has implemented a demonstration WiMAX environment to meet the needs of telecommunications researchers and educators on campus and to demonstrate "substantial service" of the Educational Broadband Service (EBS) spectrum currently allocated to CU-Boulder. In addition, the wireless and cellular networks are being reviewed to ensure adequate coverage across the Boulder campus. While various options are being explored with cellular carriers and tower companies, it is anticipated that a Distributed Antenna System (DAS) will be deployed across the campus.

a. Summary of the 2010 IT Strategic Plan

In 2010, ITS conducted a comprehensive campus-wide IT Strategic Plan which aligned campus IT goals with Flagship 2030. Specific recommendations and long- and short-term objectives within the IT Strategic Plan are incorporated into the Campus Master Plan. The

initiatives outlined in the report shape the four basic areas of investigation: academic technology, shared resources and support, collaboration for effectiveness, and active and engaged participation across campus. In turn, those four areas yielded sixteen extensive reports – the culmination of focus groups, participant surveys, and the dedicated efforts of more than 200 student, staff, and faculty participants.

The ITS Strategic Plan (<http://www.colorado.edu/itplan/>) recommends an IT framework to help enhance learning and expand access while meeting cost and quality concerns expressed by the campus community. The plan identifies the physical systems and user support systems necessary to provide convenient and reliable IT tools to all campus users. It also recommends ways to provide the leadership, funding, and management necessary to properly support a versatile and flexible IT environment. Rapid growth and change in IT means that the campus must not only respond to that change, but responsibly guide and lead it. The vision for IT is driven by how IT's goals serve the goals of CU-Boulder's vision.

The strategic recommendations of the 2010 IT Strategic Plan are intended to help campus leaders effectively implement rapidly emerging information technologies to effectively support CU-Boulder's mission. The key recommendations in this plan follow.

Teaching/Learning:

- Ensure usability of centrally provided tools, systems, and spaces.
- Align central support with local and changing needs.
- Provide better support for students, staff, and faculty.
- Facilitate effective support across campus through partnering.
- Invest adequate funds to support centrally adopted new technologies. Likewise, establish a phasing-out process for out-of-date technologies.
- Formally integrate usability guidelines into centrally adopted tools or spaces.
- Invest in teaching/support resources equal or greater to the investments in those spaces and tools.
- Create a collaborative support environment on campus.
- Target support on cross-unit needs rather than discrete organizational needs.

Research computing:

- Develop capabilities to support computing-, visualization-, and simulation-heavy research in the humanities and social sciences, including the capability to analyze non-numerical types of data, including visual, textual, geographic, and audio.
- Develop a funding model to continue to provide efficient, centralized computing and data centers for research and academic departments.
- Create a Center for Research Computing to promote

the campus's research computing capabilities.

- Create a central research computing data center that meets the research community's unique requirements for capacity, flexibility, efficiency, and security; accommodates central and independent control systems; and provides requisite staffing for primary support functions.
- Improve the reliability of the campus network and its inbound and outbound capacity.
- Ensure archival data can be preserved in usable form in perpetuity.
- Further integrate the research network with the national cyber-infrastructure such as TeraGrid.

Mobile technology:

- Convene a group of current cloud innovators and experts to develop a roadmap for cloud computing on campus.
- Look for possible cloud collaborators such as NIST, Google, etc.
- Expand wireless coverage so that it is ubiquitous, including outdoor areas and assessing use of a university-owned spectrum in the 2.5GHz band for WiMAX coverage and 4.9GHz for public safety use.
- Start development of a basic set of CU-Boulder-branded mobile apps based on the MIT Mobile Web project within the framework of the iMobileU Initiative.
- Expand the use of SMS text messaging to provide information beyond emergency notifications.
- Adopt a convergence strategy for all current and future web applications.
- Re-evaluate procurement regulations regarding use of mobile devices
- Continue to provide wireless networking services (for all devices, all frequencies) to all spaces in a building where flexibility and mobility for data access are required and when this is the most cost effective alternative.
- Supplement over time the existing voice telecommunication systems. Voice Over Internet Protocol (VOIP) wireless communications will expedite emergency responder issues. Install emergency back-up generators, as well as UPS in data closets to maintain VOIP communications for emergency responders.

Rich Collaboration Tools:

- Develop a content and media repository.
- Develop shared ("CU-cloud") canvas tools. Create centralized storage/virtual workspace/shared canvas for learning groups across campus.
- Develop a cohesive video-conferencing service model that eliminates difficulties in supporting multiple technologies, lack of interoperability, and inability to aggregate equipment purchases.
- Develop unified communications technologies combining all of the ways individuals communicate, tightly integrated with voice, electronic messaging, calendaring, and LDAP directories.

Increase Staff Effectiveness:

- Develop a better understanding of present and future business needs.
- Develop and promote a common understanding of staff effectiveness.
- Develop a better IT service environment.
- Better utilize current technology.

Other:

- Update web infrastructure
- Improve the IT service model.
- Libraries and IT should partner appropriately on the Norlin Renaissance plan especially as East Campus develops.
- Continued collaborations between IT and Libraries regarding iTunesU, audio/video streaming services, and digital repository platforms.
- Pursue technology initiatives to achieve effective ISIS utilization and resource efficiencies.
- Make meaningful data available in ISIS through data services standards and approaches.
- Establish ISIS service and governance initiatives to provide direction, clarity, and opportunity.
- Encourage primary reliance on university-wide reporting tools and the data warehouse.
- Develop an IT infrastructure master plan.
- Collaborate with Facilities Management to improve the understanding between the two departments, including mutual agreement on campus standards for construction.
- Implement a program for energy conservation and sustainability for campus data centers.
- Explore the "virtualization" of computing and instructional labs, which will reduce pressures on lab staff and recover assignable square footage for other uses.
- Support end-of-life management of electronics, including working with Procurement Services for placing responsibility of the reuse or recycling of electronics on the vendor.
- Increase coordination with Facilities Management to reduce duplication in backup power infrastructure.
- Establish a set of core principles shared between IT and Housing & Dining Services (HDS).
- Identify administrative computing services that can be shared between IT and HDS.
- Create a monthly service review meeting between IT and HDS.
- Develop mutually acceptable funding models between IT and HDS.
- Restructure the Tier 2 Computing Support Representative (CSR) program.

8. Capital Expenditures for IT Infrastructure

CU-Boulder spends more than \$500,000 annually on the increasing quantities of smart classrooms. All centrally-scheduled classrooms will have size-appropriate tech-

nology enhancements by fall 2011. The campus should then embark on strategic technology enhancements to departmentally-controlled classrooms, approximately half of which have no technology enhancements. One estimate puts the costs of build-out of departmental classrooms somewhere between \$300K and \$450K; once build-outs are complete, the campus should continue to evolve teaching and learning spaces, adding new technologies as needs and pedagogical uses dictate.

In addition to classroom and learning spaces enhancements, the initial, but not ongoing support, costs of some of which will be borne by individual building projects, there are other infrastructure costs associated with information technology. Again, some of the costs for these infrastructure enhancements will be included in individual building projects; the rest will be covered by controlled and deferred maintenance, CU-Boulder operating funds, and expenditures by non-university utility providers. These costs are not included in capital estimates in this plan. As detailed utility planning is done in the year following this plan, a clearer picture will emerge as to both costs and revenue sources. The capital needs in the next 10 years for improvements discussed in this chapter are approximately \$10 - \$13 million.

The Computing Center (built in 1973) is located at 3645 Marine Street and contains 17,233 ASF. It is located in the 100-year floodplain. As it is the backbone for the campus's core data services such as CULearn, e-mail, and CULink, the Computing Center should be relocated to an area not prone to catastrophic failure due to flooding events associated with Boulder Creek. Resources needed for the Computing Center include redundant chillers, a minimum 150 kW of back-up power, and security. Therefore, top priority should be given to moving the Computing Center to the Sybase Building, which has a robust IT infrastructure, contains 285 kW of back-up power, and is located out of the 100-year flood plain. The cost for relocating the Computing Center to the Sybase Building is estimated to be approximately \$3.4 million to \$3.8 million.

To support ever growing wired and wireless network demands across campus, the network core will need to be enhanced to support additional bandwidth and improved reliability. In addition, the legacy telephone system will soon be at end of life and will need to be replaced, possibly with a VoIP solution. To provide higher network availability Uninterruptible Power Supply (UPS) units are being added at each network closet. The cost to upgrade the backbone and distribution layers, upgrade to the latest wireless standards and to support increased demands from research is estimated to be \$7-9M.



