

2022

SUSTAINABILITY AND RESILIENCE STRATEGY REPORT

PHASE I

A COLLABORATION BETWEEN THE
COLORADO CHAUTAUQUA
AND THE CITY OF BOULDER





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OVERVIEW

This report summarizes the results of Phase I of the Chautauqua Sustainability and Resilience (S&R) Strategy, an ongoing collaboration between the Colorado Chautauqua Association (CCA) and the City of Boulder (COB). The Colorado Chautauqua is one of Colorado's premier cultural sites, welcoming over one million visitors annually.

The S&R strategy is designed to address the environmental threats and vulnerabilities faced by the Colorado Chautauqua, a National Historic Landmark (NHL) District. These threats include fire, heat, wind, and floods, all of which are damaging Chautauqua's aging infrastructure and assets, including its buildings, roads, pathways, drainage swales, electrical system, cultural assets, and ecological landscape.

Chautauqua is also experiencing increased energy demands as temperatures rise, as well as ongoing degradation stemming from overuse.



OBJECTIVE

The goal of the collaboration between COB and CCA was to “develop and implement a comprehensive strategy to advance sustainability and resiliency at the Chautauqua NHL District.”

Creating a comprehensive S&R strategy that results in a realistic and implementable plan for addressing environmental risks is critical to the continued survival and success of Chautauqua. Developing a strategy, however, is complicated because the district is a public park belonging to the residents of Boulder, with both public and private entities operating within its boundaries. These entities include CCA, the City of Boulder’s Parks and Recreation Department, Open Space and Mountain Parks, as well as private residents.

A key goal of the S&R strategy is to better align the priorities of these stakeholders to support the long-term preservation and use of the Chautauqua NHL District.

PROCESS



In 2019, a 25-member Steering Committee established the general scope of the S&R project and its goals, which were codified in the Project Charter. The Steering Committee included representatives from CCA's Board of Directors and Sustainability Committee and directors of relevant City Departments, including Historic Preservation, Parks and Recreation, Open Space and Mountain Parks, Planning, and Public Works.

The Steering Committee authorized a separate six-member Project Management Group (PMG) consisting of CCA and COB representatives and project consultants, Paul Chinowsky and Lisa Craig, authors of the Chautauqua 2020 Vulnerabilities Assessment, to oversee five study groups who were tasked with recommending sustainable solutions to identified vulnerabilities.

The five study groups addressed issues related to infrastructure, energy, fire and heat, vegetation, and governance. After meeting for over a year, the study groups presented their recommendations to the Steering Committee in August 2021. Recommendations ranged from immediate, lower-cost initiatives such as assessing the trees and shrubs on the site, to major interrelated infrastructure tasks, including undergrounding utilities, upgrading the stormwater management system, and potentially creating a new 100% renewable energy generation system.



PHASE I - INTRODUCTION

Established in 1898, Chautauqua is recognized as one of the most historically and culturally significant places in Colorado. The Chautauqua National Historic Landmark District comprises 40 acres of land owned by the City of Boulder, 26 of which are leased to the Colorado Chautauqua Association. This cultural landscape, which includes a collection of irreplaceable historic buildings, structures, and objects is situated at the urban/wildland interface, making it subject to a unique set of vulnerabilities, including increased potential for natural disasters.

The S&R strategy is the result of a collaborative effort between CCA and COB to align and coordinate various stakeholders to respond to these vulnerabilities and to develop workable solutions that will enhance the site's long-term sustainability and resilience. This report summarizes the evolution and findings of the S&R strategy process, now entering its fourth year, including the structure of this ambitious collaboration, the development of the Chautauqua 2020 Vulnerabilities Assessment, and the recommendations of the five study groups charged with addressing these vulnerabilities and creating sustainable solutions.



2020 VULNERABILITIES ASSESSMENT

The Chautauqua 2020 Vulnerabilities Assessment describes both the risks associated with climate change and the vulnerability of Chautauqua’s irreplaceable historic resources—the buildings, structures, and objects—and landscape features.

The report was authored by Paul Chinowsky, consultant with Resilient Analytics, a local Boulder environmental consulting firm, and Lisa Craig, a nationally recognized expert in developing climate change adaptation plans for historic places.

Building on a 2018 report, *The Impact of Climate Change: Projected Adaptation Costs for Boulder County*, which noted that the City of Boulder will be significantly impacted by rising temperatures, more intense precipitation events, and increased risk of wildfires, the Chautauqua 2020 Vulnerabilities Assessment highlights the fact that the Chautauqua NHL is at risk of these same events, in addition to the potential loss of its historic resources.



2020 VULNERABILITIES ASSESSMENT

The Chautauqua 2020 Vulnerabilities Assessment describes specific threats and vulnerabilities faced by the Chautauqua NHL District with respect to heat, fire, wind, increased precipitation, flood damage, and increased energy demand resulting from rising temperatures.

These environmental factors are projected to further damage Chautauqua's aging infrastructure, including its roads, pathways, drainage swales, electrical infrastructure, cultural assets, and ecological features.

The report notes that the unique combination of geographic, topographic, and physical conditions at Chautauqua make it particularly vulnerable to climate-driven disaster and that the cottages and public buildings at Chautauqua were designed with century-old materials and systems that are particularly vulnerable to wildfire and flooding.

The authors highlight the challenges that come with more visitors at Chautauqua, numbering close to a million annually, in addition to the thousands of additional recreational enthusiasts who use Chautauqua as a gateway to popular Front Range trails, putting extreme pressure on traffic and parking.



2020 VULNERABILITIES ASSESSMENT

The tables below list the key vulnerabilities in the five identified systems at Chautauqua, along with a determination of the urgency and priority for addressing these vulnerabilities.

IDENTIFIED SYSTEMS

Infrastructure
Energy
Fire and Heat
Vegetation
Governance

Priority vulnerabilities include building and structure fires, damage to road surfaces and building foundations from inadequate drainage, and existing vegetation, much of which is non-native and particularly subject to drought.

Priority Vulnerabilities

Study Area	Vulnerability	Source	Time Frame	Priority
Energy	Energy Supply	Wind, Temperature, Precipitation	Mid-Term	Medium
Energy	Power Distribution	Wind, Temperature	Long-Term	Low
Fire & Heat	Structure Fires	Drought, Temperature	Short-Term	High
Fire & Heat	Wildfire Oversight	Drought, Temperature	Long-Term	Low
Fire & Heat	Wildfire Prevention	Drought, Temperature	Mid-Term	High
Infrastructure	Structural Decay-Cottages	Climate Change	Mid-Term	Medium
Infrastructure	Drainage Improvements	Current and Projected Precipitation	Short-Term	High
Infrastructure	Drainage-Swales	Precipitation	Short-Term	High
Infrastructure	Drainage-Cottages	Precipitation	Short-Term	High
Infrastructure	Flooding	Precipitation	Long-Term	Medium

Priority Vulnerabilities (cont.)

Study Area	Vulnerability	Source	Time Frame	Priority
Infrastructure	Overuse	User Demand	Mid-Term	Medium
Infrastructure	Structural Failures- Public Buildings	Climate Change	Mid-Term	Medium
Infrastructure	Retaining Walls	Precipitation	Mid-Term	Medium
Infrastructure	Road Damage	Traffic and Temperature Changes	Mid-Term	Medium
Infrastructure	Snow Loads	Climate Change	Mid-Term	High
Infrastructure	Stormwater System	Precipitation	Mid-Term	Medium
Infrastructure	Surface Damage	Precipitation and Extreme Heat	Short-Term	High
Infrastructure	Walkway Erosion	Precipitation	Mid-Term	Medium
Infrastructure	Water Damage	Precipitation	Short-Term	High
Vegetation	Lawns- Cottages	Temperature, Precipitation	Short-Term	High

Priority Vulnerabilities (cont.)

Study Area	Vulnerability	Source	Time Frame	Priority
Vegetation	Public Area Drainage	Precipitation	Mid-Term	Medium
Vegetation	Public Area Landscape	Temperature, Precipitation	Mid-Term	Medium
Governance	Affordability	User Demand	Long-Term	Low
Governance	Governance	Regulatory	Mid-Term	Low
Governance	Ownership Demand	User Demand	Mid-Term	Medium
Governance	Regulatory Control	Governance	Long-Term	Medium

Study Groups

After identifying the five areas of focus, the Sustainability and Resilience Steering Committee assigned five study groups responsibility for researching and recommending solutions to the threats identified in the Chautauqua 2020 Vulnerabilities Assessment. The study groups were organized around the following five main areas of focus:

Infrastructure
Energy
Fire and Heat
Vegetation
Governance



Each of the five Study Groups established a scope of work and a set of goals based on the overall S&R strategy project goals and the identified vulnerabilities for their area of study.

Recommendation Criteria

The Steering Committee directed the groups to consider the following criteria for developing recommendations:

Necessity – Recommendations should be necessary to address a specific issue and be effective in mitigating risk and improving the sustainability and resilience of the Chautauqua NHL District.

Implementable – Recommendations should be acceptable to the oversight groups responsible for implementing the recommendations, including CCA, COB departments, related Boards and Commissions, and affected constituents.

Historic Preservation – Recommendations should be consistent with Boulder’s Historic Preservation Ordinance, Boulder’s Historic Design Guidelines, and the Secretary of the Interior’s Standards for Rehabilitation. All exterior physical changes to structures in the Chautauqua NHL District are subject to review and approval by the City of Boulder’s Landmarks Board. Where historic preservation covenants exist, recommendations are also subject to review and approval by the State Historic Preservation Office.

Budget and Complexity – Recommendations should consider the cost of implementation and recognize the realities and complexities of scheduling recommended projects given the demands on CCA and COB staff.



With these criteria in mind, and after meeting and discussing possible solutions for over a year, the study groups put forward prioritized recommendations.

Infrastructure

The City of Boulder provides the Chautauqua leasehold with transportation systems and wet utilities (drinking water, wastewater, and stormwater). Dry utilities (gas, electric, and communications) are provided by private utility companies.

The Infrastructure Study Group conducted a review of transportation systems and wet utilities and recommended actions to minimize related vulnerabilities. The transportation component consists of usage and materials. The utilities component consists of wet and dry utilities.



Infrastructure

The Infrastructure Group identified the following goals:

- Plan for alternative transportation modalities
- Identify and plan for specific needed improvements on certain pavement areas and drainage systems
- Identify and plan for specific needed improvements on certain wet utility systems
- Identify and implement best practices for storm water management
- Mitigate risk of increased precipitation and flooding events
- Mitigate street erosion and degradation from overuse and runoff

Infrastructure

TRANSPORTATION

As discussed in the Chautauqua 2020 Vulnerabilities Assessment, the transportation system at Chautauqua requires immediate attention. The Colorado Chautauqua was established nearly 125 years ago and was originally designed for very different transportation modes (e.g., horse and buggies, pedestrian use).

Modern modes of transportation (e.g., buses, shuttles, cars, bikes, e-bikes) have taken their toll on the infrastructure, which requires immediate adaptations. Currently, the roads are steeply graded, overused, have poor drainage systems, are cracked and eroding from constant freezing and thawing, and are littered with potholes.

Implementing solutions to repair the existing roads and mitigate future damages from extreme weather is key to the successful implementation of a Sustainability and Resilience Strategy.

Transportation solutions fall into two categories: usage and materials.

TRANSPORTATION

USAGE

Recommendation

A - Restrict use by heavy vehicles

Chautauqua must restrict heavy commercial vehicles within the leasehold, beginning with waste management trucks. These vehicles cause ongoing damage to the roads and swales as they maneuver the narrow roads. Reducing heavy vehicle traffic will mitigate damage to the asphalt roads and historic stone swales at Chautauqua. It will also reduce noise and would increase street safety.

This recommendation will require an alternative waste system to replace the existing service. Currently there are several waste collection spots on campus that must be consolidated into one location and placed on the perimeter of the leasehold for easy access by Western Disposal.

CCA staff are working through the logistics of this shift and expect to have a new system in place in early 2023. CCA staff and residents will need to alter their current waste management practices, but the many benefits of consolidating waste disposal at Chautauqua far outweigh the associated disruption.

Infrastructure

TRANSPORTATION

USAGE

Recommendation

B - Incorporate e-bike rentals

The use of e-bikes is increasing throughout the Boulder region and bike rental stations are now common throughout the area. Given their growing familiarity, the incorporation of e-bike rentals at Chautauqua is an easy way to enhance sustainability.

Use of e-bikes by residents, guests, and visitors will reduce the number of vehicular trips on Chautauqua's fragile road system, which will translate to less maintenance, and decrease parking demand. E-bike use is also an effective way of modeling the use of alternative transportation, reducing emissions, and encouraging a healthy lifestyle.

The location of bike share stations will require Landmark Alteration Certificate review and visitors will need to be educated about pedestrian safety.



An e-bike rental system could alleviate usage on the roads and enhance sustainability.

TRANSPORTATION

USAGE

Recommendation

C – Investigate alternative parking options

With the popularity of Chautauqua increasing each year, the parking situation on site and in surrounding neighborhoods is of increasing concern. Given the complications of the site, the study group recommended an analysis to determine the viability of alternative parking options.

This recommendation is an extension of the current Park-to-Park effort that provides shuttle service from off-site parking locations. The analysis would include how to mitigate use of campus residential streets by visitors to the adjacent public open space and trails system, without impacting other neighborhood streets, and with consideration for more severe weather extremes.

TRANSPORTATION

MATERIALS

The second focus for transportation systems involves the use of new or existing materials at Chautauqua, which must be considered in light of their cost, complexity, and compatibility with City of Boulder departmental plans, schedules, and budgets, as well as their appropriateness given the character of the NHL.

Recommendation

A – Rehabilitate main roads

The Chautauqua 2020 Vulnerabilities Assessment identified Chautauqua's roads as very deteriorated and needing rehabilitation. Cracked surfaces, eroding road bases, and subsidence are all creating excessive crowning and rutting. In addition to repairing existing roads, rehabilitation efforts must consider future environmental conditions such as more extreme precipitation and heat events at Chautauqua.

Specifically, the storm water management function of the roads needs to be considered beyond the function of transferring water to the main drainage area on Baseline Road. The roads need to be engineered with appropriate crowns and enhanced bases to withstand extreme weather events.

The group recommended that a highway engineering company independently evaluate the roads at Chautauqua to determine if specific guidelines and specifications need to be incorporated into the rehabilitated roads.

TRANSPORTATION

MATERIALS

Recommendation

B – Install permeable pavement in alleys and parking areas

Permeable pavement is one solution for storm water management issues in urban areas. The goal is to reduce runoff from asphalt or concrete roadways that have little or no drainage or absorption ability. With no drainage ability, these impermeable surfaces move water, oil, and other contaminants into adjacent drainage structures.

Permeable pavements are not recommended for all conditions. Specifically, they may not be appropriate for heavy traffic areas, steep slopes, or locations where heavy vehicles such as buses stop for an extended period time. Given these limitations, the east-west lanes and the adjacent parking areas at Chautauqua provide an opportunity to introduce permeable pavements.

Permeable surfaces would reduce the volume of water that moves from west to east between the major north-south streets at Chautauqua. This would reduce the volume of water that moves into the main stormwater management system, which includes the intake area adjacent to the Auditorium and the main drainage route along Baseline Road. Replacing the current gravel surfaces with permeable pavement would also mitigate gravel being carried down through the site when heavy rains occur.

The Chautauqua Historic District Design Guidelines cite macadam (asphalt) and/or gravel as appropriate materials for roads, alleys, and paths at Chautauqua. To allow for the use of paving materials that will improve surface drainage and resiliency, the Guidelines should be revised accordingly.

Note: The City of Boulder Transportation and Mobility Department currently does not use permeable paving materials, for cost and durability reasons. Given the apparent benefits of permeable paving materials in mitigating surface drainage issues, additional research should occur to assess the feasibility of their use at Chautauqua.

TRANSPORTATION

MATERIALS

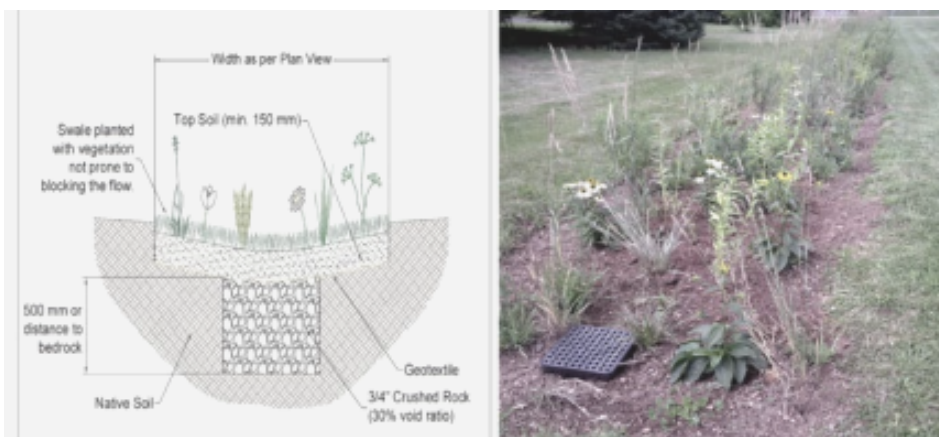
Recommendation

C – Increase green infrastructure and bioswales

Bioswales are traditional drainage areas along the sides of roads that consist of native plants that assist in filtering and retaining water to prevent excessive runoff. Bioswales reduce runoff, absorb contaminants, and enhance the aesthetic appeal of roadways. They are effective in many scenarios and are recommended by transportation planners, landscape designers, and water professionals.

There are many opportunities at Chautauqua to use bioswales. The study group recommended that a landscape architect determine the best location and vegetation for these bioswales. Bioswales can be expensive, so it may be beneficial to select one site as a demonstration area.

The Cultural Landscape Guidelines developed for the Chautauqua NHL District may also need to be revised to accommodate bioswales.



Bioswales are an effective green infrastructure method to control water flow.

TRANSPORTATION

MATERIALS

Recommendation

D – Install concrete pads for bus stops

Heavy vehicles such as buses cause subsidence in regular asphalt if they sit in one place for an extended period during hot weather. This is due to the softening of the pavement under warm conditions and the subsequent reduction of the load bearing capacity in the area. Additionally, once the asphalt begins to crack and erode, the increased torque on the pavement surface during acceleration of the vehicle causes the erosion to occur faster.

Concrete bus stops lessen road degradation due to heavy vehicles remaining at a single point for extended periods of time. Minimizing this stress significantly enhances the resiliency of the roads. When and if Chautauqua incorporates more public transportation into the transit system, it may be important to consider concrete pads at bus stops. While installing concrete is more expensive than asphalt, the long-term cost savings may be worth the initial investment.

The appropriateness of concrete pads must also be considered within the context of the Chautauqua Historic District Design Guidelines.

Infrastructure

UTILITIES

The City of Boulder oversees stormwater, drinking water, and wastewater management (i.e., wet utilities). Xcel Energy owns and oversees gas and electric power, and various communications systems providers (e.g., Century Link, Comcast, etc.) own and manage internet and broadband services (i.e., dry utilities).

While Chautauqua provides a unique opportunity to showcase new solutions, these solutions must fit within the guidelines and planning horizons of the City of Boulder, Xcel Energy, and communications services providers.

In response to this constraint, many of the recommendations presented here are for specific studies to be conducted in conjunction with the utilities providers to address known issues at the Chautauqua NHL District.

UTILITIES

STORMWATER

Recommendation

A – Incorporate drainage system improvements into City of Boulder master plan

Of the wet utilities (i.e., storm water, water supply, and wastewater), storm water is the primary concern at Chautauqua, particularly with respect to climate data projections indicating more frequent and severe events. Currently, runoff from roads, buildings, and uphill areas creates significant flow during heavy rains. Given that projected increase in the frequency of these events, stormwater management initiatives are a high priority for the Chautauqua NHL District.

Revisiting the storm water management plan for Chautauqua is a high priority. The existing storm water management plan focuses on moving water from the south to the north to where it drains into Baseline Road. This solution, which was developed prior to the latest climate change-based projections, needs to be re-examined with respect to anticipated precipitation events. An engineering study will be required to determine the capacity of the current system to absorb potentially increased water flows and to estimate anticipated flows from extreme precipitation events into the storm water management system.

A comprehensive study of Chautauqua's storm water management system will provide the City of Boulder and CCA with the information needed to implement efficient and effective storm water solutions. The current piecemeal approach is neither effective nor sustainable.

The current storm water management plan map, together with the proposed waterline replacement.



UTILITIES

STORMWATER

Recommendation

B – Redesign and reconstruct stone swales

Chautauqua's stone swales are a character defining element of the NHL District. The stone swales are not only historic, but originally served as an effective method of handling runoff. Over the years, however, they have eroded and are now in poor condition and minimally functional. Restoring the swales is a key element of an integrated approach to stormwater management.

A section of the swales near the Ranger Cottage on Kinnikinic Road has been carefully reconstructed using a dry-set material designed to increase permeability. This solution needs to be evaluated for the entire property, as well as consideration given to installing drainage pipes beneath the swales to handle more substantial water flow.

This solution is not only functional but would retain the historic visual character of the swales. Additionally, entrances to driveways should be redesigned to reduce damage to both vehicles and swales. The study group recommended that a landscape architecture or engineering firm be retained to build on the test solutions currently in place at Chautauqua. The main concern with this recommendation relates to the substantial cost of replacing and upgrading the swales.



The historic swales lining the streets at Chautauqua.

UTILITIES

STORMWATER

Recommendation

C - Reroute surface water away from buildings

Chautauqua sits on a natural slope with a 200-foot elevation gain between its north and south sides. Heavy rainfall creates localized flooding as water moves from the south-west side to the northern and eastern ends of the site. These precipitation events can be mitigated through water management techniques, including orienting downspouts away from buildings; use of rain gardens to retain water; and use of berms or integrated drains to move water away from foundations.

Where surface drainage options are not feasible or practical, consideration should be given to subsurface perforated perimeter drains with a pervious drip edge combined with downspouts connecting directly into the subsurface system. The adjustment of landscaping and downspouts would have significant and immediate benefits related to water management.

Ideally, these improvements should be part of an overall water management plan. Consideration should be given to the cost and possible disruption of existing landscaping.

UTILITIES

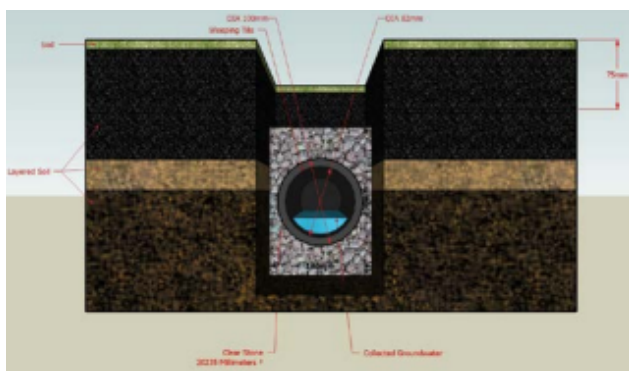
STORMWATER

Recommendation

D – Increase use of French drains

French drains are one of the oldest forms of drainage systems used in landscape design. They are simple and effective and can help prevent intrusion of water into foundation areas as water runs directly from downspouts to adjacent properties. Initially, French drains should be installed next to all public buildings, which are largely located at lower elevations and more susceptible to flooding.

The use of French drains should be encouraged elsewhere at Chautauqua, as well, along with redirecting of surface flow and green infrastructure such as rain gardens. A comprehensive approach to the management of storm water flows at Chautauqua will significantly mitigate flood risks and require minimal interaction with other systems. As with rain gardens, the demonstrated effectiveness of these solutions in public spaces could provide incentive for broader implementation.



French drains are a traditional drainage solution that could be effectively implemented around Chautauqua structures.

UTILITIES

STORM WATER

Recommendation

E – Assess and repair retaining walls

There are many places at Chautauqua, including along the eastern edge of the site adjacent to the cottages, around the (upper) tennis court, and along Kinnikinic Road, where there are signs of structurally compromised and failing stone and concrete retaining walls.

These potential failures are due in part to hydraulic pressures caused by runoff. It is critical to the integrity of these important historic features and the overall safety at the Chautauqua NHL District that retaining walls be comprehensively evaluated and appropriately repaired to mitigate damaging erosion leading to structural failure.

French drains are a traditional solution to drainage that could be effectively implemented around Chautauqua structures. Assessment of the condition of historic retaining walls will determine the extent of repairs needed to a) protect these features, b) prevent slope movement, and 3) determine ways to improve the flow of surface water across the campus.

Infrastructure

UTILITIES

STORM WATER

Recommendation

F - Assess and repair foundations

The age of the buildings at Chautauqua, combined with modifications to the buildings and structures over time, have increased the vulnerability of many foundations to flood activity.

The Infrastructure study group recommended doing a condition assessment of all foundations to assess their structural capacity and ability to withstand flood, and find ways to redirect flow away from buildings during precipitation events.

Infrastructure

UTILITIES

WASTEWATER

The City of Boulder provides sanitary sewer service in the Chautauqua NHL District. The system generally flows south to north through vitrified clay pipes. The City of Boulder recently lined most of Chautauqua's aging pipes as part of a citywide rehabilitation program, restoring their structural integrity.

The pipes in this area are primarily 6", except for the local collector pipe along Wild Rose Road, which is 8". City standards no longer allow the installation of 6" lines due to difficulties associated with cleaning, inspecting, and trenchless repair of pipes smaller than 8".

While Chautauqua's pipes do not meet City of Boulder current design standards, they have adequate capacity for the 25-year service goal established for the wastewater system.

The City's manhole rehabilitation program is also evaluating and ranking manholes throughout the entire city and prioritizing assets. Some of the manholes in Chautauqua will be rehabilitated as they move up the priority list.

Infrastructure

UTILITIES

WASTE WATER

Recommendation

A - Replace Selected Sanitary Sewer Lines

Replacement of 6" versus 8" pipes will be addressed over time as the City upgrades its lines at Chautauqua, but should remain a priority. Ensuring that Chautauqua meets all maintenance requirements is important as visitation and use of the site continues to grow.



UTILITIES

WATER SUPPLY

Recommendation

B - Install new water supply line along Lupine Lane

While there are no significant issues with water supply, there is potential to improve service to the south, or upper end, of the property.

A new supply line along Lupine Lane would supply better water pressure to residents along Goldenrod, south of Aster Lane and Boggess Circle. This would add greater reliability for these residences and reduce the dead-end mains in the system.

Infrastructure

UTILITIES

DRY

Dry utilities include gas service, broadband service, and electricity. Xcel Energy provides gas service to Chautauqua. This service will remain intact until Chautauqua is 100% electrified. As cottages and public buildings are electrified, the existing gas service will be replaced, requiring ongoing coordination with the City of Boulder and Xcel Energy.

Recommendation

A - Enhance broadband service

While broadband is not considered a traditional sustainability issue, it is central to the long-term viability of the Chautauqua NHL District. Education and learning are at the heart of the Chautauqua movement and high-speed, reliable broadband is critical, not only to meet the educational goals of the site, but also to ensure that residents and visitors have what is an expected modern amenity.

Additionally, broadband is now a safety requirement as first responders and fire crews utilize Internet connections for real-time mapping and field communications. The infrastructure group recommended that Chautauqua work with local providers and the City of Boulder to determine existing barriers to improving onsite internet service.

Matters related to energy sources, generation, storage, and conservation are a principal focus for all Chautauqua NHL District stakeholders. Discussions among CCA, the City, and Xcel Energy are focused on a long-term strategy to ensure that energy goals for the site are met.

At the core of these discussions is the transition of Chautauqua to a zero-emission, renewable energy-based site. As a part of this transition, current and future vulnerabilities must address both energy supply and energy consumption.

The Energy group analyzed how sustainable and resilient energy systems could be incorporated into future Chautauqua operations. These systems include three related areas: energy consumption patterns; energy generation, distribution, and reliability; and how alternative energy supplies could mitigate existing risks and vulnerabilities.

The goals of the Energy Study Group also include the reliability of the energy system which is becoming a greater issue of concern with the projection of more extreme weather events as well as the aging of the existing system.

The Energy Group identified the following goals:

- Increase reliability
- Improve energy efficiency throughout the site
- Evaluate possibilities for undergrounding existing overhead power lines
- Explore carbon-neutral, 100% renewable energy sources, possibly through on-site or off-site solar generation and a microgrid
- Mitigate fire risk
- Decarbonize through electrification of buildings
- Maintain aesthetics of historic campus

ENERGY INFRASTRUCTURE

Recommendation

A – Create looped distribution system

Improving the reliability and overall resilience of the electric system at Chautauqua is a key priority. Xcel currently serves Chautauqua through a single supply line from Baseline Road, which means any time the existing feeder serving Chautauqua has an outage or power quality issue, the entire site (and other Boulder residences on the same feeder) lose power.

Creating a redundant, or “looped system,” would create a second feeder connecting to the neighborhood east of Chautauqua, increasing the reliability of Chautauqua’s electric distribution system. While both feeders originate from the same medium voltage feeder line, it is unlikely that both lines would fail simultaneously.

ENERGY INFRASTRUCTURE

Recommendation

B – Underground utilities

Undergrounding the electric distribution system at Chautauqua will have many benefits, including enhanced reliability, improved aesthetics, and fire protection. The main onsite distribution system could be undergrounded with support from the City's 1% Fund.

In addition to the main system, a system of lateral lines to connect the distribution system to individual buildings is required. The cost of the lateral lines, as well as additional upgrades to accommodate the underground connections at each building and cottage, are not covered by the 1% Fund.

ENERGY DEMAND

Recommendation

A - Improve building efficiency

Reducing demand for energy is a key component of a comprehensive approach to energy systems management. Chautauqua has implemented programs to improve building efficiencies by reducing heating and cooling demands for many years, but opportunities still exist for improving building efficiencies and for reducing heating and cooling loads.

These efficiencies, including air sealing, insulation, and ventilation management can be explored over time and should be linked to Chautauqua's electrification goals so new HVAC systems can be right sized for anticipated demand. Xcel Energy incentives can be leveraged to support these efforts.



ENERGY DEMAND

Recommendation

B – Electrify buildings

One of the key initiatives required for large-scale decarbonization is the “electrification” of building loads. Currently, about 74% of annual energy use comes from methane gas. The most viable and sustainable replacement for this energy source is electricity from an increasingly renewable grid, including onsite and offsite solar.

The Energy study group recommended exploring opportunities and implementing plans to shift to all-electric energy use at Chautauqua, including building HVAC systems, domestic hot water, cooking, and other energy-loads such as landscaping equipment, maintenance vehicles, and transportation to and from Chautauqua (e.g., Park-to-Park shuttle) to minimize vehicle emissions and site impact.

Electrification of buildings includes replacing furnaces and boilers with heat pumps, replacing gas water heaters with heat pump water heaters, and replacing gas cooking with induction cooking. Electrifying buildings, combined with improved efficiency measures, onsite solar, electrification of vehicles, and Xcel’s efforts to decarbonize the larger grid could result in a 70% reduction in greenhouse gas emissions over the next five years.

Beyond reducing greenhouse gas emissions, eliminating gas use improves indoor air quality, the risk of carbon monoxide (CO) and gas exposure, and fire. Electrification at Chautauqua would be phased in and will require collaboration between the City of Boulder, CCA, the restaurant operator, and the private cottage owners.

Priority buildings should be those with high gas usage or those with aging equipment and the CCA/City owned buildings should lead this effort. Private cottage owners will be encouraged, but not required, to convert systems as they require replacement.

ENERGY GENERATION

Recommendation

A – Look for opportunities for rooftop solar

Preliminary estimates suggest potential for 100-200 KW using photovoltaic (PV) panels on rooftops within the Chautauqua NHL District. This supply would meet approximately 10-20% of the site's annual electrical load after electrification. To determine the actual practicality of putting PV on selected rooftops, feasibility assessments should be conducted on the Auditorium, the Dining Hall, Academic Hall, Columbine Lodge, the Picnic Shelter, and selected unshaded cottages.

These assessments would determine the structural capacity of the buildings to accommodate additional roof loads. In some cases, buildings may also need structural upgrades to accommodate PV systems. The location of solar arrays in the Chautauqua NHL District must also be considered in the context of the Secretary of the Interior's Standards for Historic Preservation and Boulder's historic preservation design guidelines. The Secretary of the Interior's Standards recommend a single solar array near, but not within, a historic campus versus roof-mounted solar collectors on historic buildings. Site-mounted collectors inside or next to a historic campus are a possible alternative to roof-mounted panels.

Some flexibility should be exercised provided PV panels do not damage the building/structure, are reversible, and are mounted as inconspicuously as possible.

ENERGY GENERATION

Recommendation

B – Consider PV panels on the reservoir

For many years, Chautauqua and the City have discussed adding PV panels to the roof of the reservoir located on the Enchanted Mesa above Chautauqua.

Preliminary studies for this location show the entire 500 KW pre-electrification load demand for the campus could be accommodated by a reservoir rooftop array.

While the reservoir, which sits on City of Boulder Open Space property, may prove a viable near campus option, the challenges of permitting, costs, and making connections to Chautauqua's Xcel meters are significant. This option should be explored in parallel with the other aspects of energy planning.

ENERGY GENERATION

Recommendation

C – Consider offsite solar

As described above, the preliminary estimate of onsite solar potential is about 100-200 KW, which would accommodate only a portion of the site's energy demand. To meet the remainder of its energy needs, Chautauqua should either identify an existing solar garden or partner with a developer to create a new array and subscribe to the energy produced at that site.

If the reservoir above Chautauqua is developed as an "offsite source" and connected to the Xcel grid, CCA could subscribe to that local array. In addition, the State may soon allow for self-developed offsite arrays that can be virtually connected to a customer bill (i.e., Virtual Net Metering). This option should be considered as part of the offsite renewable energy strategy to be developed as a next step of this larger process.

Fire & Heat

The Chautauqua NHL District is located within the City of Boulder urban/wildland interface and consists primarily of wood buildings, many of which are over one hundred years old. The proximity of buildings, largely constructed of wood, which is now old and dry, provides a ready source of fuel for fire.

Although Chautauqua has never been directly affected by wildfire, the risk is ever present. The south and west sides of the campus face directly onto open space where the risk of wildfire fanned by prevailing west winds poses a continuing threat. Moreover, the Chautauqua 2020 Vulnerability Assessment projects wildfires to double over the next two decades because of climate change, further highlighting the need to mitigate this risk at Chautauqua.

The Fire and Heat Study Group focused on developing options and making recommendations for protecting the irreplaceable buildings, structures, objects, and natural features that make up the Chautauqua NHL District. The goals of the group were broad in nature, addressing both fire prevention and fire suppression technologies. The group was concerned with both protection of the campus and buildings from fires originating on campus and protection of the site from wildfire originating in the open space.

Fire & Heat

The Fire & Heat Group identified the following goals:

- Take immediate action, on the part of CCA and private cottage owners, to reduce fire hazards and create defensible spaces around structures and along the perimeter of the campus
- Develop and implement a site-specific fire mitigation plan
- Increase collaboration with surrounding land managers
- Work with City and County Fire-Rescue teams and forest managers to reduce risk of wildland fires
- Explore and implement new technologies for fire mitigation and suppression
- Improve resilience of buildings given changing climate projections
- Become a demonstration and education site for fire mitigation at other historic sites

Fire & Heat

BUILDINGS

As documented in the Chautauqua 2020 Vulnerabilities Assessment, wood and timber are the prevailing building materials at Chautauqua, presenting significant wildfire challenges. In addition, the buildings and structures at Chautauqua have been subjected to the arid Front Range climate, extreme temperature swings, and winds for over 100 years, damaging the wood and exposing the buildings to significant wildfire risk.

The recommendations presented here address mitigating the risk of fire without adversely affecting the historic and natural character of Chautauqua. Chautauqua has evaluated a variety of approaches for protecting Chautauqua's wood and timber buildings, ranging from clearing fuel in and around the campus, to applying fire-resistant exterior coatings, to sprinkling buildings. The reality, however, is that hardening the Chautauqua NHL District to the threat of fire without adversely affecting its historic character is a challenging task that will likely require multiple, holistic solutions.



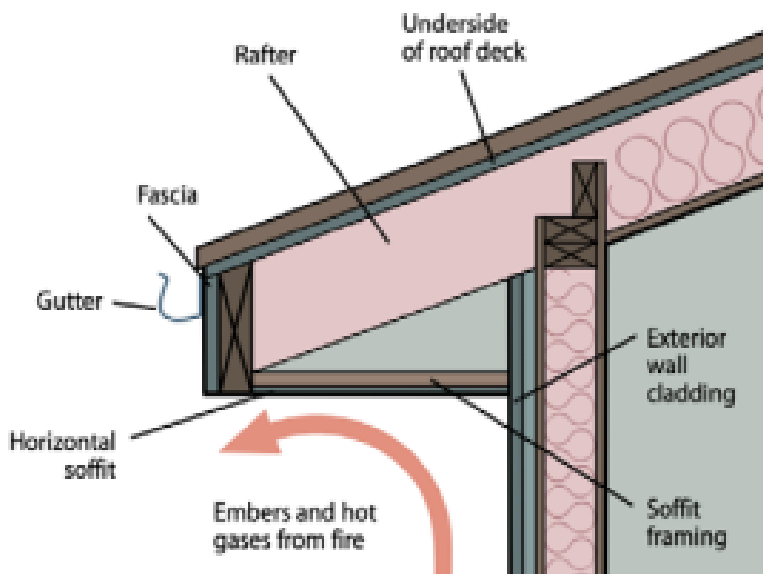
FIRE PREVENTION

Recommendation

A – Protect eaves

Windborne embers, convective heat, and radiant heat can be trapped under overhangs and in the upper portion of exterior walls where they can easily ignite. Once an eave, overhang, or soffit has ignited, fire can spread onto the roof, into the attic, or to the exterior walls. One recommendation is to protect the eaves by enclosing the overhang.

Enclosing the overhang reduces the risk of fire expanding into the attic or onto the roof of the structure. Additionally, this approach has minimal impact on the effectiveness of the eaves with respect to extreme precipitation or heat. The primary concern, however, is that open eaves are a characteristic of the buildings at Chautauqua and that enclosing the eaves will change the historic character of the structures.



Detail of protecting open eaves against fire.

FIRE PREVENTION

Recommendation

B – Install active fire suppression systems in public buildings

Chautauqua has several large public historic buildings, including the Auditorium, Academic Hall, Community House, and the Dining Hall. While these buildings currently have sprinkler systems, there are newer, less destructive, active fire suppression systems available, including mist-based suppression systems. Mist-based systems activate earlier and expel a minimal amount of water under high pressure through sprinkler heads. The system minimizes damage by enveloping the emerging fire in a fine mist while using significantly less water. The result is less water damage to the space, an important consideration for historic preservation. In addition, waterless gas-based systems are often used in areas where electrical equipment is utilized on a regular basis. These systems are currently being installed around the world in many vulnerable heritage sites.

The primary benefits of newer fire suppression solutions include minimizing water damage and increasing fire resiliency. These systems can also be installed with minimal impact to buildings. The primary concerns center around cost and protection of the wood materials, depending on which solutions are selected. While many foams and gases are gaining popularity, not all are suitable for Chautauqua. Different suppression systems could be appropriate for different buildings, but the selection of any system must consider the impact of that system on wood materials.

FIRE PREVENTION

Recommendation

C – Perform structure ignitability assessment

The two primary determinants of a building's ability to survive a wildfire are its ignitability and the quality of the surrounding defensible space. Together, these two factors constitute the ignition zone. The likelihood that building materials will ignite during a wildfire is known as structural ignitability. The Fire and Heat study group recommended that Chautauqua do an ignitability assessment to determine the level of risk associated with each building on the site. The ignitability assessment includes an evaluation of roofing materials, siding, screening materials, exposed rafters and eaves, and windows, as well as recommendations for mitigating identified risks. The benefit of this recommendation is increased awareness of the risk associated with each building. The primary concern surrounding this recommendation is the question of how to encourage/enforce mitigation measures.



Defensible zones surrounding structures is a basic element of fire protection.

FIRE PREVENTION

Recommendation

D – Improve visibility of cottage numbers

The cottage numbers at Chautauqua have evolved over time. Unfortunately, the current numbering system makes it difficult for emergency vehicles to easily find specific properties in emergency situations. Additionally, not all cottage numbers are visible from the street making it potentially difficult for emergency vehicles to respond quickly. Creating a logical cottage numbering scheme and making addresses easily visible from the street and from the rear will help emergency vehicles locate structures during emergency events. The group recommended that Chautauqua adhere to the following National Fire Protection Association recommendations:

NFPA 1 Fire Code 2018: New and existing buildings shall have approved address numbers placed in a position to be plainly legible and visible from the street or road fronting the property. Address numbers shall be a minimum of 4 inches (100 mm) high with a minimum stroke width of 1/2 inches (13 mm).

In addition, the group recommended Chautauqua follow the American Planning Association guidelines for creating coherent numbering systems for entire developments.

FIRE PREVENTION

Recommendation

E – Install fire hydrant on Boggess Circle

With the increased risk of wildfires, ensuring available water pressure to fight potential cottage fires is essential. As such, the group recommended installing a new fire hydrant at the terminus of the 8" waterline on Boggess Circle at the southwest side of the site. Installing a new fire hydrant will increase fire protection for cottages at the southwest part of the leasehold. While this effort requires coordination with the City of Boulder, the level of coordination and cost is minimal.

FIRE PREVENTION

Recommendation

F – Reduce localized debris

Intense winds at Chautauqua blow debris around the site where it collects in areas where structures break the airflow. These areas are mainly near large public buildings that break the airflow and that provide protected collection areas, including at the base of the Auditorium and Dining Hall in corners and low lying areas. In a wildfire scenario, a single ember may land in a collection of leaves and debris and easily ignite the fuel. This small fire can rapidly move up the side of the building and result in a significant structure fire.

The solution is to utilize landscaping techniques to turn a collection area into a feature that minimizes collection of debris. Specifically, fire resistant plants such as succulents can be planted together with open structure shrubs in a rock covered planting bed sloping from back to front. Such beds both break the wind and reduce collection opportunities.

Landscaping solutions reduce the threat to public buildings without requiring additional maintenance after every wind event. Additionally, this option enhances the aesthetics of the site by eliminating “dead” areas where debris collects, making the area unsightly until the debris is cleared. The area can also be a demonstration of how to incorporate native, fire-resistant plants to reduce wildfire threats.

The primary concern with this recommendation is the cost associated with initially installing these areas, as well as the investment to establish and maintain planting areas as they get established during the first year. Additionally, changes to landscaping may require Landmark Alteration Certificate review.

FIRE PREVENTION

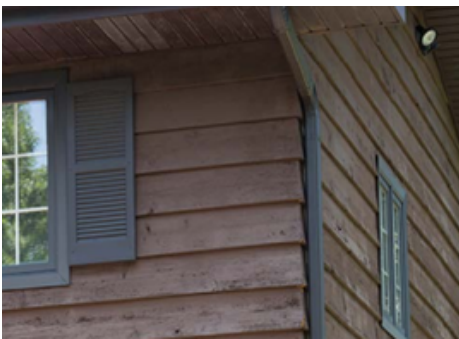
Recommendation

G – Improve fire retardancy of wood and timber buildings

While the weathering of wood over time and the resulting patina imparts historic character to many buildings at Chautauqua, desiccation of the wood matrix poses a significant threat of fire. A comprehensive analysis is needed to determine whether wood alternatives or treatments could enhance the resiliency of the buildings while retaining their historic character and meeting preservation guidelines.

Wood treatments, fire resistant coatings, and fire-retardant siding materials may be suitable if they do not cause deterioration or change the appearance of the wood or alter the materials in ways that may adversely affect the historic character of the district.

Exploration of these materials and their application should continue as a proactive step toward hardening the Chautauqua NHL District against the ever-present threat of fire.



Alternative materials such as cement board could improve fire protection if they meet preservation guidelines.

FIRE PREVENTION

Recommendations

H – Create defensible spaces

The most effective defense against fire is to create defensible spaces around buildings and the campus perimeter. This perimeter includes an ember-resistant zone extending five feet from the structure, another zone extending 30 feet that separates other structures such as decks or picnic areas with fire resistant plants, and a zone that extends from 30 feet to 100 feet from the structures which is kept clear of dead plants, trees with dead limbs, and any other elements that provide fuel to an encroaching fire.

Defensible zones around building perimeters are a key element in an integrated fire protection system, but are especially important at Chautauqua, which is surrounded by open space on three sides - presenting an increased wildfire threat.



A defensible perimeter surrounding structures is a basic element of fire protection.

Vegetation

Originally, the area at the Chautauqua NHL District was high prairie grassland with very few trees. Historic photos demonstrate that Chautauqua is naturally a high-prairie ecosystem with grasses and low-growing plants. Over the past 120 years, a more formal and social-cultural landscape has evolved, including non-native trees and plants, grasses, gardens, and lawns.

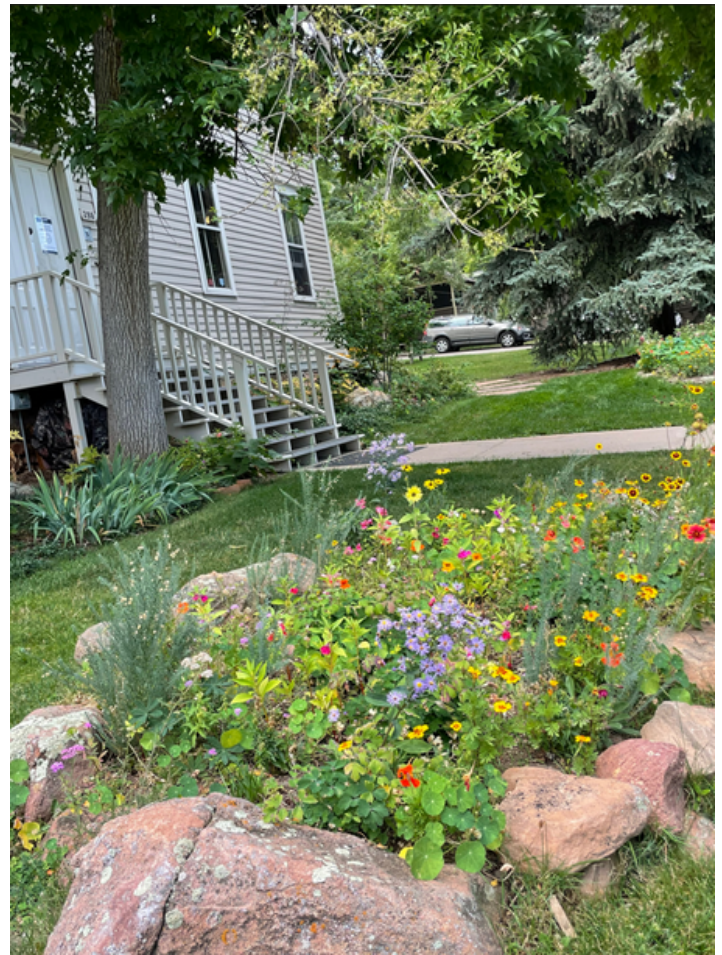
The ecological aspects of the site, especially its vegetation, are likely to be affected by climate change, leaving the current landscape environment unsustainable. With the threat of wildfire and drought, the vegetation palette at Chautauqua needs to be reexamined and vegetation replacement strategies should be considered and should be closely coordinated and integrated into the Chautauqua Design Guidelines.

Vegetation, often overlooked as a priority, plays a key role in meeting other strategic objectives, including reducing fuel for wildfires and absorbing storm water runoff. The Vegetation Study Group goals focus on changing existing perspectives of vegetation at Chautauqua in terms of appearance and functionality.

Vegetation

The Vegetation Group identified the following goals:

- Reintroduce native plants to increase sustainability, with particular emphasis on water wise and drought-tolerant plant material
- Develop and install fire wise landscaping throughout campus, with particular focus on the transition zone between the Chautauqua NHL District and open space
- Consolidate CCA and COB landscape plans to avoid duplication
- Serve as an educational site to promote fire wise and water wise techniques. Vegetation plays a large role in the long-term sustainability and resilience of Chautauqua.



Vegetation

GREEN INFRASTRUCTURE

Green infrastructure refers to the use of natural materials to enhance or replace engineered solutions to infrastructure requirements. It also refers to the use of vegetation to enhance the resilience of a site. At Chautauqua, green infrastructure solutions focus primarily on enhancing drainage solutions.

RECOMMENDATION

A – Expand use of drought-resistant plants

Chautauqua should adopt and implement a vegetation strategy that focuses on drought-resistant plants that reduce fuel for wildfires. The current use of individual planting palettes developed by residents creates inconsistency in terms of fire protection. Native plants such as columbines, asters, and blue avena grass are examples of attractive plants that are drought-resistant and can form a key part of a wildfire resistant planting palette.

The landscape palette at Chautauqua should be amended to include these types of drought-resistant plants and all residents should be encouraged to participate in this effort. In addition, it is important to remove combustible vegetation that could provide fuel for fires.

Aesthetic changes to the historic character of the Chautauqua NHL District should be considered as part of this approach and all changes should be consistent with the Secretary of the Interior's Standards for Historic Preservation and integrated into Chautauqua's Design Guidelines.



Vegetation

GREEN INFRASTRUCTURE

RECOMMENDATION

B – Install local landscape solutions

Rain gardens and bioswales are effective solutions to localized water management. The key components of a rain garden are a bermed area to hold water, the use of native plants with deep roots, and the placement of downspouts to guide water into the garden. Water from buildings, structures, and surface runoff can be directed to a rain garden where plants absorb the water through the long roots and excess water is held for later use. Rain gardens also address erosion issues.

Bioswales are storm water runoff conveyance systems that provide an alternative to storm sewers. They can absorb low flows or carry runoff from heavy rains to storm sewer inlets or directly to surface waters. Bioswales improve water quality by filtering the large storm flows they convey. At Chautauqua, bioswales should be considered in the larger public areas as well as along streets. The combined benefits of stormwater management, reduced water consumption, and less erosion point to the importance of incorporating green infrastructure solutions into a master plan for managing water at Chautauqua.



Rain gardens are an easy solution to assist in controlling drainage as well as enhancing the landscape around structures.

GREEN INFRASTRUCTURE

RECOMMENDATION

C – Replace Kentucky bluegrass

Kentucky bluegrass is a favorite among homeowners; it is fast-growing, creates a lush appearance, and provides sought after play and picnic areas. The grass, however, has shallow roots, requires significant water, and does not tolerate climate extremes well. As such, it has little value in terms of water management and erosion control, the primary focal points for green infrastructure at Chautauqua.

The Vegetation Study Group recommends replacing Chautauqua's Kentucky bluegrass with native grasses such as buffalo grass and blue grama grass, beginning with replacing grass between the cottages, along the sides of the roads. This change would significantly benefit the site because grasses with deep roots slow the movement of water, prevent erosion of soils, and enhance new growth in areas where it is difficult to get bluegrass to grow

Vegetation

STATUS

RECOMMENDATION

A – Status Update

The many trees and shrubs on the Chautauqua campus are a unique component of Chautauqua’s character. However, as insect infestations and drought conditions increase, along with the number and intensity of hotter days, the condition of these trees and shrubs has been negatively impacted.

The Vegetation Study Group recommends surveying trees and shrubs to determine their health and ability to survive changing conditions. Of particular concern are trees and shrubs that have been stressed by recent weather extremes and insect infestations. With this information, Chautauqua can update its vegetation plan with consideration for projected climate impacts.



EDUCATION

RECOMMENDATION

A – Education Program

Chautauqua should build on the proposed vegetation changes by collaborating with the City of Boulder to develop an educational program focused on wildfire-resistant plantings and green infrastructure.

As wildfires become increasingly common, individuals and organizations are looking for guidance on how to protect their properties from wildfire. The recommended changes at Chautauqua provide an opportunity to create an extremely visible, model program for those living in the western United States.

The Governance Group identified the following goals:

- Evaluate local and regional models for establishing a Sustainability District for Chautauqua
- Evaluate methods for securing financing to undertake critical sustainability and resilience improvements, such as the potential for a general improvement district
- Establish inclusive, collaborative, and efficient decision structures
- Retain the historic priority of Chautauqua as a place of learning. Chautauqua is at a critical juncture in terms of implementing a broad vision for climate resilience.

Governance

The multiple stakeholders associated with the Chautauqua NHL District, as well as the unique position of the site within the City of Boulder governance structure, creates both challenges and opportunities in terms of both short- and long-term decision making.

While previous efforts, including the Guiding Principles for Chautauqua, helped clarify joint decision-making at the site, creating a comprehensive governance plan for Chautauqua requires a collaborative effort between Chautauqua, various City departments, and other stakeholders.

The Governance Study Group focused on creation of a new governance structure that addresses Chautauqua's unique vulnerabilities and opportunities at a District level, rather than at a city level, and that enhances problem-solving, management, decision making, and innovation.

District-level governance would focus on the long-term financial and management stability of the Chautauqua NHL District.

SUSTAINABILITY & RESILIENCE DISTRICT

RECOMMENDATION

A – Develop a formal agreement

The Governance Study Group recommends creating a formal agreement between the City of Boulder and the Colorado Chautauqua Association to guide decision making about implementation of the Sustainability and Resilience Strategy. In addition to addressing oversight and decision-making authority, the formal agreement should establish lines of communication between the City and Chautauqua, as well as participation on relevant committees.

SUSTAINABILITY & RESILIENCE DISTRICT

RECOMMENDATION

B - Create a Sustainability and Resilience District at Chautauqua

The development of a Sustainability and Resilience District is a novel approach to addressing both the governance and revenue issues facing Chautauqua. As highlighted in this report, there are several potentially high-cost additions and renovations needed at Chautauqua to ensure long-term sustainability and resiliency at the site.

Designating the Chautauqua NHL District as a Sustainability and Resilience District, modeled after improvement districts, library districts, historic districts, and coastal districts, for example, would provide a helpful decision-making and regulatory structure to support Chautauqua's strategic sustainability and resiliency objectives.

Like existing municipal overlay districts, designating Chautauqua as a Sustainability and Resilience District could also allow the City and Chautauqua to address revenue needs through specific fees such as facility fees, resident fees, or even a dedicated tax. Multiple constituencies would need to agree to this recommendation, and legislative and voter input would be required if a tax of any kind is involved.



PHASE II

Phase I of the S&R project at Chautauqua concludes with a clear strategy and the recommendations outlined in this report. Phase II of the project, will include detailed plans for implementing these recommendations. These plans will require coordination among CCA, COB department heads, consultants, and planners who are versed in the technicalities of managing complex projects, overseeing budgets, and securing needed funding.

Phase II, which focuses on implementation of the strategy, will include practical, prioritized work plans for completing the many projects identified in Phase I.

Certain elements of planning for Phase II implementation are currently underway, including planning related to undergrounding utilities, wildfire prevention, and vegetation initiatives to reduce runoff. For more complicated projects requiring coordination between multiple parties and/or departments, CCA is discussing how to best implement S&R initiatives to minimize costs and disruptions to the site. While still in the early stages of discussion, these recommendations will soon shift to specific, practical, prioritized work plans needed to carry out Phase 1 recommendations.

Phase II - Implementation

Phase II

The success of Phase II implementation will depend on project management groups consisting of experts, engineers, and planners who are well-versed in the technicalities of complex work plans, costing, and fundraising. These project management groups will be responsible for implementing the recommendations of the five study groups and for developing a model of national historic preservation, city planning, and climate science practice in a historic district.

In addition to relying on recommendations for the five study groups, it will be important for leadership to rely on existing and still-relevant engineering reports, including:

1. A Comprehensive Environmental Sustainability Plan for the Colorado Chautauqua, prepared by Architectural Energy Corporation, September 2008
2. Conceptual Infrastructure Master Plan (CIMP) prepared for CCA by JVA Consulting Engineers and Ludvik Electric, December 2014. Recommends an underground conduit system along streets that would accommodate power lines, communication cables, local control wiring, and future technology systems. Provides a preliminary assessment of infrastructure needs, engineered plans, estimated costs, and recommended phasing.

The sustainability and resilience solutions developed for the Chautauqua NHL are intended to provide educational opportunities, demonstration projects, and case studies that will benefit others who manage local and national historic sites, city planners, climate scientists, and the general public.