

Comparing Mitigation Alternatives at the
SANTA BARBARA MUSEUM OF NATURAL HISTORY:
Ecological Outcomes & Policy Implications



Final Report – March 21, 2014

*A Group Project submitted in partial satisfaction of the requirements for the degree of
Master of Environmental Science and Management
for the Bren School of Environmental Science & Management*

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SIGNATURE PAGE

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As authors of this Group Project report, we are proud to archive this report on the Bren School's website such that the results of our research are available for all to read. Our signatures on the document signify our joint responsibility to fulfill the archiving standards set by the Bren School of Environmental Science & Management.

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The mission of the Bren School of Environmental Science & Management is to produce professionals with unrivaled training in environmental science and management who will devote their unique skills to the diagnosis, assessment, mitigation, prevention, and remedy of the environmental problems of today and the future. A guiding principal of the School is that the analysis of environmental problems requires quantitative training in more than one discipline and an awareness of the physical, biological, social, political, and economic consequences that arise from scientific or technological decisions.

The Group Project is required of all students in the Master of Environmental Science and Management (MESM) Program. The project is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Group Project Final Report is authored by MESM students and has been reviewed and approved by:

Matt Potoski

March 21, 2014

ACKNOWLEDGEMENTS

The Research Team would like to thank the Santa Barbara Museum of Natural History's entire staff and other associated or contracted individuals for their continued support, contribution and advice throughout the project, especially: **Luke Swetland, Barbara Barker, Gary Robinson, Karl Hutterer, Paul Collins, Mark de la Garza, Melodee Hickman, Susan Van Atta, Susanne Elledge,** and **Wayne Ferren.**

The Team also extends thanks to the various professionals who were a part of our interview and research process, including **Bret McNulty, Rosie Dyste, Glenn Russell, Jay Higgins, Walter Mark, Mike Walgren, Jill Murray,** and **Barbara Shelton.**

We would like to thank our Bren faculty advisor, **Matthew Potoski,** and our external advisors, **John Jostes** and **Frank Davis,** for their intellectual and professional guidance throughout the project.

Finally, we would like to thank the Bren School of Environmental Science & Management for providing the administrative and academic setting and services required by the Group Project process.

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ACRONYMS USED

BA	Biological Assessment
BMP	Best Management Practice
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CTCC	Tree Carbon Calculator
EIR	Environmental Impact Report
ELI	Environmental Law Institute
ELMS	Ecological Lift Mitigation Strategy
EPA	Environmental Protection Agency
ESCP	Ecosystem Service Conservation Plan
GHG	Green House Gas
HCP	Habitat Conservation Plan
HROSMP	Habitat Restoration and Open Space Management Plan
HUC	Hydrologic Unit Code
MBRT	Mitigation Banking Review Team
MRCP	Multi-Resource Conservation Plan
NCCP	Natural Communities Conservation Plan
NEPA	National Environmental Protection Act
NMFS	National Marine Fisheries Service
NRCS	National Resource Conservation Service
OC	Orange County
PVPLC	Palos Verdes Peninsula Land Conservancy
RAMP	Regional Advanced Mitigation Planning
SMS	Standard Mitigation Strategy
TMDL	Total Maximum Daily Load
USFS	United States Forest Service
USGS	United States Geological Survey
VFS	Vegetated Filter Swale

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ABSTRACT

State law requires local permitting agencies to develop and enforce mitigation requirements for environmental impacts from development projects in California. Santa Barbara mitigation programs, such as native tree replacement, are easily implemented and do not require much time or money from agencies. However Santa Barbara mitigation fails to capture other important values for ecosystems, developers, and communities. To revitalize its Mission Creek campus, the SB Museum of Natural History proposed a multi-phase redevelopment plan that would have impacted native oak and sycamore trees and triggered Santa Barbara's typical 10 to 1 tree replacement mitigation requirement. This standard mitigation practice was compared to a Museum-proposed alternative across multiple criteria. The Museum's alternative outperformed the 10 to 1 mitigation practice in terms of ecological impact, policy alignment, economic costs, and outreach potential.

While more benefit is realized with the alternative strategy, further analysis shows that it is not a feasible or desirable programmatic solution for Santa Barbara. A review of additional, large-scale mitigation frameworks in California and local stakeholder interviews revealed examples of effective mitigation practices. Tools and mechanisms from these large-scale frameworks and results from the case study analysis inform recommendations for improving the current mitigation approach in Santa Barbara. A regional planning area, strategic mitigation site selection, a cross-jurisdictional oversight committee, an independent panel of scientists, mitigation banking, and broad stakeholder involvement will improve the existing process. This improved mitigation approach will result in better outcomes for ecosystems, developers, planners, and the community of Santa Barbara.

EXECUTIVE SUMMARY

The California Environmental Quality Act (CEQA) requires local permitting agencies to develop and enforce mitigation requirements for unavoidable, significant impacts from development projects in California. If sensitive habitat is degraded or destroyed, developers must act to compensate for those impacts. In Santa Barbara, mitigation can be characterized as on-site, reactive, in-kind, single species focused, and as using a short-term planning horizon. This approach makes specific mitigation requirements easy to implement and efficient for permitting agencies. Despite these advantages, mitigation fails to capture other important values for ecosystems, developers, and communities. Ideally, mitigation should: be regional and landscape level in scope, improve ecosystem function and process, be based on the best available science, reduce time and cost for both agencies and developers, be implementable and be economically efficient.

Mitigation in Santa Barbara fails to capture all the values it could, and imperfect outcomes result. The Santa Barbara Museum of Natural History case study illustrates this imperfect mitigation standard. In 2013, The Santa Barbara Museum of Natural History proposed a Bren School Group Project to 1) analyze the ecological and social outcomes of its Multi-phased Redevelopment Plan and 2) identify alternative policy tools that could improve mitigation in Santa Barbara.

The Multi-phase Redevelopment Plan would upgrade the Museum's facilities and surrounding woodland to better meet its mission to "inspire a thirst for discovery and a passion for the natural world." Located on a 17.7-acre property at the base of Mission Canyon, the Museum sees the Redevelopment Plan as an opportunity to better utilize its outdoor space to meet its educational and research goals. Upgrades were planned to address termite and water damage, the absence of loading and service areas, inadequate fire protection, facilities below contemporary museum standards, and limited space for education and exhibits.

A Biological Impact Assessment was conducted in anticipation of CEQA requirements. This review indicated that the Museum's redevelopment project would have significant environmental effects, resulting from removal or damage to 74 coast live oak and sycamore trees. The City of Santa Barbara Planning Commission would determine specific requirements for reducing or mitigating these environmental impacts. In cases similar to these, the current standard requires replacement of impacted native trees at a 10:1 ratio. The Museum's 6.2-acre woodland could not meet this standard mitigation ratio due to space constraints, but could serve as a medium to achieve more significant environmental benefit than simple tree replacement would achieve alone. The Museum's Redevelopment Project included a mitigation alternative that would combine tree replacement at a reduced rate in combination with several additional actions.

To inform the Museum's project plans and begin a review of the City of Santa Barbara's mitigation policy, the Group Project performed a comparative analysis of two strategies: a Standard Mitigation Strategy (SMS), based on current Santa Barbara practices, and an Ecological Lift Mitigation Strategy (ELMS) based on the Museum's alternate mitigation proposal. Political, Ecology, Economic, and Outreach Parameters were qualitatively and quantitatively assessed and used to compare the Strategies.

This comparison showed that significant tradeoffs exist between strategies, and that across a majority of Parameters, the ELMS has more positive outcomes than the SMS. The variety of Management Actions that comprise the ELMS provides additive benefits, which increase the number of educational opportunities available, habitat niches available for wildlife, and water quality discharge into Mission Creek. In total, the ELMS outperforms the SMS on 24 Targets, while the SMS outperforms the ELMS on 8 Targets.

The Museum Case Study demonstrates how native tree replacement can be limited in its ability to improve ecological function and process, whereas a suite of Management Actions may replace the ecosystem service benefits of native trees via different methods.

Building from the case study analysis, the Group Project explored mitigation and regional planning frameworks to identify tools for improving Santa Barbara mitigation. The frameworks explored were Regional Advanced Mitigation Planning (RAMP), Wetland Mitigation Banking, Natural Communities Conservation Plans (NCCP), Habitat Conservation Plans (HCP), and Lake and Streambed Alteration Permitting (LSA). Each framework was examined for how well it achieved or aimed to achieve the seven established 'ideal' mitigation values. The team then highlighted beneficial tools and mechanisms that the frameworks used to move toward the ideal values.

Synthesis of our case study analysis, interview feedback and exploration of alternative mitigation frameworks led to recommendations for improving Santa Barbara's mitigation process. Mitigation can be improved if an independent panel of scientists, a cross-jurisdictional oversight committee, and broad stakeholder involvement were used proactively to create regional goals and objectives for Santa Barbara. The development of a Multi-Resource Conservation Program (MRCP) would allow Santa Barbara County and City to implement these six key mechanisms and allow environmental mitigation in Santa Barbara to capture previously foregone important values.

The MRCP should look at natural resources on a regional level in terms of ecosystem function and process, and utilize mitigation banking, mitigation fees, and transfers of development rights to plan for and implement advanced, strategic mitigation. Santa Barbara's existing plans, such as the Urban Forest Management Plan, the Climate Action Plan, Community Plans, Watershed Action Plans, and the defunct HCP, can be used to inform resource and priority identification. Compensatory environmental mitigation could then be leveraged to fulfill comprehensive, proactive and strategic goals, where on-site mitigation is not feasible or where off-site mitigation would lead to economic efficiencies and greater benefits per dollar. For example, under an MRCP, Museum mitigation would have been strategically sited on or off-site to advance regional goals and it would focus on replacing ecosystem function rather than individual oak trees.

As the science of ecosystem services advances, the Ecosystem Services Conservation Program (ESCP) should build on and refine the MRCP. The advantage of the ESCP is that rather than focusing solely on habitats or natural communities, the program values environmental resources by their ecosystem services. Development impacts in resource areas should be evaluated in terms of ecosystem service impacts and should be the basis for exchange between impacts and mitigation. ECSP currently has no precedent; however, when impacts and mitigation are boiled down to their fundamental ecosystem characteristics and 'services', relationships can be found between seemingly dissimilar factors. For example, the hydrological benefits of trees could be mitigated through the ESCP with the creation of bioswales that replace lost hydrological ecosystem services in a shorter amount of time. However, the loss of other types of benefits from trees would need to be mitigated differently; weighing these different benefits as community values would be an important aspect of the ECSP.

The Museum case study illustrated and research confirmed that mitigation in Santa Barbara needs to be improved in order to capture more environmental and social values. The mechanisms for improvement were identified in other, more progressive mitigation frameworks and the team makes suggestions for initiating implementation in Santa Barbara.

OBJECTIVES AND SIGNIFICANCE

OBJECTIVES

1. Analyze the effectiveness of mitigation policy frameworks in Santa Barbara and identify mechanisms to improve the current process.
2. Conduct an independent analysis of the ecological, policy, economic, and outreach implications of two mitigation alternatives for planned development at the Santa Barbara Museum of Natural History.

PROJECT SIGNIFICANCE

Santa Barbara's current mitigation practices require relatively low cost and little time for agencies, are simple and are relatively easily implemented. However, several important values are not achieved and additional benefits are left unrealized. Developers, community members, agencies and the environment could benefit from improvements to the status quo. An in-depth analysis of mitigation in Santa Barbara using the Museum of Natural History as a case study confirms and quantifies the ineffectiveness of current practice. This independent analysis used a systematic approach that captured performance across a wider range of parameters than mitigation typically considers. These parameters covered a comprehensive range of environmental, policy, economic, and outreach subjects.

A review of existing alternative mitigation frameworks from around California illustrated the wide scope and variety of methods for conducting effective mitigation. No single alternative mitigation strategy achieves all values or maximizes benefit to every stakeholder; however, each alternative contains select tools and mechanisms that would improve Santa Barbara's existing process. The synthesis of tools and mechanisms into recommendations provide insight for policy makers, developers, community members, local planning authorities, permitting agencies, and environmental groups about how to better mitigate environmental projects. This research and analysis serves as a starting point for increasing environmental and social benefits realized from Santa Barbara's mitigation framework and projects.

PROJECT BACKGROUND

In California, when public or private developments are proposed, the California Environmental Quality Act (CEQA) requires a review of potential impacts to environmental resources. While closely related to the National Environmental Policy Act (NEPA), CEQA actually requires the avoidance or reduction of environmental impacts by implementing feasible alternatives or mitigation measures. CEQA seeks to limit degradation to important environmental resources from development in California. Under CEQA, each development project is reviewed to determine whether significant effects to environmental resources will occur. If effects are anticipated, then the developer must try to avoid the impacts, minimize the impacts and lastly, mitigate for those impacts categorized as unavoidable. While CEQA lays out the steps of the planning process, it does not dictate specific mitigation actions for any impact. Instead, specific actions are determined at the County or City level, on a project-by-project basis using guidance from General Plan elements. General Plans capture the overall goals and objectives of a county or city across multiple elements including, conservation, land use, circulation, open space, safety, noise, and circulation.

In Santa Barbara, environmental thresholds found in the General Plan documents inform mitigation. This framework results in mitigation that is project-by-project, on-site, reactive, planned with a short time horizon, and focused on single species replacement. These characteristics make the existing process easily implementable and reduces time and cost for agencies. However, mitigation is not based on the best available science, is not regional or landscape level in scope. Further, it does not improve ecosystem function and process or reduce time and cost for developers. Development projects must pass through this framework when attempting to mitigate environmental impacts in order to meet CEQA and local permitting requirements.

In 2009, the Santa Barbara Museum of Natural History sought to redevelop its campus, and began to evaluate its potential environmental impacts to anticipate mitigation requirements. Their redevelopment plan included: new exhibits, building remodeling and construction, woodland restoration, and upgrades to safety standards, among others. From these actions, it became apparent that approximately 70 trees would be removed or damaged in the process. Removal or damage to these trees would constitute a significant environmental impact under CEQA and trigger mandatory mitigation via the City of Santa Barbara's Tree Ordinance. Preliminary studies indicate that the Museum site does not have space for tree replacement at typically required replacement ratios (5:1 or 10:1 replacement), and so the Museum would be unable to fulfill standard mitigation requirements as currently practiced in Santa Barbara.

Subsequently, the Museum explored the possibility of alternate ecologically beneficial actions to supplement the maximum feasible on-site tree replacement ratio. The Museum proposed a Bren School Group Project in 2013, asking for a comparison of the standard mitigation requirement with their alternate proposal across relevant Ecology, Policy, Economic and Outreach Parameters and an evaluation of how Santa Barbara's compensatory environmental mitigation process could be improved.

CHAPTER 1 METHODOLOGY

GENERAL APPROACH

Meeting the project objectives required an interdisciplinary approach to analyzing mitigation policies and practices, and to identifying tools and mechanisms for improving Santa Barbara's existing framework.

We initially determined that existing mitigation in Santa Barbara was not effective. This was done by first characterizing mitigation practices in Santa Barbara, then comparing it with "optimal" mitigation outcomes. The optimal mitigation outcomes were defined by values pulled from literature review.

Next, the Museum was used as a case study to confirm that existing mitigation practices were producing suboptimal outcomes. The Museum was an ideal candidate for this case study because they are a developer attempting to mitigate significant and unavoidable environmental effects within Santa Barbara's current mitigation framework. In addition, the team was able to use the Museum's alternate mitigation strategy in comparison with the standard mitigation strategy. An analytic framework encompassing four Parameters was used to compare these two mitigation strategies.

In order to develop recommendations for improving mitigation practices, the team explored other mitigation frameworks from a variety of sources. Those that were relevant and applicable were selected, then reviewed for tools and mechanisms that could be applied to Santa Barbara. The final recommendation compiled these tools and mechanisms to produce a tailored mitigation framework for Santa Barbara.

POLICY ANALYSIS

To categorize and evaluate current Santa Barbara mitigation, a review of the literature and a series of interviews were conducted. Interviews were conducted with key stakeholder groups to assess the limitations of Santa Barbara's current mitigation policies, identify opportunities for improvement, and generate recommendations for an improved compensatory mitigation system. Stakeholders included County of Santa Barbara Planning and Development Department, City of Santa Barbara Community Development Department, a former City of Santa Barbara Planning Commissioner, developers, and biological consultants. Each interviewer was asked a standard suite of depending on their profession. Planners for the county and city were asked the same set of questions, while developers were asked another set. Questions for planners focused on relevance and limitations to current compensatory mitigation, ways for improving mitigation in Santa Barbara. Developer questions explored how mitigation affects development and ways for improving the current process. Example questions can be found in Appendix D.

Stakeholder interviews were combined with a review of General Plan Elements, past project EIRs, County and City planning documents, and academic literature. These interviews were conducted with key stakeholder groups to assess the limitations of Santa Barbara's current mitigation policies, identify opportunities for improvement, and generate recommendations for an improved compensatory mitigation system. Stakeholders included County of Santa Barbara Planning and Development Department, City of Santa Barbara Community Development Department, a former City of Santa Barbara Planning Commissioner, developers, and biological consultants. Past project EIRs served as case studies illustrating recorded mitigation requirements for development similar to the Museum's such as the Miramar Beach Resort Project (2008). Studies focusing on a variety of mitigation approaches and challenges, such as the Environmental Law Institute's *Practitioner's Handbook* and Rockwood's

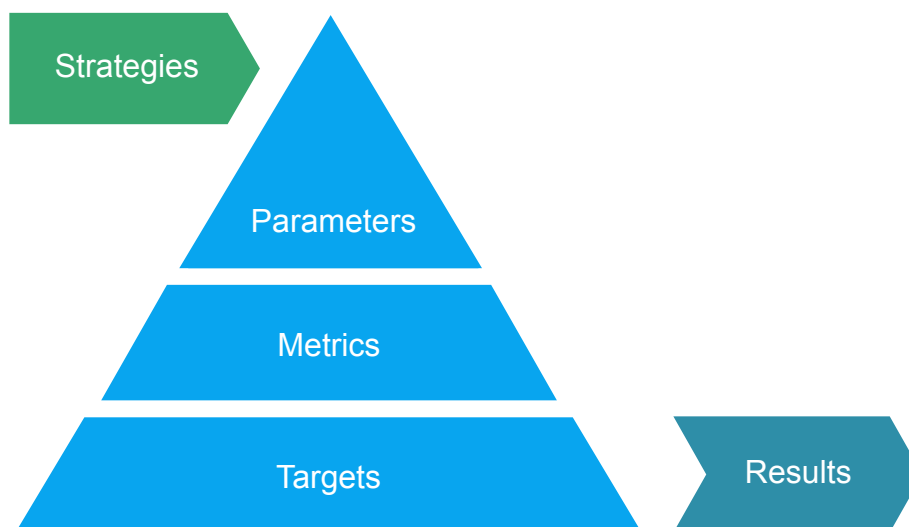
Landscape Planning for Biodiversity, identified common tradeoffs and articulated goals for compensatory mitigation (ELI, 2011; Rockwood, 1995). From this literature review and stakeholder interview process, seven values were identified that mitigation should try to maximize. These seven values (landscape and regional in scope, based on best available science, improves ecosystem process and function, implementable, reduces time/cost for agencies, reduces time/cost for developers, and economic efficiency) became integral to the evaluation criteria used for exploring alternative mitigation frameworks.

Frameworks that were 1) already implemented in CA and 2) progressive designs for mitigation were evaluated to find mechanisms for improving mitigation in Santa Barbara. A literature review of government documents, and academic research highlighted Regional Advanced Mitigation Planning, Natural Communities Conservation Plan, Stream Bed Alteration Permitting, and Mitigation Banking as policies that Santa Barbara could borrow tools from. Frameworks were characterized across three categories: Mitigation Elements, Realized versus Unrealized Values, and Relevant Mechanisms. Mitigation elements are broad descriptions of mitigation such as Off-site or Long-term planning horizon. Mechanisms are specific components of the framework that could be applied to Santa Barbara, like independent panel of scientists or banking. Realized versus unrealized values characterizes how well the mechanisms and elements capture the seven previously identified values of mitigation. Extensive literature review of academic papers, interviews and policy guidance documents informed the analysis of each framework. Comparison between Santa Barbara mitigation and alternative frameworks then revealed what tools and mechanisms could improve mitigation.

MUSEUM CASE STUDY

In order to effectively compare Santa Barbara's standard mitigation strategy with the Museum proposed mitigation strategy, the team created an analytic framework that encompassed both ecological and social outcomes. The strategies were broken into individual Management Actions, which were then evaluated across four Parameters: Ecology, Policy, Economic, and Outreach. These Parameters were further distilled into Metrics, and then Targets (see Figure 1.1 below).

Figure 1.1. Museum Case Study Analytic Framework



The alternate mitigation strategy was proposed by the museum, with the Management Actions outlined by their campus redevelopment plan. The standard mitigation strategy is based on practiced mitigation in

Santa Barbara, which also guided the development of Management Actions for this strategy. The Ecology, Policy, Economic, and Outreach Parameters were developed with the assistance of the Museum. Finally, the team conducted a literature review to assign the appropriate Metrics for each Parameter.

Since the four Parameters encompassed different disciplines, various methods were employed in order to develop the Metrics and Targets. The Ecology Parameter Metrics were developed by a comprehensive literature review. The Policy Parameter used Santa Barbara's General Plan, Action Plans, and Ordinances to determine the Metrics. The Economic Parameter used costs estimates from the Museum's consultants. Lastly, the Outreach Parameter used the Museum's Mission Statement to guide the Metric development.

The following section defines the Mitigation Strategy alternatives and the associated Management Actions, as well as articulates the process used to populate Metrics within the Ecology, Policy, Economic, and Outreach Parameters.

MITIGATION STRATEGIES

Within the Museum Case Study, two mitigation strategies are used and compared to test the effectiveness of Santa Barbara's current mitigation practices.

STANDARD MITIGATION STRATEGY (SMS)

Traditionally, native tree mitigation has created a precedent of over-planting the compensatory trees at a ratio of 10:1 in order to offset high attrition rates in seedlings and saplings in order to achieve, a 1:1 replacement ratio. According to the Biological Assessment (BA), the Museum's campus does not have the physical space available to plant the compensatory 740 new oak (*Quercus agrifolia*) and sycamore (*Platanus racemosa*) trees (Watershed Environmental Inc., 2013). Due to this lack of on-site capacity, the Standard Mitigation Strategy (SMS) is broken into two Management Actions: On-site Tree Replacement and Off-site Tree Replacement, which together would provide enough space to achieve a compensatory planting ratio of 10:1. This Strategy would satisfy current city mitigation requirements, and carries with it a range of environmental, political, economic, and social implications, which this analysis estimates and describes.

ECOLOGICAL LIFT MITIGATION STRATEGY (ELMS)

The Museum has proposed a set of actions as a part of their Multi-Phase Development Plan, which intended to create environmental benefits on campus and for the Mission Creek watershed. This set of actions is grouped into the alternate mitigation strategy: the Ecological Lift Mitigation Strategy (ELMS). The ELMS encompasses several Management Actions intended to replace trees at a reduced ratio than the standard and also to generate other ecological benefits to the Museum's campus and the watershed.

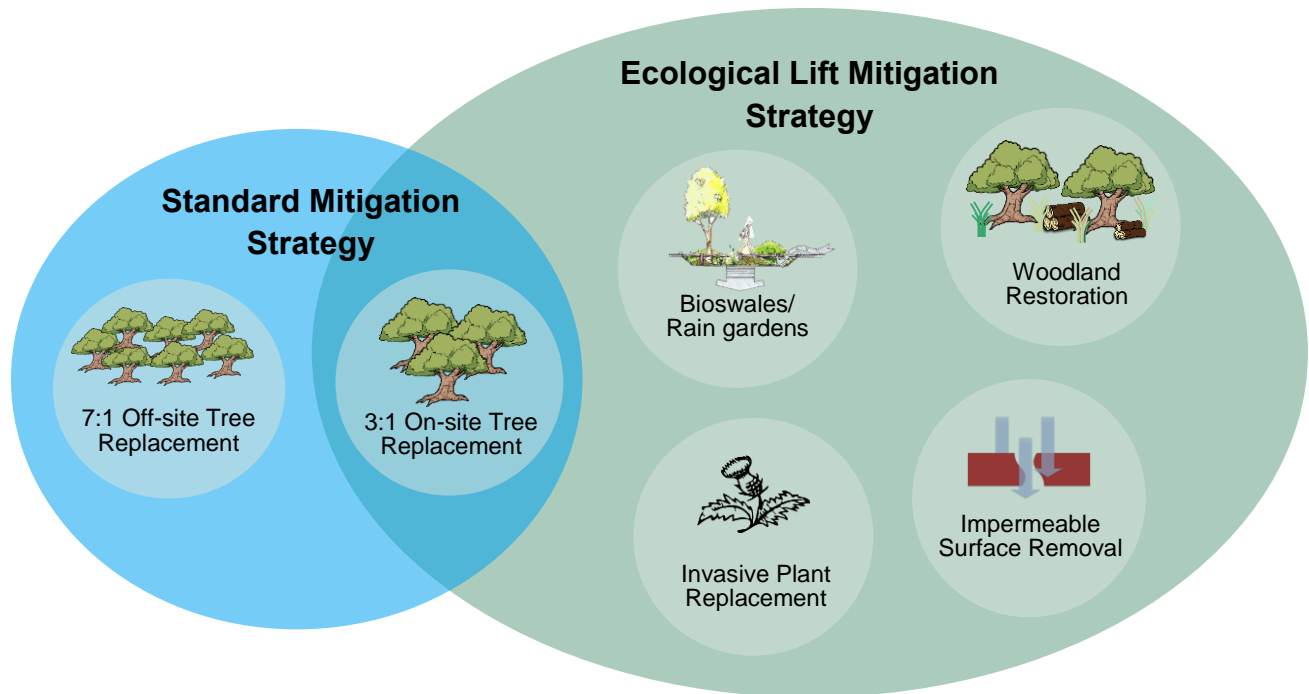
Each Strategy is made up of certain activities and steps that would, by different routes, attempt to compensate for the Multi-Phase Development Project's adverse impacts to several dozen oak and sycamore trees on the Museum campus or create other, related benefits for the Museum or community.

MANAGEMENT ACTIONS

Each Strategy is composed of Management Actions that would generate the stated legal, ecological or social goals of the parent Strategy. These Actions are the actual steps taken to address those goals by

either meeting the mitigation standard or by directly affecting related ecological characteristics. The Management Actions from SMS are Off-site Tree Replacement and On-site Tree Replacement; from ELMS, On-site Tree Replacement, Bioswale and Rain Garden Installation, Oak Woodland Restoration, Invasive Species Replacement, and Impermeable Surface Removal (see Figure 1.2 below). These are defined below.

Figure 1.2. Management Actions by Management Strategy



7:1 OFF-SITE TREE REPLACEMENT

Planting 514 trees off-site at an indeterminate location.

The 7:1 On-site Tree Replacement Management Action would result in the planting of 514 trees off-site (390 coast live oaks and 124 sycamores), representing a replacement ratio of 7:1. The team assumes that the off-site property where trees would be planted would be closed to the public because additional visitation would likely require a Conditional Use Permit (CUP) from the City.

3:1 ON-SITE TREE REPLACEMENT

Planting 226 trees on the museum property.

The 3:1 On-site Tree Replacement Management Action would result in the planting of 226 native trees on-site (170 coast live oaks and 56 sycamores), representing a replacement ratio of 3:1. In the opinion of Watershed Environmental, the Museum's environmental consultants, this is the maximum number of trees that can feasibly be planted on-site and is designed to replace the lost tree canopy within 10-20 years. The Museum would guarantee that all trees planted on-site would be maintained in perpetuity, if the Management Action was implemented as a component of the ELMS.

BIOSWALE AND RAIN GARDEN INSTALLATION

The construction of 15,000 square feet of special landscaping designed to treat storm runoff quantity and quality.

Bioswales are common, adaptable storm water Best Management Practice (BMP) that address water quality concerns. Generally, bioswales are open, vegetated channels designed to convey surface runoff much like a ditch or concrete channel (Groves et al. 1999, CalTrans 2009). This reduces erosive power and increases infiltration to groundwater, encouraging the deposition of excess sediment, nutrients and pollutants in the swale.

The Museum Multi-Phase Development Proposal and associated Engineers Reports and Landscaping Plan identified three locations on the Museum's campus appropriate for major bioswale installation, generally siting them along natural drainages. For instance, a natural conveyance cuts through the woodland on the Western side (or Parcel One, see Appendix A, Figure A.1) of the property and provides a topographically appropriate location for a bioswale (VFS A). These three swales would collectively channel the great majority of runoff generated on the property and would receive flows from 27 acres of upstream residential development (See Appendix A, Figure A.2). Table A.1 in Appendix A lists major design characteristics of the three 'vegetated filter swales' (VFS) A, B and C taken from the Flowers Drainage Report, while

Figure A.3 in Appendix A, shows cross-sections and additional design characteristics of the swale.

Rain gardens, a 'green infrastructure' BMP similar to bioswales, are intended to affect these same ecological Targets. However, 'rain garden' is a colloquial term. Their structure and function is most similar to that of a bioretention cell: they affect the aforementioned ecological Targets via water retention and increased soil infiltration, rather than just by conveyance through a vegetated area as a bioswale does. The network of bioswales and raingardens can be seen on the excerpt of the Master Landscaping Plan from Van Atta Associates in Appendix A, Figure A.5.

WOODLAND RESTORATION

A comprehensive improvement to habitat quality in the Museum's existing 6-acre oak woodland.

Woodland Restoration would comprehensively examine aspects of the site's ecology and take steps to improve total ecosystem function. The goals of this action are to manage the woodland for the 4 essential wildlife habitat elements (food, shelter, water, space) and for maximized ecosystem service contribution. The specific components of this action include: replacing all invasive species with natives; planting palette and planting locations that create or enhance new and existing habitat within the woodland to create a variety of niches and microhabitats; selective placement of coarse woody debris to enhance habitat; modification and reduction of the existing trail system to lessen erosion and runoff generation; and limiting recreation to less-impactful activities, for example: no horses, no dogs off leash, or biking.

The Open Space Management Plan serves to guide spatial elements of this action. From that plan, a total of 5.44 acres of the 6.2-acre oak woodland will be restored. The .76 acres of remaining oak woodland exists on the boundaries of the whole area, close to residential properties and is considered to have low value ecosystem function. These areas will be function as transition zones at the woodland/residential interface.

INVASIVE PLANT REPLACEMENT

The removal of invasive plants and trees and replacing with native species.

The Santa Barbara Museum of Natural History (Museum) currently boasts several acres of oak woodland, which consists of a blend of native and non-native vegetation for the understory. In order to better fulfill the museum's guiding principle to promote sustainability, the team proposed Invasive Plant Replacement as one of the Management Actions within ELMS.

Much of the data used for evaluating the Metrics came from the Biological Assessment and the Habitat Restoration and Open Space Management Plan (HROSMP), both of which are internal documents created for the Museum by Watershed Environmental, Inc. The HROSMP provides an inventory of the plant species present, as well as the quantity or extent of these species.

IMPERMEABLE SURFACE REMOVAL

The reduction of total stormwater runoff generated on site, largely by converting nearly 30,000 square feet of impermeable area to permeable surfacing.

The Museum's Proposal specified some types of permeable pavement, pavers and crushed gravel, along with the location and areas (See Appendix A,

Figure A.6). Thus, steps were taken to identify general permeable pavement characteristics most relevant for the Parameters and make assumptions for the types most likely to be used. Most types of permeable pavement- permeable asphalt, concrete, pavers, crushed stone, and other designs – has such high permeability that for all but the largest of rain events, all of the rain percolates through and essentially no runoff is generated. A proper design – one chosen for the site, usage, local soils and slope, etc. – would ideally produce zero runoff from an average rain event.

Thus the Impermeable Surface Removal Management Action entails both reducing the total area of impermeable structures on-site, including buildings and pavement, as well as installing permeable pavement at a significant scale and connecting the former to the latter to further decrease total runoff potential.

PARAMETERS

Each Management Action was evaluated across four different disciplines, or Parameters. These broad evaluative categories capture Action effects on various aspects of Ecology, Policy, Economics, and Outreach. See

Table 1.1 for breakdown of Metrics and Targets by Parameter.

ECOLOGY PARAMETER

The Ecology Parameter evaluates the change to ecosystem function resulting from each Management Action. These changes are organized into impacts to major ecosystem functions, assessed by the following Metrics: biodiversity, hydrogeomorphic, biogeochemical cycling, and cultural.

The biodiversity Metric captures net changes in species type, richness, and abundance. The hydrogeomorphic Metric is defined by the water and sediment cycles. The biogeochemical Metric is the flow of nutrients and pollutants. The cultural Metric addresses anthropogenic aspects of an ecosystem, like annual energy reductions, the landscape's fire resistance and the community's sense of place.

The two primary resources used for this Parameter were literature review and qualitative scales. In order to determine the quantitative values for the appropriate Metrics, the team conducted a literature review. Various methods were employed to distill the pool of quantitative values from scientific literature and technical reports into one figure. These specific methods and technical approaches are unique to each Metric within the different Management Actions, and further discussion is found in Chapter 3, under Ecological Parameter Analysis. To assess qualitative Metrics, the team developed qualitative scales that were unique to Museum Mission Fulfillment, Cultural Significance, and Fire Resistance. First, the team conducted a literature review to determine the critical components of each scale. Next, critical thresholds were determined for values ranging from +3 to -3, with +3 generally being favorable, and -3 being the least favorable. Lastly, the team employed the assistance of experts within each respective field in order to corroborate these scales. The specific methods behind each scales' development is discussed in Appendix C.

POLICY PARAMETER

Relevant policies within the City of Santa Barbara's General Plan, Ordinances, Guidelines and Standards, and Action Plans were pulled together to create the Policy Parameter. These policies serve as proxies for the City of Santa Barbara's values, since they are created by stakeholder inclusion and similar public processes. In essence, the Policy Parameter determines if a Management Action adequately represents the stated community values. The Team went through the list of the relevant policies, determined if the Management Action aligned with the policy, and then totaled the number of policies that were consistent with the Management Action. All other things being equal, an Action that is consistent with policy would be recommended over one that isn't.

The Policy Metrics section in Appendix B elaborates further on the contents of the General Plan, Ordinances, Guidelines and Standards, and Action Plans.

ECONOMIC PARAMETER

The Economic Parameter employs cost estimates from the Museum and literature review in order to assess the long- and short-term costs of each Management Action. Preparation, installation, monitoring, and maintenance costs are captured in this Parameter. The total cost Metric add the long- and short- term costs together. The team also tried to capture potential savings from volunteer labor based on the tasks that could be accomplished without specialized knowledge.

The cost estimates provided by consultants to the Museum were easily translatable to each Management Action. However, not all Metrics had existing cost estimates. In these instances, the team conducted a literature review to determine the approximate cost of a service or good, then scaled it down to a range that was appropriate for the Management Action.

OUTREACH PARAMETER

The Outreach Parameter explores opportunities for educational and community outreach stemming from proposed mitigation strategies. Alignment with the Museum's institutional mission and changes to the level of involvement by community members is captured through this Parameter. Qualitative scales were developed for the two Metrics within this Parameter: Education Utility and Community Involvement. Each Management Action's net impacts on these scales were ranked from +3 to -3, from most to least favorable, respectively.

Table 1.1. Parameters, Metrics and Targets

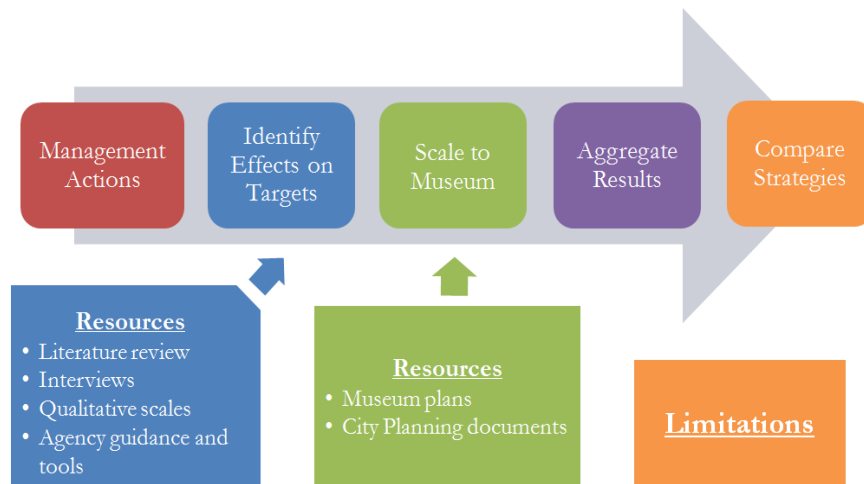
Ecology Parameter				
Biodiversity Metric	Hydrogeomorphic Metric	Biogeochemical Metric	Cultural Metric	
<ul style="list-style-type: none"> • Native trees planted • Native trees impacted • Native vegetation planted • Invasive vegetation removed • Total new native plant species • Habitat quality impact • Habitat area impact 	<ul style="list-style-type: none"> • Runoff volume reduction • Infiltration Rate • Erosion Rate 	<ul style="list-style-type: none"> • Carbon sequestration • Suspended solid reduction • Hydrocarbon reduction • Nitrate/phosphate reduction • Heavy metals removal rate • Heat island effect 	<ul style="list-style-type: none"> • Annual energy reduction • Carbon emissions reduction • Fire Resistance • Museum Mission Fulfillment • Cultural Significance 	
Policy Parameter				
City General Plan	Ordinances, Guidelines, and Standards	Action Plans		
<ul style="list-style-type: none"> • Consistency with Environmental Resources Element • Consistency with Conservation Element 	<ul style="list-style-type: none"> • Consistency with zoning ordinance • Consistency with tree preservation ordinance • Consistency with street tree planting and maintenance ordinance • Consistency with landscape design standards for water conservation • Consistency with stormwater guidelines 	<ul style="list-style-type: none"> • Climate Action Plan • Draft Urban Forestry Management Plan 		
Economic Parameter				
Short Term Costs	Long Term Costs	Total Costs	Total Cost, with Volunteer Savings	Annual Maintenance Costs
<ul style="list-style-type: none"> • Preparation costs • Implementation costs • All costs accrued in year 	<ul style="list-style-type: none"> • Maintenance costs • Monitoring • All costs accrued in years 2 – 5 	<ul style="list-style-type: none"> • Short term costs and long term costs • All costs accrued in years 1-5 	<ul style="list-style-type: none"> • Total cost minus cost savings from volunteer labor 	<ul style="list-style-type: none"> • Annual costs beginning year 6 • Maintenance, contingencies, and monitoring costs

1			
Outreach Parameter			
Educational Utility	Community Involvement		
<ul style="list-style-type: none"> • Provision of educational programming and exhibition • Opportunity to educate a diverse visitor group through multiple educational pathways 	<ul style="list-style-type: none"> • Volunteer involvement in Management Action implementation • Expanding or diversifying the Museum's current community • Citizen science opportunities in longitudinal studies • Impact on visitation and donation rates 		

ANALYTIC PROCESS

For each Management Action, the Team determined the Action's effect on Targets by using a wide range of resources: literature review, interviews, qualitative scales, and agency guidelines and tools. The information from these resources was then scaled down to the Museum level by utilizing Museum-developed plans and City Planning documents. The identified results of each Management Action were then aggregated. The aggregation process considered the area coverage as well as the intensity of impact in order to fairly represent each Management Action. The entire analytic process is described in Figure 1.3 below.

Figure 1.3. Museum Case Study Analytic Process



CHAPTER CONCLUSION

The next section will elaborate on the detailed results and discussion. Chapter 2 covers the information from existing environmental mitigation practices, while Chapter 3 covers detailed methodology, results, and discussion for the Museum case study.

CHAPTER 2 EXISTING ENVIRONMENTAL MITIGATION PRACTICES IN SANTA BARBARA

Sub-par mitigation can threaten critical species and their habitats, cause time delays and high risks for developers, and result in fragmented project-by-project outcomes. In this Chapter, the team classifies environmental mitigation in Santa Barbara and identifies important values that compensatory environmental mitigation should maximize in order to create the best outcomes for ecosystems, developers, planners and communities.

In the next Chapter, the team analyzes a case study at the Museum of Natural History and demonstrates how the existing environmental mitigation policy in practice continues to fail to capture identified values. In the case study, the team compares the standard mitigation strategy against a developer-proposed alternative across environmental and social parameters. In Chapter 4, alternative mitigation policies are analyzed in order to develop programmatic recommendations to improve mitigation in Santa Barbara, which are described in detail in Chapter 5.

ENVIRONMENTAL MITIGATION OVERVIEW

Transportation, infrastructure, and development projects in California are required to identify and disclose the potential environmental impacts of their projects. Under the California Environmental Quality Act (CEQA), designated permit review agencies must avoid and minimize environmental impacts or mitigate impacts where avoidance is not feasible. Mitigation includes a three-step process: (1) Avoidance of impacts, (2) Minimization of adverse impacts, and (3) Compensatory mitigation (Fulton and Shigley 2005). In this report, environmental mitigation is defined as compensatory mitigation, or the offsetting for lost habitat area or function as required by a federal or state regulatory program (ELI 2011).

Mitigation for unavoidable environmental impacts is a major source of conservation and restoration efforts in California. Nationwide mitigation is usually connected to Endangered Species Act and Clean Water Act permitting, conserving or restoring habitat for federally listed species and preventing the net loss of wetlands. CEQA requires identified environmental impacts to be avoided or mitigated, whereas its national counterpart, the National Environmental Policy Act (NEPA), only requires disclosure of impacts. As a result of this stricter standard, environmental mitigation is ubiquitous in California, used for environmental impacts that may not include endangered species, such as those to native trees. Mitigation programs and policies are designed and enforced by local jurisdictions to comply with CEQA and meet locally established goals.

A review of environmental mitigation projects in Santa Barbara, suggest that permitting agencies encourage on-site, in-kind mitigation to facilitate a direct exchange of mitigation actions for impacts (B. McNulty, personal communication, Feb. 6, 2014; G. Russell, pers. comm., Feb. 14, 2014; B. Shelton, pers. comm., February 10, 2014). In the case of native tree impacts, on-site, in-kind mitigation would be the replacement of removed trees as close to their original place as possible on the development parcel. When on-site compensatory mitigation is not possible, permitting agencies may allow off-site, in-kind mitigation (R. Dyste, pers. comm., Feb. 10, 2014). For example, removal of oak trees on a development site may be mitigated by planting oak trees elsewhere.

Mitigation outcomes across the country and in California have not been closely tracked. Initial mitigation legislation did not include monitoring requirements, but short-term (5 year) monitoring is now conducted to ensure compliance (The State Bar of California Environmental Law Section, 2013). A number of future

issues affect the trajectory of current mitigation practices and create new mitigation goals, including climate change, changing population demographics, and increased land development pressures. Climate change, in particular, calls into question whether replacement of environmental impacts will be effective under shifting climatic conditions (B. Shelton, pers. comm., February 10, 2014).

APPROACHES TO ENVIRONMENTAL MITIGATION

Mitigation approaches vary, based on a number of different elements: site location, planning timeline, planning horizon, scope of species and habitats addressed, and type of features exchanged. Standard mitigation focuses on replacing impacted features and processes on the project site (ELI 2011). Compensation sites are usually restricted to the property location of the environmental impacts from the infrastructure or development project. When mitigation requirements cannot be fulfilled on the development site, off-site locations are selected opportunistically to minimize costs to the permittee. Standard mitigation is also conducted on a project-by-project basis. Consequently, review agencies consider permit applications of each proposed project in isolation. Additionally, mitigation requirements are selected species-by-species according to the individual project impacts identified (ELI 2011). The standard approach does not take into account the collective and interactive impacts on a site, nor does it consider landscape or watershed-level needs. Table 2.1 summarizes the elements of standard and alternative mitigation approaches (see discussion of alternative mitigation approaches in Chapter 4).

Table 2.1. Mitigation Elements

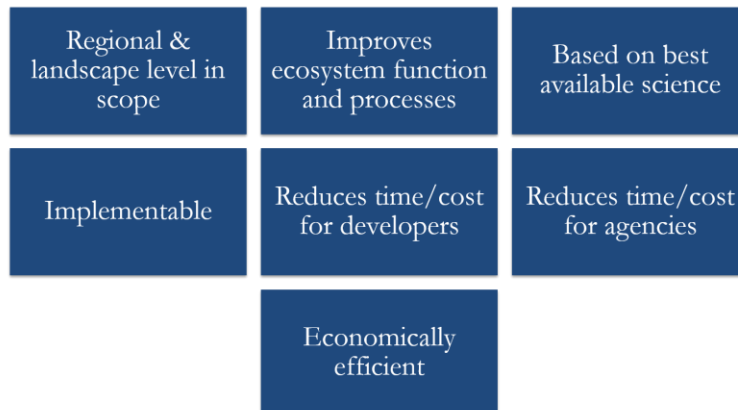
Standard Mitigation Approach	Alternative Mitigation Approach
On-site	Off-site
Reactive planning	Advanced planning
Short-term planning horizon	Long-term planning horizon
Single species replacement	Habitat function/ecosystem services replacement
In-kind/Direct	Out-of-kind/Indirect and In-lieu

There is a spectrum of mitigation approaches that vary in their ecological outcomes, economic effects, ease for developers, and ease for permitting agencies. Some mitigation approaches use advanced planning to identify target areas and species that would benefit from conservation or restoration, instead of identifying mitigation requirements from scratch after a development project is proposed. Off-site mitigation is then facilitated in these pre-identified locations. Alternative forms of mitigation may also address multiple species of special concern simultaneously and broaden its spatial scale beyond the development site to the landscape (G. Russell, Feb. 14, 2014). Most mitigation is in-kind, meaning environmental damages are replaced with the same impacted features or species as required by current case law.

VALUES ASSOCIATED WITH ENVIRONMENTAL MITIGATION

As described above, mitigation approaches vary in spatial and temporal components. This results in tradeoffs between ecological benefits, economic efficiency and effectiveness. Figure 2.1 below lists seven major values identified in the literature and through the stakeholder interview process that compensatory mitigation should maximize in order to create the best outcomes for ecosystems, developers, planners and communities (Rockwood, 1995; G. Russell, pers. comm., Feb. 14, 2014; J. Jostes, pers. comm., Feb. 4, 2014; B. Shelton, pers. comm., February 10, 2014; J. Higgins, pers. comm., February 6, 2014).

Figure 2.1.Values Associated with Environmental Mitigation



The City and County of Santa Barbara use a standard approach to mitigation; this includes on-site, reactive planning, a short-term planning horizon, single species replacement, and in-kind transfer. Below, the team analyzes how the standard mitigation approach realizes or fails to realize the above identified values, using native tree mitigation in Santa Barbara as an example.

NATIVE TREE MITIGATION IN SANTA BARBARA

Native tree mitigation policies in the City and County of Santa Barbara are an example of standard mitigation because they emphasize on-site mitigation, are reactive to impacts with no strategy for optimal tree placement, operate under a short-term planning horizon, and focus on in-kind, single species replacement.

Historically, native tree impacts have been mitigated in the City and County of Santa Barbara through replacement ratios (J. Storrer, pers. comm., Feb. 7, 2014). In the 1980's, the county required impacted oaks to be replaced at a 3:1 ratio for the Celeron Pipeline Project-Inland Segment, the Point Arguello Pipeline Project and the Point Pedernales Pipeline Project (J. Storrer, pers. comm., Feb. 7, 2014). In the early 1990's, the replacement ratio was increased to 10:1 for the Celeron Pipeline Project-Coastal Segment. According to John Storrer, the increase in replacement ratios was due to a "recognition of the temporal loss of habitat value from sapling to mature tree" and that 3:1 was too inexpensive. Others suggest that the replacement ratio is based on the fact that typically only 10% of replacement trees survive to maturity (M. de la Garza, pers. comm., April 11, 2013; G. Russell, pers. comm., Feb. 14, 2014; B. Shelton, pers. comm., February 10, 2014). At one time, the 10:1 replacement ratio was codified in the County's Environmental Thresholds and Guidelines Manual, but the most recent edition does not include a specific replacement ratio. Similarly, the 10:1 replacement ratio is not codified in a City of Santa Barbara guidance document, but instead the standard is based on the "past practice of requiring 10:1 replacement" (P. Lawson, pers. comm., Aug. 1, 2013).

An example of how native tree mitigation is typically practiced in the County is captured in the Miramar Beach Resort Project. In 2008, Caruso BSC Miramar LLC received approval from the County of Santa Barbara Board of Supervisors for a new plan to redevelop the Miramar Hotel. According to the Proposed Subsequent EIR for the Miramar Beach Resort Project (2008), the project has the potential to significantly impact three sycamores and nine oak trees through relocation. Consequently, project approval required standard compensatory mitigation for tree impacts, in short: (1) Impacted native trees shall be replaced on-site at either a 10:1 or 3:1 replacement ratio depending on the size of the replacement tree (1-gallon

versus 24-inch box trees); (2) Trees shall be replaced in-kind with native replacement trees of the same species; (3) Trees shall be maintained until established (five years); (4) Relocated trees do not require a replacement ratio, but if they fail shall be replaced by two, 60" box oak trees (County of Santa Barbara Department of Planning and Development, 2008b).

In the case of the Miramar Beach Resort Project, mitigation practices were reactive to the project at hand, subsequently operating under a short-term planning horizon made even shorter by restricting maintenance to only five-years. The Miramar Beach Resort Project is typical of native tree mitigation practices in both the County and City of Santa Barbara. In this section, the team analyzes how native tree mitigation in practice realizes or fails to realize the values associated with compensatory mitigation outlined earlier in this Chapter.

REALIZED VALUES

Currently, standard native tree mitigation realizes a number of environmental mitigation values: It (1) is implementable and (2) reduces time and/or costs for agencies.

Native tree mitigation in the City and County of Santa Barbara is implementable and reduces time and costs for implementing agencies because it is consistent with past practice, provides some flexibility, is economically feasible, and defensible. Past projects with native tree impacts, both in the City and County, have consistently been required to mitigate impacts with either tree replacement ratios or relocations with contingency replacement ratios in case of failure, such as in the case of the Miramar Beach Resort Project (County of Santa Barbara Department of Planning and Development, 2008b). Similarly, the California Department of Fish and Wildlife requires tree replacement ratios through Lake or Streambed Alteration Agreements (§1600 permits) for native tree impacts, typically 10:1 for oaks and sycamores (E. Brown, personal communication, September 25, 2013); this consistency across multiple jurisdictions and many projects makes it easier for agencies to implement mitigation requirements because they are grounded in past practices.

Additionally, ratios are flexible, making it easier to implement mitigation requirements because they can be tailored to specific projects and sites. Typically, the 10:1 ratio is required if developers are planting 1-gallon trees, but the ratio has been reduced if projects plant more mature trees, such as in the case of the Valle Verde Expansion Project where a 3:1 coast live oak tree replacement ratio was required using 15-gallon or 24-inch box trees (Rodriguez Consulting, Inc., 2011). Similarly, the State Street Hospitality New Hotel Project impacted one coast live oak tree and it was recommended by a consulting arborist that it be replaced with 24-inch trees at a 4:1 ratio. According to the Negative Declaration, "Given the constrained site, its location in an urban, commercial area, and the lack of space available to allow more oak trees to grow and thrive on the site, the 4:1 replacement ratio would be acceptable mitigation in this circumstance" (County of Santa Barbara Planning and Development, 2012). Site-constraints have made it difficult for all projects to accommodate the 10:1 replacement ratio and in the case of some projects mitigation has been flexible to lower ratios that are vetted by consulting biologists or in-house arborists, making it easier for agencies to implement native tree mitigation.

Lastly, native tree mitigation is implementable because consistency with past projects and the flexibility of the ratios suggests that, in practice, it is possible for developers to mitigate native tree impacts without undermining the economic feasibility of their projects. Consequently, the mitigation requirements are defensible if challenged in court, making standard native tree mitigation less risky for agencies to implement (B. McNulty, pers. comm., Feb. 6, 2014). Consistency with past practice also minimizes agency bureaucracy and time delays because it is predictable. It does take time and expertise (arborists or biologists) to arrive at the "best" replacement ratio, but the large number of past projects required to

mitigate with replacement ratios provides a library of examples that reduces the amount of time spent by agencies determining if an impact has been sufficiently mitigated. Moreover, the predictability of standard native tree mitigation reduces time and costs for agencies because they can anticipate what the mitigation will be for native trees.

UNREALIZED VALUES

In contrast to realized values, standard native tree mitigation fails to realize the following environmental mitigation values: (1) Regional and landscape level in scope, (2) improves ecosystem function and process, (3) based on best available science, (4) reduces time and/or costs for developers and (5) economically efficient.

Standard native tree mitigation, as it is currently practiced, is not regional or landscape level in scope and fails to leverage replacement trees to achieve City or County forest management objectives. Current practices mitigate tree impacts on a project-by-project, species-by-species basis and emphasize on-site mitigation. When off-site mitigation efforts are required they are currently not coordinated on a local scale, let alone a regional or landscape level scale, but are left up to the developer to identify and secure for planting. Recently, the City of Santa Barbara's Parks and Recreation developed a draft Urban Forest Management Plan identifying specific tree resource management issues in the City, which include (City of Santa Barbara Parks and Recreation, 2013):

- (1) Need to develop a proactive approach to systematic removal and replacement of poor performing trees, or trees at the end of their life;
- (2) 8,000 vacant planting sites;
- (3) Park tree maintenance limited to safety/opportunity to restore/enhance riparian canopy, eliminate invasive species and increase native habitat in open space parks and parks with creeks.

Standard native tree mitigation fails to guide tree replacement to the sites in the City of Santa Barbara that are most in need of trees. Instead, the emphasis on on-site tree replacement forces sites that may not maximize the ecosystem service benefits of trees, such as habitat or shade and climate effects, to host the greatest density of trees that it can. The draft Urban Forest Management Plan is making strides to develop a city-wide plan that guides and leverages tree replacement mitigation through a tree mitigation bank to help the City of Santa Barbara achieve a number of key objectives:

- (1) Optimize tree canopy;
- (2) Optimize age and enhance species diversity;
- (3) Maximize the economic, environmental, and aesthetic benefits of the urban forest;
- (4) Provide urban forest benefits that enhance visitor experience in City parks and facilities;
- (5) Enhance and preserve trees within native habitats including riparian areas, oak woodlands and protected open spaces;
- (6) Enhance City investments in the health and management of the urban forest.

The Urban Forest Management Plan is a step in the direction of regional and landscape level planning, but would better capture this value if it looked at the natural connections between the City's urban forest and the County and Federal lands that surround it.

Standard native tree mitigation in the City and County of Santa Barbara does not, as a rule, improve overall ecosystem function and process because it emphasizes individual, specimen, and heritage trees. As described above, tree replacement ratios do not consider the ecosystem services provided by trees or the placement of trees in order to optimize ecological and social benefits. Subsequently, when current

tree mitigation improves overall ecosystem health, it is not strictly a result of the ratios themselves, but rather, a side effect of planting replacement trees.

In addition, the emphasis on specimen and heritage trees actually discourages landowners from being good environmental stewards, undermining ecosystem function and process across the landscape. Historically, tree protection ordinances have placed an emphasis on saving “specimen” or “heritage” trees, while allowing for trees under a certain diameter to be cut (Light and Pedroni, 2002). Consequently, many landowners cut down trees before they reach the diameters specified in the ordinances to avoid being subject to the requirements and limitations of owning a “specimen” tree. These ordinances can create perverse incentives for landowners to eliminate these natural resources on their property, discourage landowners from planting native trees on their property, and generally deter good environmental stewardship. Subsequently, standard native tree mitigation undermines ecosystem function and process.

Santa Barbara County and City Planners try to rely on best available science to formulate their mitigation requirements. The County has a biologist and arborist on staff to guide all compensatory environmental mitigation, as well as native tree mitigation, and the input of environmental consultants and arborists are sought by the City to assess impacts and mitigations for projects in its jurisdiction (B. McNulty, personal communication, February 6, 2014; B. Shelton, personal communication, February 10, 2014). However, in the case of native tree mitigation, replacement ratios oversimplify native tree survivorship issues because best available science simply does not exist to inform ratios on a project-by-project basis. The 10:1 replacement ratio is promulgated because the assumption is that 90% of the trees will die; however, survivorship rates are site and species specific, and impossible to capture in a blanket mitigation ratio (Tyler et al., 2008).

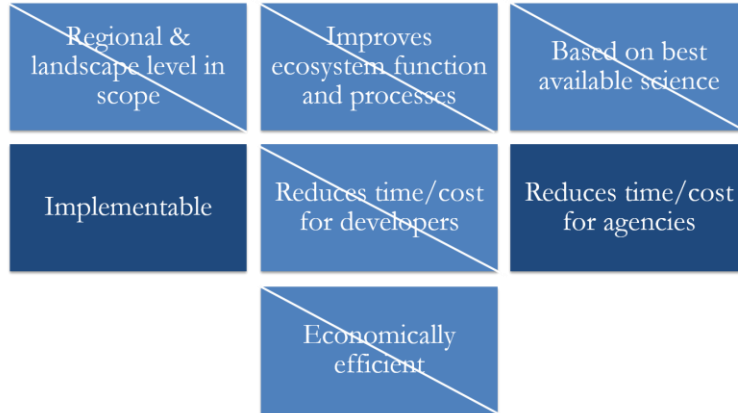
More importantly, the survivorship of larger, more mature trees is not necessarily greater than that of a 1-gallon replacement tree or a replacement tree planted from an acorn (Bernhardt and Swiecki, 2001); suggesting that ratios should not necessarily be decreased because a developer is willing to pay more for a large tree. Lastly, monitoring and enforcement periods, usually five years, are insufficient in the cases of some species for trees to fully establish, for example, slow growing hardwoods like oaks and sycamores (Bernhardt and Swiecki, 2001). Under standard native tree mitigation, a trade-off is made between maintenance periods that are long enough to ensure survivorship and the economic feasibility of a project. Consequently, standard native tree mitigation fails to capture the value of being based on the best available science.

Whereas standard native tree mitigation does reduce time and/or costs for agencies, it fails to reduce time and/or costs for developers. Native tree mitigation can be extremely costly for a developer when it requires the purchase of additional land for off-site tree replacement (J. Higgins, pers. comm., February 6, 2014). A program that identifies sites for compensatory tree replacement would reduce time and costs for developers, but such a program currently does not exist in the City or County of Santa Barbara.

Lastly, standard native tree mitigation also fails to be economically efficient. As described above, standard mitigation fails to leverage the community to voluntarily grow trees on their property. In addition, without a plan that helps landowners and developers identify sites for replacement trees, the City misses out on opportunities to achieve its forest-based objectives through mitigation.

Figure 2.2 below summarizes the values that standard native tree mitigation realizes and fails to realize.

Figure 2.2. Realized and Unrealized Environmental Mitigation Values in Santa Barbara



CHAPTER CONCLUSION

In this Chapter, the team classified environmental mitigation in Santa Barbara and found that it utilizes a standard approach to mitigation, including on-site, reactive planning, a short-term planning horizon, single species replacement, and in-kind transfer. In addition, the team identified seven important values that compensatory environmental mitigation should maximize in order to create the best outcomes for ecosystems, developers, planners and communities. Finally, the team discovered that current environmental mitigation practices in Santa Barbara fail to capture all but two of these important values.

In the next Chapter, the team analyzes a case study at the Museum of Natural History and demonstrates how an existing environmental mitigation policy in practice continues to fail to capture these identified values. In the case study, the team compares the standard mitigation strategy against a developer-proposed alternative across environmental and social parameters. In Chapter 4, alternative mitigation policies are analyzed in order to develop programmatic recommendations to improve mitigation in Santa Barbara, described in detail in Chapter 5.

CHAPTER 3 MUSEUM CASE STUDY

As described above, mitigation in Santa Barbara does not capture all values that mitigation could. For developers, the current framework presents challenges. The Santa Barbara Museum of Natural History case study is illustrative of these challenges. In this Chapter standard mitigation is compared against the Museum's alternative using the analytic framework described in Chapter 1. Ecological methods and specific results from the analysis of Economic, Policy, Outreach, and Ecology Parameters are presented for each Strategy and Management Action. Discussion of results and an analytic comparison of the two strategies highlight shortcomings and benefits of each. In Chapter 5, these conclusions are tied to recommendations for improving mitigation in the future.

BACKGROUND: THE SANTA BARBARA MUSEUM OF NATURAL HISTORY

To celebrate its centennial anniversary, the Santa Barbara Museum of Natural History sought to upgrade and redevelop its aging Mission Canyon campus to better meet its institutional mission and values. The Museum developed a range of overall plan goals, abbreviated **NATURE**: **N**ative habitat restoration; **A**menities for visitors and researchers; **T**ransforming exhibits; **U**pscaling fire protections; **R**ehabilitate historic structures; and **E**nvironmental sustainability and design, to guide this multiyear, Multi-Phase Redevelopment Plan. The Redevelopment Plan would have impacted over 70 native coast live oak and sycamore trees during renovation (Spiewak 2013). Removal or damage to these trees would have constituted a significant environmental impact under CEQA, triggering mandatory mitigation via the City of Santa Barbara's Tree Ordinance. Preliminary studies indicated that the Museum site does not have space for tree replacement at the typically required replacement ratios (10:1 replacement) and so the Museum would be unable to fulfill standard mitigation requirements.

Unable to meet the required ratio, the Museum explored the possibility of other on-site, ecologically beneficial actions substituting for a portion of the tree mitigation requirements. Subsequently, the Museum proposed a Bren School Group Project to compare its mitigation alternative with the standard strategy across relevant environmental and social parameters and to evaluate compensatory environmental mitigation in Santa Barbara.

In June 2013, the Museum placed an indefinite hold on the Redevelopment Plan. The Museum released a letter explaining this decision and its determination to find new ways of meeting their overall plan goals (Swetland 2013). This decision prompted the Group Project to emphasize the Museum's Plan as a theoretical case study in the context of analyzing Santa Barbara mitigation. This did not change the overall analysis framework or the Parameters and values used to assess the mitigation strategies.

ECOLOGY PARAMETER ANALYSIS

Analysis of the Standard Mitigation Strategy (SMS) and of the Ecological Lift Mitigation Strategy (ELMS) Management Actions centered on four Parameters: Ecology, Economic, Policy, and Outreach. The breakdown of these Parameters by Metric and Targets allowed for specific and standardized evaluation of each Management Action. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1. The Ecology Parameter method was tailored to each Action given the significant difference in scale and scope between them. Specifics about how the Ecology Parameter was tailored to each Action are found in the following section. Each Management Actions performance across the four Ecological Metrics of Biodiversity, Hydrogeomorphic, Biogeochemical and Cultural, are presented.

OFF-SITE TREE REPLACEMENT

BIODIVERSITY

The Off-site Tree Replacement Management Action would result in the planting of 514 trees off the museum site (390 coast live oaks and 124 western sycamores), representing a replacement ratio of 7:1 (see Table 3.1 below). Following the recommended 16 to 25 ft. on-center spacing dimensions for coast live oaks and western sycamores outlined in the Vegetation Restoration Guidelines developed by San Francisquito Creek Joint Powers Authority, this Management Action assumes that trees are installed on an equilateral triangular, or hexagonal, grid system an average of 20.5 ft. apart (2000). As hexagonal systems accommodate 15% more trees per area than a typical square system, the area required to plant off-site would be a total of 4.3 acres (Tnau Agritech Portal Horticulture, N.A.).

No specific location exists for this Management Action, as the proposed project was halted before an off-site location for planting was identified; however, it is assumed that the location would not be near buildings. The Off-site Tree Replacement Management Action does not overlap with any other Management Actions.

Table 3.1 Off-site Tree Replacement: Number of trees impacted and replaced by species

Species	Impacted Trees			7:1 Off-site Tree Replacement
	Phase 1	Phase 2 & 3	Total	Planting Totals
Coast live oak <i>Quercus agrifolia</i>	42	14	56	390
Western sycamore <i>Platanus racemosa</i>	10	8	18	124
Total	52	22	74	514

Source: Watershed Environmental Inc., 2013.

Five years of monitoring are required to ensure survival of the trees such that mitigation requirements are met. After the five-year period, trees are no longer required to be monitored and replaced; thus, natural factors such as herbivory, fire, drought, and disease, can influence survival rates (Tyler et al, 2008). Depending on the life stage — acorn, seedling, sapling, or adult — mortality rates and the factors that influence it can vary significantly (Tyler et al, 2008).

No studies were found that indicate the survival rate for naturally occurring or planted western sycamores. However, a study by Tyler et al. examined the factors that affect coast live oak seedling survival in the central coast area and found survivorship rates for coast live oaks between 18 months and 66 months to be 36%, but the rate varied depending on-site location, the year in which trees were planted, and treatment such as exclusion of browsers like cattle (2008). It is possible that coast live oaks planted under the off-site tree Management Action would have greater than 36% survivorship after five years of management; however, it is unlikely that they would have 100% survivorship. According to Bernhardt and Swiecki, specialists in the field of California oak woodland restoration, it typically takes at least five to ten

years of protection for an existing juvenile oak (one that is naturally occurring and not planted) to reach a size class that no longer requires protection to survive browsing, mowing, or frequent fires (2001).

Due to the lack of quantitative data on the survivorship rates of seedlings, saplings and adult coast live oaks and sycamores, it is difficult to know how many would survive after the five-year monitoring period. Subsequently, benefits described below that are time and tree count dependent, such as carbon sequestration rates, will include results under different assumptions about seedling survivorship (see Table 3.2 below).

Table 3.2 Off-site tree numbers after 5-year monitoring period by survivorship rate

Species	Tree Count by Survivorship Rate			
	100%	75%	36%	10%
Coast live oak <i>Quercus agrifolia</i>	390	293	140	39
Western sycamore <i>Platanus racemosa</i>	124	93	45	12
Total	514	386	185	51

Assuming the Off-site Tree Replacement Management Action is executed in an undeveloped setting that takes advantage of natural connections to larger western sycamore-coast live oak communities, it is likely that 4.3 acres of new habitat could support a diversity of wildlife. The new habitat has the potential to provide habitat and food to black bear, black-tailed deer, and a number of bird species, such as: acorn woodpecker (*Melanerpes formicivorus*), red-shouldered hawk (*Buteo lineatus*), scrub jay (*Aphelocoma californica*), the federally endangered least Bell’s vireo (*Vireo bellii pusillus*), and least tern (*Sternula antillarum*; Steinberg, 2002). In fact, western sycamore-coast live oak communities have been found to provide wintering grounds for 32 bird species and an acre can support around 251 birds (Steinberg, 2002). The 4.3 – acre site could theoretically support up to 1000 wintering birds.

However, the Management Action’s effect on wildlife is limited by the fact that the trees planted would be evenly-aged and would not provide the diversity of structure that natural western sycamore-coast live oak communities provide, and so would not support the maximum diversity of species. Additionally, the urban setting must be considered; it would likely reduce potential habitat quality benefits due to the limited productivity and diversity of the urban ecosystem.

No other vegetation is being planted as a result of the on-site tree replacement Management Action.

HYDROGEOMORPHIC

Forests filter and regulate the flow of water. Their canopies intercept rainfall, slowing its descent to the forest floor, which can absorb up to 18 inches of precipitation before. In a North Carolina watershed study, the mean soil infiltration rate decreased from 12.4 in/hr to 4.4 in/hr when a site was converted from forest to suburban turf (Kays, 1980). Additional studies have also found that when forested areas were converted to crops and grazed pasture hourly rainfall infiltration rates decreased (Bharati et al. 2002). Average interception of rainfall by a forest canopy ranges from 10-40% depending on a number of factors, including species, season, and precipitation rates. A single deciduous tree can intercept from 500 to 760 gallons per year and a mature evergreen can intercept more than 4,000 gallons per year in urban

and suburban settings. A Forest Service study demonstrated that a single small tree that was less than ten years old, was able to intercept 67% of the rain that fell within its canopy (Penn State Extension, 2008). Subsequently, planting trees will increase infiltration rates and decrease erosion rates; however, without a site-specific study, the exact amount of impact cannot be quantified.

Vegetation promotes rainfall infiltration into the soil and reduces the rate of runoff more than non-vegetated land (Forest Commission Forest Research, 2010). According to a study by McPherson et al. in Santa Monica, California a single tree in the urban forest reduces stormwater runoff on average by 7 m³ or 1,856 gallons annually (2001). This number multiplied by the total number of trees planted was used to estimate the amount of runoff reduction expected at the Museum site created by this Action. The methods behind determining changes in infiltration rate and erosion rates are the same as the Off-site Tree Replacement Management Action.

BIOGEOCHEMICAL

To calculate carbon sequestration benefits of the Off-site Tree Replacement Management Action, the team utilized the United States Forest Service (USFS) Center for Urban Forest Research Tree Carbon Calculator (CTCC). The local climatic zone (Central Coast) and carbon sequestration rates were determined based on hypothetical tree age for coast live oaks and London planetree (*Plantanus hybrida*). London planetree was selected because the CTCC database does not include western sycamore, but states that a rough estimate can be calculated based on a tree species in the database that has the most similar mature size and growth rate. London planetree was the closest equivalent to western sycamore in the CTCC. As trees store carbon over time, this benefit was calculated from 5 to 120 years. At 120 years, the CTCC demonstrates that the carbon sequestration rates of coast live oak and sycamore trees have both leveled off to zero. The Management Action was further evaluated under the 100%, 75%, 36%, and 10% survivorship scenarios.

Floodplain and riparian woodland can reduce diffuse pollution by: enhancing siltation and sediment retention (Jeffries et al., 2003); phosphate and nitrate removal (Gilliam, 1994); fixing heavy metals (Gambrell, 1994); and hydrocarbon removal (Cook and Hesterberg, 2013). Furthermore, the action of riparian and floodplain woodland in encouraging out-of-bank flows and slowing down flood flows promotes sediment deposition and retention, reducing downstream siltation. Lowrance et al. (1984) found riparian woodland to be particularly efficient at both intercepting aerial drift of pesticides and trapping pesticides bound to sediment in runoff. Both a mature, managed woodland (50 m wide) and a newly restored woodland (38 m wide) achieved almost complete pesticide reduction (Lowrance et al., 1997; Vellidis et al., 2002). In addition, additional tree plantings also reduce heat island effects (EPA n.d.).

CULTURAL

The location of the Off-site Tree Replacement Management Action is assumed to be distant from buildings and so no annual energy reductions or their associated emission reductions in carbon dioxide equivalents were calculated.

Qualitative scales assessing Fire Resistance, Museum Mission Fulfillment and Cultural Significance described in Chapter 1 were used to evaluate this Metric. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1.

ON-SITE TREE REPLACEMENT

BIODIVERSITY

The On-site Tree Replacement Management Action would result in the planting of 226 native trees on the Museum property (170 coast live oaks and 56 western sycamore), representing a replacement ratio of 3:1 (see Table below; Watershed Environmental Inc., 2013). In the opinion of Watershed Environmental – the Museum’s environmental consultants – 226 is the maximum number of trees that can feasibly be planted on-site and the Management Action is designed to replace the lost tree canopy within 10-20 years.

Table 3.3. On-site Tree Replacement: Number of trees impacted and replaced by species

Species	Impacted Trees			3:1 On-site Tree Replacement
	Phase 1	Phase 2 & 3	Total	Planting Totals
Coast Live Oak <i>Quercus agrifolia</i>	42	14	56	170
Sycamore <i>Platanus racemosa</i>	10	8	18	56
Total	52	22	74	226

Source: Watershed Environmental Inc., 2013

Although the replacement trees are being planted throughout the Museum property, an acreage estimate based on an average tree’s footprint, rather than the entire museum property, would result in a more accurate cost estimate. The footprint of replacement trees is based on the 20.5 feet average spread requirements of coast live oak and western sycamore plantings in riparian areas reported in San Francisquito Creek Joint Powers Authority’s Vegetation Restoration Guidelines (2000). Thus, 226 trees with a 20.5 feet diameter result in a required total area of approximately 1.7 acres. This area is important for calculation of some costs and considering net impact to various Ecology Parameters.

There is a five-year monitoring period for this Management Action during which, if a mitigation tree dies it must be replaced; this is in accordance with tree mitigation requirements approved by the City of Santa Barbara for past projects, such as the Valle Verde Retirement Community Project (see Rodriguez Consulting, Inc., 2011). During this period there are associated maintenance, monitoring, and reporting costs. On-site-trees planted are assumed to have 100 percent survivorship as the Museum would continually monitor and care for these trees, if the Management Action is a component of ELMS. Given this stewardship no reduction in overall tree numbers is considered. However for the purposes of this study, if the On-site Tree Replacement Management Action is implemented as a component of SMS, it is assumed that the Museum would act as a typical developer would and lower survivorship rates would apply (see Table 3.2 below).

Table 3.4 On-site tree numbers after 5-year monitoring period by survivorship rate

	Tree Count by Survivorship Rate			
Species	100%	75%	36%	10%
Coast live oak <i>Quercus agrifolia</i>	170	80	61	17
Western sycamore <i>Platanus racemosa</i>	56	42	20	6
Total	226	122	81	23

Additionally, no other vegetation is being planted as a result of the On-site Tree Replacement Management Action; as a result, the area of native vegetation added, area of non-native vegetation removed, and new number of native species was not considered for this Management Action.

HYDROGEOMORPHIC

According to a study by McPherson et al. in Santa Monica, California a single tree in the urban forest reduces stormwater runoff on average by 7 m³ or 1,856 gallons annually (2001). This number multiplied by the total number of trees planted was used to estimate the amount of runoff reduction expected at the Museum site created by this Action. The methods behind determining changes in infiltration rate and erosion rates are the same as the Off-site Tree Replacement Management Action.

BIOGEOCHEMICAL

The methodology for determining carbon dioxide sequestration, suspended solids removal, hydrocarbons removal, nitrate and phosphate removal, heavy metals removal, and reductions in heat island effect are the same as those presented in the Off-site Tree Replacement Management Action.

CULTURAL

Energy and emissions reductions (CO₂ equivalents) were calculated using the Center for Urban Forest Research (CUFR) Tree Carbon Calculator (CTCC; USFS Climate Change Resource Center, 2011; See

Table A.2 in Appendix A for model inputs). The energy reductions Target captures the effect of trees on annual energy consumption for air conditioning (MWh) and heating (MBtu). The emissions reductions Target captures the effect of trees on greenhouse gas (GHG) emissions associated with the generation of electricity and combustion of heating fuels (kg of CO₂ equivalents).

The distances azimuths of mature mitigation trees from the Museum and peripheral buildings are critical for calculating annual energy use and emission reductions. A map of tree locations by species and their distance to buildings was created based on the internal draft Landscape Plan designed by Van Atta Associates, Inc (2013; see Appendix A,

Figure A.8). In the draft plan, replacement trees are at least 15 feet from structures to comply with local fire prevention guidelines – the County of Santa Barbara has designated Mission Canyon as a high fire hazard area and thus recommended against planting any closer than 10-15 feet, both horizontally and vertically from structures (City of Santa Barbara Fire Prevention Bureau, 2004, pg. 21; Santa Barbara County, 2010; Santa Barbara County Fire Department, n.d.).

Qualitative scales assessing Fire Resistance, Museum Mission Fulfillment and Cultural Significance Bioswale and Rain Garden Installation. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1.

BIOSWALES AND RAIN GARDENS

BIODIVERSITY

The addition of native plants in these swales and gardens, particularly species not currently on the campus, affect the 'biodiversity' Metric by increasing diversity on campus. The current "Woodland Management Plan" proposes a planting palette for the woodland swale, VFS A, that translates to a species count; this palette was applied to VFS B, C and the rain garden areas to describe the plant biodiversity change created by all areas. This assumption uses the best available information, though it seems likely that the final plant palette would be larger due to the variety of swale and garden locations. These swales and gardens may also generally provide improved habitat for various animal species, though it is hard to estimate this quantifiably, particularly as to whether it would increase the number of animal species present. They can also provide habitat that allows biological communities to live on excess nutrients present in the runoff

HYDROGEOMORPHIC AND BIOGEOCHEMICAL

Generally, bioswales are open, vegetated channels designed to convey surface runoff much like a ditch or concrete channel (Groves et al. 1999, CalTrans 2009). However, bioswales are designed with natural soils appropriate vegetation, and shaped to slow flows. This reduces erosive power and increases infiltration to groundwater, encouraging the deposition of excess sediment, nutrients and pollutants in the swale. Bioswales can prevent nutrient and sediment overloading of local ponds, creeks and rivers, increase groundwater recharge, and trap substantial amounts of common stormwater pollutants like heavy metals, organics and particulates (Jurries 2003).

Rain gardens, another BMP, are similar to that of bioretention cells: they affect the hydrogeomorphic and biogeochemical Targets via water retention and increased soil infiltration. A rain garden fits in and compliments the natural hydrology of the area and complements it; runoff flows into the garden and then ponds, infiltrates the soil, and returns to the water table or is available to plants and wildlife for their life cycles. During infiltration, sediment and pollutants settle into the soil and so remain on site rather than traveling directly into streams.

These BMP's design characteristics can vary substantially as unique site-by-site considerations are made. The Santa Barbara Museum of Natural History's site characteristics strongly determine performance of bioswales and rain gardens. The site has soils with very low infiltration rates, rated USGS Soil Class D, meaning these rain events generate flashy, relatively large surface flows with relatively less precipitation going into groundwater (Earth Systems Consultants, 2010).

The Museum's Multi-Phase Development Plan, associated Engineers Reports and Landscaping Plan identified three locations on the Museum's campus appropriate for major bioswale installation, generally siting them along natural drainages. One drainage cuts through the woodland on the Western side (or

Parcel One, see Appendix A, Figure A.1) of the property and provides an appropriate location for a bioswale (VFS A). The design would lengthen and widen this ditch, install check dams to slow flows, add a gravel under-drain to improve drainage, and plant vegetation that prefers wetter conditions (Flowers Associates, Inc., 2013; Habitat Restoration and Open Space Management Plan (HROSMP), 2013). The combination of two additional swales would collectively channel the majority of runoff generated on the property and some flows from the 27-acre upstream residential development (see Appendix A, Figure A.1). Table A.1 in Appendix A summarizes major design characteristics of the three 'vegetated filter swales' (VFS) A, B and C, taken from the Flowers Drainage Report. The locations of these swales can be seen in Appendix A, Figure A.1.

A literature review was carried out to determine best available information on experimental or real-world performance of stormwater BMPs that could be used to estimate the likely effectiveness of those planned at the Museum. The most climatically and geographically relevant studies of these were pulled together to create a statistically informal range of estimated removal rates for stormwater pollutants of interest. The International Stormwater Best Management Practices Database (ISBMPD) project was also used to further inform the removal estimates. The ISBMPD is essentially a meta-analysis of approximately 530 BMP studies from around the world. Results gathered from the Database were selected by class of BMP and a description of the sample size, geographic distribution and other relevant information for that class was included to inform interpretation of the results.

Information from the City of Santa Barbara Creeks Division Annual Reports was used to link the literature review with Mission Creek and Santa Barbara by identifying the pollutants of concern in the region (City of Santa Barbara, 2012). These reports present years of water quality test results along nearby creeks and in their estuaries in accordance with State and Federal testing requirements. Normally, repeated exceedances of the EPA's water quality criteria can result in the listing of a waterway as 'impaired' for that pollutant or criteria. An impaired listing caused that pollutant or criteria to be considered of the highest concern for Mission Creek. Additional creeks reports identified other water quality issues that are of concern to Santa Barbara and Mission Creek.

Using these three key pieces of information- identifying the swale design characteristics, documented BMP pollutant removal rates, and pollutants of concern in the Mission Creek watershed the effectiveness of the Museum's proposed swales and gardens was estimated.

CULTURAL

Qualitative scales assessing Fire Resistance, Museum Mission Fulfillment and Cultural Significance described in Chapter 1 were used to evaluate this Metric. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1.

IMPERMEABLE SURFACES REMOVAL

BIODIVERSITY

The biodiversity impact of permeable surfacing installation is very difficult to estimate. This analysis only went so far as to propose that by connecting water and nutrient cycles with the soils below the permeable surface (as opposed to the disconnect created by impermeable surface) animal, plant and microbial communities may be affected by this marginal return toward more natural conditions.

HYDROGEOMORPHIC AND BIOGEOCHEMICAL

Chapter 3 Museum Case Study

The same general process for evaluating bioswale and rain garden impacts to the Ecology Parameter and its four Metrics was applied for evaluating impermeable surface removal and permeable surface installation. Agency BMP documentation and reports from the literature were used to advise the estimated results of installing permeable surfacing at the Museum.

The Redevelopment Project identified the areas of all impermeable regions on-site throughout each development phase. Using changes in area, for example changes in total building area, estimates of runoff were generated for single storms and for total annual rainfall. Reducing building footprints and the amount of paved area on-site will intrinsically reduce runoff. Combining this with replacing impermeable area with permeable paving or laying new permeable paving, the Museum will reduce runoff flows even more.

Estimates of site runoff are done by multiplying a storm size - essentially a rain depth- by an area. This gives a volume of runoff specific to the storm and area characteristics. If the surface has zero permeability, as the current pavement does, then this value is a rough estimate of runoff generated; 95 percent of rainfall converting to surface runoff was conservatively used in calculations, rather than 100 percent. A permeable surface, allowing high percolation of rain, would generate essentially zero runoff at low to medium volumes; 10 percent of rainfall converting to runoff was conservatively used in calculations, rather than 0 percent. The difference in these values represents how much storm runoff the Museum could avoid generating by either reducing impermeable areas or by replacing currently impermeable pavement with new, permeable systems.

Several scenarios were considered, varying by storm size, duration or project design. Runoff generation was calculated for a 1-inch storm, a 3.5-inch storm, and Santa Barbara's annual rainfall of 18 inches/year, across anticipated surface area changes.

Runoff generation was also considered under the condition that no new impermeable concrete is poured (~34,000 sq. ft. planned), but rather that this area is paved with permeable surfaces. Further, if other impermeable surfaces such as rooftops are connected to permeable areas like permeable pavers or rain gardens, the same area can have an even greater contribution to sending storm runoff into the soil and groundwater. This analysis estimated the hydrological effect of connecting 50 percent of building rooftop area runoff to nearby permeable areas.

By directing storm runoff into the soil below the pavement, many water pollutants borne in the runoff are deposited on site and do not make it into nearby waterways. Some degradation may occur by biological communities, much like the processes occurring in soils below swales and rain gardens. A literature review reveals that deposition does occur, varying by soil type and by length of flow path through that soil to the nearest waterway. There is not an extensive body of evidence concerning removal rates, but several sources indicate high performance for this analysis's water pollutants of concern.

CULTURAL

Qualitative scales assessing Fire Resistance, Museum Mission Fulfillment and Cultural Significance described in Chapter 1 were used to evaluate this Metric. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1.

INVASIVE PLANT REPLACEMENT

BIODIVERSITY

Effects to biodiversity of the sight focused on changes to native tree number, vegetation areas, wildlife abundance and quality of habitat. Increases to native tree numbers were equivalent to the number of non-native trees removed. Non-native trees would be replaced with either coast live oak (*Quercus agrifolia*) or sycamore (*Platanus racemosa*). Calculations for other vegetation involved assumptions and estimates. Vegetation surveys conducted on the Museum site described the diversity of plants qualitatively. No count of plant or species number was given in reports; instead standard language was used to describe the density of non-native and native vegetation cover. Percent land cover of non-native was thus estimated from these descriptions found in the *Botanical Resource* section of the Biological Assessment (Watershed Environmental Inc., 2013). , This section lists several types of understory vegetation (e.g. Ornamental, Non-Native Annual Grassland, etc.), as well as a qualitative description native vs. non-native coverage. These qualitative descriptions were translated to the following percentage values: “dominant” was estimated at 90 percent cover, “predominant” was 75 percent cover and “mix” was 50 percent cover.

The team multiplied the total area of each vegetation type by the estimated percentage of non-natives, and then calculated the total amount of native vs. non-native vegetation coverage (See Appendix A, Table A.3). The calculated areas for non-native plant cover were then multiplied by 90 percent to capture the “less than 10 percent herbaceous broadleaved weed species cover over the long-term” standard presented on page 50 of the Habitat Restoration and Open Space Management Plan (Watershed Environmental 2013). This calculation gives an estimate of non-native plants removed.

The removal area was combined with a standard success criterion for revegetation with native plants of 80 percent (Watershed Environmental Inc., 2013. Consequently, 80 percent of the removal area became the estimated area for new native vegetation cover. This area calculation was applied only to Museum parcels 1, 2, and 3 – effectively concentrating on the 6.2 acre oak woodland only.

Specific changes to species type and number were estimated using the list of native and non-native plants currently found on the museum property and the new planting palette described in the HRSOMP – refer to Appendix A, Table A.4. To simplify the analysis, restoration were assessed as occurring all together, not in stages as the Redevelopment Plan indicates. It was also assumed that restoration would be successfully completed after five years of monitoring and maintenance.

HYDROGEOMORPHIC AND BIOGEOCHEMICAL

Pages 36-37 of the HROSMP, describe no significant changes to the sites hydrogeomorphic functions due to changes in vegetation type (Watershed Environmental Inc., 2013). While in the short term some increased infiltration and erosion from restoration activity would be expected, impacts are likely to be minor

A literature review focused on native vegetation pollutant removal studies was conducted to determine whether or not changes in native vs. non-native vegetation type would impact the biogeochemical Targets. Studies did not reveal conclusive information regarding pollutant removal of suspended solids, hydrocarbons, nitrate/phosphates, heavy metal, or thermal pollution.

CULTURAL

Qualitative scales assessing Fire Resistance, Museum Mission Fulfillment and Cultural Significance described in Chapter 1 were used to evaluate this Metric. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1.

WOODLAND RESTORATION

BIODIVERSITY

Biodiversity analysis of this action began with establishing baseline information about existing resources and spatial coverage of vegetation. Completed documents by the Museum's consultants informed much of this process. Information from Watershed Environmental's Biological Assessment (BIA) and Habitat Restoration and Open Space Management Plan (HROSMP) was used (Watershed Environmental Inc., 2013). Wayne Ferren provided his White Paper analysis, Bill Spiewak his Arborist Report and Flowers and Associates their drainage study (Ferren, 2013; Bill Spiewak and Assoc., 2013; Flowers and Associates, Inc., 2013). Information regarding type of vegetation, habitat, amount of non-native plant cover, and animal species present and installed were found in these documents.

The HROSMP planting palette describes species number and plant quantity that would be installed at the Museum site. Restoration would focus on establishing, riparian zones, grassland meadow areas, dense oak woodland, and dry open areas. This site information was combined with academic studies surveying species diversity, amount of cover, and niche habitat structure in natural ecosystems of the coast range – healthy, undisturbed oak woodlands are home to more than 300 species of mammals, amphibians, reptiles and birds, 2,000 plant species and 4,000 insects (Standiford & Huntsinger, 2012; Tietje & Vreeland 2004; Merenlender, 1997). Predictions about how changes in habitat quality and woodland structure would impact biodiversity were then made from both sources of information.

Area calculations for changes to overall habitat cover were made from information in HROSMP. From that plan, a total of 5.44 acres of the 6.2-acre oak woodland will be restored. The .76 acres of remaining oak woodland exists on the boundaries of the whole area, close to residential properties and is considered to have low value ecosystem function. These areas will be function as transition zones at the woodland/residential interface and so were not considered in describing new habitat.

HYDROGEOGRAPHIC

Literature research focused on water movement in oak woodlands does not provide information that would contradict Watershed Environmental's assessment.

BIOGEOCHEMICAL

There is no specific information available to estimate nutrient cycling in the current woodland. Restoration that includes changes to the species composition of the woodland and a reduction of approximately 200 trees may have effects to nutrient and pollutant capture and storage; however, specific quantities were not estimated.

CULTURAL

Qualitative scales assessing Fire Resistance, Museum Mission Fulfillment and Cultural Significance described in Chapter 1 were used to evaluate this Metric. Identical methods for evaluating Economic, Policy, and Outreach Parameters were used across all Management Actions and are described in Chapter 1.

Results from the analysis of each Management Action are presented below. These results are categorized by Parameter, Metric and Target. Overall Strategy results are combined from individual Management Action results with overlapping effects eliminated.

MUSEUM CASE STUDY: RESULTS AND DISCUSSION

Table 3.5 and Table 3.6 presented below are the best representations for each Metric and indicate the overall effect of Management Actions and Mitigation Strategies. However, these numbers and single word descriptors, without qualification, do not tell the whole story. Synthesis of the outputs will put them in greater context and allow for a greater understanding of which conclusions can be drawn and which cannot. The discussion that follows will elaborate on the results – their meanings and limitations, draw comparison between mitigation strategies, and identify the implications for research and mitigation scenarios.

Table 3.5 Aggregate Results for Mitigation Strategies

		Standard Mitigation Strategy	Standard Mitigation Strategy with 10% tree survival	Ecological Lift Mitigation Strategy
Ecological Parameter	Biodiversity			
	Native Trees Planted	740	74	226
	Native Trees Impacted	0	0	7
	Non-Native Trees Removed	0	0	101
	Native Vegetation Planted (acres)	0	0	5.52
	Non-Native Vegetation Removed (acres)	0	0	5.98
	Total New Native Vegetation Planted (# of species)	0	0	7
	Habitat - Quality Impact	Increased; See results	Poor quality habitat	Increased; See results
	Habitat - Area Impact (acres)	4.3	4.3	No net change
	Hydrogeomorphic			

Stormwater Runoff Volume Reduction (acre foot/year)	1.3 +		2.09 +
Infiltration Rate (in/hr)	Increased		Increased
Erosion Rate	Reduced		Reduced
Biogeochemical			
Total Carbon Dioxide Sequestered at 20 years and 100% survival (kg)	724,656	72,466	220,660
Suspended Solids Estimated Removal Rate	Increased		75% - 95%+
Hydrocarbons/Oil & Grease Estimated Removal Rate	Uncertain		78%
Nitrates/Phosphates Estimated Removal Rate	Increased		15% - 85%
Heavy Metals Estimated Removal Rate	Uncertain		80% - 90%
Heat Contributed to Heat Island Effect	Reduced		Reduced
Cultural			
Annual Energy Reductions	22	2.2	No net change
Annual Carbon Emissions Reductions	9	0.9	No net change
Fire Resistance	-1		-1
Museum Mission Fulfillment	+1		+3
Cultural Significance	+1		+3

Policy Parameter	Consistency with City of Santa Barbara General Plan Environmental Resources Element (out of 20)	15	15	19
	Consistency with City of Santa Barbara General Plan Conservation Element (out of 4)	4	4	4
	Consistency with City of Santa Barbara Ordinances (out of 3)	2	2	3
	Consistency with City of Santa Barbara Guidelines and Standards (out of 2)	1	1	2
	Consistency with City of Santa Barbara Action and Management Plans (out of 2)	2	2	2
Economic Parameter	Short Term Costs	\$1,572,436	\$1,572,436	\$820,901
	Long Term Costs	\$240,202	\$240,202	\$537,709
	Total Costs	\$1,812,638	\$1,812,638	\$1,359,749
	Annual maintenance cost	\$1,984	\$1,984	\$48,412
	Total Cost minus savings from volunteer labor	\$1,799,144	\$1,799,144	\$1,169,293
Outreach Parameter	Community Involvement	+1	+1	+2
	Educational Utility	+3	+3	+3

Table 3.6 Results for Management Action Metrics

		Standard Mitigation Strategy					
		Ecological Lift Mitigation Strategy					
		Off-site 7:1 Tree Replacement	On-site 3:1 Tree Replacement	Bioswales & Rain Gardens Installation	Impermeable Surfaces Removal	Invasive Plant Replacement	Woodland Restoration
ECOLOGY PARAMETER	Biodiversity						
	Native Trees Planted	514	226	0	0	0	0
	Native Trees Impacted	0	0	5	2	0	0
	Non-Native Trees Removed	0	0	1	0	101	101
	Native Vegetation Planted (acres)	0	0	0.33	0	5.31	5.44
	Non-Native Vegetation Removed (acres)	0	0	0.12	0	5.98	5.44
	Total New Native Vegetation Planted (# of species)	0	0	6	0	7	7

Habitat - Quality Impact	Increased	Increased	Increased	Increased	Increased	Increased
Habitat - Area Impact (acres)	4.3	No net change	Uncertain; See Discussion	No net change	No net change	No net change
Hydrogeomorphic						
Stormwater Runoff Volume Reduction (acre foot/year)	Increased	1.3	Increased	0.79	No net change	No net change
Infiltration Rate (in/hr)	Increased	Increased	Increased	50 - 150	No net change	No net change
Erosion Rate	Reduced	Reduced	Reduced	Reduced	No net change	No net change
Biogeochemical						
Total Carbon Dioxide Sequestered at 20 years and 100% survival (kg)	503,996; See Figure A.10 in Appendix A	220,660; See Figure A.10 in Appendix A	No net change	Uncertain- See Discussion	Uncertain	Uncertain
Suspended Solids Estimated Removal Rate	Positive	Positive	75%	90%+	No net change	Uncertain
Hydrocarbons/Oil & Grease Estimated Removal Rate	Uncertain	Uncertain	78%	90%+	Uncertain	Uncertain

	Nitrates/Phosphates Estimated Removal Rate	Increased	Increased	15 to 60%	50 to 85%	Uncertain	Uncertain
	Heavy Metals Estimated Removal Rate	Uncertain	Uncertain	80%	90%+	Uncertain	Uncertain
	Heat Island effect	Reduced	Reduced	Reduced	Reduced	Reduced	Reduced
	Cultural						
	Annual Energy Reductions Cooling at 20 years and 100% survivorship (MWh)	0	22	No net change	No net change	No net change	0
	Annual Energy Reductions Heating at 20 years and 100% survivorship (Mbtu)	0	9	No net change	No net change	No net change	0
	Annual Emissions Reductions CO₂ equivalents at 20 years and 100% survivorship (kg)	0	9,314	No net change	No net change	No net change	0
	Museum Mission Fulfillment	0	+2	+2	+1	+2	+3

	Cultural Significance	+2	+2	+2	+1	+3	+3
POLICY PARAMETER	Consistency with City of Santa Barbara General Plan Environmental Resources Element (out of 20)	15	15	8	6	7	13
	Consistency with City of Santa Barbara General Plan Conservation Element (out of 4)	4	4	2	1	4	4
	Consistency with City of Santa Barbara Ordinances (out of 3)	2	2	0	0	1	0
	Consistency with City of Santa Barbara Guidelines and Standards (out of 2)	1	1	2	1	2	0
	Consistency with City of Santa Barbara Action and Management Plans	2	2	0	0	2	0

	(out of 2)						
ECONOMIC PARAMETER	Short Term Costs (Immediate costs/Year 1)	\$1,560,658	\$11,788	\$171,000	\$255,000	\$319,130	\$155,092
	Long Term Costs (Years 2 - 5)	\$39,556	\$200,636	\$9,860	\$2,400	\$152,561	\$299,999
	Total Costs (Through Year 5)	\$1,600,214	\$212,424	\$182,000	\$257,400	\$471,691	\$455,090
	Annual maintenance cost (Year 6 and Beyond)	\$0	\$1,984	\$2,465	\$600	\$26,825	\$39,000
	Total Cost minus savings from volunteer labor	\$1,600,214	\$198,930	\$171,000	\$255,000	\$302,566	\$319,036
EDUCATION AND OUTREACH PARAMETER	Educational Utility	0	+3	+3	+2	+3	+3
	Community Involvement	0	+1	+2	+1	+1	+3

OFF-SITE TREE REPLACEMENT AT A 7:1 RATIO

ECOLOGY PARAMETER

Off-site Tree Replacement at 7:1 Ratio results in 514 native trees planted either in the same or nearby watershed. An increase in native wildlife species number and abundance is expected. This Management Action's impacts are all off-site, and given the hexagonal or equilateral triangular planting layout 4.3 acres would be required. The planting of trees where there is currently none in the pattern described would yield 4.3 acres of new/improved habitat. The movement of water over and through the off-site location with 514 trees will change. Infiltration rates are expected to increase and erosion is expected to decrease from the planting of trees on a site where there is no trees. There is an anticipated 1.3 acre-feet per year of stormwater runoff reduced per year. Over 20 years with, 100 percent survival, the trees planted will sequester 503,996 kg of carbon; however, with 10 percent survival 50,399 kg is sequestered. Suspended solid, nitrates/phosphates, and heat coming out of the woodland will be reduced. It is uncertain how hydrocarbons and heavy metal concentrations will be affected. Cultural components of ecology are captured through the use of the qualitative scales. This Action is not scored for Fire Resistance, but gets a +1 for Cultural Significance, and 0 on the Museum Mission Fulfillment scale.

The Off-site Tree Replacement Management Action positively affects the ecological characteristics of the location where planting occurs. While absolute numbers regarding several of the Metrics are uncertain (change to number of wildlife species, infiltration rate change, etc.) research has shown that trends do exist.

The extensive root system that oaks and sycamores have stabilizes hillsides and reduces erosion (Keeley & Swift, 1995). Trees are a structurally significant component of ecosystems that provide habitat, shade, food, and water holding capacity of the soil (Block & Morrison, 1991; Keeley & Swift, 1995). Trees that defoliate provide nutrients to the soil, increasing a soils' ability to support understory plants (Dahlgren et al. 2003). There is little question that trees on a landscape provide ecological benefits. There is less clarity about how much a single tree impacts a site. Multiple factors including age, presence of existing trees, existing site conditions, presence of wildlife and others, will determine precise effects. Understanding these different factors requires detail that currently doesn't exist. This lack of high-resolution detail led to the qualitative description of 'increased' for storm water runoff volume reduction, infiltration rate, nitrate/phosphate removal rate, and suspended solids removal rate. Gaps in the scientific literature make predictions about a tree's future performance regarding heavy metal, grease and oil removal from water speculative.

The off-site location of this Action determines in large part what sort of impacts will occur. The cultural Metrics of ecology are focused on impacts/changes relative to the Museum site. While it is not known how close the off-site planting location will be relative to the Museum, it is clear that no suitable 4.3-acre site exists walking distance miles of the Museum. This distance makes it impossible for the Action to have any effect on the Museum's energy reduction or annual carbon emission totals. Further, the uncertainty regarding understory vegetation, proximity to roads and other trees on the off-site location makes scoring fire resistance not applicable.

The carbon sequestration estimate is given as 503,996 kg carbon at 20 years. The USFS' Center for Urban Forest Research Tree Carbon Calculator reports numbers on an additive basis, so if all 514 trees survived to age 20, they would have sequestered 503,996 kg carbon. This is considered the upper limit of sequestration; it is unlikely that every tree would survive to this age. Current requirements stipulate a 5-year monitoring period, during which time if a tree death occurs, it is replaced. Trees are considered established if they can survive for 3 years without water. It is assumed that once this occurs at year 5, mitigation is complete. Discussion with experts tend to agree that survivorship is usually extremely low –

most of the mitigation trees planted die after several years, and sometimes they all die (personal correspondence). If only 10 percent survive, then 50,399 kg carbon would be sequestered. For those that do survive, natural variability will change growth rates and consequently overall size, adding considerable uncertainty to carbon sequestration totals Standiford, McCreary, & Frost, 2002.

POLICY PARAMETER

Comparing this Management Action to values and objectives found in relevant current policy goals, implemented actions and possible implementing actions, there is alignment to 15 of 20 in the General Plan Environmental Resource Element. Comparing this Management Action to values and objectives found in relevant current policy goals and policies, from the 1979 Conservation Element, there is alignment to four of four. Of the three local ordinances concerning zoning or tree preservation/planting, Off-site Tree Replacement aligns with 2 of them. The Landscape Design Standards for Water Conservation are met with this Management Action. Two out of two of the Action Plan's goals are met with this Action.

In total, off-site tree replacement is consistent with 24 out of 31 of the relevant policy goals, implementation actions, requirements and guidelines. The City's General Plan is written with the intent to identify important city values and guide development and management so that the "health, safety and welfare of the community" are maintained (City of Santa Barbara, 2011). This evaluation shows that off-site tree replacement, while not necessarily prescribed by existing policy, meets the goals and objectives of several policies in Santa Barbara and would represent the City's overall intention well.

ECONOMIC PARAMETER

Total cost for Off-site Tree Replacement is calculated at \$1,600,214. This total includes both short-term, long-term costs. There are no savings from the use of volunteers. Short-term costs alone account for \$1,560,658 of the total and long-term costs account for \$39,566. The short-term cost is dominated by the cost of land acquisition in Santa Barbara.

Costs associated with this Management Action are dominated by land acquisition and is also the source of greatest uncertainty in these estimates. While it is conceivable that the Museum would buy land, plant trees and then hold on to the land, it is much more likely that they would rather sell or donate the land to a land trust or other non-profit. This reduces management costs and removes liability concerns the Museum may have. Additionally, the Museum could look to pay for a conservation easement and plant trees instead of buying the land outright. These additional scenarios were not accounted for in this assessment and could add considerable variability to land cost.

Cost variability is not solely determined by land purchasing. Watershed Environmental reported maintenance costs included a 5 percent contingency replacement. The actual percentage of mitigation trees that will have to be replanted may be significantly higher for this Management Action, given site variability and the lack of daily monitoring/maintenance. Actual costs may increase by several thousands of dollars (approximately 5 percent) depending on contingency replacement.

OUTREACH PARAMETER

Evaluation of the Outreach Parameter consisted of two qualitative scale rankings. For the Educational Utility score, Off-site Tree Replacement ranks as a -2. Ranking based on the Community Involvement scale yields a -1.

Planting 7:1 trees off-site somewhere would provide much of the same volunteer opportunities as the On-site Replacement action. Depending on the site chosen and its characteristics (ownership, access, etc.) it may be more difficult to arrange for regular long-term volunteer opportunities; much of it depends on the

terms of the agreement, but this would certainly be a facet the Museum should pursue. Again depending on the site, there could be substantial effects on biodiversity, habitat creation, etc. that would lead to some citizen scientist opportunities. The common thread for this Action across these Community Involvement categories is a dependency on the selected site's characteristics. By extending its presence beyond the campus borders, the Museum may create new connections, encourage new visitors or increased visitation rates, and generate new donations by becoming more prominent in the local community. The reverse could also be true with donations decreasing from people who are disappointed their money is being spent by the Museum in other locations. Further, the off-site location may make it difficult to coordinate educational opportunities, especially for a diversity of visitor types. As a result of this expected inaccessibility, this Management Action receives a zero or no change score.

ON-SITE TREE REPLACEMENT AT A 3:1 RATIO

ECOLOGY PARAMETER

On-site Tree Replacement at 3:1 Ratio results in 226 native trees planted on the Museum property, but does not cause any further change to on-site vegetation. An increase in native wildlife species number and abundance is expected. This Management Action's impacts are all on-site, and therefore the area of impact is the same pre- and post-action. No net change to total habitat area is expected. The movement of water over and through the Museum site post on-site tree replacement is expected to change. Infiltration rates are expected to increase and erosion is expected to decrease from the planting of trees. Runoff from storms is predicted to decrease by approximately 1.3 acre-feet per year. Planting 226 trees on the Museum site will have effects on nutrient and chemical cycling. Over 20 years with 100 percent survival, the trees planted will sequester 220,660 kg of carbon. At year 20, the Museum will reduce electricity consumption by 22 MWh, 9 Mbtu and GHG emitted by 9,314 kg per year. Suspended solid, nitrates/phosphates, and heat coming out of the woodland will be reduced. It is uncertain how hydrocarbons and heavy metal concentrations will be affected. Cultural components of ecology are captured through the use of the qualitative scales. This Action scores -1 on the Fire Resistance scale, +2 for Cultural Significance, and +2 on the Museum Mission Fulfillment scale.

The On-site Tree Replacement Management Action positively impacts the ecology of the Museum site. While the area of habitat is not changed, the quality of habitat is increased due to increasing diversity of canopy structure and stand age. Many of the benefits will be delayed until the planted saplings grow to a significant size, approximately at 15 years. Across the site, acorn production will increase, providing more food for native animals, and niche habitat will be created for nesting birds, mammals, insects and invertebrates. The overall canopy cover of the Woodland will increase through time from 80 percent to nearly 100 percent. This particular change is not necessarily beneficial to all animal and plant species equally. The increased density of the woodland will eliminate some of the open areas and create a more forested ecosystem.

While additional trees planted on-site will benefit the ecology, several components of the site that are incongruous with the optimal native habitat will remain. Approximately 100 non-native trees, and an understory dominated by invasive plants will temper the beneficial effect of new trees. The persistence of English Ivy, non-native grasses, and patches of ornamentals will continue to limit the amount of native habitat and the overall biodiversity on-site. Without comprehensive habitat restoration, the on-site woodland will experience only marginal increases to habitat quality.

Similarly to off-site tree replacement, soil infiltration rate is expected to increase and with less water sheeting off the surface, erosion will decrease. Stormwater runoff reduction is predicted to decrease approximately 1.3-acre ft. per year. The current site's infiltration rate is very low, so improvements to the hydrology of the site need not to be dramatic to be significant (Flowers and Associates Inc., 2013). With

minimal site preparation required for planting trees, the breaking up and aeration of the soil will yield modest benefits.

The Museum is committed to stewardship of trees planted on-site and would plan to continually maintain on-site trees in perpetuity. This agreement allows the consideration of a 100% survival rate. Further, should a tree die at age 6, the Museum is not required to replant the tree, but would do so anyway. These management commitments allow for the 22,660 kg estimate of carbon sequestered at year 20 to be considered very achievable. The Museum's continued stewardship beyond the required 5-year period is not typical of other developers. Given this and the large proportion of mitigation tree death described by interviewees, it is highly unlikely that the most of the trees planted for mitigation would survive to maturity.

Improvements to the biogeochemical Metric are estimated; however, exact magnitudes of improvements are highly variable. Currently, the Museum woodland contains 1,200 trees. The addition of approximately 18 percent more trees will increase overall water uptake and filtration by plants and create soil conditions that are more efficient at capturing nutrients and suspended solids. Studies considering heavy metal removal and hydrocarbon/oil removal from runoff have not been done for trees or woodlands, leading to an indeterminate conclusion.

Cultural impacts from an ecology lens show on-site tree replacement having positive and negative effects. This Action aligns well with the Museum Mission Fulfillment objectives, and would provide a small positive impact to Cultural Significance. Respectively, the +2 score and +1 score indicate that On-site Tree Replacement would fit well with Santa Barbara's and the Museum's values. The small to intermediate height of the trees during their initial growth phase will be easily burnable and may be considered as ladder fuels. Fire in Mission Canyon is of large concern to residents (County of Santa Barbara, 2013). Fire and the other cultural values can be in opposition.

Thermal regulation from trees that are nearby buildings are a known advantage. The reduction effects of trees on electricity consumption for the Museum from on-site trees were calculated as 22 MWh per year – a substantial savings for the Museum with its 96,539 sq. ft. area. Savings of gas for heating were calculated at 9 Mbtu annually. Annual reduction to GHG emissions from this reduced electricity and gas use are 9,314 kg. These benefits are not seen immediately; rather they come after each tree has grown to sufficient size to offer benefits. This analysis focused on 20 years as the example, but in reality tree growth would be highly variable. Further, climate variation will dictate the needs of the Museum so these numbers are accurate but rough estimates of actual savings.

POLICY PARAMETER

On-site Tree Replacement as a mitigation tool is the current standard. Comparing this Management Action to values and objectives found in relevant current policy goals, implemented actions and possible implementing actions, there is alignment to 15 of 20 in the General Plan Environmental Resource Element. Comparing this Management Action to values and objectives found in relevant current policy goals and policies, from the 1979 Conservation Element, there is alignment to 4 of 4. Of the three local ordinances concerning zoning or tree preservation/planting, this Management Action aligns with 2 of them. The Landscape Design Standards for Water Conservation are met with this Management Action. Two out of two of the Action Plans are met with this Action.

On-site Tree Replacement affects the Policy Parameter in nearly identical ways as the Off-site Tree Replacement Action. On-site tree replacement is able to align with more policies because the known planting location allows for explicit application of the storm water management policies and guidelines. The ambiguity of the off-site characteristics could result in a location that does not require storm water guidelines, either because plantings would not be considered development, or because the location in the watershed would not be in an urban setting. The value to the city of Santa Barbara of native trees near

buildings is reflected in its storm water guidelines and policies, thus indicating that on-site tree replacement is a favorable mitigation outcome.

ECONOMIC PARAMETER

Total costs for on-site Tree Replacement is calculated as \$212,424. This total includes both short-term, long-term costs, and savings from the use of volunteer labor where possible. Short-term costs alone account for \$11,788 of the total and long-term costs account for \$200,636. The long-term cost is dominated by the salary of an Open Space Project Manager – a 30-hour per week position paid \$25.00 per hour for 5 years. Over 5 years, the Open Space Project Manager will cost approximately \$195,000.

On-Site Tree Replacement is nearly the cheapest Management Action, second only to the Bioswale and Rain Garden Management Action. Land acquisition is not necessary, enabling short-term costs (those associated with installation) to remain low – \$11,788. Maintenance make up the bulk of this Action's cost, specifically, the woodland manager's salary. The woodland manager is considered critical to ensure survival of the trees through time and to creating volunteer opportunities. The material cost of trees, gopher cages, flagging, labor and irrigation material is low compared to the required monitoring and oversight from a manager. Leveraging volunteer labor for plantings and site preparation could reduce much of the labor cost; however, the extent to which this actually occurs depends on the organizational ability of the Museum. Creative use of resources could make this Action's economic impact lower than reported here.

OUTREACH PARAMETER

Evaluation of the Outreach Parameter consisted of two qualitative scale rankings: for the Educational Utility score, this Action ranks as a +3. Ranking based on the Community Involvement scale yields a +1.

Replacing the maximum number of trees possible on-site would increase volunteer opportunities in terms of both quantity and variety – thereby increasing Community Involvement. However, there are not clear citizen scientist opportunities directly created by this step. This Action would be replacing tree species that already exist on campus and so would likely not provide reasons for new demographics or underserved community members to visit. Similarly, it is not clear that this Action would increase overall visitation or provide compelling reasons to donate because it is not doing anything new or creating any kind of exhibit.

Replacing the maximum number of trees possible on-site would provide opportunities for passive and active learning similar to oak woodland restoration. Possible lessons about ecosystem dynamics may not be as easily displayed in the tree replacement Management Action, but active learning could be integrated into tree planting through citizen science experiments or an adopt-a-tree program. This Management Action has the potential to reach a broad set of people, including children, the elderly and disadvantaged communities, but the extent of this educational access will depend on the execution of outreach and the design of educational programming.

BIOSWALES AND RAIN GARDENS INSTALLATION

ECOLOGY PARAMETER

As designed, proposed bioswale and rain garden siting will adversely impact five native trees (oaks and sycamores), though this may be reducible by 2-3 individuals with variance in Vegetated Filter Swale (VFS) A's design. Additionally, the removal of one non-native tree in VFS A will occur. The total acreage of the swales and gardens, 14,484 sq. ft., or 0.33 acres, will be planted fully with native vegetation; only VFS A's 0.12 acres will have non-native vegetation

*removed first. This planting palette will include six native plant species not currently on-site: five species of rush (genus *Juncus*) and one species of monkeyflower, as well as other species that are currently represented on-site (yerba mansa, deer grass and Santa Barbara sedge) for a total of 6 new native species. This Action will provide generally improved habitat quality for various animal species due to the increase in native plant cover. New habitat will be generated for the 0.15 acres of pavement that are replaced with native vegetation. This Action will have direct impacts to all three Targets within the Hydrogeomorphic Metric. Swales and gardens will reduce stormwater runoff volume discharged to Mission Creek by the campus and increase infiltration rates. This Action is designed to slow down storm runoff flows, thereby reducing the high energy potential that leads to soil erosion. The total carbon dioxide sequestered at year 20 by this Management Action is likely to be no net change from current conditions. Bioswales and rain gardens will impact various biogeochemical Targets via interception, settling, sorption, infiltration and biomass production. This Action would remove some percentage of nearly all likely pollutants present in stormwater passing through the swales and gardens – see "Results" for all removal numbers – which includes runoff originating on-site as well as from residential neighborhoods higher in the watershed. This Action will marginally reduce the heat island effect of the Museum's campus by increasing vegetative cover and reducing pavement area. Runoff temperatures would also be reduced by as they pass through these systems. This Management Action is not anticipated to have any measurable effect on the Museum's annual energy use, nor by extension reduce the site's annual carbon emissions. The Bioswale and Rain Garden Action is scored as a +2 for Fire Resistance, +2 for Museum Mission Fulfillment and +2 for Cultural Significance.*

As proposed, Bioswale and Rain Garden Installation would produce net positive environmental benefits to several fundamental ecological Metrics by raising plant diversity on-site, flattening peak storm flows and generally reducing water pollutant loading to Mission Creek from both on- and off-site storm runoff (McEwan & Jackson 1996, Jurries 2003). The Action's effect on some of the Metrics considered in this analysis are not as easily predictable, such as effects on animal habitat quality, the extent of certain water pollutant removal rates, and others; these effects, both certain and less so, are discussed below in the order of presentation in the Results section.

Bioswales and rain gardens would directly cause adverse impact to five native trees' root structures during site preparation and construction, contributing to the original mitigation requirements. The Flowers report and the Woodland Management Plan describe how this may be minimized by narrowing the swale when near sensitive trees and correspondingly widening it when possible, impacting perhaps just two individuals.

It is possible that this would benefit native animal species via improved habitat conditions. However, there are complicating considerations: the limited diversity, population, and mobility of animals in this urban environment, the site's location along Mission Creek (where creeks often serve as urban wildlife corridors), 'habitat forcing', and a question of impact scale. These factors make it very difficult to predict to what extent local habitat will be improved, though it seems ecologically sound to presume a small but net uplifting effect from improved (native) shelter and food resources on-site. Though the total acreage (0.33 acres) affected is a relatively small area, and the 0.15 acres shifting from currently barren land even smaller, the cumulative impacts of small land-use shifts throughout Santa Barbara's fully developed watersheds are essentially the only way to have net positive ecological lift to habitat quality and quantity on a large scale.

Based on the site's very impermeable soils (USDA Class D, estimated at 0.01 to 0.001 inches/hour) and depending in part on final design parameters, the swales and gardens' increased infiltration rates will be most effective at returning rainfall to groundwater from small to average rain events. Once a swale has been filled or 'ponded' during a large event, additional water will discharge directly to Mission Creek. Even when filled, however, the swales and gardens will slow runoff flow (with designed residence times of about 10 minutes) which will contribute to lowering the peak flows entering Mission Creek; this is the real benefit, in terms of flood control. This benefit would extend to incoming runoff from the uphill residential

neighborhoods for small to average rains. The same slowing effect will also decrease erosion rates on-site and where flow from these swales enters the creek, compared to current conditions, depending particularly on the design of those confluences. The design of the swales is intended to treat a certain size storm effectively - the 'design storm', in this case a 1 inch event over 24 hours - and the Flowers report estimates that the swales will decrease total site peak flows by about 2%. Note that this estimate does not include the effect of the rain gardens, nor does it consider the bioswales having specially designed under-drains to increase their runoff capacities and infiltration rates.

For bioswales to remain effective over time they must have their plant matter and top layer of organic matter periodically pruned and removed, such that the pollutants they filter from stormwater are removed from the site and taken for either landfilling or treatment (Fairfax County, 2005). Due to this cycling of plant life and organic matter, the bioswales and rain gardens were estimated to be nearly carbon neutral, in the sense that plants will regularly grow - sequestering carbon- and then be removed, effectively releasing that carbon (depending on the details of disposal, degradation, etc.).

Percent removal of pollutants would be highest during low flows (which carry the highest concentrations of pollution, though may contain smaller total loads) due to longer residence times, slower physical passage, and complete or nearly complete infiltration through the bioswales' vegetation and soils. In practice, bioswales tend to be documented as most effective at removing suspended solids/sediment, oils/greases/hydrocarbons, and heavy metals (CalTrans 2004 and 2009, CRWA 2008, Groves et al 1999, ISBMP Database 2013, Jurries 2003, Schueler 1987, Xiao & McPherson 2011). Nutrient removal is variable depending on the exact design, plant life and incoming quantities, but would likely be positive for various forms of nitrogen and phosphorus (soluble, mineral and organic). Performance is highest when nutrients are contained within organic matter, and lower for very soluble or biologically unavailable forms. This would be due to the swales' efficacy at settling out particulate or organic soil matter, which typically carries a fraction of total nutrients via sorption. This would extend to other pollutants, for example heavy metals: the more strongly a pollutant sorbs to particulate or organic matter, the more effective a swale will be at removing it.

The literature is mixed concerning bacterial loading from bioswales; some swales have been found to remove bacteria (such as various forms of *coliform*) from runoff (Jaffares & Green 2013), and others found to export bacteria (CalTrans 2004). This may be due to increased animal life in the swales. Either way, the swales cannot be expected to lower incoming bacteria concentrations. The swales would remove pollution in runoff incoming from the 27 acres of upstream residential neighborhoods as well; again, with higher efficacy after small to average rain events. The bioswales are designed to treat minor flows from the upstream neighborhoods. One of the major shortcomings would be the lack of coliform treatment, as this tends to be a high input from residential neighborhood, and is of particular concern to Mission Creek (Jaffares & Green 2013).

The EPA and the Creeks Department have identified the water pollutants of highest concern in Mission Creek to be sediment, heavy metals and bacteria counts. Bioswales and rain gardens, if operating properly, remove sediment and heavy metals very effectively, benefiting Mission Creek. The Santa Barbara Creeks Division's local, large-scale bioswale installation at Upper Las Positas Creek (ULPC) gives an interesting local perspective of bioswale efficacy: the first two years of monitoring data available suggest that these bioswale installations do not seem to decrease coliform, nutrients or sediment in a substantial, regular fashion. However, it has been shown in other studies that bioswales are typically not very effective until all vegetation has filled in and disturbed areas from construction become settled – which can take several growing seasons. Nonetheless, these results indicate, in conjunction with literature review results, that bioswales and similar BMPs may be less effective in Southern California's climate and topography than in wetter, better draining, and more botanically productive regions.

These swales and gardens can be expected to reduce thermal pollution to Mission Creek. Stormwater running off hot surfaces like roofs, roads and parking areas has been shown to be substantially hotter than runoff from vegetated areas - hotter by several degrees, and one study found a difference of nearly 15 degrees (Fairfax County 2005). This depends on several factors such as daily temperature and cloud cover. Given that Santa Barbara receives rain in the winter, when pavement is likely to be cool, thermal modulation of runoff would not be dramatic. However, due to the sensitivity of creek organisms to water temperature, this is an important benefit of the Bioswale and Rain Garden Action. The more fully vegetated the swale and the longer the residence time, the more thermal pollution reduction can be expected.

Similarly, this action would likely reduce the overall heat island effect of the Museum's campus, though it is not expected to be a large effect. Typically, a conversion of hardscape area to vegetated or more natural areas reduces this effect - even a simple lawn is many degrees cooler than a rooftop in full sun. Some of the bioswale and rain garden installation area will be replacing currently hardscape areas, though just a few thousand square feet in total.

Due to the small heat island reduction and the lack of shade provision for the Museum buildings, this Action isn't expected to lower the Museum's annual energy use, nor reduce the site's annual carbon emissions due to energy consumption.

This Action received a score of +2 on the Fire Resistance Scale, indicating that bioswales may increase fire resistance both directly in their area and also for the site as a whole. This is due to a plant palette that is largely lowland or wetland species (which are not particularly flammable) and the likelihood of generally wetter conditions. The woodland swale (VFS A) may serve as a fire-break as it is a 4 to 6 meter wide ditch with wet conditions and few highly combustible fuels. This creates a gap between trees and runs entirely through the woodland, North to South. It is functionally similar to a designed firebreak, though it does provide some extent of combustible plant material. Proper maintenance would lower the fire risk and bolster this swale's efficacy as a woodland firebreak.

The Bioswales and Rain Gardens Installation Management Action provides an opportunity for the Museum to inspire awe in and connect visitors to the water cycle and received a score of +2 on the Museum Mission Fulfillment Scale. This indicates a strong correlation with Museum values and the overall mission to connect people through education and discovery to the natural world and sustainability. The bioswales connect people to the benefits natural areas provide in terms of pollution reduction, groundwater infiltration, and flood control, inspiring awe and appreciation of the natural world.

There is the opportunity for the Museum to serve as a leader and resource to the community by teaching the benefits of and processes for implementing bioswales in landscaping throughout the private community. Similarly, this Action could lead to longitudinal scientific study or citizen science projects to improve bioswale implementation, performance and impact throughout the City, providing the community with an opportunity to expand our understanding of the natural world.

This Action received a score of +2 on the Cultural Significance Scale, indicating that it would add to the unique character of Santa Barbara and integrate well with the landscape. While bioswales and rain gardens are not precisely the habitat typically found in this area, they would exemplify historically relevant, local wetland and plant types. Bioswales and rain gardens are not present historically in Santa Barbara; rather, they are a relatively new Best Management Practice for storm water control. While the structural components of these tools are new, the plants that are employed as central components of the bioswale or rain garden are native riparian/wetland species of Santa Barbara. The use of these plants gives this action some historical connectivity and good integration with the current landscape. A sense of

place is created and Santa Barbara's values are present in the bioswale and rain garden as they reflect the City's sustainability and biological values.

POLICY PARAMETER

The Bioswale and Rain Garden Installation Management Action was determined to be consistent with 8 goals or policies from the General Plan's Environmental Resources Element. Comparing this Management Action to values and objectives found in relevant current policy goals and policies from the 1979 Conservation Element, the team found alignment with 2 of 4. Bioswale and rain garden installation does not align with any of the three local ordinances concerning zoning or tree preservation/planting, or with the two selected Action Plans. The 2 Landscape Design Standards for Water Conservation are met with this Management Action. The Bioswale and Rain Garden Action was found to be consistent with all relevant portions of these documents, particularly meeting the considerations of the Landscape Design Standards for Water Conservation and the Stormwater Guidelines, along with 8 relevant goals or policies from the Environmental Resource Element of the General Plan.

The only apparent conflict with current policies is VFS A's negative impact to several sensitive trees. This would conflict with the City's stated intent to preserve and protect existing individuals of sensitive tree species, best summarized in the City's Tree Ordinance. This conflict showcases the management tradeoffs that develop when comparing the effects of different mitigation actions and their impacts.

ECONOMIC PARAMETER

The Bioswale and Rain Garden Installation Management Action is estimated to have a Short-term cost of \$171,000. Long-term costs total would be approximately \$9,860, primarily from maintenance. The annual cost of maintenance is an estimated \$2,465. This Action would have an approximate total cost (through year 5) of \$182,000, but may be as low as \$48,000 or as high as \$300,000.

The best estimate of cost for this Action is for a Year 5 Total Cost of \$182,000; several dozen real-world bioswale and rain garden construction history is entrained in this estimate via the literature and agency provided cost summaries (CRWA 2008, CRWP 2012, Ohio EPA 2011, SEWRPC 1991, UDPREP n.d.). However, the Bioswale and Rain Garden Action could cost anywhere between \$48,000 and \$300,000 through Year 5. This cost depends on the extent of engineering and design characteristics, and subsequent construction time and complexity; bioswales can range from very simple – almost a grassy ditch – to more engineered like those proposed at the Museum. For example, VFS A would have a gravel underdrain system as part of its design, which is an expensive option and a more technical construction process. However, professional bids on all of the associated swales and gardens would have provided for a far more accurate picture of the costs.

Volunteer labor was not assessed for bioswale and rain garden implementation because it did not seem sensible that much of the work would be doable by the average Museum volunteer. Professional contractors, operating heavy equipment, planting knowledgeably and at scale, would complete the construction phase. The maintenance phase lends itself to volunteer labor, however, as it largely involves pruning, watering, weeding and other non-physically demanding tasks.

OUTREACH PARAMETER

The Education and Community Involvement Qualitative Scales were applied to this Management Action, resulting in scores of +3 and +2, respectively.

These landscaped areas are designed to slow peak runoff flows, return flows to the water table and remove some amount of water pollutants. This would be a new feature on the Museum campus. Swales and rain gardens would need to be designed, built, and regularly maintained to varying degrees

depending on design. The build and maintenance phases would provide opportunity for active learning - including possible citizen science programs. They also serve as a static, visual exhibition that would facilitate passive learning similar to the existing indoor exhibits. Additionally, with a range of manual labor, planting, and landscape maintenance activities not currently ongoing at the Museum, it seems reasonable this Management Action would grow the volunteer pool. Due to the novelty of these multi-functional, educational installations that can be applied at most scales in most places it seems reasonable that new demographics may be inclined to visit the Museum to see these in action.

Further, they may foster a sense of connection between people and their environment- everyone and every property has an impact on water quality, and these installations teach that universal connection to the water cycle. By providing such visual exhibition of this connection, people may be inclined to donate- particularly if those people are effectively taught the direct benefits to the upstream and downstream community.

This Management Action has the potential to reach a broad set of people, including children, the elderly and disadvantaged communities, but the execution of this expanded educational access will depend on the execution of outreach and the design of educational programming.

IMPERMEABLE SURFACE REMOVAL

ECOLOGY PARAMETER

Impermeable surface removal will directly impact 2 native trees of concern via surface removal or creation. Increased Habitat Quality is expected in Mission Creek due to effects on water and nutrient cycling, and potentially in the earth beneath currently impermeable surfaces. However, there is no anticipated Habitat Area impact. The Impermeable Surface Removal Action was estimated to reduce total site runoff by about 0.79 acre-feet per year, an 11% reduction. Infiltration rates in the areas affected will increase to between several inches/hour to many dozens of inches/hour (Dreelin et al. 2006, Booth & Brattebo 2003). Given the site's low permeability soils infiltration will likely be closer to the low estimate (Dreelin 2006). It is uncertain whether this Action would sequester carbon, long-term. The changes in permeable and impermeable surfaces would likely reduce pollutants in incoming storm runoff by the amounts shown in Table 3.6. Removal rates were estimated to be high for all pollutants considered, while bacterial removal would likely be positive. A conversion of thousands of square feet of asphalt to concrete may reduce the heat island effect on the Museum's campus, and the installation of permeable surfaces would cool high temperature runoff as it permeates the system and moves into Mission Creek. This Management Action is not anticipated to have any measurable effect on the Museum's annual energy use, nor reduce the site's annual carbon emissions. The Impermeable Surface Removal Action was scored as +3 for Fire Resistance, +1 for Museum Mission Fulfillment and +1 for Cultural Significance.

As proposed, Impermeable Surface Removal would produce net positive environmental benefits to several fundamental ecological Targets by substantially reducing site runoff, flattening peak storm flows, and reducing water pollutant loading and thermal pollution to Mission Creek. The Action's effects on some of the other Targets are not as easily predictable, such as effects to habitat area or site carbon sequestration. These effects, both certain and less so, are discussed below in the order of presentation in the Results section.

This Action would directly cause adverse impact to two native trees' root structures during site preparation and construction, contributing to the original mitigation requirements. Permeable pavement would not be installed across the entire parking lot, in order to minimize impacts to sensitive trees whose roots lie beneath the existing pavement. However, if the trees were to survive they would benefit in the long run due to increased access to water and soil nutrients. This Action would have some small net positive effect on Mission Creek's habitat quality via its hydrogeomorphic and biogeochemical benefits. For example, it

has been observed that steelhead trout often cannot travel against the unnaturally swift peak storm flows (McEwan & Jackson 1996). With a lessened peak flow, habitat quality may be improved for steelhead in Mission Creek. This is noted to be a very small improvement – but it represents the small, point-source net improvement that is necessary in an urban environment at a large scale to produce large improvements. While it is acknowledged that the soil habitat below the newly permeable areas may be improved for various forms of life, citing the total area of the permeable surfacing as improved habitat did not seem appropriate due to the tenuous, unsupported nature of the overall claim – no research was discovered in the literature that has directly addressed this question.

Less hardscape area would reduce the volume of rain falling on impermeable surface and therefore, reduce site runoff (Shuster et al. 2005). More significantly, the new permeable pavement would reduce or eliminate runoff from those areas (Bean et al. 2006). Instead, rainfall would be directed to the soil and groundwater, flowing ultimately into Mission Creek but at a slower, more diffuse rate. Ultimately, in an 18-inch rain season, storm runoff would likely be reduced by 0.8 acre-feet per year – 3 percent of the whole site's annual runoff. The hardscape area of the site could see its total runoff generation decrease by around 11%, when considering 95% of rainfall on normal pavement would run off and that 5% of rainfall on pervious pavement would soak in, and using the 'Simple Method' shown by Schueler (1987).

Other scenarios were considered as well as guiding recommendations. For example, if the Museum's Project poured no new impermeable concrete – that is, only pour permeable, new concrete - this would double overall runoff reduction to about 22%; it is the net tripling of concrete on-site that somewhat offsets the benefits of the installed permeable surfaces. Further, if the Museum were to connect half of all building/rooftop runoff to permeable pavement zones (or rain gardens, with spillover to permeable pavement) or achieve the same effect via rain cisterns, total runoff production by the hardscape region of campus would be reduced by 44%. It may not be possible to achieve these reductions, particularly during large or fast storms, because of the low permeability of the underlying soil and a potential for full saturation of the pavement systems regardless of design characteristics.

New permeable surface areas would likely be effective at returning rainfall to groundwater from small to average rain events. Larger events reduce effectiveness because the soils are so impermeable that these permeable pavers would not be able to operate at nearly the efficacy found at sandier sites (tens to hundreds of inches per hour in permeability). The design of these areas would certainly need to consider how the underlying soils would react to periodic saturation and prevent under-pavement channels from forming; if underdrains are necessary across a large fraction of the permeable pavements, this would immediately raise costs but would increase holding capacity. If a significant number of rain cisterns were installed to capture roof runoff, this could substantially reduce peak storm flows even further. In fact, large-scale implementation of rainwater harvesting from the Museum rooftops would dramatically increase this Action's hydrogeomorphic benefits; the essentially unchanged building area (from Current to Phase 3) is not contributing to the overall mission of this Action as designed. The Action will also decrease erosion rates on-site compared to current conditions by lowering the amount of runoff coursing across campus, slowing overall runoff velocity and reducing the volume ejected directly into the Creek at high speed.

The carbon footprint of the Action would depend entirely on the source material for the new pavement, the fate of the old pavement and building materials. If the source material were reused or recycled from old pavement – even from the site's own old pavement – this Action could end up carbon-neutral. If, however, the old pavement is landfilled and new asphalt, concrete, and permeable pavement/pavers are constructed from entirely new materials and process, this Action would generate substantial carbon emissions.

Percent removal of pollutants would be highest during low flows (which carry the highest concentrations of pollution, though may contain smaller total loads) due to better infiltration through the permeable surfaces to the soils below. Permeable pavements are documented as most effective at removing suspended solids/sediment, oils/greases/hydrocarbons, and heavy metals (Collins, Hunt & Hathaway 2007, Rushton 2001, Sansalone, Kuang & Ranieri 2008). Additionally, they will remove half or more of the nutrient load present in runoff and would likely be effective at bacterial removal. All of this removal is achieved via particle settling and sorption in the pore spaces of the soil beneath the permeable pavement. The further the underground flow path to the nearest surface water body, the more effective this will be. Note however that these are percent removal rates; because these surfaces most generally receive rainfall directly from the sky, there are few pollutants present. The more runoff from other, dirtier sources that can be directed into these permeable zones, the more pollutants these zones will remove via infiltration and subsequent deposition (Bean et al. 2007).

Similarly to the Bioswale and Rain Garden Installation Management Action, reduction in thermal loading depends on daily temperature, cloud cover and rain. Regardless of the specific amount of reduction, the sensitivity of creek organisms to water temperature, makes this is an important benefit of the Impermeable Surface Removal Action. The larger the area of permeable surfacing that directly replaces impermeable surfaces, the more thermal pollution reduction can be expected (Shuster et al. 2005).

The water pollutants of highest concern in Mission Creek were identified by the EPA and Creeks Department to be sediment, heavy metals and bacteria counts. Permeable surfaces, if operating properly, remove sediment and heavy metals very effectively and so would be relevant and beneficial to Mission Creek. However, this may not be a large effect due to the lack of pollutants in the stormwater that these areas would be receiving. If permeable areas are designed to specifically intercept runoff from likely 'dirty' sources (e.g. the up-gradient neighborhood) this net beneficial effect on Mission Creek would be amplified.

This Action could lower the Museum's annual energy use and thus reduce the site's annual carbon emissions due to energy consumption; however, this was not quantified and the actual reduction may be negligible considering mild local weather and the overall large amount of shading around paved areas from trees.

This Action received a score of +3 on the Fire Resistance Scale, indicating that it is made up of totally non-flammable materials. However, essentially all of the new permeable surfaces would directly replace old, impermeable surfaces- meaning the total area of inflammable surfaces isn't changing, as both new and old pavement is inflammable.

The Impermeable Surface Removal Management Action provides an opportunity for the Museum to inspire awe in and connect visitors to the water cycle and received a score of +1 on the Museum Mission Fulfillment Scale. This indicates a correlation with Museum values and the overall mission to connect people through education and discovery of the natural world and sustainability. The interactions between the Impermeable Surfaces Removal Management Action and the Bioswales and Rain gardens Installation Management Action provides the Museum with an opportunity to create a showcase of how permeable and impermeable surfaces interact with bioswales, natural wetlands and the water cycle. However, it seems unlikely the Impermeable Surfaces Removal Management Action alone would draw people in and create an opportunity for visitors to be awed by nature.

This Action received a score of +1 on the Cultural Significance Scale, indicating that it could marginally add to the unique visual character of Santa Barbara and integrate somewhat with the landscape. The removal of impermeable surfaces and replacement with permeable pavers is not strictly historically

accurate, but a sense of place is created and Santa Barbara's sustainability and biological values are reflected in this Action. Visual enhancement will be small but significant, as permeable pavers are designed to be the most aesthetically pleasing form of permeable surfacing. The Action meshes well with the surrounding campus and landscape via its environmental improvements, but would not specifically build Santa Barbara's unique visual character.

POLICY PARAMETER

Policy alignment analysis found this Action to be either in support of or neutral to all relevant Target documents, particularly meeting the considerations of the Stormwater Guidelines, along with 6 relevant goals or policies from the Environmental Resources Element of the General Plan. This Action well-represents the type of project that the City and its natural resource departments (e.g. Creeks) have identified as ecologically and socially beneficial, and one that they suggest directly in guiding documents. Impermeable surface removal does not align with any of the three local ordinances concerning zoning or tree preservation/planting, or with the two selected Action Plans. This Management Action meets one of the Landscape Design Standards for Water Conservation.

The only apparent conflict with current policies is VFS A's negative impact to several sensitive trees, compounding the original compulsion for Project mitigation. This would conflict with the City's variously stated intent to preserve and protect existing individuals of sensitive tree species, best summarized in the City's Tree Ordinance. This conflict showcases the management tradeoffs that develop when comparing the effects of different mitigation actions and their impacts.

ECONOMIC PARAMETER

Removal of impermeable surfaces is estimated to have a short-term cost of \$255,000. Long-term costs would total around \$2,400. The Annual Cost of maintenance following year five and beyond is an estimated \$600. The Total Cost (through year five) is estimated at \$257,400.

As described, the Impermeable Surface Removal Action would likely cost around \$257,000 through Year 5. Depending on the extent of engineering and design characteristics, and subsequent construction time and complexity, permeable surfaces can range from \$0.75/sq. ft. for permeable asphalt to \$8 or more per square foot for permeable stone pavers. Again, a range of resources were used to determine these likely costs (CRWP, 2012; Ohio EPA, 2011; NCHRP, 2005; US EPA, 2014). The Museum planned on using largely stone pavers, for aesthetic reasons, resulting in higher cost. However, professional bids on exact areas of different permeable surfaces, site preparation and installation would provide for a far more accurate picture of the costs.

Volunteer labor was not assessed for this Action because much of the work would not be doable by the average Museum volunteer. Professional contractors, operating heavy equipment, would more likely complete the construction phase. The maintenance phase does not lend itself to volunteer labor either, requiring a knowledgeable crew or street-vacuuming machine. This could be more expensive depending on the availability of such a machine locally.

OUTREACH PARAMETER

The Education and Community Involvement Qualitative Scales were applied to this Management Action, resulting in scores of +2 and +1, respectively.

The removal of the old and installation of new surfacing would likely not generate much volunteer work opportunity as it requires heavy equipment and would almost certainly be contracted out. Maintenance - cleaning the surfaces to maintain permeability - could provide some limited volunteer work. The

monitoring of water quality changes coming from new permeable and old impermeable areas of campus provides some citizen science opportunity. It is unlikely that this Action would have any effect on attendee diversity; beyond its use a tool to educate on the connections of our lives to the water cycle, it similarly seems unlikely to connect currently underserved community groups. In conjunction with other Actions it could encourage attendance by new community groups as a part of a network of learning opportunities; standalone, it would likely not be a compelling reason to visit the Museum and so would not directly increase overall visitation. This Action is relatively costly; being visually apparent and interesting, some visitors or donors may feel compelled to donate or donate more

This Management Action has the potential to reach a broad set of people, including children, the elderly and disadvantaged communities, but the execution of this expanded educational access will depend on the execution of outreach and the design of educational programming.

INVASIVE PLANT REPLACEMENT

ECOLOGY PARAMETER

Overall, Invasive Plant Replacement would have positive changes to endemic fauna and flora on the museum property. This Management Action would remove 101 non-native trees and 5.98-acres of non-native understory vegetation. 5.21-acres of native vegetation will be planted with a planting palette that includes 7 new native species. As a result, habitat quality will increase, but no new habitat area will be generated. No changes are expected to storm water runoff volume, infiltration rate or erosion for this action. Changes to total carbon dioxide sequestered, suspended solids removed hydrocarbons/oil and grease removed, nitrates/phosphates removed, heavy metals removed, or the heat island effect are not expected. This action is not expected to change carbon sequestration of energy use on the Museum Campus. Non-native replacement received a -1 for Fire Resistance and a +2 for Museum Mission Fulfillment. A score of +3 is given for Cultural Significance.

Since the on- and off-site tree replacement actions capture native tree planting, including tree planting again for the Invasive Plant Replacement seemed excessive. Instead, this Management Action calculated the number of non-native trees and the area of non-native understory that would be removed. The 101 non-native trees that are removed also include subspecies that are not endemic to Santa Barbara; for example – Hollyleaf cherry (*Prunus ilicifolia* subspecies *lyonii*). The final numbers for area of non-native plants removed and area of natives planted is meant to reflect the minimum net decrease and net increase, respectively. In other words, these figures are simply an approximation and may not be the final result after 5 years. The projected net changes may actually be greater, since the calculations presented just meet the minimum goals set forth in the HROSMP (Watershed Environmental Inc., 2013b). Assuming that vegetation restoration efforts follow the planting palette, there should be a net gain of 7 new native species; however, there is no guarantee that all seven species will survive after the 5-year regulatory maintenance and monitoring period, unless the museum continues to ensure their survival.

This action focused on the extent of the vegetative cover for the entire landscape instead of specific species types in order to estimate changes hydrogeomorphology. Since there would be no net loss in vegetative cover, it was assumed that there would not be any long-term changes to runoff volume, infiltration, and erosion. This assumption was corroborated by the HROSMP (Watershed Environmental Inc., 2013b). Short-term impacts from vegetative removal and ground disturbance will be present, but this impact is not significant.

Definitive research regarding south-coast native-plant performance of pollution removal is lacking. Given this and the lack of current information regarding the on-site woodland's biogeochemical cycling, it is uncertain how this action will affect total carbon dioxide sequestered, suspended solids removal

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hydrocarbons/oil and grease removal, nitrates/phosphates removal, heavy metals removal, or contributions to the heat island effect.

Within the annual energy reduction and carbon emission reduction Metrics, there was no net change since there is no net change in vegetative area cover. The Fire Resistance Metric received a score of -1 for several reasons. First, the native trees that are planted on-site could act as ladder fuels by the end of year 5. Second, compared to large blankets of English ivy, the native plants are generally more flammable, based on the amount of litter they produce as well as the chemical and physical properties. Even though there are other factors involved in fire resistance, the native trees and vegetation planted is at such a large extent that they're given greater weight. For the Cultural Significance Metric, the Invasive Plant Replacement received the highest score possible because it aligned with all of the criteria associated with the given score. Native plants are historically accurate and greatly enhances the visual character of Santa Barbara. Native plants are part of the ethnobotany exhibits that showcase Chumash heritage, and provides unique habitat for the endemic fauna.

POLICY PARAMETER

This action fulfills 7 out of 20 listed goals or policies from the City of Santa Barbara General Plan Environmental Resources Element. Four out of four goals or policies in the City of Santa Barbara General Plan Conservation Element are aligned with. One out of three applicable City of Santa Barbara Ordinances are aligned with. Two out of two Guidelines and Standards are met. Finally, this Action aligns with two out of two relevant Action Plans.

In total, this Management Action aligns with 16 out of the 31 relevant policy goals, implementation actions, requirements, and guidelines. These 16 policies primarily address native habitat restoration, protection, and enhancement. In addition, most of these policies capture certain values like water conservation from planting native drought-tolerant plants. This evaluation shows that the museum-proposed action would represent the City's overall intention well.

ECONOMIC PARAMETER

The short-term costs for this Action are \$319,130. The long-term costs are \$152,561. The total cost for years one through five is a total of \$471,691, but a potential for saving \$169,125 exists if volunteer labor is used. The projected annual cost of this Management Action (starting from year 6 and beyond) is \$26,825.

The assumptions behind calculating this Metric is that there is a continuous patch of pure non-native plants – and this does not accurately reflect the vegetative cover. The landscape will often be composed of a blend of native and non-native plants, so removal efforts may actually be greater, depending on the management decision. For instance, the woodland manager may decide to mow down an entire area, regardless of the native plants that are within a patch of non-native plants, then start to plant native seedlings in that area. The costs generated for this Parameter is meant to be an approximation, not an absolute value.

OUTREACH PARAMETER

This action would have a positive effect on Educational Utility, receiving a score of +3. For Community Involvement, Invasive Plant Replacement scored moderately well, at +1.

Native plant restoration provides a multitude of passive and active learning activities, such as monitoring and reporting; learning plant identification; planting natives; and removing various non-natives. The broad range of activities presents a higher chance that more museum patrons will find something they're

interested in. Native plants also allow visitors to learn about natural history, sustainability, and restoration science. These factors contributed to the maximum score possible on the Educational Utility scale. Community Involvement received a score of +1 because it only fulfilled 1 out of three categories within the score description. This Management Action will expand the Museum's volunteer pool and the range of activities available to them because of the work-intensive process of planting, monitoring, and maintaining the native vegetation on site.

WOODLAND RESTORATION

ECOLOGY PARAMETER

Woodland restoration includes the removal of 101 non-native trees and 5.44 acres of non-native vegetation from the museum site. While, no new trees are planted the 5.44 acres of invasive vegetation removed would be replaced with native. A total of 7 new vegetative species will be added to the museum property. This Action would increase habitat quality as a result of these outcomes, but would not change the total habitat area. No change to the current storm water runoff, erosion, or infiltration rates is expected. This action does not change annual energy usage, or carbon emission volume of the Museum. Evaluating Woodland Restoration with the qualitative scales for fire resistance, museum mission fulfillment and cultural significance yields scores of -1, +3 and +3 respectively.

It is uncertain how this action will affect total carbon dioxide sequestered, suspended solids removal hydrocarbons/oil and grease removal, nitrates/phosphates removal, heavy metals removal, or contributions to the heat island effect. Woodland restoration is not typically designed to achieve maximum performance of these Targets. Further studies that categorize coast live oak woodland effects on these Targets would allow estimation of performance.

Even though the total area considered for this Management Action is smaller compared to the Invasive Plant Replacement Management Action, there is greater consideration given to overall habitat improvement, especially for wildlife. This action also takes into account edge effects, which is something that the Invasive Plant Replacement Management Action does not address. Some of these include encroachment by ornamental plants (which may also be invasive) from neighbors. In order to account for the different in habitat quality, the project area for this Management Action is actually further split into two categories: a high ecosystem function area and a moderate ecosystem function area, 2.17 acres and 3.27 acres, respectively. This added up to a total of 5.44 acres.

Changes to the sites habitat and habitat area are not anticipated to significantly change runoff, infiltration or erosion rates. Page 36 of HROSMP states:

The habitat restoration and open space Management Actions that are proposed are anticipated to have little effect on the hydrogeomorphic functions within the property. Habitat restoration and open space management will not alter the flow regime of Mission Creek, will not dissipate energy generated by stormwater runoff, will not affect groundwater flow or discharge, and will not change how stormwater runoff from the museum property is conveyed to Mission Creek." (Watershed Environmental Inc., 2013)

Literature research focused on water movement in oak woodlands does not provide information that would contradict Watershed Environmental's assessment.

A literature review focused on woodland pollution removal studies was conducted to determine whether or not this Action would impact the biogeochemical Targets. Studies did not reveal conclusive information regarding pollutant removal of suspended solids, hydrocarbons, nitrate/phosphates, heavy metal, or thermal pollution.

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Fire resistance for this action received a score of -1, indicating a general decrease in fire resistance. This is largely a result of the increase in coarse woody debris in the understory – which add a lot of fuel. The large quantity and extent of coarse woody debris added (0.054-acres) in combination with native, flammable plants, significantly increases the fire risk.

For Museum Mission Fulfillment this action received a score of +3 because it provides the community with one of its only opportunities to experience a thriving riparian oak woodland community within the urban environment of Santa Barbara. Due to the unique nature of this Management Action, it has the opportunity to inspire awe in visitors of all ages, while creating opportunities for communities to connect across economic, geographic and cultural backgrounds by creating an accessible space for all of these communities to enjoy nature together in an urban environment. Trees are scattered across Santa Barbara's landscape and many are concentrated on privately owned land. Through this Management Action, the Museum is acting as a leader to private landowners who are responsible for these natural resources on their property and is seizing the opportunity to exemplify and teach good stewardship practices.

Cultural Significance also received a score of +3. The 6.2-acre oak woodland on the Museum campus currently represents significant value for the surrounding Mission Canyon community, provides habitat for birds and small mammals, and is utilized as an outdoor resource for educational components of the museum. Historically, buildings have been present in the woodland as the land was once part of the Hazard estate. Restoration of the site would remove non-native plants and trees, narrow trails and build in a large diversity of microhabitats. The restoration of the woodland clearly fits into the historical context of Santa Barbara and enhances a rare piece of natural habitat found in the city. This action aligns with Santa Barbara's sense of place, clearly represents its value of conserving natural resources and does so by focusing enhancing, rather than changing, the natural communities already present.

POLICY PARAMETER

This action fulfills 13 out of 20 listed policies with the City of Santa Barbara General Plan Environmental Resources Element. 4 out of 4 policies in the City of Santa Barbara General Plan Conservation Element are fulfilled. This Action does not align with any of the policies listed under the Santa Barbara City Ordinance, Guidelines and Standards, and Action and Management Plans.

The Woodland Restoration Action aligns with only 17 of the 31 policy Metrics. Alignment is found exclusively in the General Plan Elements, indicating that this Action captures the values and goals of Santa Barbara well. There is no alignment with specific ordinances, action plans or guidelines. This illustrates that there currently is no requirement or mandate regarding this level of detailed restoration but that the outcomes are those favored by the City of Santa Barbara.

ECONOMIC PARAMETER

The short-term cost for this action (\$155,092) and long-term cost (\$140,999) add to a total of \$296,090 in the first 5 years. The cost savings realized from volunteer labor comes to \$136,054 for the first 5 years. The annual cost of this Management Action (starting from year 6 and beyond) is \$39,000.

Total cost for this action comes largely from the salary of a Woodland Manager. It is considered that this manager would be integral to maintaining the health of native plants, eliminating establishment of invasive species, developing volunteer opportunities, and monitoring the woodland. The Woodland Manager would help ensure the success of the overall restoration and help the Museum utilize the space fully. The duties of this position currently fall to no member of the Museum staff; however, similar outcomes may still be

achieved given a rearrangement of responsibility and duties. Should an alternative to the Woodland Manager be found, a significant decrease in cost from this Action would result.

OUTREACH PARAMETER

Woodland restoration receives a score of +3 for both educational utility and community involvement.

The Woodland Restoration Action received the highest score, a +3, for Educational Utility because it met all of the required criteria. A thorough restoration of the oak woodland on the Western portion of the campus would provide opportunity for new passive and active educational opportunities. Informational signs could create a passive learning exhibit about oak woodland ecosystems and the restoration activities could provide opportunity for active learning. This Management Action has the potential to reach a broad set of people, including children, the elderly and disadvantaged communities, but the success of this expanded educational access will depend on the execution of outreach and the design of educational programming.

Community Involvement also received a +3. A thorough restoration of the oak woodland on the Western portion of the campus would involve a substantial amount of work, much of which would be appropriate for volunteer labor. Increased volunteer work opportunities both long and short term, a new variety of volunteer work and various citizen scientist opportunities would be provided by this Management Action. Many people already visit the Museum grounds; taking steps to increase the ecological health of the woodland and improve the user experience would encourage attendance by new demographics or currently underserved community members. This Action would likely increase visitation in general, and be a visually apparent, naturally inspiring reason for visitors to donate or current donors to donate more because it dovetails so well with the Museum's institutional mission.

AGGREGATED RESULTS

The Management Action analysis presented above built the foundation for understanding broad effects that the Museum's actions may have. While this in and of itself is critical to understanding the case study, it is only the foundation. Aggregation of individual Management Action effects into Mitigation Strategy effects and comparison of each Strategy are the final steps in the analytic framework. This section aggregated the On-site and Off-site Tree Replacement results into the SMS and the On-site Tree Replacement, Bioswale and Rain Garden Installation, Impermeable Surface Replacement, Invasive Plant Replacement and Oak Woodland Restoration results into the ELMS results.

STANDARD MITIGATION STRATEGY

Combining multiple Actions together into Strategies required different considerations for each Target; some Targets effects were added together for cumulative impact, while others were subtracted. Generally, for the SMS results were additive because both Actions are simultaneously fully implementable.

ECOLOGY PARAMETER

A total of 740 native trees are planted, native wildlife abundance and number is expected to increase, and 4.3 acres of habitat is generated and improved. Improvements are seen both on-site and off-site.

Specific total hydrogeomorphic effects are uncertain; however, trends are clear. The combined effect of off-site and on-site tree planting will reduce erosion at both locations, increase water infiltration rates, and reduce runoff volume.

With 100 percent survival, a total 724,626 kg of carbon dioxide will be sequestered after 20 years of tree growth. This is the upper limit for carbon question with 10 percent survival more commonly the case for development projects, 72,462 kg of carbon dioxide would be sequestered. Suspended solids, nitrates/phosphates and temperature, present in runoff water will be reduced at both locations. The nature and amount of storage and processing of hydrocarbons and heavy metals is uncertain.

This Strategy scored -1 for Fire Resistance, +1 for Cultural Significance, and +1 on the Museum Mission Fulfillment scale.

POLICY PARAMETER

Comparing this Strategy to values and objectives found in relevant current policy goals, implemented actions and possible implementing actions, there is alignment to 15 of 20 in the General Plan Environmental Resource Element. Comparing this Strategy to values and objectives found in relevant policy goals and policies, from the 1979 Conservation Element, there is alignment to 4 of 4. Of the three local ordinances concerning zoning or tree preservation/planting, the SMS aligns with 2 of them. The Landscape Design Standards for Water Conservation are met with this Management Action. Two out of two Action Plan's goals are met with this Strategy.

ECONOMIC PARAMETER

Total cost for this Strategy is calculated at \$1,812,638. This total includes both short-term and long-term costs. Savings from volunteers comes to \$13,494. Short-term costs alone account for \$1,572,436 of the total and long-term costs account for \$240,202.

OUTREACH PARAMETER

Given no overlap in either action's impacts, each qualitative score for outreach is shown here. For the Educational Utility score, a +3 is given. Ranking based on the Community Involvement scale yields a +1.

ECOLOGICAL LIFT MITIGATION STRATEGY

The Ecological Lift Mitigation Strategy is a combination of the 3:1 On-site Tree Replacement, Bioswales and Rain Gardens, Impermeable Surfaces Removal, Invasive Plant Replacement, and Woodland Restoration Management Actions. No general rule applied to results for the ELMS because there was substantial spatial overlap between each action and several could not be implemented fully without compromising parts of other actions

ECOLOGY PARAMETER

Species diversity at the museum campus will be increased as a result of the ELMS. A total of 226 native trees will be planted, with seven native trees impacted, and 101 non-native trees removed. 5.52 acres of native understory vegetation will be planted, replacing the 5.98 acres of invasive vegetation removed. There will be a total of seven new native species planted as a part of this Strategy. The overall habitat quality will increase, with no net change in the area of habitat impacted.

The total hydrogeomorphic effects are improved: stormwater runoff volume is reduced by over 2.09 acre-feet per year, with increased infiltration rates and reduced erosion rates realized across campus.

A total 220,660 kg of carbon dioxide will be sequestered after 20 years of tree growth. Given that most runoff during storm events comes travels through the Museum campus via natural drainages that are getting enhancement into bioswales, this Action's impacts were considered applicable to the entire Strategy. For runoff routing through the treatment zones, the suspended solids removal rate is estimated to be at least 75 percent. Approximately 78 percent of hydrocarbons will be removed. The estimated nitrate/phosphate removal rate ranges between 15 and 85 percent. About 80 percent to 90 percent of heavy metals flowing through the site are expected to be removed. Generally, pollutant loading to Mission Creek should decrease following the implementation and maturation of ELMS's Management Actions for all considered pollutant categories. The campus 'heat island effect' will be reduced as a result of this Strategy; thermal input to Mission Creek will also decrease, thereby increasing the habitat quality benefits of ELMS.

This Strategy received a score of -1 for Fire Resistance, +3 for Mission Museum Fulfillment, and +3 for Cultural Significance.

POLICY PARAMETER

Comparing this Strategy to values and objectives found in relevant current policy goals, implemented actions and possible implementing actions, there is alignment to 19 of 20 in the General Plan Environmental Resource Element. Comparing this Strategy to values and objectives found in relevant current policy goals and policies, from the 1979 Conservation Element, there is alignment to four of four. The ELMS aligns with three out of three local ordinances concerning zoning or tree preservation/planting. There is alignment with two out of two Guidelines and Standards, and alignment with two out of two Actions and Management Plans.

ECONOMIC PARAMETER

The short-term cost of implementing this Strategy is \$820,901. The estimated long-term cost is \$527,709. The total cost from year 1 to 5 is \$1,359,749. The total cost of this Strategy minus the potential savings from volunteer labor for years 1 through 5 is \$1,169,293. The annual maintenance cost from year 6 and beyond is \$48,412.

OUTREACH PARAMETER

The ELMS is expected to have an overall benefit to the Museum's Outreach programs and goals. This Strategy scores a +2 for the Community Involvement Scale and a +3 for Educational Utility.

DISCUSSION AND COMPARISON OF MITIGATION STRATEGIES

This section compares strategies across each Parameter. This comparison directly answers "Which mitigation Strategy yields the most benefit across social and environmental components. Comparison indicates that, as suspected, ELMS outperforms SMS across most Parameters. While ELMS provided greater overall benefit SMS does provide ease of implementation and has the most potential to be cost effective. Ultimately however, the stakeholder values would affect which Strategy would be considered "better" because tradeoffs may be beneficial to one stakeholder and negative to another.

ECOLOGY PARAMETER

Ecological performance of each Strategy is identified as beneficial with both strategies positively impacting the biodiversity, hydrogeomorphic, biogeochemical and cultural value of the Museum site. The degree with which each Strategy actually achieves predicted outcomes however, is variable and may not be exactly as described above. Various factors will affect outcomes; some of these depend on implementation and management, while others such as climate change, precipitation, and wildlife behavior are not directly controllable. The randomness that is associated with all natural processes will affect both strategies. While all natural variation cannot be accounted for, the multiple related-but-separate Actions comprising the ELM Strategy, would perform better under a wider range of environmental conditions.

The effect of this variability is greatest for the Ecology Parameter. Comparison indicates a direct tradeoff between the Standard and Ecological Lift Mitigation Strategies. The Standard Strategy would plant 514 more trees, and create 4.3 more acres of new habitat than the Ecological Lift Strategy. At first glance this outcome sounded far superior to the alternative however; this represented the best-case scenario. Interviews with developers and consultants indicate that 100 percent survival of mitigation trees is nearly impossible and that frequently close to 90 percent of planted mitigation trees die soon after the 5-year monitoring period ends. If the Museum proceeded like any other developer and did the minimum required by the City, then 74 is a more accurate estimate of the total number of trees that would reach maturity. This effectively replaces each impacted tree at a 1:1 ratio. On the other hand, the Museum redevelopment would receive scrutiny from the public, visitors and neighbors, thus providing incentive for the Museum to ensure that mitigation trees planted in its woodland survive. In the first case, the SMS results in 148 fewer trees than ELMS; while in the second case, the total number of trees is higher. Either of these two scenarios are more likely to occur than the best case scenario of 514 more trees and 4.3 acres of new habitat that SMS initially depicts.

The SMS does not offer any additional improvements to habitat, or native biodiversity beyond the planting of trees. Conversely, the ELMS creates higher quality habitat by implementing a long-term Management Action, where land stewards actively replace invasive vegetation with native vegetation, and manage the bioswales, impermeable pavement and woodland function. The off-site 7:1 location is highly variable; depending on the site's connectivity to adjacent habitats, it could either have high or low habitat value. An additional unpredictable component to the off-site mitigation site is the shape; this aspect determines how much edge effect will negatively impact the site. The uncertainty associated with the SMS does not necessarily make it an inherently inferior alternative. While the ELMS provides greater predictability in terms of tree survival and increases in habitat quality, all of these impacts are localized to the Museum campus. The Museum site is isolated by the surrounding urban environment and Mission Canyon. While creeks serves as a significant habitat corridor for movement through urban landscapes, the Museum's location on the edge of the connected natural areas will reduce the recruitment of native animals.

Beyond wildlife and habitat, ecological performance includes water and sediment flow through the site. Both Strategies will increase root diversity and structure of the Museum site and stabilize the soil. With more vegetation in both scenarios, runoff and erosion are expected to decrease. For the ELMS, this variable will change largely depending on the bioswales and the types of surface on-site, in addition to the soils. The engineering features behind the bioswales will determine the maximum capacity filtration and retention thresholds for storm runoffs. The inclusion of tree plantings on site and the use of bioswales and rain gardens will elevate the ELMS's performance for this Metric above the SMS's. Generally the ELMS includes all of the benefits given to the SMS and increases performance for each Target.

Comparison of the biogeochemical Metric shows the SMS sequestering approximately 500,000 kg more carbon than the ELMS. The long life, large size and continual growth of trees make them ideal carbon sequestration tools, and with more trees, more carbon is sequestered. SMS performs well, but this is contingent on 100 percent survival of trees. If only 10 percent of the trees survive, then only 10 percent or approximately 72,466 kg of carbon would be sequestered in total. This would contrast with the 220,660 kg that is more likely sequestered in the ELMS.

While clear predictions for carbon sequestration comparison are available, the same is not the case for pollution removal performance. Extensive literature was available for understanding how the ELMS would process pollutants. This research showed that the core Actions effecting these Targets were the bioswales, rain gardens and permeable pavement. As frequently employed Best Management Practices for storm water management, these Actions capture and filter runoff well. The planting of trees alone is not a standard storm water management practice and while land use shifts to forested habitat do improve hydrogeomorphic Targets, the magnitude of improvement is far less than BMPs. Given these differences it is clear that while both Strategies are improvements to the status quo, the ELMS would greatly outperform the SMS.

Comparison of the cultural impact from the resulting ecological landscape created by both Strategies show significant differences. For fire resistance the SMS and the ELMS received a score of -1, but each for slightly different reasons. The ELMS received a -1 because of the addition of 0.0544 acres of coarse woody debris and the addition of 226 native trees. These actions create increase total fuel load and create ladder fuels. The SMS fire resistance score is based solely on the score received for 3:1 Tree Replacement Management Action, since nothing is known about the potential site for the 7:1 Tree Replacement Management Action. Therefore, direct comparisons of the aggregate scores can be misleading. For both Museum Mission Fulfillment and Cultural Significance, the ELMS scores higher because it is on-site and has more components that could potentially support both of these cultural Targets. SMS, by comparison, is primarily off-site and so has reduced opportunities to be utilized by the public.

POLICY PARAMETER

The purpose behind this Parameter is to assess alignment with the values and goals within Santa Barbara, using policies like the General Plan and Action Plans as a proxy for these values and goals. The ELMS generally has greater coverage of the values and goals set forth in Santa Barbara's policies, compared to the SMS, even though the difference is somewhat small. What is not captured in the results section regarding policy is current feasibility. A distinction can be drawn however, between how well the ELMS meets overarching goal of the General Plan Environmental Resource and Conservation Elements. The ELMS is more comprehensive and can be considered more sustainable. It is a holistic Strategy and if mitigation was not the goal but rather restoration, the ELMS would result in much more value for the City.

ECONOMIC PARAMETER

Economically, the ELMS is cheaper, but only with the assumption that the Museum has to purchase land in order to complete the 10:1 ratio for tree planting. However, if there was a landowner, or landowners, willing to donate land for tree plantings, then the SMS costs could theoretically be reduced by around \$1 million. Planting trees, irrigating, and monitoring are fairly inexpensive; no specialized equipment, concrete or grading required. In this case, the simplicity of SMS is an advantage that leads to lower cost. However, if only 10 percent planted trees survive to maturity, then the investment required for the SMS compared to the ultimate benefit would be very high. Cost savings can be seen in the ELMS as well.

Strategic use of volunteer could reduce costs by approximately \$180,000. While there are fewer opportunities to reduce the cost associated with the ELM Strategy, there is also guaranteed benefits. Depending on specifics moving forward, either Strategy may prove cheaper than the other.

OUTREACH PARAMETER

Scores given to each of the Strategies for this Parameter are largely based on *potential* opportunities for education and community involvement. For Educational Utility, the team evaluated whether or not a Strategy would provide the necessary tools and demonstration opportunities for hands-on learning. Though both the SMS and the ELMS received +3 for Educational Utility, the ELMS actually has a greater diversity of learning opportunities, stemming from the wide array of Management Actions within the Strategy. Visitors are able to learn more about the natural world beyond planting trees and monitoring growth; they have additional opportunities to learn about water quality and native communities.

Community Involvement examined the potential to reach out beyond the existing pool of volunteers and visitors. This is evaluated by the quantity and diversity of opportunities created. The SMS received a score of +1 because it increases the amount of opportunities for volunteer labor for tree planting. Since these newly created opportunities are very narrow and focused, it probably does not appeal to people with other interests. The ELMS received a score of +2 because it creates both a large quantity and a diversity of attractions and volunteer opportunities. Ultimately, neither Strategy directly changes visitation, donor flow or education of visitors. A strategically utilized SMS could do more than a poorly leveraged ELMS. However, if the Museum were to work to utilize either Strategy to its greatest effect, then the ELMS would yield the best results for outreach.

CASE STUDY CONCLUSIONS

The Santa Barbara Museum of Natural History case study illustrates clearly the advantages and limitations of the City's standard mitigation practice. In this scenario, a developer designed plan could satisfy a reduced tree replacement requirement and add a variety of additional ecosystem and social benefit. The inflexible current system that only accepts in-kind, single species replacement does not encourage a diversity of mitigation alternatives that do show clear advantages. Tree replacement captures less ecological value than habitat restoration, and fewer social values than bioswale and rain garden installation. While the Museum proposed alternative offered clear advantages, it was still on-site, had a short-term planning horizon, and was reactive. These components characterize standard mitigation as well and, on a broad scale, lead to similar unrealized values presented in Chapter 2.

As a developer, the Museum was unique. There existed natural habitat on-site that was suitable for restoration and engineered bioswales and rain gardens. The biological expertise of the staff and education driven mission of the Museum would lead it utilize each Management action to its advantage more thoroughly than most developers. The detail and depth with which the Museum would pursue stewardship of its campus is not typical of the development community as a whole. Therefore, if a more flexible system where every project's mitigation was negotiated or developer driven, these same outcomes could not be expected.

CHAPTER 4 ALTERNATIVE MITIGATION POLICIES

The Museum Case Study in Chapter 3 indicated that the Museum proposed alternative strategy, ELMS, outperformed standard mitigation, SMS, in Santa Barbara across environmental and social parameters. Although ELMS outperformed SMS it is still not a programmatic solution that would capture the values identified in Chapter 2 that are currently missing from Santa Barbara mitigation. ELMS is still on-site, reactive and uses a short term planning horizon and consequently, it is limited in its ability to capture important values.

In this chapter, the team reviews alternative mitigation approaches practiced in California and identifies mechanisms that may be transferable to mitigation in Santa Barbara to improve its ability to capture identified values. Natural Communities Conservation Planning, wetlands mitigation banking, Regional Advanced Mitigation Planning, and streambed alteration permitting were analyzed. Table 4.1 summarizes the beneficial mechanisms identified in each of the four alternative approaches that enable them to capture important environmental mitigation values. Following this summary table is a background description, highlighted mechanisms and complications and criticisms for each alternative, with additional details in Appendix E.

Table 4.1. Summary Table of Identified Mitigation Values, Tools and Mechanisms

Values Associated with Environmental Mitigation	
<ul style="list-style-type: none"> • Regional and landscape level in scope • Improves ecosystem function and processes • Based on best available science • Implementable • Reduces time and/or costs for developers • Reduces time and/or costs for agencies • Economically efficient 	
Tools and Mechanisms that Achieve Environmental Mitigation Values	
Natural Communities Conservation Planning	<ol style="list-style-type: none"> 1. Formal planning agreement outlines geographic area, goals, and identification of species present 2. Independent panel of scientists 3. Broad stakeholder involvement including developers, landowners, local 4. Mitigation banking to establish a reserve 5. Assurances for participating developers that they will not bear the costs of damages done to the environment for conditions identified after the planning agreement is established
Wetland Mitigation Banking	<ol style="list-style-type: none"> 1. Lands are identified by bankers who then work with owners to acquire or manage the restoration/maintenance of the wetland 2. Preservation and restoration of functioning wetlands 3. Army Corps of Engineers approves use as a bank 4. Mitigation wetlands are constructed or preserved prior to development project impacts to wetlands. 5. Once the wetland is permitted, there is no need for involvement from

	Agencies for further evaluation resulting in streamlined permitting
Regional Advance Mitigation Planning	<ol style="list-style-type: none"> 1. Coordination between local, state, and federal jurisdictions 2. Definition of planning areas according to expected infrastructure projects and mitigation opportunities 3. Administration of program supported by developer fees 4. Proposed state revolving fund to be used as capital for mitigation actions 5. Single project manager oversees regional areas and is guided by participating secretaries and directors of infrastructure and natural resource agencies
Lake and Streambed Altering Permitting	<ol style="list-style-type: none"> 1. Negotiated Agreements 2. California Department of Fish and Wildlife decide on mitigation actions necessary 3. Variable length agreements are implemented depending on scope of project

In the next Chapter, the team builds on the mechanisms identified in Table 4.1 and develops programmatic recommendations to improve mitigation in Santa Barbara.

NATURAL COMMUNITIES CONSERVATION PLANNING

The NCCP program began in 1991 with the passing of the State’s Natural Community and Conservation Planning Act. The purpose of Natural Communities Conservation Planning is stated by the California Department of Fish and Wildlife to be “to conserve natural communities at an ecosystem level while accommodating compatible land use.” The program was created in response to the controversies and gridlock commonly caused by endangered species listing under the federal Endangered Species Act.

Resource agencies felt the approach to endangered species protection was too “piecemeal,” lacking in protection of ecosystems. Developers felt the approach exposed them to uncertainties and risk associated with possible future listings of endangered species on their properties. To address these shortcomings, the NCCP process was devised to balance conservation and development.

Chapter 4 Alternative Mitigation Policies

Table 4.2 summarizes Natural Communities Conservation Planning elements, realized and unrealized values, and mechanisms that can be applied to improve environmental mitigation on Santa Barbara.

Table 4.2. Natural Communities Conservation Planning

Mitigation Elements	
<ol style="list-style-type: none"> 1. Off-site 2. Advanced planning 3. Long-term planning horizon 4. Habitat function replacement 5. In-kind 	
Realized Values	Unrealized Values
<ul style="list-style-type: none"> ➤ Improves ecosystem function and processes <ul style="list-style-type: none"> ▪ Builds reserve networks for listed species 	<ul style="list-style-type: none"> ➤ Reduces time and/or costs for agencies <ul style="list-style-type: none"> ▪ Time and cost required for extensive upfront planning
<ul style="list-style-type: none"> ➤ Regional and landscape level in scope <ul style="list-style-type: none"> ▪ Planning encompasses cities or counties 	<ul style="list-style-type: none"> ➤ Implementable <ul style="list-style-type: none"> ▪ Requires voluntary landowner participation to create reserves ▪ Payout from developers to participating landowners may be delayed
<ul style="list-style-type: none"> ➤ Reduces time and/or costs for developers <ul style="list-style-type: none"> ▪ Predictable ▪ Minimizes bureaucracy and time delays by removing CDFW from individual project permitting 	
<ul style="list-style-type: none"> ➤ Economic efficiency <ul style="list-style-type: none"> ▪ Leverages funding from multiple projects to achieve wider ecological outcomes ▪ Savings from combined planning 	
<ul style="list-style-type: none"> ➤ Based on best available science <ul style="list-style-type: none"> ▪ Independent panel of scientists recommends conservation strategies and develops reserve design principles 	
Mechanisms	
<ol style="list-style-type: none"> 1. Formal planning agreement outlines geographic area, goals, and identification of species present 2. Independent panel of scientists 3. Broad stakeholder involvement including developers, landowners, local and state agencies 4. Mitigation banking to establish a reserve 5. Assurances for participating developers that they will not bear the costs of damages done to 	

the environment for conditions identified after the planning agreement is established

HIGHLIGHTED MECHANISMS

THE PLANNING AGREEMENT

The creation of an NCCP begins with a formal agreement between the CDFW and local entities, with the USFWS usually signing on. Typically, one local authority leads development of an NCCP. This local agency receives assistance from CDFW and U.S Fish and Wildlife to work with landowners, environmental organizations, and business. This Planning Agreement provides the basic framework for conservation efforts: outlining the geographic area, establishing planning goals, providing coordinated and standardized mitigation, preliminary identification of species and conservation objectives, and finally, processes for public involvement. Additionally, an independent panel of scientists is gathered to recommend:

- Scientifically sound conservation strategies for species and natural communities listed under the Agreement.
- A set of reserve design principles that address the needs of species, landscapes, ecosystems, and ecological processes in the planning area.
- Management principles and conservation goals that can be used in developing a framework for the monitoring and adaptive management component of the plan (Cal. Fish and Wildlife Code, Section 2810(b)(5)).

ASSURANCES

The CDFW *can* issue assurances for participant developers, but is not required to do so. These assurances address unforeseeable circumstances, such as the future listing of a species, and state that a developer will not be required to contribute additional land, water, or financing in the future unless consent is obtained. This rule effectively guarantees that developers will not bear any cost for damages done to the environment if those damages were not accounted for in the initial agreement. Should an environmental impact occur that was unforeseen at the time of the agreement, compensation would be the responsibility of the local authority.

COMPLICATIONS AND CRITICISMS

Generating a successful NCCP is no simple, quick, or easy task. Several components of the process are critical to success. Without these, a weak and ineffective NCCP may result (Hopkins, 2004).

1. Intensive stakeholder involvement through an educated steering committee
 - a. Adequate representation requires a diverse set of stakeholder groups, several of which may have inadequate scientific and planning knowledge. Ensuring a common base of knowledge is necessary.
2. An independent scientific review panel
 - a. The panel is tasked with reviewing proposed components of the agreement and gives recommendations.
 - b. Despite this, there will still be significant uncertainty about environmental impacts and future scenarios.
3. Active and continuous involvement by Agencies

The assurances and no surprises component of the NCCP have received heavy criticism. The policy locks in species protection measures that may be inadequate given the amount of scientific data, and relieves landowners of future obligation to provide additional, meaningful mitigation measures. NCCPs are active for decades at a time (Ranch Palos Verdes has a 50 year horizon, Orange County – 75 years), ensuring that when environmental impacts occur federal and state taxpayers will bear the burden. Currently no money has been set aside to meet this obligation (Mueller, 1997).

While benefits of large scale regional planning are clear, they are not necessarily the best solution for every region. “It works best in urbanizing areas or for resource use that depends on long-term regulatory predictability, like water supply and delivery” (O’Connell, 1997; Hopkins 2004). This does not characterize the City of Santa Barbara, but may apply at the county level. Similarly, it is clear that there is not enough push for development in the City limits to create incentive for an undertaking as large and protracted as a Natural Communities Conservation Plan.

WETLAND MITIGATION BANKING

Development in wetlands invariably includes draining, filling, or general disruption of wetland integrity, such that lead agencies must grant permission before it can commence. Per the Clean Water Act and the adoption of the 'no net loss' of wetland policy goal, the federal government requires that any wetlands destroyed must be mitigated (NWPF, 1988). This entails, in order of preference, restoring, creating, or preserving wetlands.

Mitigation Banking is the development of a 'bank' of restored, enhanced, created, or preserved wetlands; these wetlands are then translated into a bundle of area-based or function-based 'wetland credits' and made available for sale to developers in need of mitigation permitting for a development project elsewhere (Gregg and Ruhl 2001; EPA, 1995).

Chapter 4 Alternative Mitigation Policies

Table 4.3 summarizes Wetland Mitigation Banking elements, realized and unrealized values, and mechanisms that can be applied to improve environmental mitigation on Santa Barbara.

Table 4.3. Wetland Mitigation Banking

Mitigation Elements	
<ol style="list-style-type: none"> 1. On or Off-site 2. Advanced planning 3. Long-term planning horizon 4. Habitat function replacement 5. In-kind or in-lieu 	
Realized Values	Unrealized Values
<ul style="list-style-type: none"> ➤ Improves ecosystem function and processes <ul style="list-style-type: none"> ▪ Creates large, continuous wetland habitat 	<ul style="list-style-type: none"> ➤ Based on best available science <ul style="list-style-type: none"> ▪ No existing mechanisms that require Private Commercial Banks to utilize best-available science, build on existing natural lands, or consider long-term and multiple conservation planning objectives ▪ Detailed wetland bank citing criteria was recently developed ▪ Banking credits are frequently released before wetlands are ecologically established
<ul style="list-style-type: none"> ➤ Economic efficiency <ul style="list-style-type: none"> ▪ Leverages funding from multiple projects to create or protect contiguous wetland area ▪ Savings from economy of scale efforts to establish wetlands 	<ul style="list-style-type: none"> ➤ Implementable <ul style="list-style-type: none"> ▪ Requires voluntary landowner participation to create reserves ▪ Payout from developers to participating landowners may be delayed
<ul style="list-style-type: none"> ➤ Reduces time and/or costs for developers <ul style="list-style-type: none"> ▪ Predictable ▪ Minimizes bureaucracy and time delays because developers purchase credits from already established banks 	<ul style="list-style-type: none"> ➤ Improves ecosystem function and processes <ul style="list-style-type: none"> ▪ Certified banks have been found to be unsuccessful as a result of a lack of compliance and enforcement by regulatory agencies
<ul style="list-style-type: none"> ➤ Regional and landscape level in scope <ul style="list-style-type: none"> ▪ 2008 rules require watershed level planning to select mitigation sites 	<ul style="list-style-type: none"> ➤ Regional and landscape level in scope <ul style="list-style-type: none"> ▪ Prior to 2008, no regional analysis is used to prioritize wetlands mitigation sites ▪ Banks may be cited opportunistically by private companies
<ul style="list-style-type: none"> ➤ Reduces time and/or costs for agencies <ul style="list-style-type: none"> ▪ Regulators monitor and enforce as 	

necessary at a handful of banks (large properties) rather than visiting many small, disjointed projects across the region.	
Mechanisms	
<ol style="list-style-type: none"> 1. Lands are identified by bankers who then work with owners to acquire or manage the restoration/maintenance of the wetland 2. Preservation and restoration of functioning wetlands 3. Army Corps of Engineers approves use as a bank 4. Mitigation wetlands are constructed or preserved prior to development project impacts to wetlands. 5. Once the wetland is permitted, there is no need for involvement from Agencies for further evaluation resulting in streamlined permitting 	

HIGHLIGHTED MECHANISMS

BANK CREATION AND OVERSIGHT

In order to create a mitigation bank, a “bank sponsor” must undergo a specific legal process. First, they must propose creating wetland credits by one of the four methods (restored, enhanced, created, or preserved wetlands) either on land they hold the property title to or on another landowner’s property via a right of entry agreement. Landowners can be a state wildlife agency, county park, or private preserve owner. The bank sponsor, or banker, does not need to own the land during bank establishment or credit sale. However, the banker must demonstrate long-term (“perpetual”) control over the property; typically, this is demonstrated by placing the property under a restrictive covenant, a conservation easement, or by fully transferring the land title.

Second, a banker seeks preliminary approval from the relevant regulatory agencies after acquiring land or access to land by drafting a proposal “banking instrument.” An interagency Mitigation Bank Review Team (MBRT) evaluates the proposed mitigation bank by its banking instrument and decides whether it is feasible as described. The Army Corps of Engineers serves as the chair of the MBRT; other agencies, such as EPA, FWS, state resource agencies, NMFS, NRCS, and whoever else may be relevant to the project, have a seat. If feasible, the Sponsor and MBRT then develop, complete and sign a final banking instrument, which outlines the maintenance, monitoring and enforcement mechanisms that establish the responsibility of the bank sponsor to develop and operate the bank properly.

PRESERVATION AND RESTORATION OF FUNCTIONING WETLANDS

Banking is ecologically superior to on-site mitigation because it creates large contiguous patches of wetland habitat; this means higher biodiversity and increased ecosystem function as a result of the cumulative effects of having contiguous, healthy habitat. On-site mitigation can create small, isolated, and generally poor habitat that supports less biodiversity and provides lessened ecological functions like water quality improvements and flood control.

Mitigation banks are meant to be well established, healthy and ecologically functional before their credits are available to developers for purchase, meaning development causes no lag in ecosystem services. As development destroys wetlands nearby, the mitigation wetland that is mitigating that destruction already exists and is actively providing ecosystem benefits to the watershed.

Mitigation Banking puts mitigation in the hands of people and companies that are capable, practiced, and knowledgeable. When developers design and manage wetland mitigation projects, success rates are low.

STREAMLINED PERMITTING

Banking speeds development permitting for developers and agencies. Since the mitigated lands were permitted in the past, developers need only buy credits from the bank; there is no permitting process for each and every development, only for the creation of a bank, which then serves multiple development projects. Thus developers and agencies save time and money on future projects.

Mitigation Banking is more cost effective for both developers and regulators because it is mitigation at a large scale. This 'economy of scale' means that more mitigation can be done per dollar, improving the cost effectiveness for developers. Banking is a more cost effective form of mitigation to regulate as well, because there are fewer locations to visit; regulators monitor and enforce as necessary at a handful of banks (large properties) rather than visiting many small, disjointed projects across the region.

Developers do not need to complete mitigation for their own project. This means that for as many permittee projects as a mitigation bank can provide credits to, there are that many fewer projects that require mitigation permitting, planning and execution. Developers do still require the lead agency (usually Army Corps) to evaluate their project and determine the "wetland debit" in terms of area and functionality, in order to permit their project based only on the permittee purchasing an equivalent number of 'wetland credits' from a bank.

Once the permitting process of a bank goes through, it eliminates the need for developers to do anything beyond propose their project and have the Corps decide how many wetland debits they're incurring. Then the developers buy the credit, and a bank can sell the credits at any price they want.

COMPLICATIONS AND CRITICISMS

People report the following drawbacks of the MBRT process: it can be hard to coordinate so many busy professionals regularly; participation may be delegated to a junior employee without decision-making authority, prolonging the process by weeks or months; reaching consensus can be difficult, and sometimes one or two agencies who disagree with the final terms of the instrument will refuse to sign. This prolongs the process further; however, ELI notes that in many cases, the parties agree to disagree and the dissenting agency removes itself from the process. This may speed it up, but also reduces the benefit of MBRT: namely, uniting diverse, varying environmental agencies and their varied objectives, and strengthening the process by bringing together people with complementary areas of expertise.

Detailed siting criteria are generally not outlined in the majority of bank authorizing instruments, nor consistently found in banking guidance and statutes issued by regulators. Only ten states in 2002 had bank-siting criteria codified. This results in a decreased ability of regulatory agencies to effectively evaluate the long-term sustainability of proposed projects. This was not required until 2008.

In theory, mitigation banking is restoration, creation, enhancement or preservation of wetlands to compensate for wetland losses in advance. However, regulatory agencies allow bank sponsors to release credits for sale before the wetlands are functionally mature. In this case, regulatory agencies sometimes require higher mitigation ratios or the percentage of credits available is tied to certain restoration milestones. There are cases where mitigation bank credits are sold, but the bank never achieves the area, functionality, or both, that its bank instrument declared/mandated (ELI 2002). There are three requirements for credit release: (1) banking instrument and mitigation plan approval (2) the bank site has

been secured (3) appropriate financial assurances have been established. Additionally, the Federal Guidance for the Establishment, Use, and Operation of Mitigation Banks state that "... initial physical and biological improvement should be completed no later than the first full growing season following initial debiting of bank" (Federal Guidance for the Establishment, Use and Operation of Mitigation Banks. 60 Fed. Reg. 228, 58605-58614. 1995).

Mitigation banking may lead to the exportation of wetland ecosystem services out of urban areas and into less developed, lower priced lands within the designated planning area. In cases where mitigation banks do succeed, they are creating wetland services away from where they are most needed – within watersheds that are highly developed.

The regulatory agencies simply do not have the resources or people to monitor all mitigation sites properly.

Ecosystem valuation science is changing rapidly; even so, it is difficult to accurately assess the underlying functions provided by a particular wetland in a way that it can be compared to another wetland. Estimating the value of these functions is crucial, but is still hazy and done differently by everyone, including the different agencies that grant credits to a bank (Army Corps of Engineers, Environmental Protection Agency, California Department of Fish and Wildlife).

There are overlapping jurisdictions and many players in this market, the majority of whom are not the buyers and sellers. When a bank is used to mitigate impacts from a variety of development projects, there can be a mixture of federal agencies, state agencies, banking companies, and developers/permit applicants that creates disjunction, confusion, redundancy, and often wasted time in the negotiation process. These are the typical complaints of bureaucratic procedures; a good policy is designed to circumvent these well-studied downfalls of bureaucracy as much as possible without sacrificing strength of regulation.

There are examples of mitigation banks done right: healthy, diverse, functional, self-sustaining wetlands that are placed under long-term protective agreements. In contrast, there are mitigation banks that have accomplished very little; resembling nothing more than a barren, anoxic pond, or some similarly dysfunctional landscape. Research from the past fifteen years has found many banks that fail to produce healthy, functional ecosystems and are not mitigating for the loss of natural wetlands (NRC, 2001; Kenny, 2006; Mack & Micacchion, 2006; Johnson et al., 2002; Reiss et al., 2007; Spieles, 2005).

By and large, the ecosystem services created by mitigation banks appear to be less than those generated by natural wetlands. This means that at the least, large mitigation ratios are necessary to achieve no net loss of wetland services; because this does not typically occur, the federal 'no net loss' policy is probably failing.

The National Research Council's 2001 report evaluating the effectiveness and success of wetlands compensatory mitigation to-date concluded that the Corps could not provide adequate data concerning the status of compensation wetlands; further, that there was no evidence that the national 'not net loss of wetland area and function' goal was being met.

Mack and Micacchion's study of Ohio mitigation banks found that nine of twelve of Ohio's oldest mitigation banks- 400 hectares of wetland- "not only fell short of Ohio's more scientifically advanced wetland assessments, they also fell short – by large margins – of the performance standards the Army Corps and federal EPA had set for them." This is after the Corps and EPA had been certifying these banks for many years as eligible to sell mitigation credits.

Spieles (2005) evaluated 36 wetland mitigation banks in 21 states and determined that less than half of the wetlands were successful, and concluded that mitigation banks do not appear to be more successful than individual mitigation projects. Johnson et al. (2002) found that 54% of 24 wetland mitigation projects (not exclusively banks) in Washington were minimally successful or not successful. They determined that generally, on-site wetland mitigation projects can provide more water quality and quantity functions, but less habitat functions. The study concluded that the overall failure seemed to be largely attributed to a lack of compliance enforcement by regulatory agencies.

This issue has long been the main complaint of environmental group and scientists; that while the scientific community can speak theoretically of the ecological benefits of large, continuous habitat, there is little evidence to suggest that the mitigation banking industry is actually producing healthy, functional habitat (Fleischer, 2005).

REGIONAL ADVANCE MITIGATION PLANNING

Regional Advance Mitigation Planning (RAMP) is a new approach to mitigating unavoidable biological resource impacts caused by state infrastructure projects in California. The two main transferable components of RAMP to Santa Barbara are a regional spatial scope and proactive planning. These elements are intended to strengthen ecological outcomes, leverage mitigation funding to achieve wider results, and cut permitting delays.

In 2008, infrastructure and natural resource agencies in California formed the Regional Advance Mitigation Planning Work Group to develop a new mitigation approach that would meet infrastructure and conservation planning goals. They developed a mitigation framework, RAMP, and commenced a pilot project in Central Sacramento Valley. Key infrastructure agencies and natural resource agencies collaborated in the development of a *Draft Statewide Framework for Regional Advance Mitigation Planning in California*, including California Department of Transportation, California Department of Water Resources, California Department of Fish and Game, California State Parks, California Wildlife Conservation Board, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, National Oceanic and Atmospheric Administration Fisheries Service, Federal Highway Administration, The Nature Conservancy, University of California, Davis, and Resources Legacy Fund. Currently under development is an additional document, the *Regional Advance Mitigation Planning Guidance Manual*, which will provide guidance to region-level agency staff members on how to implement the regional assessments and action plans that are central to the RAMP approach.

Chapter 4 Alternative Mitigation Policies

Table 4.4 summarizes Regional Advance Mitigation Planning elements, realized and unrealized values, and mechanisms that can be applied to improve environmental mitigation on Santa Barbara.

Table 4.4. Regional Advance Mitigation Planning

Mitigation Elements	
<ol style="list-style-type: none"> 1. Off-site 2. Advanced planning 3. Long-term planning horizon 4. Habitat function replacement 5. In-kind 	
Realized Values	Unrealized Values
<ul style="list-style-type: none"> ➤ Improves ecosystem function and processes <ul style="list-style-type: none"> ▪ Builds reserve networks for impacted species ▪ Allows mitigation to commence prior to project impacts in order to cease conservation opportunities 	<ul style="list-style-type: none"> ➤ Reduces time and/or costs for agencies <ul style="list-style-type: none"> ▪ Time and cost required for extensive upfront planning
<ul style="list-style-type: none"> ➤ Regional and landscape level in scope <ul style="list-style-type: none"> ▪ Planning encompasses large regions – assessment areas selected according to planned infrastructure projects and mitigation opportunities ▪ Crosses jurisdictional boundaries and includes participation from local to federal agencies 	<ul style="list-style-type: none"> ➤ Implementable <ul style="list-style-type: none"> ▪ Extensive coordination among agencies required ▪ Funding source must be established, which may require changes in state legislation of passage of voter approved bonds
<ul style="list-style-type: none"> ➤ Reduces time and/or costs for developers <ul style="list-style-type: none"> ▪ Predictable ▪ Minimizes bureaucracy and time delays by approving mitigation actions prior to infrastructure project implementation 	
<ul style="list-style-type: none"> ➤ Economic efficiency <ul style="list-style-type: none"> ▪ Leverages funding from multiple projects to achieve wider ecological outcomes ▪ Savings from combined planning (Funding from infrastructure agencies or state bonds combined to support program administration) 	
<ul style="list-style-type: none"> ➤ Based on best available science <ul style="list-style-type: none"> ▪ Project director manages use of science to establish reserve opportunities 	
Mechanisms	
<ol style="list-style-type: none"> 1. Coordination between local, state, and federal jurisdictions 2. Definition of planning areas according to expected infrastructure projects and 	

mitigation opportunities

3. **Administration of program supported by developer fees**
4. **Proposed state revolving fund to be used as capital for mitigation actions**
5. **Single project manager oversees regional areas and is guided by participating secretaries and directors of infrastructure and natural resource agencies**

HIGHLIGHTED MECHANISMS

REGIONAL PLANNING

Although RAMP is a statewide initiative developed by state and federal infrastructure and natural resource agencies, the program would operate on the regional level. The RAMP Work Group proposes the development of “regional assessment areas” where advance mitigation planning and implementation would occur. Regional assessment areas are established to balance the estimated mitigation demand from infrastructure projects with potential habitat supply. In an analysis to identify a regional assessment area, the state program manager will: 1. Define a broad area with anticipated planned infrastructure projects. 2. Identify potential projects for a broad area. 3. Identify smaller planning areas within the broad area. 4. Define preliminary boundaries. 5. Assess potential mitigation demand. 6. Assess potential habitat supply. 7. Refine boundaries (RAMP Framework, 2012).

A series of mitigation options is also identified in the regional assessment areas. The highest value options identified by the RAMP Work Group are:

Avoid all impacts through strategic placement of the infrastructure project and the use of other avoidance measures (e.g., construction timing, nonintrusive construction methods). If full avoidance is not possible, then minimization measures (e.g. construction timing, innovative design, best management practices) would be used to minimize potential impacts.

Purchase (either through a cash transaction with a mitigation bank sponsor or an agency exchange between internal accounts with notification to the mitigation bank sponsor) in-kind credits at a RAMP-sponsored mitigation or conservation bank, or private mitigation or conservation bank that is fully established in the regional assessment area, as long as the site also has a record of outstanding performance in meeting the standards of success or has notable ancillary benefits (see sidebar).

Pre-purchase in-kind credits at a RAMP-sponsored mitigation or conservation bank, or private bank that is under development in the regional assessment area, as long as the site is likely to establish a record of outstanding performance toward meeting the standards of success or have notable ancillary benefits.

Seek to become a participating agency in an HCP or NCCP that is being considered or under development in the regional assessment area for coverage of all or some types of infrastructure project impacts (RAMP Framework, 2012).

After the definition of a regional assessment area, focus turns towards creating the management structure, collecting specific data on proposed infrastructure projects and conservation opportunities, creating a financial plan, and developing an action plan for implementation of the program.

FUNDING

The RAMP Framework document proposes two options for creating a permanent funding mechanism for the RAMP program. These mechanisms are to support the administrative and planning aspects of RAMP, not the actual mitigation project costs:

Collect approximately 1.5% of the projected cost of mitigation from infrastructure agencies seeking mitigation.

Collect a flat fee from infrastructure agencies seeking mitigation, approximately \$5,000 per project. This money would be given to a third party to create a permanent deposit to generate enough interest, dividends, or appreciation to fund staffing and the administration and planning.

Funding, separate from ongoing RAMP management costs, is also needed to support the development of regional assessments and action plans. Possible mechanisms for funding regional assessments include: voter-sponsored bond or legislation related to regional assessments, federal transportation funds, blueprint planning grants, sustainable community strategies, or California Strategic Growth Council (SGC) Proposition 84 funds (RAMP Framework, 2012).

Funding mitigation action plans is a unique challenge because it requires funding in advance of infrastructure project impacts. Although mitigation project funding traditionally comes at the time of the project impacts, advance mitigation is central to the design of RAMP. Funding on a project-by-project basis removes the advantages of proactive planning, namely more cost-effective outcomes and leveraging of funds from many projects to create a more comprehensive ecological solution. The budgeting process of Proposition 1E funds for DWR allow for release of funding in advance of mitigation.

Another concept proposed by the RAMP Work Group to support regional assessments and action plans is state revolving funds or revolving funds for each mitigation region. State legislation would be required to enable funds to be held by the state Treasury (Ramp Framework, 2012). State infrastructure bonds could be used to capitalize the revolving fund and then agencies would be reimbursed when mitigation funds are later paid. Additionally, state appropriation funding to the Natural Resources Agency.

GOVERNANCE STRUCTURE

The RAMP Work Group has proposed a governance structure to allow for management that is efficient and puts decisions at the level of legal authority (RAMP Framework 2012). RAMP would be governed by a RAMP steering committee composed of secretary and director level members of participating state and federal agencies. This committee would serve to integrate regional priorities into a statewide initiative. A single program manager would be selected by the steering committee to oversee project managers of each regional mitigation area.

COMPLICATIONS AND CRITICISMS

RAMP is a newly proposed mitigation approach and is in its initial stages of implementation. A pilot project has been initiated in the Sacramento Valley and outcomes from that project will guide RAMP's evolution. Without a long history of implementation, it is difficult to determine how successful the program will be. RAMP is unique because it is designed to mitigate biological impacts of large-scale infrastructure projects. Infrastructure projects have long-term planning horizons for development projects and expected impacts are known and quantified ahead of project start dates; this makes mitigation in

advance of expected impacts feasible. Private development on the local level is not as predictable and so advanced mitigation is unlikely to be feasible.

LAKE AND STREAMBED ALTERATION PERMITTING

The Lake and Streambed Alteration Program (LSA) is a part of CDFW’s Habitat Conservation Program. This program applies to any work that would affect rivers, streams, or lakes that flows at least intermittently through a bed or channel. This includes ephemeral streams, desert washes, and watercourses with a subsurface flow. It may also apply to work undertaken within the floodplain of a body of water.

The LSA permitting procedure is triggered if any person, business, state or local government agency, or public utility proposes an activity that will:

- Substantially divert or obstruct the natural flow of any river, stream or lake;
- Substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or
- Deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.

Table 4.5 summarizes Lake and Streambed Alteration Permitting elements, realized and unrealized values, and mechanisms that can be applied to improve environmental mitigation on Santa Barbara.

Table 4.5. Lake and Streambed Alteration Permitting

Mitigation Elements	
<ol style="list-style-type: none"> 1. On-site and off-site 2. Reactive planning 3. Long-term planning horizon 4. Single species replacement 5. In-kind and In-lieu 	
Realized Values	Unrealized Values
<ul style="list-style-type: none"> ➤ Improves ecosystem function and processes <ul style="list-style-type: none"> ▪ Creates large, continuous wetland habitat ▪ Allows for contributions to identified high-value areas 	<ul style="list-style-type: none"> ➤ Reduces time and/or costs for agencies <ul style="list-style-type: none"> ▪ Time and cost required for extensive upfront planning
<ul style="list-style-type: none"> ➤ Regional and landscape level in scope <ul style="list-style-type: none"> ▪ 2008 rules require watershed level planning to select mitigation banking sites ▪ In-lieu fees can be used regionally 	<ul style="list-style-type: none"> ➤ Regional and landscape level in scope <ul style="list-style-type: none"> ▪ Prior to 2008, no regional analysis is used to prioritize wetlands mitigation sites ▪ Banks may be cited opportunistically by private companies ▪ Permittee-responsible is not regional or landscape level

<ul style="list-style-type: none"> ➤ Reduces time and/or costs for developers <ul style="list-style-type: none"> ▪ Predictable ▪ In-lieu fees eliminates monitoring requirements on individual projects ▪ Banking enables monitoring and enforcement as necessary at a handful of locations 	<ul style="list-style-type: none"> ➤ Improves ecosystem function and processes <ul style="list-style-type: none"> ▪ Certified banks have been found to be unsuccessful as a result of a lack of compliance and enforcement by regulatory agencies
<ul style="list-style-type: none"> ➤ Economic efficiency <ul style="list-style-type: none"> ▪ In-lieu funds contribute to already identified targets high value areas ▪ Savings from economies of scale 	
<ul style="list-style-type: none"> ➤ Based on best available science <ul style="list-style-type: none"> ▪ Agencies oversee restoration efforts enabling scientific oversight ▪ Scientific expertise is utilized as tie-breaker 	<ul style="list-style-type: none"> ➤ Based on best available science <ul style="list-style-type: none"> ▪ No existing mechanisms that require Private Commercial Banks to utilize best-available science, build on existing natural lands, or consider long-term and multiple conservation planning objectives
Mechanisms	
<ol style="list-style-type: none"> 1. Negotiated Agreements 2. California Department of Fish and Wildlife decide on mitigation actions necessary 3. Variable length agreements are implemented depending on scope of project 	

HIGHLIGHTED MECHANISMS

NEGOTIATED AGREEMENTS

CDFW needs to be notified of the proposed project, then they determine whether or not the project will significantly adversely affect fish and wildlife resources. If the project is determined to have significant impacts, then a LSA Agreement is needed. CDFW first conducts an on-site inspection to determine the measures necessary to protect fish and wildlife resources, then submits a draft agreement to the landowner. If the landowner disagrees with the measures, both parties first informally discuss and attempt to reach a consensus, then resort to arbitration by a scientific expert that is agreed upon by both parties.

The Agreement includes reasonable conditions necessary to protect fish and wildlife resources and must comply with the California Environmental Quality Act (CEQA). While CEQA simply states that mitigation is needed for impacts to lakes and streams, the LSA Agreement outlines the specific impacts and mitigation measures. Agreements vary project by project, but the agreement always includes sections addressing authorized activities, amendments, liability, renewal, suspension and cancellation, notification, conditions, fees, and best management practices (California Department of Fish and Wildlife, n.d.). Depending on the time frame of the project, there are 3 Agreements issued: Standard Agreement (less than 5 years), Standard Long-term Agreement (more than 5 years), and Master Agreement (more than 5 years, multi-

phase project; Sacramento River Watershed Program, n.d.). The purpose of the Agreement is to protect fish and wildlife resources while conducting the project.

CHAPTER CONCLUSION

In this chapter, the team reviewed Natural Communities Conservation Planning, wetlands mitigation banking, Regional Advanced Mitigation Planning, and streambed alteration permitting and identified mechanisms that may be transferable to mitigation in Santa Barbara to improve its ability to capture identified values. In Chapter 5, the team builds on the mechanisms identified above and develops programmatic recommendations to improve mitigation in Santa Barbara.

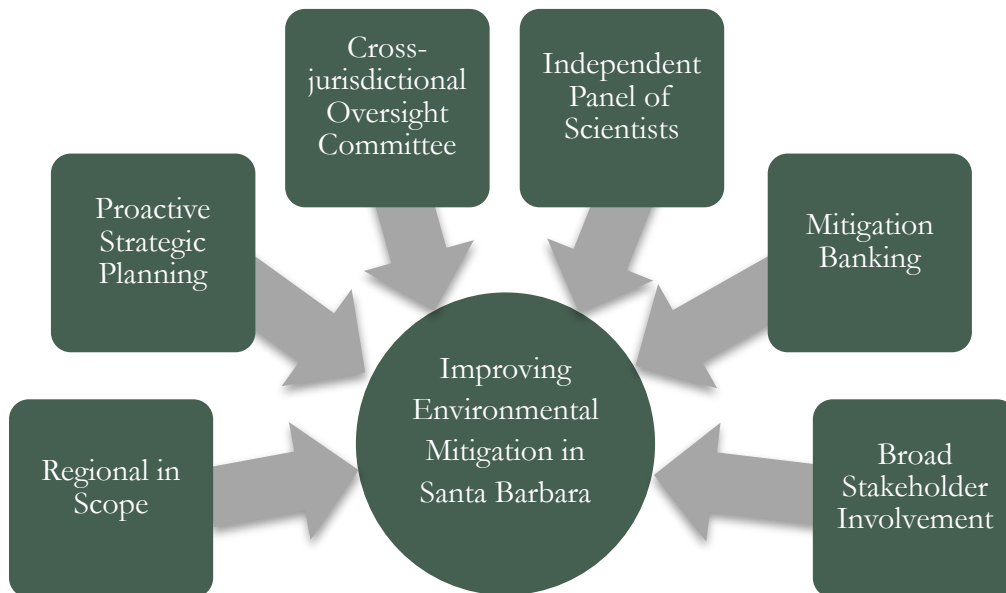
CHAPTER 5 RECOMMENDATIONS

In Chapter 2, it was demonstrated that mitigation in Santa Barbara only achieves two of the seven identified values that mitigation programs should maximize to create better outcomes for ecosystems, developers, planners and communities (see Table 4.1). The case study analysis at the Santa Barbara Museum of Natural History, described in Chapter 3, confirmed that environmental mitigation in Santa Barbara is only implementable and reduces time and costs for agencies. The Museum Case Study also demonstrated that a proposed alternative mitigation strategy could outperform Santa Barbara’s standard mitigation in achieving environmental and social outcomes, indicating that there is substantial room for improvement to the status quo. In Chapter 4, the team identified a number of mitigation elements and mechanisms utilized in alternative mitigation programs that could programmatically improve environmental mitigation in Santa Barbara (see Table 4.1).

Alternative mitigation is consistently advanced, strategic, regional or landscape-level in scope, focused on ecosystem function and process, economically efficient, and based on best available science. Standard mitigation practices in the City and County of Santa Barbara could benefit from adopting more of these mitigation elements into its strategy. While a wide range of mechanisms were documented from Natural Community Conservation Planning, wetland mitigation banking, Regional Advance Mitigation Planning, and streambed alteration permitting, a subset of those approaches were chosen by the team as likely to be the most implementable and provide the greatest benefit to Santa Barbara.

We recommend that Santa Barbara improve environmental mitigation by adopting six key elements and mechanisms identified through the alternative mitigation case studies (Chapter 6) and stakeholder interviews (Chapter 2): Regional planning area, strategic site selection, cross-jurisdictional oversight committee, independent panel of scientists, mitigation banking and broad stakeholder involvement (see Figure 5.1).

Figure 5.1. Recommended Mitigation Elements and Mechanisms



In order to implement these six key elements and mechanisms, the team recommends that Santa Barbara develop a Multi-Resource Conservation Program, utilizing ecosystem service sciences, where possible, and community stewardship initiatives.

IMPLEMENTATION OF THE MULTI-RESOURCE CONSERVATION PROGRAM

The development of a Multi-Resource Conservation Program (MRCP) would enable Santa Barbara County and City to implement the six key mechanisms identified above and empower environmental mitigation programs to capture important values currently missed.

The current system of mitigation in Santa Barbara mitigates environmental impacts on a project-by-project level and in isolation. A regional planning area and strategic site selection would enable the MRCP to leverage compensatory environmental mitigation to fulfill comprehensive and strategic regional goals. Subsequently, the MRCP would look at natural resources on a regional level by selecting a regional planning area that takes into account both expected development and environmental mitigation opportunities. Mapping of resources in Santa Barbara County and City is critical for developing mitigation goals that reflect the specific resource needs of this region.

The MRCP would build off of the planning process initiated when Santa Barbara County attempted to develop a Habitat Conservation Program (HCP) for the tiger salamander. According to County Planners, a great deal of the County was surveyed and biological resources were inventoried (B. McNulty, personal communication, Feb. 6, 2014). The MRCP would build off of this data and expand to include urban natural resources, such as creeks, urban forests, and coastal resources. In addition, the MRCP would include an integrated resource management plan that incorporates strategic goals and visions from Santa Barbara's existing City and County plans, such as the Urban Forest Management Plan, the Climate Action Plan, Community Plans, Watershed Action Plans, and the defunct HCP into a comprehensive regional plan.

Climate change planning should be a central focus in any new mitigation program in Santa Barbara. County and City planners cited climate as a driving issue in the region, showing that there is already an awareness of climate issues among planners (G. Russell, pers. comm., Feb. 14, 2014; B. Shelton, pers. comm., February 10, 2014). The National Oceanic and Atmospheric Administration (NOAA) recently announced grant awards totaling \$278,000 to the proposed Santa Barbara Area Coastal Ecosystem Vulnerability Assessment led by researchers at UCSB, UCSD, and USGS. The project will "create a vulnerability assessment of coastal ecosystems (beaches, wetlands and watersheds) for southern Santa Barbara County to assist the Cities of Santa Barbara, Carpinteria, and Goleta and the County of Santa Barbara in planning for adaptation to climate change" (Marine Science Institute, UCSB 2014). This effort is unique because it assesses how climate change will impact ecosystems, where most climate change planning only analyzes expected impacts to infrastructure and the built environment. The research aims to inform local land-use decision-making, which provides an opportunity to connect a newly developed mitigation program to cutting-edge climate change planning.

In order to advance carefully identified regional goals, mitigation must be strategically sited. Off-site mitigation can be used where on-site mitigation is not feasible or where off-site mitigation would lead to better economic efficiencies and greater ecological benefits. Areas with high natural resource value, in terms of ecosystem function and process, would be identified in both the City and the County and sites would be strategically selected in these areas.

Mitigation banking may be an effective method to strategically site mitigation projects in Santa Barbara. Banking is a mechanism commonly used by alternative mitigation programs, such as NCCP and wetlands mitigation. The bank facilitates strategic site selection by serving as the strategically identified conservation or restoration site. One of the advantages of using a mitigation bank is that it allows conservation or restoration to be identified and often implemented before development projects requiring mitigation take place. Planners need to be careful to avoid the pitfalls of mitigation banking discussed in Chapter 4, namely ineffective outcomes as a result of poor monitoring and enforcement. Another complication of mitigation banking is that it can export mitigation benefits to other parts of the region, removing them from the area of development impact. To manage this risk, the planning area needs to be carefully selected, possibly separating the city mitigation planning from the county.

A cross-jurisdictional oversight committee is recommended to ensure the success of a regionally focused mitigation program. The planning area should reflect natural resource needs, instead of jurisdictional boundaries that are unrelated to landscape features like watersheds. RAMP and NCCP both utilize an oversight committee to improve coordination in program development and implementation. The Santa Barbara County Association of Governments (SBCAG) is an already existing model for a cross-jurisdictional oversight committee. Currently, SBCAG coordinates transportation planning and initiatives between the county and different cities. By broadening the focus of this already existing group a mitigation oversight committee could be easily implemented.

City and County planners expressed particular concern that best available science is not used consistently in the development of mitigation requirements (G. Russell, pers. comm., Feb. 14, 2014; J. Jostes, pers. comm., Feb. 4, 2014; B. Shelton, pers. comm., February 10, 2014). In order to create an ecosystem function and process focus in the MRCP, the team recommends an independent panel of scientists be used to develop mitigation requirements. In streambed alteration permitting independent scientists develop specific mitigation requirements when a developer and the California Department of Fish and Wildlife disagree on the requirements. An independent panel could lend credibility to a new program and could contribute natural resource, conservation planning, and mapping expertise.

Broad stakeholder involvement is essential for the implementation of any new mitigation program. The alternative mitigation programs reviewed in Chapter 4 indicate that stakeholder involvement is required for successful program design and implementation. Additionally, the cancelled Santa Barbara County HCP contains lessons about how a lack of stakeholder support can thwart a planning process.

If the Multi-Resource Conservation Program were in place for the Museum's prior proposed redevelopment project, native mitigation trees would be strategically sited on or off the Museum site to advance previously identified regional goals. Focus would be placed on oak woodland habitat as a functional ecosystem rather than individual tree replacement. A tree mitigation bank based on the Urban Forest Management Plan currently under development could also be created to strategically place trees. Currently, there are no major incentives for long-term stewardship of mitigation trees beyond the required 5 years. By planting mitigation trees in the most ecologically appropriate place, and then encouraging long-term monitoring and maintenance, better ecosystem function outcomes can be achieved.

The Museum Case Study in Chapter 3 demonstrated that evaluating mitigation in terms of ecosystem services can illuminate tradeoffs within and between ecological, social, political and economic values. However, the Case Study also illustrated that our understanding of ecosystem services needs to advance before we can fully and adequately value impacts and mitigation in terms of ecosystem services. Nonetheless, under the MRCP, we recommend that development impacts be evaluated in terms of

ecosystem services, where possible, in order to build a stronger understanding of the ecosystem services currently provided in the City and County.

BARRIERS TO IMPLEMENTATION

The recommended Multi-Resource Conservation Program is logistically implementable in Santa Barbara because similar alternative mitigation programs exist in California. Two main barriers were identified through the stakeholder interview process – money and political will. The MRCP would require significant up-front time and cost for its planning and design, in order to gain the benefits of regional scope, ecosystem process and function focus, use of best available science, economic efficiency through leveraged mitigation projects, and increased predictability for developers. Planners indicated that limited funding and staffing are barriers to improving mitigation in Santa Barbara (G. Russell, pers. comm., Feb. 14, 2014; B. Shelton, pers. comm., February 10, 2014). State grants and local parcel taxes should be explored as funding sources for the MRCP. Stakeholder interviews indicated that, in addition to funding, lack of political will or political disagreements across the county may be a barrier to implementation.

CHAPTER CONCLUSION

In Chapter 2, it was demonstrated that mitigation in Santa Barbara only achieves two of the seven identified values that mitigation programs should maximize to create better outcomes for ecosystems, developers, planners and communities (see Table 4.1). The case study analysis at the Santa Barbara Museum of Natural History, described in Chapter 3, confirmed that environmental mitigation in Santa Barbara is only implementable and reduces time and costs for agencies. The Museum Case Study also demonstrated that a proposed alternative mitigation strategy could outperform Santa Barbara's standard mitigation in achieving environmental and social outcomes, indicating that there is substantial room for improvement to the status quo. In Chapter 4, the team identified a number of mitigation elements and mechanisms utilized in alternative mitigation programs that could programmatically improve environmental mitigation in Santa Barbara (see Table 4.1).

We recommend that Santa Barbara improve environmental mitigation by adopting six key elements and mechanisms identified through the alternative mitigation case studies (Chapter 6) and stakeholder interviews (Chapter 2): Regional planning area, strategic site selection, cross-jurisdictional oversight committee, independent panel of scientists, mitigation banking and broad stakeholder involvement (see Figure 5.1). In order to implement these six key elements, the team recommends the development of a Multi-Resource Conservation Program that is regional in scope, focused on ecosystem function and process, based on best available science, implementable, reduces time and/or costs for developers and agencies by increasing predictability, and is economically efficient by leveraging mitigation projects.

CONCLUSION

Environmental mitigation in Santa Barbara utilizes a standard approach to mitigation, including on-site, reactive planning, a short-term planning horizon, single species replacement, and in-kind transfer. Through the course of a literature review and stakeholder interviews, the team identified seven important values that compensatory environmental mitigation should maximize in order to create the best outcomes for ecosystems, developers, planners and communities: (1) Regional and landscape level in scope, (2) improves ecosystem function and process, (3) based on best available science, (4) implementable, (5) reduces time and/or costs for developers, (6) reduces time and/or costs for agencies, and (7) economically efficient. The team discovered that current environmental mitigation practices in Santa Barbara fail to capture all but two of these important values. Environmental mitigation in Santa Barbara is merely implementable and reduces time and costs for agencies.

The Santa Barbara Museum of Natural History case study illustrated clearly the advantages and limitations of the City's standard mitigation practice. In this scenario, a developer designed plan satisfied a reduced tree replacement requirement and created additional ecological and social benefits. The inflexibility of the current system, which only accepts in-kind, single species replacement, does not encourage a diversity of mitigation alternatives that the Case Study demonstrated to be advantageous. Tree replacement captured less ecological value than habitat restoration and fewer social values than bioswales and rain garden installation. Overall, the Ecological Lift Mitigation Strategy (ELMS) was shown to contribute significantly to a broad set of ecosystem service and function goals.

Although ELMS outperformed SMS it is still not a programmatic solution that would capture the values identified in Chapter 2 that are currently missing from Santa Barbara mitigation. ELMS is still on-site, reactive and uses a short term planning horizon and consequently, it is limited in its ability to capture important values. In Chapter 4, the team reviewed Natural Communities Conservation Planning, wetlands mitigation banking, Regional Advanced Mitigation Planning, and streambed alteration permitting. The team identified mechanisms that may be transferable to mitigation in Santa Barbara to improve its ability to capture important environmental mitigation values and described program complications and criticisms.

In conclusion, we recommend that Santa Barbara improve environmental mitigation by adopting six key elements and mechanisms identified through the alternative mitigation case studies in Chapter 6 and stakeholder interviews: Regional planning area, strategic site selection, cross-jurisdictional oversight committee, independent panel of scientists, mitigation banking and broad stakeholder involvement. In order to implement these six key elements, the team recommends the development of a Multi-Resource Conservation Program that is regional in scope, focused on ecosystem function and process, based on best available science, implementable, reduces time and/or costs for developers and agencies by increasing predictability, and is economically efficient by leveraging mitigation projects.

RECOMMENDATIONS FOR FUTURE RESEARCH

The team recommends that future research develop an implementation plan for the Multi-Resource Conservation Program and, as the science of ecosystem services advances, analyze the role that ecosystem services can play in the City and County's environmental mitigation programs. Our study demonstrated that the scientific community's understanding of ecosystem services is still far from complete enough to fully evaluate environmental impacts and quantify mitigation options in terms of

Conclusion

ecosystem services. However, the field is rapidly growing and ecosystem service valuation may eventually be the basis for exchange between impacts and mitigation.

The legality of using ecosystem services as the basis for exchange between environmental impacts and mitigation is still unclear. However, there is an argument to be made that when impacts and mitigation are boiled down to their ecosystem services a nexus can be found between a number of seemingly unlike factors. It is possible that, eventually, native tree impacts may be mitigated not through tree replacement, but through the mitigation of the lost ecosystem services. For example, the hydrological benefits of trees may be mitigated through the creation of bioswales that replace lost hydrological ecosystem services in a shorter amount of time. The Museum Case Study demonstrated how native tree replacement can be limited in its ability to improve ecological function and process, whereas a suite of management actions may replace the ecosystem service benefits of native trees in new ways. Subsequently, we recommend that future research evaluate how ecosystem services evaluation could further elevate Santa Barbara's mitigation programs.

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APPENDICES

APPENDIX A: FIGURES AND TABLES

Figure A.1. Museum Site Topography

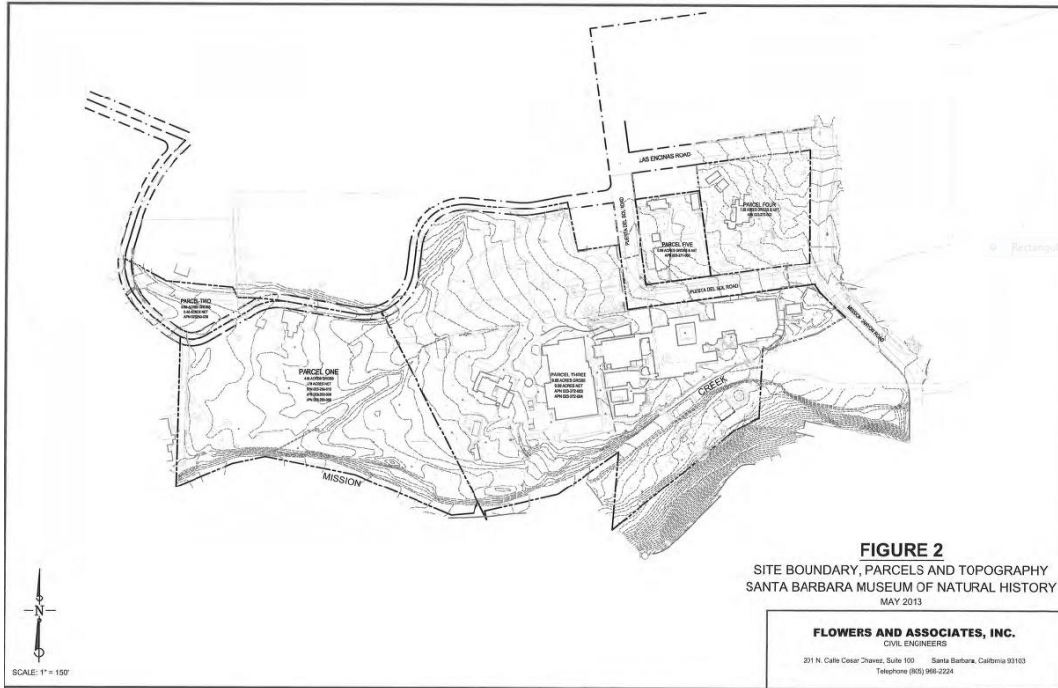


Figure A.2. Upstream Areas Draining through the Museum Property

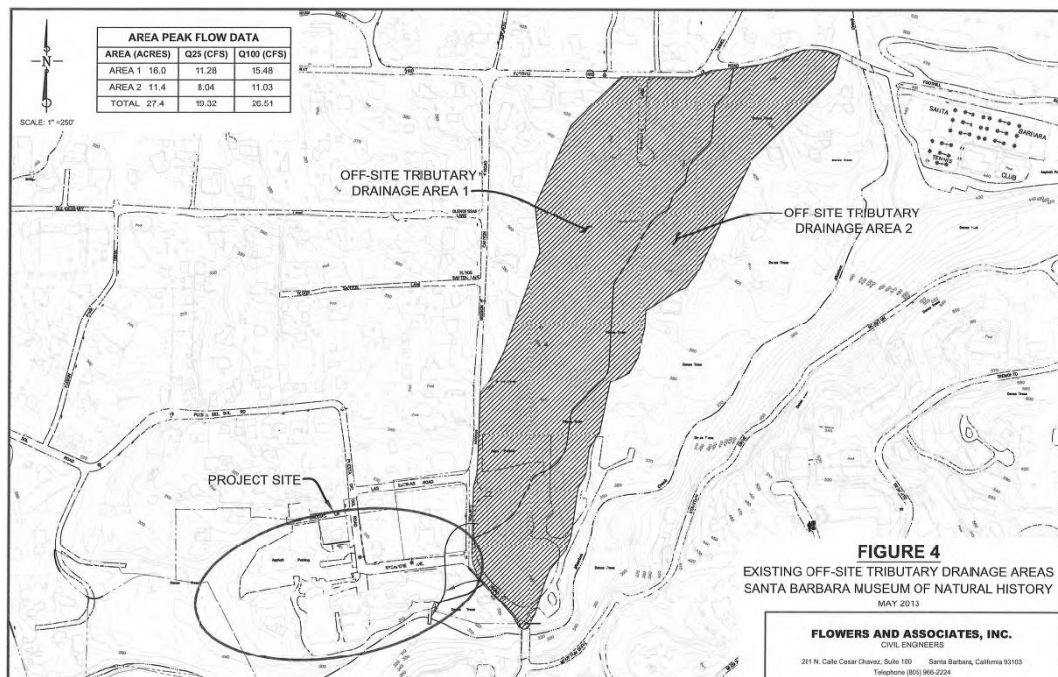


Table A.1. Major Design Characteristics of the Three Large Bioswales

Proposed Vegetated Filter Swales (VFS) Filter Flows and Drainage Capacities (Q100).										
Drainage Area	VFS	Section	Required Filtered Area	Q _{wQ} Flow (cfs)	Q _{wQ} Depth (ft)	Length (ft)	Velocity (ft/sec)	Filter Time (sec)	Q ₁₀₀ (cfs)	Q _{wQ} Depth (ft)
A	A	A-A	4.23	0.71	0.24	105	0.72	146	49	2.0
A	A	B-B	4.23	0.71	0.14	90	0.52	173	49	1.1
A	A	C-C	4.23	0.71	0.12	135	0.47	287	49	1.0
A	Subtotal					330		606*		
B	B	B	1.88	0.27	0.155	320	0.52	615*	6	0.60
C	C	C	1.66	0.16	0.14	320	0.49	653*	5	0.64

*Minimum Filter Time = 600 seconds

Figure A.3. Swale Cross-sections and Design

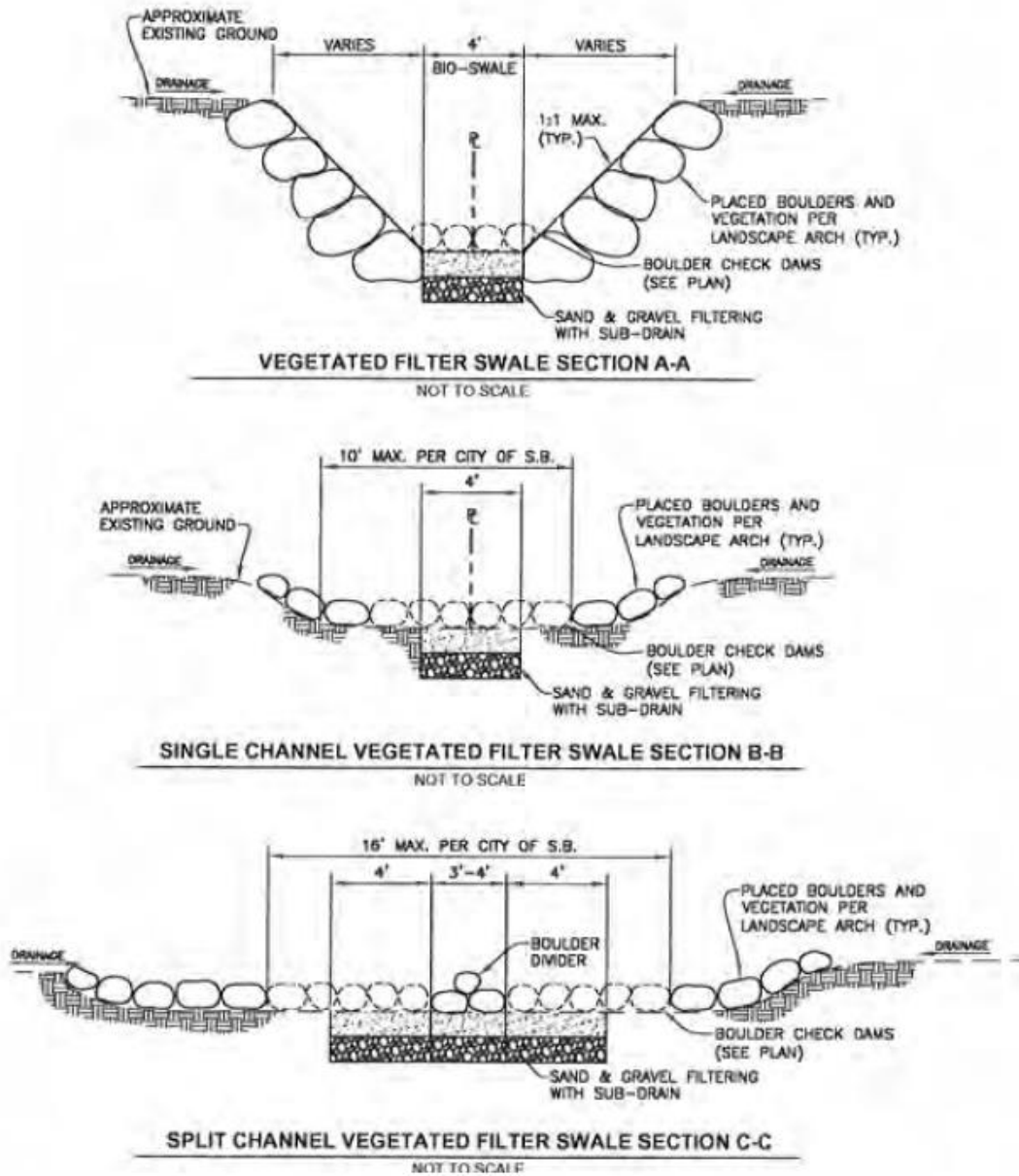


Figure A.4. Locations of the three large bioswales (VFS A, B & C, names highlighted on figure)

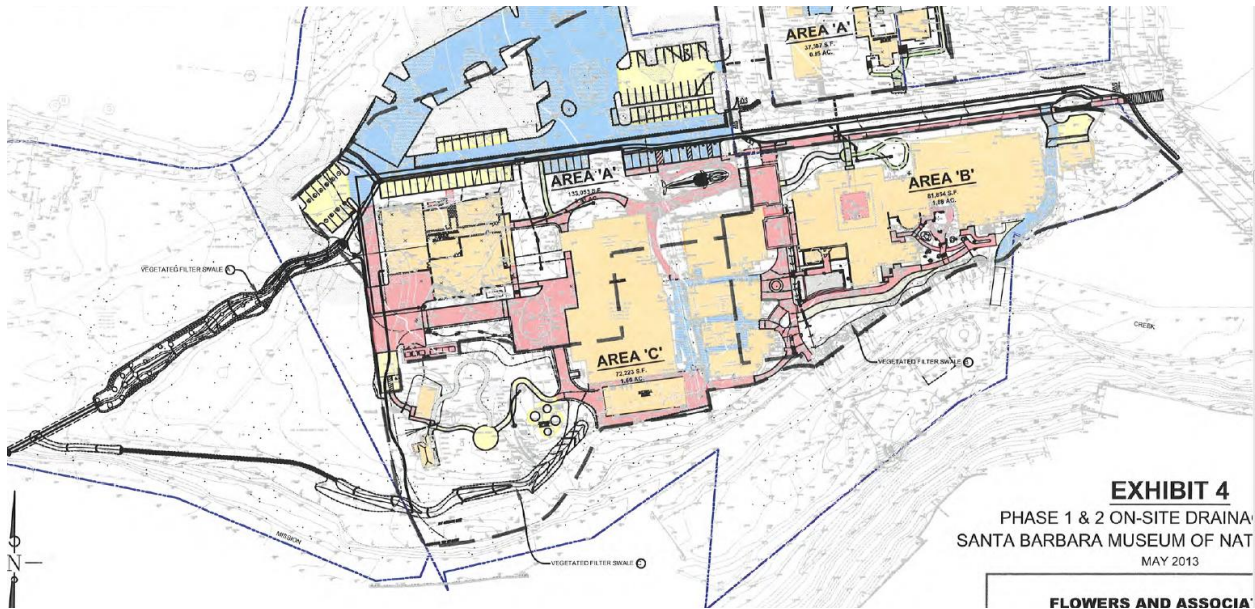


Figure A.5. Rain Garden Network (shown as green flow paths)

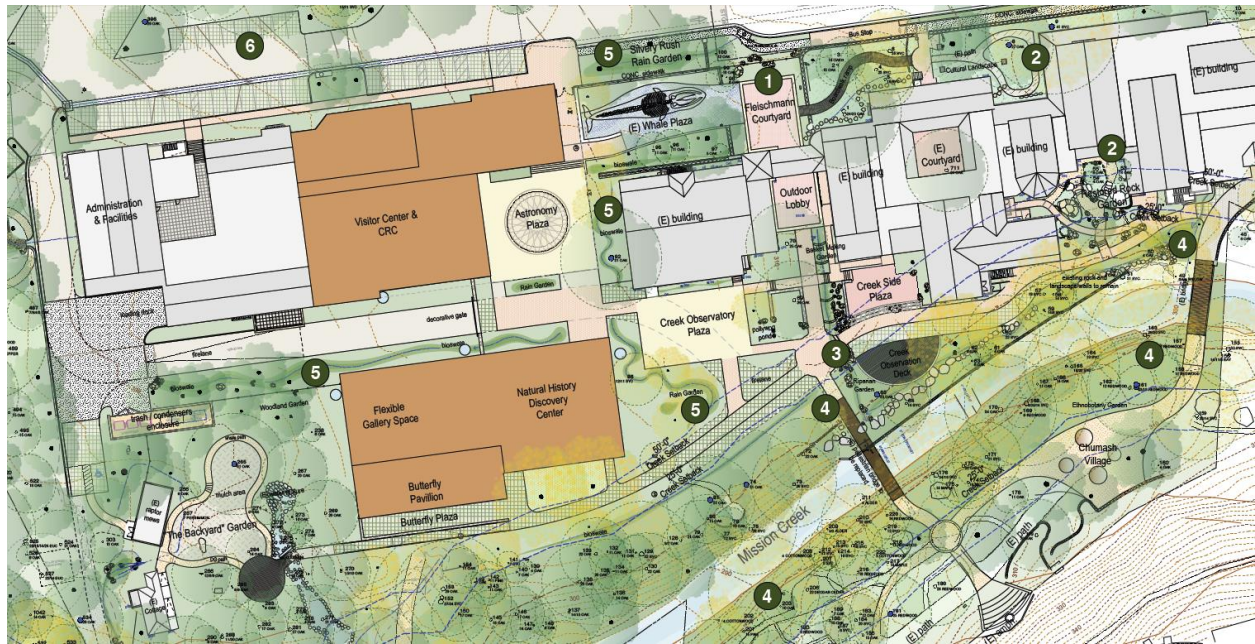
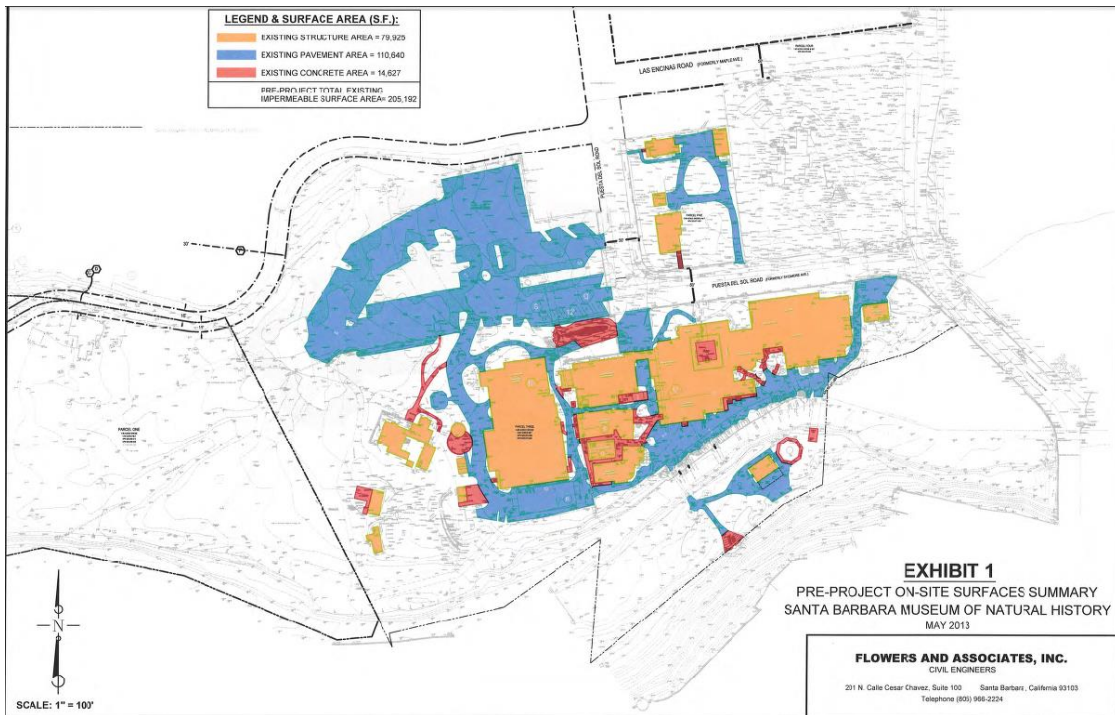
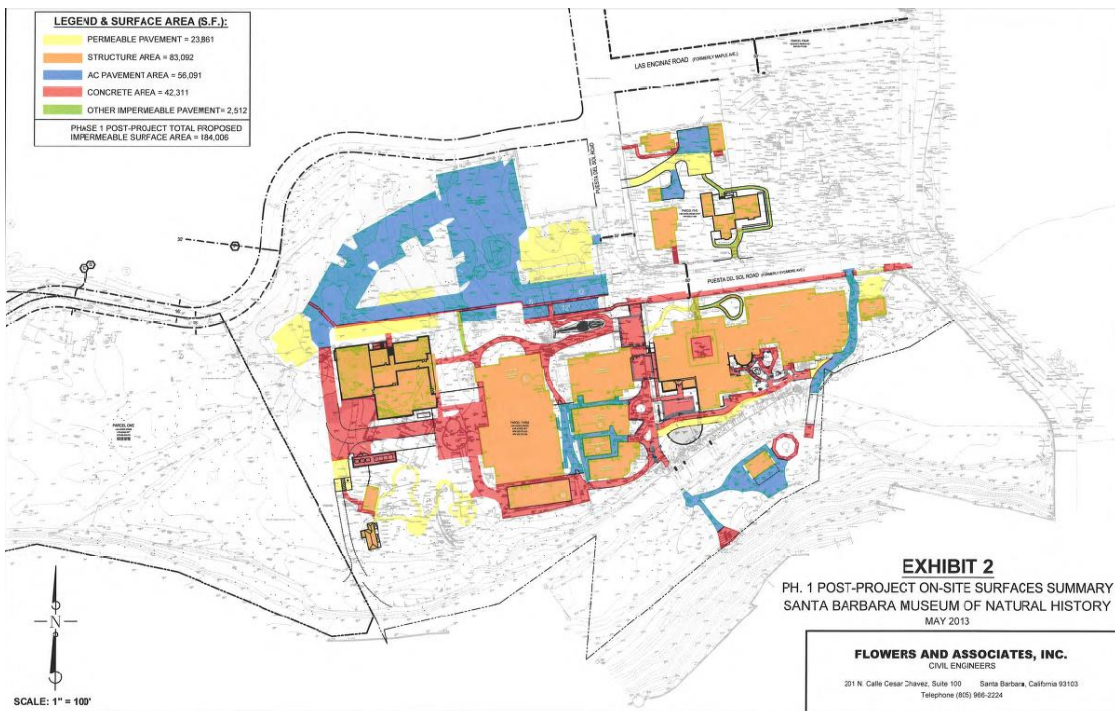


Figure A.6. Impermeable Surface Images: Pre-project, Phase 1 and Phase 2&3

Pre-project



Phase 1



Phase 2 & 3

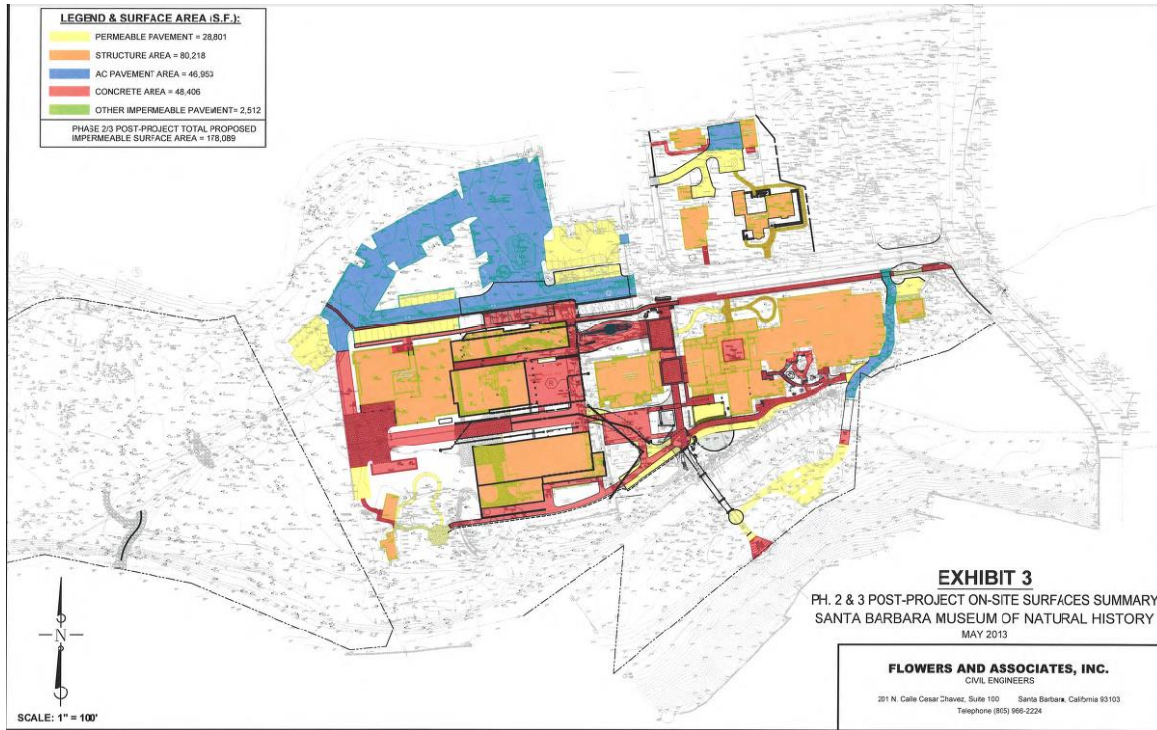


Table A.2. Inputs for the Center for Urban Forest Research Tree Carbon Calculator

Electricity CO₂ emissions factor	395 (kg/MWh); <i>state average</i>
Electricity CH₄ emissions factor	0.0030 (kg/MWh); <i>state average</i>
Electricity N₂O emissions factor	0.0017 (kg/MWh); <i>state average</i>
Tree species of interest	<i>Platanus hybrida</i> and <i>Quercus agrifolia</i>
Tree age	20, 40, 80, 120 years
Tree distance to nearest building	Adjacent (0'-20'), Near (20'-40'), Far (40'-60'). <i>Trees greater than 60 feet from buildings were excluded.</i>
Tree direction from nearest building	East, South and West. <i>Trees not in this azimuth range were excluded.</i>
Building age	Pre-1950 or Post-1980
Type of air conditioning/heating equipment	Central Air/heat pump and Natural Gas
Heating emissions factor- CO₂	53.1 kg/MBtu; <i>based on heating fuel type</i>
Heating emissions factor CH₄	0.0059 kg/MBtu; <i>based on heating fuel type</i>
Heating emissions factor N₂O	0.0001 kg/MBtu; <i>based on heating fuel type</i>

Figure A.8. Tree Distance to Buildings by Species

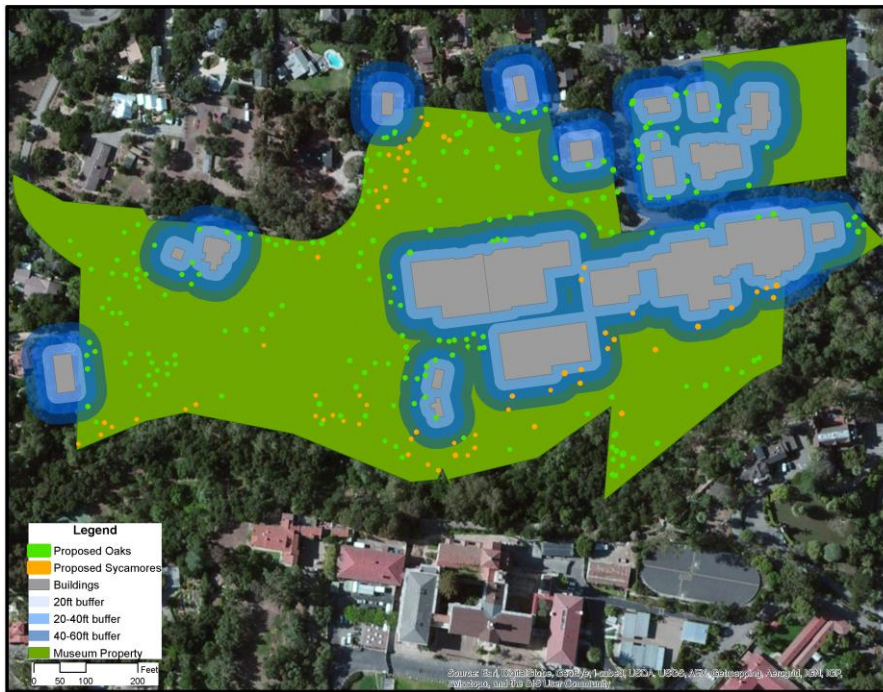


Table A.3. Land Area Calculations for Non-Native Plant Removal Management Action

Parcel 1								
Vegetation Type (canopy cover)	Area	Area	Native			Non-Native		
	(sq. ft.)	(acres)	% Native	Area (ft2)	Area (acres)	% Non-native	Area (ft2)	Area (acres)
Arroyo Willow/CLO/SYC Riparian Woodland	4,565	0.05	50%	2,282.50	0.052	50%	2,282.50	0.05
CLO Woodland	102,168	2.03	10%	10,216.80	0.235	90%	91,951.20	2.11
CLO/SYC Riparian Woodland	97,399	2.24	25%	24,349.75	0.559	75%	73,049.25	1.68
Eucalyptus	2,382	0.05	50%	1,191.00	0.027	50%	1,191.00	0.03
Non-Native Annual Grassland	6,932	0.16	10%	693.20	0.016	90%	6,238.80	0.14
Land Cover Type								
Pavement Road/Driveway/Parking Lot	726	0.02						
Structure	1,449	0.03						
Subtotal Parcel 1	215,622	4.95		38,733.25	0.889		174,712.75	4.01

Parcel 2								
Vegetation Type (canopy cover)	Area	Area	Native			Non-Native		
	(sq. ft.)	(acres)	% Native	Area (ft2)	Area (acres)	% Non-native	Area (ft2)	Area (acres)
Non-Native Annual Grassland	1,527	0.04	10%	152.70	0.004	90%	1,374.30	0.03
CLO Woodland	25,915	0.59	10%	2,591.50	0.059	90%	23,323.50	0.54
Subtotal Parcel 2	27,443	0.63		2,744.20			24,697.80	0.57

Parcel 3								
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Appendix A: Figures and Tables

Vegetation Type (canopy cover)	Area	Area	Native			Non-Native		
	(sq. ft.)	(acres)	% Native	Area (ft2)	Area (acres)	% Non-native	Area (ft2)	Area (acres)
CLO Woodland	24,073	0.55	10%	2,407.30	0.055	90%	21,665.70	0.50
CLO/SYC Riparian Woodland	63,583	1.46	25%	15,895.75	0.365	75%	47,687.25	1.09
CLO/SYC Riparian-Developed Understory	37,343	0.86	50%	18,671.50	0.429	50%	18,671.50	0.43
Eucalyptus	3,563	0.08	50%	1,781.50	0.041	50%	1,781.50	0.04
Mixed CLO/Ornamental	32,100	0.74	25%	8,025.00	0.184	25%	8,025.00	0.18
Oak-Ornamental-Developed Understory	104,109	2.39	10%	10,410.90	0.239	90%	93,698.10	2.15
Ornamental	31,368	0.72	50%	15,684.00	0.360	50%	15,684.00	0.36
Land Cover Type								
Bare Ground	5,394	0.12	0%	-	-	0%	-	-
Pavement Road/Driveway/Parking Lot	51,494	1.18	0%	-	-	0%	-	-
Structure	65,667	1.51	0%	-	-	0%	-	-
Walkway	10,372	0.24	0%	-	-	0%	-	-
Subtotal Parcel 3	429,066	9.85		72,875.95	1.673		207,213.05	4.76

Parcel 4								
Vegetation Type (canopy cover)	Area	Area	Native			Non-Native		
	(sq. ft.)	(acres)	% Native	Area (ft2)	Area (acres)	% Non-native	Area (ft2)	Area (acres)
CLO Woodland	18,173	0.42	10%	1,817.30	0.042	90%	16,355.70	0.38
Oak-Ornamental-Developed Understory	30,962	0.71	50%	15,481.00	0.355	50%	15,481.00	0.36
Ornamental	13,228	0.30	50%	6,614.00	0.152	50%	6,614.00	0.15

Appendix A: Figures and Tables

Land Cover Type								
Bare Ground	2,221	0.05	0%	-	-	0%	-	-
Pavement Road/Driveway/Parking Lot	1,288	0.03	0%	-	-	0%	-	-
Structure	1,645	0.04	0%	-	-	0%	-	-
Subtotal Parcel 4	67,518	1.55		23,912.30	0.549		38,450.70	0.88

Parcel 5								
Vegetation Type (canopy cover)	Area	Area	Native			Non-Native		
	(sq. ft.)	(acres)	% Native	Area (ft2)	Area (acres)	% Non-native	Area (ft2)	Area (acres)
Ornamental	12,909	0.30	50%	6,454.50	0.148	50%	6,454.50	0.15
Oak-Ornamental-Developed Understory	11,790	0.27	50%	5,895.00	0.135	50%	5,895.00	0.14
Land Cover Type								
Pavement Road/Driveway/Parking Lot	1,740	0.04	0%	-	-	0%	-	-
Structure	3,493	0.08	0%	-	-	0%	-	-
Walkway	125	-	0%	-	-	0%	-	-
Subtotal Parcel 5	30,056	0.69		12,349.50	0.284		12,349.50	0.28

Grand Total Parcels 1-5	769,705	17.67		150,615.20	3.458		457,423.80	10.50
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Hardscape	137,999	3.17
Vegetative Cover	631,706	14.50
Total Area	769,705	17.67

Total Area for Non-native plant coverage for parcels 1-3, excludes ornamental veg. type **6.64** acres This calculation is used for cost estimates

Total Area for Non-Native Plant Removal, with success rate of 90% in 5 years	5.98	acres	This calculation is used for Mgmt Action Totals
Total area of natives planted in place of non-natives, with success rate of 80% in 5 years	5.31	acres	This calculation is used for Mgmt Action Totals

Source: Data for this spreadsheet is taken from the Internal Draft Biological Assessment, by Watershed Environmental (Revised August 16, 2013); page. 12 - 13

Table A.4. Planting Palette for Phases 1, 2 & 3 (From Watershed Environmental Inc., 2013)

Phase 1- High Value Riparian Restoration			Quantity		
Riparian Planting Palette (Polys 1, 2,& Bioswale Poly 3)			Riparian	Riparian	Bioswale
Scientific Name	Common Name		Poly 1	Poly 2	Poly 3
<i>Artemisia douglasiana</i>	mugwort	herb	133	143	0
<i>Anemopsis californica</i>	yerba mansa	herb	0	0	150
<i>Carex barbarae</i>	Santa Barbara sedge	herb	0	0	354
<i>Clematis ligusticifolia</i>	creek clematis	vine	17	18	14
<i>Eleocharis macrostachya</i>	common spikerush	herb	0	0	150
<i>Elymus condensatus</i>	giant wild rye	herb	67	71	0
<i>Heteromeles arbutifolia</i>	toyon	shrub	17	18	0
<i>Juncus effuses</i>	spreading rush	herb	0	0	226
<i>Juncus patens</i>	common rush	herb	0	0	226
<i>Juncus xiphioides</i>	brown-headed rush	herb	0	0	150
<i>Mimulus cardinalis</i>	scarlet monkey flower	herb	0	0	354
<i>Pteridium aquilinum var. pubescens</i>	western bracken	fern	0	0	150
<i>Ribes amarum</i>	bitter gooseberry	shrub	67	71	0

Appendix A: Figures and Tables

<i>Ribes malvaceum</i> var. <i>malvaceum</i>	chaparral current	shrub	67	71	0
<i>Ribes speciosum</i>	fuchsia-flowered gooseberry	shrub	67	71	0
<i>Rosa californica</i>	wild rose	herb	67	71	0
<i>Rubus ursinus</i>	California blackberry	vine	26	28	0
<i>Salvia spathacea</i>	hummingbird sage	herb	370	397	0
<i>Satureja douglasii</i>	yerba buena	herb	46	50	0
<i>Scrophularia californica</i>	figwort/bee plant	shrub	104	112	0
<i>Solidago velutina</i> subsp. <i>californica</i>	California goldenrod	herb	416	446	0
<i>Stachys bullata</i>	common wood mint	herb	370	397	0
<i>Symphoricarpos mollis</i>	creeping snowberry	shrub	133	143	0
<i>Venegasia carpesioides</i>	canyon sunflower	herb	67	71	0

2,033 2,178 1,774

Phase 2 -Moderate Value Riparian & Oak Woodland Restoration

Riparian Planting Palette (Polys 4 and 7)

Quantity

Scientific Name	Common Name		Riparian Poly 4	Native Grass Poly 4	Bank Stabilization Poly 7
Annual Wildflowers	Annual Wildflowers	herb	0	n/a	0
<i>Artemisia douglasiana</i>	mugwort	herb	66	0	27
<i>Clematis ligusticifolia</i>	Creek Clematis	vine	8	0	3
<i>Elymus condensatus</i>	giant wild rye	herb	33	0	13
<i>Heteromeles arbutifolia</i>	toyon	shrub	8	0	3
<i>Muhlenbergia rigens</i>	deer grass	grass	0	78	0

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<i>Stipa (Nassella) pulchra</i>	purple needlegrass	grass	0	623	0
<i>Penstemon heterophyllus</i> var. <i>heterophyllus</i>	foothill penstemon	herb	0	78	0
<i>Ribes amarum</i>	bitter gooseberry	shrub	33	0	13
<i>Ribes malvaceum</i>	chaparral current	shrub	33	0	13
<i>Ribes speciosum</i>	fuchsia-flowered gooseberry	shrub	33	0	13
<i>Rosa californica</i>	wild rose	herb	33	0	13
<i>Rubus ursinus</i>	California blackberry	vine	13	0	5
<i>Salvia spathacea</i>	hummingbird sage	herb	182	0	74
<i>Clinopodium (Satureja) douglasii</i>	yerba buena	herb	23	0	9
<i>Scrophularia californica</i>	figwort/bee plant	shrub	51	0	21
<i>Solidago velutina</i> subsp. <i>californica</i>	California goldenrod	herb	205	0	83
<i>Stachys bullata</i>	common wood mint	herb	182	0	74
<i>Symphoricarpos mollis</i>	creeping snowberry	shrub	66	0	27
<i>Venegasia carpesioides</i>	canyon sunflower	herb	33	0	13

1,001 778 404

Phase 3 -Oak Woodland Non-Native Tree and Ground Cover Removal Areas

Planting Quantities

Quantity

Dry Shade Planting Palette (Poly 6 & 7)

Scientific Name	Common Name		Oak Wldd Poly 5	Oak Wldd Poly 6
<i>Ceanothus spinosus</i>	greenbark ceanothus	shrub	0	31
<i>Heteromeles arbutifolia</i>	toyon	shrub	8	20

Appendix A: Figures and Tables

<i>Frangula (Rhamnus) californica</i>	coffee berry	shrub	0	31
<i>Rhus integrifolia</i>	lemonade berry	shrub	0	14
<i>Sambucus nigra (mexicanus) subsp. Caerulea</i>	blue elderberry	shrub	4	14
<i>Elymus condensatus</i>	giant wild rye	herb	32	0
<i>Epilobium canum subsp. canum</i>	California fuchsia	herb	88	0
<i>Eriogonum fasciculatum var fasciculatum</i>	California buckwheat	shrub	39	0
<i>Keckiella cordifolia</i>	climbing penstemon	herb	22	0
<i>Frangula (Rhamnus) californica</i>	coffee berry	shrub	12	0
<i>Rhamnus crocea</i>	redberry	shrub	9	0
<i>Rhus integrifolia</i>	lemonade berry	shrub	7	0
<i>Ribes amarum</i>	bitter gooseberry	shrub	39	0
<i>Ribes malvaceum var. malvaceum</i>	chaparral current	shrub	39	0
<i>Ribes speciosum</i>	fuchsia-flowered gooseberry	shrub	32	0

110

331

Figure A.9. Total Carbon Dioxide Sequestration Rates for Native Trees

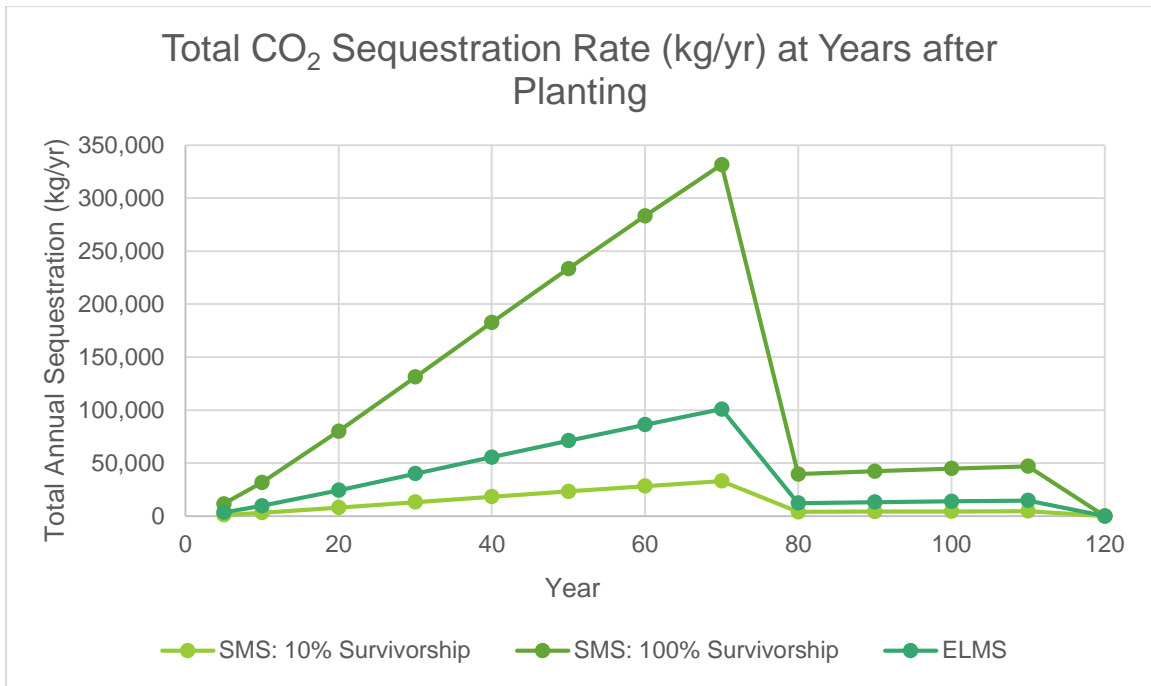
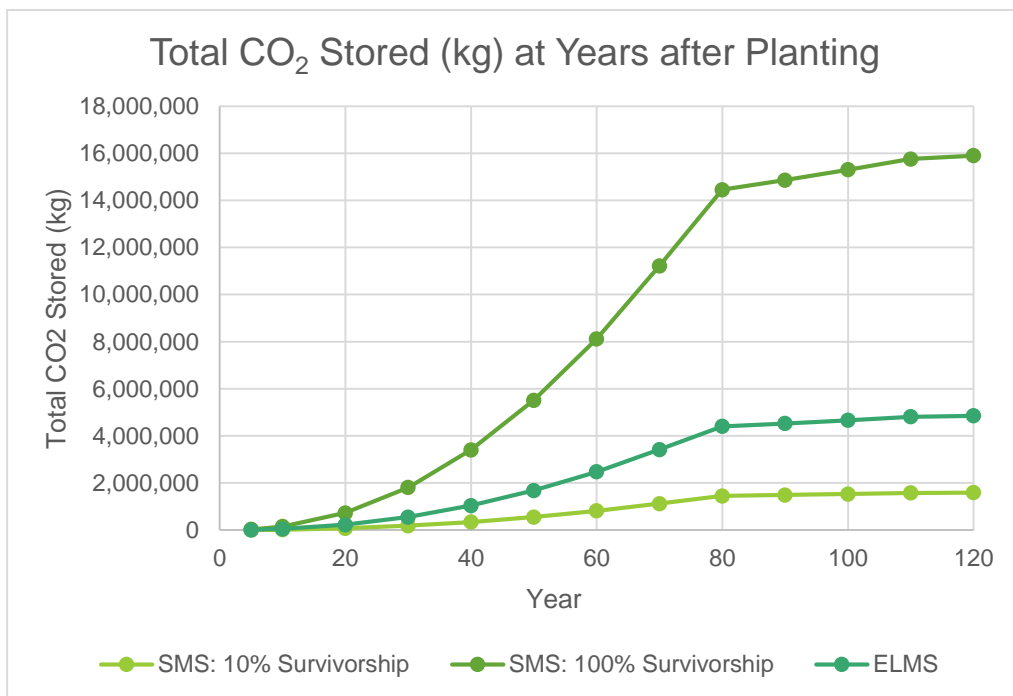


Figure A.10. Total Carbon Dioxide Storage for Native Trees



APPENDIX B: METRICS

ECOLOGY METRICS

BIODIVERSITY

The Biodiversity Metric captures effects to species diversity and habitat quality. This Metric focuses on Targets - specific measurable or describable characteristics - like species type, population size, habitat quality assessment and habitat area changes. This Metric compares native and invasive species population sizes, changes to tree species of concern and changes to habitat quality across the Management Actions and pre- and post-Development Plan phases.

HYDROGEOMORPHIC

The Hydrogeomorphic Metric captures effects to three major components of the water and sediment cycles. Changes to stormwater runoff volume, soil infiltration rate and erosion rate are the Targets used to evaluate this Metric. Developing an understanding of runoff flow across the site and into Mission Creek is a critical ecological consideration, along with peak runoff flows, on-site retention time and flow returns to groundwater and the Creek, due to the substantial effects of these characteristics on flood control and habitat quality. In particular, understanding and improving Mission Creek habitat quality is one of the City's highest environmental priorities.

BIOGEOCHEMICAL

Chemical and nutrient cycling are essential components of ecosystem function and health. As the mobilizing medium, the water cycle is intimately tied to nutrient cycling- particularly runoff generation. The Museum site generates runoff and pollution, and receives significant runoff from the surrounding urban landscape, making the campus's ability to retain these incoming pollutants particularly relevant. This Metric uses Targets based on standard water quality measurement and assessment: changes to suspended solid, hydrocarbon, nutrient, heavy metal and bacterial capture and cycling are considered across the Actions and Plan phases.

CULTURAL

The Cultural Metric assesses changes to humanistic values and characteristics of local ecology. This Metric's anthropocentric Targets include the landscape's fire resistance, local cultural significance, and fulfillment of the Museum's institutional mission. These three Targets were assessed using qualitative scales developed for this purpose by the Research Team; for more information on all scale development, see: Methods for Developing Qualitative Scales. Given the dry Mediterranean climate and the predominantly chaparral ecosystem, fire is a natural ecological characteristic in and around Santa Barbara. Concern over damaging fires is high and prompts evaluation of an Action's effects on site fire resistance. Cultural significance reflects Santa Barbara's current and historical values that the Management Action may affect such as historical accuracy, effect to the visual character, pace or 'sense of place' of Santa Barbara. Museum Mission Fulfillment evaluates the alignment between the Management Actions and the Museum's mission statement. As a natural history museum, the Museum seeks to inspire "awe for nature and a thirst for discovery" in visitors, promote sustainability, practice community stewardship and expand visitor's understanding of the natural world.

POLICY METRICS

CITY OF SANTA BARBARA GENERAL PLAN: ENVIRONMENTAL RESOURCES ELEMENT

The City of Santa Barbara's General Plan is the guiding document that broadly examines and expresses the goals of the city. The City has a legal mandate to use the General Plan as the blueprint for local development and growth decisions or policies. A core piece of the general plan is the Environmental Resources Element, which contains policies, implementation actions and possible implementation actions that advance the goal to "protect and use natural resources wisely to sustain their quantity and quality, minimize hazards to people and property, and meet present and future service, health and environmental needs." This Metric uses an 'alignment' Target, considering Management Actions' outcomes in light of specific parts of the ER element. If an Action would likely achieve the desired effect of a stated policy or goal, it is considered to be in alignment with that part of the ER element.

CITY OF SANTA BARBARA GENERAL PLAN: CONSERVATION ELEMENT

In addition to the Environmental Resources Element, the City of Santa Barbara General Plan includes the Conservation Element, which focuses on conservation, development, and the use of "natural resources including water, forests, soil, and mineral deposits." This element established a Biological Resource Goal, the aim of which is to "enhance and preserve the City's critical ecological resources in order to provide high quality environment necessary to sustain the City's ecosystem."

ORDINANCES

Different ordinances created by the City of Santa Barbara reflect desired growth and management outcomes in the city. The 2013 Zoning Ordinance Title 28 Chapter 87.250, the Tree Preservation Ordinance (Municipal Code Section 15.24), and the Street Tree Planting and Maintenance Ordinance (Municipal Code 15.20) are the Ordinance Targets selected, based on their relevance to the issue at hand.

GUIDELINES AND STANDARDS

Additional City guidelines and standards are used to compare Management Action outcomes. Specific Targets are the Landscape Design Standards for Water Conservation and the Storm Water Guidelines.

ACTION PLANS

Action plans are used to identify smaller scale or community-specific values and management goals. The Climate Action Plan and Urban Forestry Management Plan are relevant for evaluating mitigation action outcomes.

ECONOMIC METRICS

SHORT TERM COSTS

The short-term costs include any expenses incurred within the first year of the project. This mostly includes preparation, construction, and maintenance costs.

LONG TERM COSTS

The long-term costs include expenses incurred from year two to year five. This primarily includes maintenance and monitoring costs, as well as contingency replacement costs for plants.

TOTAL COSTS

This sums up the short-term and long-term costs for a broader look at the total costs associated with each Management Action and/or Strategy.

ANNUAL MAINTENANCE COSTS

This captures the annual costs of upkeep (if applicable) starting from year six and beyond for each Management Action. This cost Metric is used to assess the expenses for Management Actions that extend past the required five year regulatory requirement for compensatory mitigation actions.

TOTAL COST MINUS SAVINGS FROM VOLUNTEER LABOR

This takes the Total Cost then subtracts the potential savings realized from volunteer labor. This Metric only considers costs from year one through five, and does not integrate the annual maintenance costs.

OUTREACH METRICS

EDUCATIONAL UTILITY

Due to the intrinsically critical nature of education to the Museum's institutional purpose, assessing a Management Action's potential educational value was paramount. The Educational Utility Scale uses the following Targets to assess Action potentials for expanding educational opportunities: changes to learner demographics, frequency of educational provision, active or passive learning opportunity, and extension of learning or knowledge to the community outside the Museum.

COMMUNITY INVOLVEMENT

As a non-profit and education-centered institution, the Santa Barbara Museum of Natural History is focused on providing services to the entire community. Management Actions may provide new avenues to engage citizens, which is measured the Community Involvement Scale. The qualitative scale used to evaluate this Metric focuses on changes to volunteer numbers, citizen science potential, visitor demographics, visitation rates, and donor activity.

APPENDIX C: METHODS FOR DEVELOPING QUALITATIVE SCALES

COMMUNITY INVOLVEMENT

METHODS

Publically accessible properties undergoing large development projects often conduct a Social Impact Assessment to consider project implications for all affected community members. As an institution founded on and built around public outreach and community involvement, by nature of its institutional design, the Museum places very high priority on ensuring its campus, programs, exhibits and research have positive social implications.

One of two Metrics created to evaluate the Outreach Parameter, the 'Community Involvement' (CI) Metric captures several key aspects of how the Museum, its visitors, and the larger community interact. Drawing from the Museum's Mission statement and other institutional language, advised by certain definitions and other community outreach evaluations, the CI Metric was designed to gauge the implications of the Management Actions for volunteers, visitors and members of the Museum's community.

To gauge these implications, the CI scale was designed to assess how the Management Actions will impact the following categories:

Effect on...

Volunteer pool

Volunteer activities

Citizen scientist opportunities (or scientific value to the community)

Visitor diversity

Community groups currently underserved by the Museum

Visitation rates

Visitor-to-donor conversion rate, or current donors' donation rate

This scale ascribes qualitative statements to tiers; each tier seeks to capture a change in these CI categories, from pre- to post-Management Action. The tiers correspond to varying degrees of change and to varying numbers of categories affected, as described in the statements, and have a score associated with them. These scores are intended as a shorthand for the tier, and are not otherwise used in any quantitative summing, averaging, etc.

The preceding categories were selected as the most important aspects of Community Involvement for the Museum. Other categories, such as effects on Museum programs or exhibits, could be considered under conventional definitions of 'Community Involvement'. However, the second Outreach Parameter Metric, 'Education', captures these and related categories; these two Metrics together describe fully the Outreach implications of the Museum's Management Actions and were designed to minimize overlap. It is important to consider both Metrics when evaluating the Outreach implications of the MAs.

SCALE STRUCTURE

The following describes the considerations and steps taken in applying the CI scale to the six Management Actions. The scale is made up of three main clauses, each addressing at least a couple of categories. To achieve a score of +3, a reasonable argument must be made that a Management Action would completely satisfy all three clauses, and so add positively to all the important CI categories identified. If just two of the three clauses are satisfied, the MA is assigned a score of +2; If just one of the three clauses, a +1. In addition to this steady decrease in clause satisfaction, the language becomes weaker, indicating a lower likely effect or a lowered likelihood of effect.

A score of 0 indicates that it seems unlikely the Management Action would have any effect on any of the CI categories, rather that it would essentially not change the Museum's current state of community involvement as defined.

The scale continues into the negative, with a similar structure and process as with the positive side. A score of -1 indicates a negative change in one of the categories; a -2, two of the categories, and a -3 indicates negative impacts to all three categories. The language used scales up in strength as the scale goes more negative indicating a higher likely negative effect or higher likelihood of effect.

SCALE

Table C.5. Scale for Community Involvement

+3	Definitively expands the Museum's volunteer pool size and expands their range of activities, long term, with large potential for citizen science opportunities; (and) expands visitor demographic diversity, and particularly connects communities that currently are underserved by the Museum; (and) clearly increases visitation rates among community members, and clearly increases the visitor to donor conversion or causes current donors to donate more [Whole description met]
+2	Expands the Museum's volunteer pool size or expands their range of activities, with potential for citizen science opportunity; (and/or) expands visitor demographic diversity, or potentially connects communities that currently are underserved by the Museum; (and/or) increases visitation rates among community members, or increases the visitor to donor conversion or causes current donors to donate more [2/3 achieved]
+1	May marginally expand the Museum's volunteer pool size or their range of activities, long or short term, with little to no potential for citizen science opportunity; (and/or) has a small potential effect on visitor diversity, or could connect communities that currently are underserved by the Museum; (and/or) has marginal potential to increase visitation rates among community members, or the visitor to donor conversion, or whether current donors donate more [1/3 achieved]
0	Would not have an effect on the Museum's volunteer pool size and would not expand their range of activities; has no effect on visitor diversity, and does not connect communities that currently are underserved by the Museum; has no impact to visitation rates among community members, the visitor to donor conversion, or whether current donors donate more

Appendix C: Methods for Developing Qualitative Scales

-1	May marginally shrink the Museum's volunteer pool size or their range of activities; (and/or) may have a small negative effect on visitor diversity or could potentially further isolate communities currently underserved by the Museum (and/or) has marginal potential to cause visitation rates among community members to decline, or has marginal potential to lower the visitor to donor conversion or encourage current donors to donate less [1/3 achieved]
-2	Shrinks the Museum's volunteer pool size, or their range of activities; (and/or) has a negative effect on visitor diversity, or further isolates communities currently underserved by the Museum (and/or) causes visitation rates among community members to decline, or lowers the visitor to donor conversion or causes current donors to donate less [2/3 achieved]
-3	Definitively shrinks the Museum's volunteer pool size and their range of activities, long term; (and) shrinks visitor diversity, and particularly isolates communities currently underserved by the Museum (and) clearly causes visitation rates among community members to decline, and clearly decreases the visitor to donor conversion or clearly causes current donors to donate less [Whole description met]

CULTURAL SIGNIFICANCE

METHODS

Santa Barbara identifies its own cultural heritage as a blend of Indian, Spanish, Mexican and American influence. This heritage is manifested in the style, character, pace and appearance of the city – the culture of the city. Pieces of the past that add texture to the fabric of the community, enhance the city's unique appearance and contribute to a sense of place are culturally significant. Santa Barbara's general plan uses criteria set forth by the Federal Advisory Council on Historic Preservation to determine what may be considered historically significant. Historically significance is:

“Districts, sites, buildings, structures, and objects of State and local importance that possess integrity of location, design, setting, materials, workmanship, feelings, and association and:

- That are associated with events that have made a significant contribution to the broad patterns of our history; or
- That are associated with the lives of persons significant in our past; or,
- That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant distinguishable entity whose components may lack individual distinction; or,
- That have yielded, or may be likely to yield information in history or prehistory.

It is with this understanding of historical significance that the city then identifies the following visual resources as culturally significant: creeks, hillsides, shoreline, specimen and street trees, and open space. Resources relevant to the Santa Barbara Museum of Natural History are creeks, street trees and open space. Creeks “contribute significantly to the aesthetic quality of the city.” Mission Creek in particular is identified as the “predominant natural feature that bisects the city,” and as open space “the creek side environment of Mission and other creeks contributes to meeting the spatial and spiritual needs of the community residents by offering visual relief in the built environment.” Trees in Santa Barbara are “invaluable in the preservation of the rustic, visually pleasing appearance of Santa Barbara,” and can make “outstanding contribution to the appearance of a neighborhood.” Open space contributes to a “unique visual quality unparalleled in California.”

Appendix C: Methods for Developing Qualitative Scales

Goals identified to ensure visual resources are not degraded are:

- Restore where feasible, maintain, enhance, and manage creek side environments within the city as visual amenities consistent with sound flood control management and soil conservation techniques.
- Prevent the scarring of hillside areas by inappropriate development
- Protect and enhance the scenic character of the City
- Maintain the scenic character of the City by preventing unnecessary removal of significant trees and encouraging cultivation of new trees
- Protect significant open space areas from the type of development which would degrade the City's visual resources.

Based on the preceding information, a qualitative scale was developed to categorize the cultural significance of each Management Action.

SCALE

Table C.6. Scale for Cultural Significance

+3	Post action, the site greatly enhances unique visual character of Santa Barbara, by being historically accurate and integrating with existing landscape. A unique sense of place that captures Santa Barbara's style, character, pace and values is created in the best way possible.
+2	Post action, the site adds to the unique visual character of Santa Barbara, is mostly historically accurate and integrates well in the existing landscape. A contribution to the Santa Barbara style and character is achieved, though not in the best way possible.
+1	Visual quality is only marginally enhanced in the existing location, and minimal contributions are seen to Santa Barbara style and character.
0	There is no change to the visual quality, historical accuracy or unique character of the site post action.
-1	There is slight degradation to the visual quality, and misalignment to the unique character of the location post action.
-2	There is clear degradation to the visual quality, historical inaccuracies and misalignment to the unique character of the location post action.
-3	Visual quality is significantly degraded, historical inaccuracies are present and there is gross misalignment to the unique character of the location post action.

EDUCATIONAL UTILITY

METHODS

The central component of the Museum’s mission is education. Museum programs “are designed to foster understanding and appreciation of our rich natural and cultural heritage, promote scientific literacy, and inspire a passion for learning” (sbnature.org). The prior proposed development project intended to expand educational programming throughout the Museum’s campus, utilizing outdoor space as a learning tool in addition to the indoor exhibits. The ‘Education Utility Scale’ measures the potential educational value of Management Actions that compose the SMS and ELMS considered in the prior proposed development project.

Drawing from the Museum’s mission statement and other institutional language, the Education Scale includes the following components:

Access to education – Range of people educated (age, race, and socioeconomic status)

Type of learning – active and/or passive

Content of lessons - natural history, sustainability, culture and science

This scale ascribes qualitative statements to tiers; each tier seeks to capture a change in these educational categories, from pre- to post-Management Action. The tiers correspond to varying degrees of change and to varying numbers of categories affected, as described in the statements, and have a score associated with them. These scores are intended as shorthand for the tier, and are not otherwise used in any quantitative summing, averaging, etc.

SCALE STRUCTURE

The following describes the considerations and steps taken in applying the education scale to the six Management Actions. A score of 0 indicates that the Management Action would result in no change to educational utility. The positive scores (1 - 3) represent increasing access to education and a transition from only passive learning to both passive and active learning. Passive learning is accomplished through observation of exhibits or displays without involvement by the learner. Active learning includes hands-on involvement in learning through activities such as citizen science, restoration, or experimentation. The negative scores (-1 - -3) represent decreasing access to education and fewer opportunities for learning.

SCALE

Table C.7. Scale for Educational Utility

+3	Provides a wide range of visitors, including children, the elderly, and disadvantaged communities with frequent opportunities to passively and actively learn about natural history, sustainability, culture and science. Learning and knowledge acquisition spreads to communities outside of the Museum.
+2	Provides many different visitors, including children, the elderly, and disadvantaged communities with frequent opportunities to passively or actively learn about natural history, sustainability,

	culture and science. Passive learning is accomplished through observation of exhibits or displays without involvement by the learner. Active learning includes hands-on involvement in learning through activities such as citizen science, restoration, or experimentation.
+1	Provides a portion of visitors with some opportunities to passively learn about natural history, sustainability, culture and science. Passive learning is accomplished through observation of exhibits or displays without involvement by the learner.
0	No positive or negative impact on educational contributions of the Museum.
-1	Reduces opportunities for visitors to learn about natural history, sustainability, culture and science. Visitors are awarded fewer chances to passively or actively acquire new knowledge.
-2	Severely reduces opportunities for visitors to learn about natural history, sustainability, culture and science. Visitors are awarded significantly fewer chances to passively or actively acquire new knowledge.
-3	Visitors have zero opportunities to learn about natural history, sustainability, culture and science. No passive or active learning takes place.

FIRE RESISTANCE

METHODS

A landscape's fire resistance means its ability to prevent spread and increases in intensity of fire. It is impossible to completely prevent the initial fire ignition from both man-made and natural sources, so this scale focuses on spread and increase. In order to determine a landscape's proclivity for fire resistance, the team examined the opportunity for vertical and horizontal spread, as well as the amount and type of fuels present.

This scale is not meant to be all encompassing of factors contributing to fire resistance; nor does it account for the complex interactions between these factors. Some important factors that have been left out include weather (dry vs. wet, windy vs. calm). This scale is meant to focus on major proxies responsible for fire spread and increases in intensity. In addition, this scale should be simple enough to use without specialized knowledge of fire ecology.

UNDERSTORY FUEL ACCUMULATION

The assumption is made that when discussing fuels, concern is focused on *surface fuels* – that is, all fuels that lay above the soil horizon A, or the topsoil (Sikkink and Keane, 2012). Specifically, these surface fuels pertain to the dead vegetative matter, not live vegetation. Live vegetation is discussed in understory type. If there are large amounts of fuel present, then it's likely that a fire would burn longer and hotter. In addition, if the understory fuels have volatile organic chemicals like oil, resin, wax, and/or pitch, those chemical components compound the ability of the understory to burn longer and hotter.

UNDERSTORY TYPE

Fire retardant plants means that plants are *less* flammable, but not altogether resistant to fire. Given enough heat, all vegetation will ignite. The Mission Canyon Community Plan includes a guideline for human constructed landscape, which provides a list of native plants with various levels of resistance to fire (County of Santa Barbara Planning and Development Department, 2013). This plan establishes a series of zones, from Zone 1 (closest to buildings) to Zone 4 (furthest away from buildings), with corresponding fire resistant plants. The plants recommended for Zone 1 are the most fire resistant, with Zone 4 being less fire resistant. The Plan also includes a list of “Undesirable Plant Species,” which outlines native plants that have physical and chemical properties that allow them to be highly flammable. Some examples of flammable properties include: production of profuse amounts of litter, rough or peeling bark, and contain volatile substances.

VERTICAL SPREAD

Vertical spread of fire means the ability of fire to spread from the ground to the tree canopy and vice versa. This can be achieved through ladder fuels such as tall shrubs next to trees or dead vines attached directly on trees. The upward vertical spread of fire is usually undesirable since it tends to destroy tree canopies, and the trees themselves. If there is a large presence of ladder fuels, then that means that the fire resistance is low since it encourages the vertical spread of fire.

HORIZONTAL SPREAD

Horizontal spread is encouraged when there is a continuous swath of vegetative material. Thus, the appropriate proxy for determining the horizontal spread of fire is the quantity of fire breaks present. These firebreaks can be either man-made, in the form of roads or sidewalks, or natural, in the case of bare dirt. The greater the amount of firebreaks, the more fire resistant the landscape is. The definition for “fire breaks” is any stretch of land more than or equal to 20 feet wide that consists of bare dirt or any non-vegetated land type. The 20 feet minimum is designed to be sufficient to stop a low-burning, low-intensity fire. If the fire is occurring in the presence of ladder fuels and/or high wind conditions, then the presence of firebreaks is negligible since the fire will spread from canopy to canopy or with embers carried by the wind.

SCALE

Table C.8. Scale for Fire Resistance

+3	Completely resistant to fire: There is no vegetation present.
+2	Extremely resistant to fire: there is no understory fuel accumulation through routine removal by gardeners and land managers; the understory vegetation is composed high fire resistant plants from the Firescape Zone 1 list. There are no ladder fuels, and there are firebreaks that exceed 20 feet in width throughout the museum property.
+1	High resistance to fire: there is a small amount of understory fuel; the understory vegetation is composed of moderate fire resistant plants from the Firescape Zone 2 list. There are no ladder

Appendix C: Methods for Developing Qualitative Scales

	fuels, and there are firebreaks that are at least 20 feet in width throughout the museum property.
0	Moderate resistance to fire: there is a moderate amount of understory fuel; the understory vegetation is composed of slightly fire resistant plants from Firescape Zones 3 and 4. The presence of ladder fuels is in limited quantities, and there are firebreaks that are 15 – 20 feet in width throughout the museum property.
-1	Low resistance to fire: there is an abundance of understory fuel; the understory vegetation has no fire resistance and is composed of plants from Fire Zone 4 and Undesired Plant Species List. The Presence of ladder fuels is present in moderate quantities. The limited presence of firebreaks fall well below 15 feet in width.
-2	No resistance to fire: There is an overabundance of understory fuel accumulation, and has volatile chemicals in the plants and/or vegetative litter. The understory type is highly flammable, and contains plants under the Undesired Plant Species List. Ladder fuels are present throughout woodland, and are no firebreaks within the museum property.
-3	Flammable: Understory fuel accumulation exceeds 1 foot in depth and is completely comprised of extremely flammable vegetative litter that has volatile chemicals within it. The understory vegetation is dead and dried out, and contains plants from the Undesired Plant Species List. Ladder fuels are present throughout woodland, the trees are crowded together, with no breaks in canopy cover. There are no firebreaks within the museum property.

APPENDIX D: STAKEHOLDER INTERVIEW QUESTIONS

FOR PLANNERS AND MITIGATION SPECIALISTS

1. What are the top issues for planning in the County of Santa Barbara?
2. How important or relevant is compensatory environmental mitigation in the County of Santa Barbara?
3. What do you see as the limitations of compensatory mitigation in Santa Barbara?
4. What are the barriers to implementing alternate mitigation approaches?
5. Are there barriers to collaboration between jurisdictions?
6. Do relationships exist that allow for collaboration between jurisdictions?
7. How do feel best available science informs mitigation requirements in Santa Barbara?
8. How would you improve compensatory environmental mitigation in Santa Barbara?

FOR DEVELOPERS

1. How do environmental mitigation requirements affect your development process? Time? Costs? Development outcomes?
2. If you knew you were required to spend 100k on environmental mitigation where would you put it?
3. Do you prefer on-site or off-site mitigation requirements?
4. Do you feel best available science informs mitigation requirements in Santa Barbara?
5. How would you improve compensatory environmental mitigation in Santa Barbara?

APPENDIX E: BACKGROUND ON ALTERNATIVE MITIGATION POLICIES

NATURAL COMMUNITIES CONSERVATION PLANNING

THE RANCHO PALOS VERDES CASE STUDY

BACKGROUND

The City of Rancho Palos Verdes entered into an agreement with CDFW and USFWS to develop the NCCP Subarea Plan. This plan is intended to cover the entire Palos Verdes Peninsula; however, only the city of Rancho Palos Verdes has entered the formal agreement (URS 2004).

Development of this plan was broken into two phases:

- Phase 1: The development of a landscape scale database with biological and land use information. The database focuses on remaining naturalized open spaces within and adjacent to the city. The final product for phase 1 efforts were alternative reserve designs that met the biological targets for conservation. From these designs, the city could choose which reserve system would best suited its needs.
- Phase 2: Refining the reserve design and development of the Subarea Plan for agency and public review/comment. Results from phase 2 helped the city focus on the acquisition of key private lands and conservation of key habitats within public land. Conserved land would be added to the Ranch Palos Verdes Habitat Reserve area. The Palos Verdes Peninsula Land Conservancy (PVPLC) became the Habitat Manager overseeing management and restoration efforts in the Reserve.

This Subarea Plan is intended to compensate for current and future development needs within the city through habitat conservation and management (URS 2004). This plan allows each individual project to be analyzed within the context of the region. The primary function of the Subarea Plan is to grant the City an incidental take permit through ESA Section 10(a), thereby clearing the City to approve projects that would normally be stifled under ESA review and granting take permits in lieu of CDFW. The plan was established through agreement with the Wildlife Agencies that regularly oversee ESA reviews, and enabled a preemption of these processes for individual projects so long as the conditions laid out in the NCCP's Implementing Agreement are met.

The full extent of the plan addresses the following:

- Areas identified for conservation
- Mechanism for conservation (acquisition and easements)
- Interim protection measures for areas not expected to be ultimately conserved
- Actions the City will take to obtain ESA Section 10(a) take authorizations for covered species (including current and future management)
- Maintenance and compatible uses of conserved land
- Funding for land management
- The process for mitigating development on non-conserved land, obtaining permits for development and take authorizations

Appendix E: Background on Alternative Mitigation Policies

This plan was developed to comply with the California Endangered Species Act, southern California coastal sage scrub NCCP Process Guidelines, the City's Coastal Plan, and California's Coastal Act regulations. Implementation of this plan will rely on the City's authority through the General Plan policies, Coastal Program, zoning ordinances, community plan amendments, and environmental use regulation.

Species requested for take under this plan are:

- A. Palos Verdes blue butterfly (endangered)
- B. El Segundo blue butterfly (endangered)
- C. Coastal Gnatcatcher (threatened)
- D. Lyon's Pentachaeta (endangered)
- E. 8 additional species not officially listed but known to occur within the City

*These 8 additional species are listed on the California Rare Plant Ranking System under Rank 1B and Rank 4. The cactus wren is a State Species of Concern.

OUTCOMES

Under this agreement, the City of Rancho Palos Verdes was granted permits/management authorizations for the take of listed species. The conservation and mitigation detailed in the NCCP is the total amount required by the City for any development projects they choose to do, so long as they comply with the plan. The duration of the agreement was set at 50 years, with a chance to renew.

The NCCP agreement required updates to the City's general plan before implementation took effect. Furthermore, updates to the Municipal Code of Ordinances code, Zoning Ordinance, Local Coastal Plan and "relevant regulations" occurred.

IMPLEMENTATION ACTIONS

From Sections 4-12 and 5-7 of the NCCP, implementation would:

- Dedicate 322.2 acres of City owned land to an existing 423.5 acres of biological open space
- Add 90.2 acres of public land not owned by the City
- Acquire and add 684.5 acres of private land to the reserve system with funds from the City, Los Angeles County, Wildlife Agencies and the PVPLC (Palos Verdes Peninsula Land Conservancy)
- Stipulate that all future project-specific mitigation will be in the form of providing lands to the reserve or funds for habitat restoration. Mitigation ratios are 3:1 for coastal sage scrub, riparian scrub, and native grassland, 0.5:1 for non-native grassland, and 0.05:1 for less than 0.3 acres of native grassland.
- Have the City enter an agreement with the PVPLC to contribute \$100,000 for maintenance and \$91,000 in in-kind services per year (adjusted for inflation). The PVPLC will contribute \$50,000 for managing the reserve.
- Reduce/eliminate USFWS and CDFW involvement in project-specific review and approval
- Third-party developers will be able to 'take' covered species and habitats incidental to a project based on approvals extended through the local project permitting process
- Future designations of critical habitat, or listing of species will not require more additional land, restrictions, mitigation or compensation.

Appendix E: Background on Alternative Mitigation Policies

- Within two years, a Public Use Master Plan shall be developed by the City and PVPLC to address public access, trailheads, parking, trail use, fencing, signage, lighting, fire and brush management, etc.
- PVPLC will develop a Reserve Habitat Management Plan and an annual Target Exotic Plan Removal Plan

ECONOMIC IMPACT

The resulting NCCP reserve system area is 1,504 acres. This was achieved through multiple acquisitions and conservation easements. Some of this land was already under City ownership and required conversion of use. Approximately 684 acres was needed to meet the goal. The estimated cost of acquiring this land based on a commissioned appraisal was \$26.7 million.

The NCCP agreement obliges the City of Rancho Palos Verdes to provide both cash and in-kind services for management of the preserved area. For the 2010-2011 fiscal year, these obligations cost the City \$425,111. The costs associated with the NCCP program, broken down by category, are presented in Table E.1..

Table E.1. Costs of NCCP in Palos Verdes

Financial Assistance to the PVPLC for habitat management	\$109,900
Payment to PVPLC for managing ocean front habitat	\$16,511
Mandated Fuel Modification	\$108,000
Public Safety (Ranger services)	\$75,000
Waste Removal	\$5,000
City Signage	\$2,000
Burma Road Maintenance	\$25,000
Landslide Abatement District Assessments	\$84,000
Total	\$425,411

ENVIRONMENTAL IMPACTS

The Subarea Plan's proposed reserve system management plan is found to be sufficient to cover biological mitigation for the City's Capital Improvement Plan projects, and for an estimated 9 private projects. The EIR does identify some direct significant impacts to biological resources, but finds that all of these are reduced to non-significant impacts because the following goals of the NCCP process are met (from Section 5.1.3 Cumulative Impacts)

1. Conserve target species throughout the planning area
 - a. 96 percent of existing habitat area is conserved
 - b. 94 to 100 percent of covered species locations are conserved

- c. A habitat restoration program will add land to the Reserve in the future
2. The largest and most contiguous lands are in the Reserve
3. Reserve areas are close together and linked by corridors
4. All known habitats and subtypes are included in the reserve system

THE ORANGE COUNTY CASE STUDY

BACKGROUND

The Natural Community Conservation Planning and Habitat Conservation Plan (NCCP/HCP) for Orange County was signed and put into effect in 1996, with a permit term of 75 years. The regulatory framework is based on the NCCP Act of 1991, and the federal listing of several species on the Endangered Species List. The listed species includes: coastal California gnatcatcher (threatened), Pacific pocket mouse (endangered), and southwestern arroyo toad (endangered). Additionally, Section 4(d) of the Endangered Species Act gives the NCCP/HCP planning process some flexibility in regard to the treatment of endangered species; this Special Rule was enacted by the Department of the Interior to encourage preparation of NCCPs.

Preparation of the NCCP/HCP involved federal, state, and local government agencies; landowners; and environmental interest groups. Environmental interests represented by a Working Group of: the National Audubon Society, the Natural Resource Defense Council, and The Nature Conservancy. The Consultant Team was made up of the working group and the CDFW, USFWS, and participating landowners. The NCCP/HCP was prepared concurrently with an Environmental Impact Statement and an Environmental Impact Report, as per the National Environmental Quality Act and the California Environmental Quality Act.

The NCCP/HCP only pertains to the coastal and central subregions of the County of Orange. These two subregions are referred to as the “Planning Area,” and are 208,000 acres. Within this area, there is a 37,380 acre Reserve System.

The fundamental requirements for the NCCP/HCP include:

- Maintaining net habitat values on a long-term basis for the target and identified species.
- Not appreciably reducing the likelihood of species survival and recovery in the wild, and achieving other Incidental Take permit issuance standards
- Identifying areas where new economic uses would be allowable, consistent with the subregional conservation strategy.

Landowners, one of the major stakeholders, is divided into two categories; participating landowners and non-participating landowners. In order to be categorized as a participating landowner, significant land contributions and/or funding toward implementation of the Reserve System and Adaptive Management program is required. Participating landowners’ development activities and land uses consistent with the NCCP/HCP are considered fully mitigated, and no additional mitigation will be required of the participating landowners for impacts to identified species and their habitat. Non-participating landowners are those who did not contribute significant land or funds towards the NCCP/HCP. Consequently, they are not offered the same conditional mitigation waiver. Instead, they need to ensure:

- On-site avoidance of Take

- Satisfaction of applicable FESA and CESA provisions under the consultation and permit provisions of these statutes
- Payment of a mitigation fee to the non-profit management corporation as provided for in the NCCP/HCP and Implementation Agreement

OUTCOMES

The outcomes from the planning process are the following:

- A Habitat Reserve System – identifies habitats and protection for these habitats. This is managed by the Nature Reserve of Orange County, a 501 (c) 3 non-profit management corporation. The NROC coordinates activities within the reserve system, receive and disburse funds to reserve owners/managers, hire staff and biologists to conduct adaptive management activities and prepare annual reports for public review.
- A commitment to adaptive management – the Management Actions proposed within the NCCP/HCP will be monitored and modified over time to respond to new scientific information, changing conditions and habitat needs.
- The development of an Interim Management program – this program accounts for the remaining portion of land in the Reserve System that has “prior commitments” to the NCCP/HCP plans. The private landowners, in this case, would allow the non-profit management entity to implement “interim” habitat management measures during the transfer from private to public lands. The purpose of this is to improve habitat values on lands designated for inclusion within the reserve.

ENVIRONMENTAL IMPACTS

This NCCP/HCP protects multiple habitats and numerous species, including species that are not listed under the Endangered Species Act (ESA). Some of the habitats that are protected in the NCCP/HCP include oak woodlands, Tecate cypress forest, cliff and rock, and chaparral. Other species of concern are referred to as “target species,” and they enjoy the same protection as endangered species under ESA. This broader conservation protection program helps prevent target species from being listed under ESA in the future, thereby avoiding high administrative costs and conflict between developers and agencies. Another expected outcome is increased local control and the streamlining of regulatory processes related to these target species and habitats. If the programs and terms of the Implementation Agreement are implemented properly, then mitigation for designated development requirements are considered to be satisfied by state and federal standards. Some of the activities covered by the NCCP/HCP include public infrastructure utilities like roads, utilities, and recreational facilities; private residential, commercial, and industrial development.

POLITICAL IMPACTS

By delineating the boundaries of the Habitat Reserve System, the NCCP/HCP provides certainty to the public and affected landowners with respect to future development and open spaces. The specifications of the NCCP/HCP include target areas and types of land use that would be compatible with the program. The predictability, streamlined process, and consistency of application create incentives for stakeholders to become participating landowner. An example of this streamlining is the eliminated need for mitigation pertaining to development addressed within the NCCP/HCP. In addition, this program integrates existing open space planning to the Habitat Reserve system and subregional conservation strategy, which further simplifies management of the Planning Area.

ECONOMIC IMPACTS

The NCCP/HCP identifies funding to pay for the creation and long-term management of the Reserve System. About 20,000 acres of private lands would be added to the reserve at no cost to the County or other public agencies, while 750 acres of private lands would be sold to the public sector by willing landowners. These 750 acres were identified prior to the commencement of the NCCP/HCP, and the total estimated cost for land acquisition is \$9 million. Mitigation fees from non-participating landowners will be put forth for this purchase.

The general revenue stream is expected to come from various sources, including endowments, mitigation fees from non-participating landowners, and grants. The NCCP/HCP program creates a non-wasting endowment fund of \$10,665,000 to pay for the adaptive management program within the reserve (non-wasting meaning only the interest generated from the principle would be used). The endowment funding itself is provided by a number of agencies and private organizations. Mitigation fees are expected to generate \$6 million within the first 20 years from non-participating landowners. Revenue from this sector would go towards major restoration and revegetation for Reserve System lands. The Nature Reserve of Orange County is the non-profit corporation responsible for collecting these fees and disbursing the funds towards the restoration programs.

APPLICATION OF NCCP SANTA BARBARA

Overall, NCCPs offer benefits to conservation minded environmentalists, agencies, and to developers. The success of the Palos Verdes Peninsula Subarea plan relied on several characteristics specific to the region:

1. There was one primary developer (the City of Rancho Palos Verdes) that was making the NCCP agreement.
2. There were two managing agency for the new reserve network (the Palos Verdes Peninsula Land Conservancy and the Nature Reserve of Orange County)
3. Palos Verdes already owned half of the acreage for the reserve
4. Large portions (600 acres) of suitable private land habitat existed for conservation and were available for purchase. 2/3 of the 600 acres was acquired from one landowner, simplifying the process.
5. Rancho Palos Verdes and the surrounding area primarily consists of low density, high-cost housing with country clubs, open space and beaches interspersed throughout. There does not exist a plan to incorporate affordable housing, new roads, or other forms of intense development, making the decision to set land aside for conservation easier.
6. Palos Verdes had sufficient funds available.
7. There was tremendous motivation to work something out in order to prevent an endangered listing of the Gnatcatcher

Characteristics in Palos Verdes and Orange County that lent itself well to an NCCP do not necessarily exist in Santa Barbara. An NCCP first and foremost addresses incidental take of species. Sensitive species around and in Santa Barbara are present; however, only steel head trout have critical habitat, within the City limits. Oak trees are not listed under any state or federal act as sensitive. Further, the initiation of an NCCP in Santa Barbara would need to consider if there is currently demand for projects that may be impacting sensitive species/habitat, and if developing a simpler permitting process for the impact of those species is efficient.

BENEFITS OF NCCP

One benefit to developers for NCCP is a streamlined process that eliminates the need to interact with CFW or other agencies. Instead of interacting with these agencies, developers interact with the local authority that implements the NCCP. Wildlife agencies will receive notification through the CEQA process of a project and can request voluntary consultation within the normal public or CEQA review period. NCCP gives cities the deciding authority to issue take authorizations. These issuances are documented and maintained in a list that is updated annually.

This and the assurance that no additional funds be required are the streamlining components of the NCCP. CEQA review is still required, and environmental impact assessments are still required. Under Endangered Species Act Habitat Conservation Plans, individual developers/landowners must consult with agencies and resolve the issue. Once the mitigation land is designated, the permit holder is charged with management and monitoring. This current process does not offer the same benefits as an NCCP would.

WETLAND MITIGATION BANKING

SITE DETERMINATION

Bankers determine properties for wetland credit production through a variety of channels, such as word of mouth and advertisements; this entails more than a general land-for-sale search, because it requires identifying a property with degraded wetlands. For example, if wetlands are making development infeasible on a property that wetland would potentially be a prime location for a mitigation bank. In the case of Public Commercial banks – banks sponsored by public entities – property selection is often based on the agency's current land reserves and utilizes the scientific tools of conservation planning to identify priority properties in the long-term and in association with other conservation objectives. However, there are no mechanisms that require Private Commercial Banks to utilize best-available science, build on existing natural lands, or consider long-term and multiple conservation planning objectives.

Siting is advised by the original 1995 guidance to be “carefully considered for ecological suitability.” Banks can be established on already protected land, but credits are only produced if additional ecological value is realized through the establishment of the bank. Mitigation banks may not be established on FWS National Wildlife Refuge System lands because those lands are already targeted for restoration. Other public lands have not followed FWS's lead in designating their lands as exempt.

The 1995 guidance states that “the service area [where the credits can be sold] should be based on hydrologic and biotic criteria”, and suggests using hydrologic unit codes, or HUCs, in conjunction with ecoregion maps to match credits to appropriate debits. However, the Corps/MBRT can authorize trades outside of this area case-by-case where “determined practicable and environmentally desirable.”

If a current or prospective banker thought someone owned a property that would be very suitable for a WMB, the banker would simply arrange to either purchase the land or secure contracted, long-term access through the normal channels. As of 2008, a project is required to establish: the real estate instrument for site protection; financial assurances for near and long-term stewardship; monitoring and contingency planning; and specific identification of parties responsible for different project tasks. The ELI report found that on public lands (circa 2002) less than half of 54 banks had an instrument that specified the legal assurance for land protection. Of the 25 that did, ten used restrictive covenants, seven used conservation easements, and six used deed restrictions.

2008 RULE

According to the EPA: " These regulations are designed to improve the effectiveness of compensatory mitigation to replace lost aquatic resource functions and area, expand public participation in compensatory mitigation decision making, and increase the efficiency and predictability of the mitigation project review process."

In short, the most significant change in the 2008 rule was creating a set of rules that apply equally to all three compensation mechanisms, requiring them all to have the same dozen components in their 'instrument' or driving document. This is in response to many people claiming that having different rules for the different mechanisms creates inherently unequal playing fields, favoring a mechanism in one case while disfavoring it in another. Following this new rule EPA says they have created equivalent standards and greater accountability, favoring providers of high quality and timely mitigation, regardless of the mechanism.

Another very important change was the establishment of specific evaluation and decision-making time frames for proposed new banks and in-lieu fee programs. This is in response to the purportedly slow MBRT process, while still maintaining that process for the 'pros' discussed above. Further, measurable, enforceable ecological performance standards were written into the rule, along with requiring regular monitoring – where before, this was usually part of an instrument, but not actually legally mandated.

The 2008 rule also incorporated several important ecological concepts recommended by the National Research Council, to improve the success of the mitigation. For example, bank site planning is now required to consider watershed level and larger conservation efforts, wildlife management plans, HCPs etc. Further, the Sponsor has to fully detail the consistency with those larger efforts in the bank instrument. The hope is that this creates more connected, contiguous areas of habitat, and that it aligns mitigation efforts so that they are helping to work toward the conservation goals set for a region by its premier environmental or conservation constituents. Similarly, the rule requires increased public participating in compensatory mitigation decision making- however, no further information was discovered that reveals where or how this 'increased participation' actually occurs.

In Summary of the 2008 Changes:

The Corps and EPA promulgation of 2008 expanded upon prior guiding documents, creating regulations on the creation and maintenance of wetlands or mitigation banks. The need for these rules was clear; the members of this market (the banks, the regulators, the scientists) generally agree that wetland mitigation, specifically mitigation banking, can be done and done well (Meadows 2007). Lacking better regulation, though, it is very difficult to accomplish; it is made especially difficult by the fundamental complexity of attempting to restore or create habitat, especially wetlands with their complicated hydrologies. That said, the new regulations require many of the listed 'pros' of mitigation banking, such as watershed level planning, that were before simply theoretical benefits and 'guiding actions' but that will now be mandated. They specifically address the major issues that the 2001 NRC Report and the 2002 ELI Report highlighted.

REGIONAL ADVANCE MITIGATION PLANNING

RAMP GOALS

The RAMP Working Group identified three goals with a series of supporting objectives that the RAMP program seeks to address. These goals give insights on needed components of a new mitigation program and also illuminate the gaps the Working Group perceives in current mitigation approaches.

From the Draft RAMP Framework:

Goal 1: Improved Regional Mitigation and Conservation Planning

Objective 1: Integrate RAMP Statewide Framework with regional and statewide planning efforts

Objective 2: Improve coordination and collaboration in statewide and regional planning efforts

Objective 3: Improve community outreach to local governments, nongovernmental organizations, local farm bureaus, tribal governments, conservation and mitigation bank sponsors, and land owners

Objective 4: Reduce data gaps and other restrictions to improve future planning

Goal 2: Improved Mitigation and Conservation Effectiveness

Objective 1: Establish a management structure with the authority, responsibility, accountability, support, and funding to achieve the anticipated benefits of RAMP

Objective 2: Create a network of connected conservation lands that will ultimately increase the quantity and quality of habitat for listed and at-risk or native species

Goal 3: Improved Efficiency (Faster, Better, Cheaper)

Objective 1: Create an effective and efficient process for determining locations for establishing off-site mitigation areas that is specific to RAMP

Objective 2: Reduce project delivery costs when implementing off-site mitigation

Objective 3: Reduce monitoring, operations, maintenance, and management costs for mitigation land