Making Wellesley a **LEED**er in Sustainable Design:

The Synthesis of Wellesley's Sustainable Building Guidelines

Prepared for Wellesley College's Advisory Committee on Environmental Sustainability
ES 300: Environmental Decisionmaking
Spring 2014

Environmental Studies Program, Wellesley College
Wellesley, MA

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EXECUTIVE SUMMARY

The task given to the Environmental Decisionmaking class to create sustainable building guidelines for Wellesley provided a unique opportunity to evaluate our campus' strengths and weaknesses in building design over the years. We researched the history and present state of Wellesley College to understand the development goals and needs of the institution. We contacted peer institutions to learn about their sustainable building guidelines and to elicit advice for our own endeavor. We explored alternatives to the Leadership in Energy and Environmental Design (LEED) standard in order to understand a broader range of sustainable building practices. Finally, we conducted a comprehensive, qualitative analysis of the LEED credits and proposed a new way to prioritize and imagine the sustainable building process. This report, composed of Environmental Decisionmaking's comprehensive research and analysis, provides the foundation for successfully integrating sustainability in our campus buildings, for both redevelopment and new construction, now and in the future.

Through our research of the College we found that its buildings have been designed based on a set of specific criteria that reflect our social values and what has been done at other institutions. Historically, the College has made intentional decisions with regards to its buildings and has, and continues to have, a deep commitment to preserving the campus heritage and sense of community. Examining the stakeholders involved in past and current building projects, we discovered a strong leadership team with individuals from a wide range of backgrounds. However, we also saw an over-representation throughout the project teams of a small group of individuals as well as an under-representation of certain areas, such as sustainability. Historically, Wellesley's building process has been in sporadic phases of construction, which are determined by the capital and leadership available at the time. As a result of this pattern, the college has never needed a comprehensive building process plan.

Contacting those involved with sustainable building processes at peer institutions helped to guide and focus our work. We learned what aspects of building guidelines are a must (e.g.

iterability) and what needs to be paid special attention (e.g. occupancy). Researching other sustainable building standards, such as the Sustainability and Tracking Rating System, we developed a sense for what sustainability building guidelines should look like and should do. At the end of all this research, we concluded that LEED should remain the center of sustainable buildings at Wellesley.

In order to utilize our newly formed background knowledge and bring LEED into an even more sustainable, Wellesley-specific realm (which we have titled, LEED+), we conducted qualitative environmental, social, and economic analyses of every LEED credit. We then used the results of this analysis to prioritize the existing LEED credits for Wellesley building projects. Having identified gaps in the LEED credits, we also proposed several additional credits that we believe architects and project managers should include in the sustainable building process at Wellesley.

In the end, we created two checklists for architects and interested parties. The first is the existing LEED checklist with our prioritizations for each credit included next to the LEED points. The second is the LEED+ checklist which has been ordered by building lifecycle phase and includes our proposed credits. We hope that these guidelines lay the groundwork for sustainable building at Wellesley College.

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ACKNOWLEDGEMENTS

We would like to express our deepest appreciation to our advisor, Professor Monica Higgins, whose guidance and feedback truly carried us through this project and semester. We would not have been able to remain sane, nor would our report be as comprehensive and successful, without you!

We are also indebted to Patrick Willoughby, Shane Chase, and Jay Turner, as well as the rest of the Advisory Committee on Environmental Sustainability, for their constant support throughout the process. Your insights and resourcefulness were invaluable to the completion of our report.

We owe much gratitude to each of our peer institution contacts – Chris Powell, Paul Breen, Richard Bigelow, Chelsea Fried, Jennifer Kleindienst, and Amy Johns – for their willingness to speak with us and to provide insights on how to complete this project.

Finally, a huge thank you to Jess Hunter, the ES Program, and all faculty, staff, and students who supported us by attending the Advisory Committee on Environmental Sustainability meeting and the Ruhlman presentation. Your questions and feedback were critical in the development of our research and report

INTRODUCTION

Wellesley celebrates a rich history and traditions that are inextricably linked to her environment. At its core, the institution values uplifting women through education and creating a community that allows young women to experience the active role that women can play in improving society. Inherent in both of these values is the idea of a better future; a future that is better because of the positive impact Wellesley women will have in their chosen fields – and because Wellesley College as acts as a leader amongst her peers in advancing education, community, and environmental stewardship. On the eve of a major campus renovation, the College has the unique opportunity to act on these values while also addressing shortcomings in the capacity and functionality of her built environment. Embracing environmental sustainability at this moment allows the College to advance her mission as an institution of higher education and also to play an active role in improving society.

Sustainability is not a new or novel concept being introduced to the College in this document; sustainability has guided decisions made at the College since its founding. Financial decisions at the college, for example, are generally made in a manner that both promotes institutional priorities and assures future financial stability. Likewise, when making decisions that may impact the community or educational experience at the College, adequate care is taken to maintain social stability. What is suggested in this document is that environmental sustainability should play an important role in the decisions made at the College that have the potential to impact our environment.

Wellesley as a campus and community has the potential to advance sustainability, especially environmental sustainability. As Muscoe Martin, a prominent ecological designer explains,

> "The word sustainable has its roots in Latin *subtenir*, meaning 'to hold up' or 'to support from below' by its inhabitants, present and future. Certain places, through the peculiar combination of physical, cultural, and spiritual characteristics, inspire

people to care for their community. These are the places where sustainability has the best chance of taking hold."[1]

Wellesley is undoubtedly a place where people care about their community and as such, there is great potential to bring about sustainable change on campus.

As a result of pressures from members of the Wellesley community, alumna, and advances at peer institutions, sustainability initiatives have increasingly been prioritized at the College in recent years. The list is impressive: recycling, composting, bike-share, Environmental Studies and Sustainability Certificate Programs, sustainable landscaping commitments, and, most recently, a green revolving fund. Even with these programs, environmental sustainability initiatives on campus have not yet addressed one of the most fundamental and resource- and energy-intensive aspects of any institution: its buildings.

We, the students of Environmental Decisionmaking, one of the capstone courses of the Environmental Studies Program, have been assisting the Advisory Committee on Environmental Sustainability with developing sustainable building guidelines that will advance the broader environmental sustainability goals of the College, while assuring that Wellesley's future buildings will be more sustainable. Through examination of the strategies of peer institutions, consultation with numerous stakeholders, and an in-depth analysis of the Leadership in Energy and Environmental Design (LEED) credits, our class has developed a set of sustainable building guidelines that could transform Wellesley into a leading sustainable institution while enhancing our thriving community.

When we started this project, we suspected that our guidelines would align with the existing LEED standard because it is the standard most used and recognized by people the world over. Furthermore, Wellesley has two LEED certified buildings and has current building sustainability goals based on the LEED rating system.

[1] Al Reem, "Definitions of Sustainable Development," Environment (2012), Web.

Of all the sustainable building standards we studied this semester, LEED is by far the most comprehensive. It offers the most prestige in certification and is well-known by most architects, contractors, and distributors. Over the last ten years, LEED has put green buildings on the map, reforming the building construction industry by making sustainable a worthwhile achievement.

As such, we have proposed guidelines which take the LEED standard, modify it to Wellesley, and attempt to fill any gaps left by LEED. For these reasons, we call have titled our guidelines, LEED+. Two of our aspirations were to have our guidelines include both outcome and process-based criteria and to be grouped according to the lifecycle stages of a building. Process-based criteria are needed because sustainability must be about more than achieving reductions in energy use and resource consumption; true sustainability also requires a just and participatory road towards realizing these goals over time. To echo Muscoe Martin, sustainability is achieved when a building's occupants are enfranchised and given power to create the space that will sustain them. Grouping criteria by life-cycle stage helps to highlight that sustainability can and should be considered throughout the building's lifecycle.

We have presented the results of our analysis in the form of a "Wellesley LEED+ checklist." The checklist is meant to be an easily replicable and distributable model for incorporating sustainability into renovations and new construction. Our checklist should provide Wellesley with an identified path to be more innovative and deliberate with its decisions regarding building design and operations. It is our hope that the checklist will enhance, rather than burden, the projects within the Campus Renewal Plan (formerly Wellesley 2025) and any future building projects at the College. As this report will reveal, a sustainable building is much more easily achieved than many believe.

CONTEXT

Wellesley College History

College campuses have often served as a testing ground for new types of social arrangements, cutting-edge building technology, and novel approaches to urban design. This is in part because of the funding resources colleges have and their contained nature. However, it is important to realize that colleges also tend to constrain designs to what is observed at peer institutions because there are too many stakeholders (i.e., alumni, students, faculty and staff, trustees, and administration) and there is too much at stake (e.g., reputation, desirability, cost) to break entirely from the norm. Wellesley is no exception in this regard, and its built environment reflects both the social values of the Wellesley community and precedents set by other schools.

At the college's inception in 1875, the original College Hall was designed and built to reflect the precedents' of other female educational institutions, such as Mount Holyoke Seminary and Vassar College. Those campuses were established with one central building that would house faculty, classes, and students together.[2] Later, in the 1900's, Wellesley's campus's architecture assumed a gothic style to compete with other male institutions.[3] However, Wellesley has also emerged as a precedent-setter with the construction of the cogeneration power plant placing the college at the forefront of the sustainability movement.[4] This shows that Wellesley has the capability and means to become a proactive leader in sustainable design. In order to continue this trend, the College needs to commit to integrating sustainability into her building design.

In analyzing Wellesley's campus's history, a deep commitment to preserving campus heritage and sense of place becomes apparent. Many recent interventions on campus were done with the intent of restoring the local environment to uphold and expand on the vision of Frederick

[2] Florence Converse. *Wellesley College: A Chronicle of the Years, 1875-1938*. Hathaway House Bookshop, 1939.

[3] Op. cit.

[4] Patrick Willoughby, Personal interview, March 10, 2014.

Law Olmsted Jr.[5] In the redesign of Alumni Valley, Michael Van Valkenburgh combined the concepts of restoration, historic preservation, and sustainability in order to achieve a sense of place he calls 'experiential ecologism.'[6]

Present State of the College

Contributors to building project plans

Examination of the Wellesley Campus Renewal Plan (formerly Wellesley 2025)[7] found that the plan has a strong leadership team and contributors from a wide range of backgrounds. However, there is also an over-representation of a select group of individuals. These individuals, mostly members of the Steering Committee, may have been placed in the subsidiary committees to allow for a strong leadership presence between the various groups, but we question whether their over-representation may lead to an uneven distribution of influence. In other words, because these people are in prominent positions on multiple committees, the decisions by those committees may be biased towards the views of these select individuals. We suggest that the various groups be made up of different individuals so that representation is more evenly distributed. With more people, more opinions, and more ideas, building project plans may be better-rounded.

In regards to sustainability, representation in authoritative groups was limited to a single individual, Patrick Willoughby, *Director of Sustainability*. However, it would be most beneficial to the College to have more than one individual concerned with sustainability in leadership positions within these groups. These individuals should have the knowledge and power to examine and approve plans that complement and help realize the College's sustainability goals. As previously mentioned, having more than one person's view on a matter is important.

[5] J Glassock, *1875-1975: A Century of Women*, Wellesley College (1975), Print.

[6] Michael Van Valkenburgh Associates, Alumnae Valley Restoration (2012), Web.

[7] Board of Trustees, *Wellesley 2025: A Plan for Campus Renewal*, Wellesley College (2012), Web.

Additionally, we believe that every building project, including the Campus Renewal Plan, should have within its main committees, a sustainability committee or working group. In the case of the Campus Renewal Plan, it seems that the Advisory Committee on Environmental Sustainability was consulted, but was not a major contributor. An increased presence of this Committee could be extremely beneficial to the success and advancement of the College's sustainability, both in its buildings and its overall reputation.

The student body also lacked representation. The past, current, and future students of Wellesley College have the most intimate knowledge about how campus buildings are functioning and whether they are meeting students' needs. They are also the individuals who are likely to benefit most from these renovations. For these reasons, we believe that students should be well-represented in regularly consulted committees and working groups. While the lifetime of the average student at Wellesley is significantly shorter than the average duration of a building or renovation project, we believe that, even on a rotating basis, the inclusion of students is important to the proper and adequate improvement of the College.

We also thought that the Town of Wellesley should be better a more prominent participant. The College lies within the Town and so there should be some consultation between the two groups. While Wellesley College has its own goals and aspirations, they should lie within the goals of the Town and vice versa. Additionally, the Town already has a good number of sustainability-related groups and committees, which may have valuable input and information.[8] Subsequently, we feel there should be at least a couple members from the Town in more than just a consulting position.

On a slightly different note, we believe there would be benefits if sustainability education were made available for all participants in building projects. While having members of the sustainability community on key committees would be great in terms of integrating more

[8] "Sustainable Wellesley 2014", Wellesley's Environmental Organizations (2014), Web.

sustainability measures, educating all committee and working group members on sustainability would be even better. Our emphasis on developing a just and transparent process would be strengthened with more informed members of the community around the table. Thus, providing sustainability education in these committees could serves as a means to more deeply ingrain and include sustainability in the decisionmaking process throughout the College.

Finally, we believe that every building or renovation project undertaken by the college, including the Campus Renewal Plan, should include a page explicitly listing every contributor. This transparency is important because stakeholders in the project have the right to know exactly who is making the decisions, who is represented, and who is not.

In conclusion, examination and critique of the Campus Renewal Plan taught us that there should be many, well-represented individuals from multiple backgrounds (e.g., administrators, students, Townspeople) in building project committees, that these individuals should either represent sustainability or they should be educated about sustainability, and that the building plans themselves should be transparent and explicitly list plan contributors.

The College Building Process

Throughout Wellesley College's history, new buildings have been built during sporadic phases of construction determined largely by the availability of capital (usually obtained from alumna donations) and ambitious leadership.[9] Perhaps as a result of the sporadic nature of capital campaigns, the institution has never developed a comprehensive process for building evaluation, renovation, and construction planning. Another symptom of the lack of comprehensive building policies is poor management of existing buildings; 62 percent of the College's buildings have not had a major renovation in over 50 years.[10]

[9] Glassock, Op. cit.

[10] *Wellesley College Annual Report 2013*, Wellesley College (2013), Web.

The lack of clear, transparent building guidelines has been brought to light by the undertaking of the ambitious Campus Renewal Plan, which represents the most significant renewal of the campus since it was rebuilt 85 years ago.[11] There exist three versions of the plan: the Base Plan, the Expanded Plan, and the Comprehensive Plan. Based on the availability of capital, the College will decide as it moves forward whether it will take on projects in the Expanded and Comprehensive Plans. The Base and Expanded Plans include renovation of more than 15 and 19 percent of all existing building area on Wellesley's campus, respectively.[12] New construction in either the Base Plan or Expanded Plan affects less than 1% of the existing campus building area.[13]

To gather ideas for the renovation, five working groups representing five distinct parts of the College's academic and student life initiatives were established: (1) arts and media, (2) the humanities, (3) science and the environment, (4) student residential experience, and (5) wellness and sports. Groups were asked to think about what the college will need for at least the next decade or two beyond the completion of the Campus Renewal Plan. Working group planners included options representing a range of assumptions. Based on these, they created programmatic test fits, which were estimated and adjusted by the College's cost consultants.[14]

At first, the groups came up with a combination of plans that would have increased campus building space by more than 14 percent and would have cost the College an estimated $1.38 billion (significantly more than its maximum budget of $550 million). Wellesley then hired Venturi, Scott Brown and Associates, a Philadelphia-based architecture firm, to help the College consolidate those plans. The firm and Campus Renewal Plan's Steering Committee

[11] Matt Rochelaeu, "Wellesley College planning up to $550m worth of projects to renovate, expand campus buildings by 2025," Boston News (2013), Web.

[12] Ibid

[13] Board of Trustees, Op. cit.

[14] Ibid.

held a series of about 20 meetings with College trustees and top administrators, and consulted about 80 individuals (primarily faculty, staff, and other campus leaders) to draft the plan. The Consolidated Program Plan for 2025, the big report, was the final product of these meetings. Wellesley's trustees reviewed the final version of the plan, and work is now under way to implement it.[15] In a memo to the community in Spring 2013, President Kim Bottomly said that administrators will have a clearer sense of the College's future financing and fundraising capacity by the 2017-18 academic year.[16]

Because every building and building project undertaken at the College is different, it is vital that our checklist be created to take advantage of modularity and long-term iterability. It is also important that they be succinct and clear to the College community. Iterability will be one of the most important aspects for the institution to incorporate into its facilities management policies. Just as building codes are re-evaluated and updated every three years by the International Code Council, Wellesley should endeavor to adopt an iterative process for evaluating and maintaining the quality as well as the usability of the campus.

College Sustainability Goals

The majority of our knowledge of Wellesley's current sustainability goals with respect to building projects comes from the Wellesley Campus Renewal Plan.[17] Other goals within the Renewal Plan focus on bringing buildings up to regulation standards and on improving the school so that all students are appropriately accommodated. The focus is on the comfort and wellbeing of the students. However, each of these priority goals is, on paper, physically separated from any sustainability-oriented goals. In addition, while improvements to sustainability are listed as one of the College's goals, sustainability is almost an afterthought.

[15] Kim Bottomly, "Wellesley 2025: A Plan for Campus Renewal," Wellesley Email Newsletter (2011), Web.

[16] Rocheleau, Op. cit.

[17] Wellesley College 2013.

However, it is also possible to see how investing in sustainable buildings will contribute to other stated goals. Adopting sustainability measures that address indoor environmental quality could improve the comfort and well-being of the students. For example, working to increase the amount of natural lighting in study areas not only is good for the environment by reducing the need for electric lighting, but studies have also proven that increased exposure to natural lighting can improve students' mood, concentration, and overall mental and physical health.[18] Thus, if we are able to highlight how sustainability can contribute to the already stated 'programmatic goals,' then sustainability will no longer be an afterthought and will instead by a means to achieve our broader goals.

The only concrete Campus Renewal Plan sustainability goal directly related to buildings was that all new buildings should be, at minimum, LEED silver certified. While this is an admirable goal which should help to increase the overall sustainability of Wellesley, we believe that a more holistic, thoughtful approach would be better. For example, once the stated goal is met, there is little to no incentive to continually improve sustainability. As such, we believe that more open-ended goals would be preferable. As the College prefers benchmarking as a way of measuring progress, sustainability goals should be measurable. However, they should also allow for continual sustainability improvements. In addition, LEED's singular focus on points and certification can sometimes result in a quest for points rather than a quest for the most sustainable building that is possible.

The other sustainability goals were much more abstract and general. For example, one of the stated Campus Renewal Plan goals is to "preserve and protect the campus water supply."[19] While this is a great sustainability goal and will be very important in upcoming years as the world realizes that potable water supplies are quickly dwindling, the report offers no concrete ways in which to actually achieve this goal. The other stated goals are similar. They present solid sustainability aims, but provide no means by which to achieve them. In our

[18] Edwards, L and Torcellini, P 2002, *A Literature Review of the Effects of Natural Light on Building Occupants*, Technical Report, National Renewable Energy Laboratory, Colorado.

[19] Wellesley College (2013), Op. cit.

sustainable building guidelines, it will be important to not only articulate our goals, but it will be important to articulate how these goals can be achieved.

In order to get an even better sense of the College's sustainability goals, we also examined Wellesley's 2012 Sustainability Report. While somewhat dated, this was the only sustainability goals-related document we were able to find. This document was much more comprehensive and thorough (in terms of sustainability) than the Campus Renewal Plan, but we felt that the stated goals were too numbers-oriented. The ideal goal set should be a compromise between broad, general goals and completely quantitative goals. As previously stated, while quantitative goals allow for easy benchmarking and progress tracking, they also limit motivation to continue sustainability efforts once the goal has been reached. For example, instead of saying that Wellesley should reduce water usage by 20 percent by 2025,[20] the goal should be to only use potable water for drinking-related purposes or to install greywater systems for watering the grounds, for use in Paramecium Pond, and for non-vital water uses.

[20] Ibid.

BENCHMARKING

In order to determine what college sustainable building guidelines usually look like and contain, examined six institutions identified by the 2012 Energy Sightlines Report (listed below).[21] We researched their sustainability websites as well as sustainability-related groups and campus initiatives, and then attempted to contact each institution directly. For those who responded (all institutions except for Amherst), we interviewed individuals who were, or are currently, involved in or have extensive knowledge of each institutions' building practices (listed below). The goal of the interviews was to learn about the effectiveness of each institution's sustainable building guidelines and to understand their overall sustainable building mentality. Additionally, we asked whether they use LEED, and if so, to what degree, or if they were involved with any other sustainable building standards.

Peer Institutions

Amherst College: no contact
Brown University: Chris Powell, *Sustainability Coordinator*
Mount Holyoke College: Paul Breen, *Director of Facilities Management and Planning*
and Richard Bigelow, *Associate Director and Chief Engineer*
Pomona College: Chelsea Fried, *Environmental Analysis Major '14*
Wesleyan College: Jennifer Kleindienst, *Sustainability Coordinator*
Williams College: Amy Johns, *Director of the Zilkha Center for Environmental Initiatives*

Based on personal communications with and internet research of the six peer institutions, we learned that Wellesley is not currently a leader among her peers when it comes to sustainable building practices. We found that half of our peers, Brown, Wesleyan, and Mount Holyoke, aim for LEED silver certification and two, Pomona and Williams, aim for LEED gold. However, some of the institutions, which currently aim for silver feel that it is not enough, that they should be aiming for gold. Amherst does not aim for any LEED certification.

[21] *Energy Consumption Higher Than Co-generation Peers*, Sightlines Report, Wellesley College (2013), Web.

We also discovered that many of our peers employ a variety of sustainable building standards. Amherst's guidelines are supposedly based on SUNY Buffalo's. Pomona and Wesleyan both are a part of a program called AASHE STARS (discussed further in the next section). Williams is perhaps the most progressive and is on its way to certifying a Living Building.

Some positive logistical takeaways from our research were 1) the importance of transparency, making the building process clear to all participants from beginning to end, and 2) the importance of good communication and implementation by the facilities departments. One individual requirement we liked was Brown's commitment to do always exceed current building codes by 25 percent, to always be a step ahead. This would ensure the continued improvement of sustainability as codes change over time. Another notable was Mount Holyoke's requirement to annually re-evaluate the sustainable building guidelines. Re-evaluating would guarantee that the guidelines remain effective and applicable to the institution. This concept of iteration is something that we most definitely want to represent in Wellesley's guidelines.

In the end we learned a lot from our peer institutions. Ultimately though, our main discovery was that most institutions do prefer LEED to any other sustainable building standards, but that LEED is not tailored to each institution. This led us to the conclusion that we needed some sort of a LEED checklist that was tailored to Wellesley's needs and priorities.

SUSTAINABLE BUILDING STANDARDS

The next step of the project was to examine available sustainable building standards including those used by our peer institutions. Wellesley currently has a commitment to LEED but we decided that it was important to look into other standards as well and to compare them across the board. Even if the decision was to use LEED as a base and improve upon it, looking at these other standards gives us more information about what building guidelines can and should look like and incorporate/consider.

LEED

Leadership in Energy and Environmental Design (LEED) is recognized around the world as a premier sustainable building standard. LEED certification is one of the highest and most recognized achievements for sustainable buildings.[22] Wellesley currently uses LEED because it is the system most used and recognized by architectural firms and it is also greatly respected by peer institutions and the public.[23]

LEED looks at the performance areas of sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. Within each of these categories, there are specific prerequisites that projects must meet and even more credits that projects and aim to achieve. Each of the credits earns projects points and the total number of points the project earns determines its level of LEED certification – certified, silver, gold, or platinum.[24]

[22] "LEED Overview," USGBC (2014), Web.

[23] Wellesley College Advisory Committee on Environmental Sustainability, Personal interview, March 10, 2014.

[24] USGBC (2014), Ob. cit.

As a big name, well-respected sustainable building standard, LEED makes sustainability a viable business practice. It also quantifies sustainability in a way that allows for benchmarking and comparison. Because it allows for a wide variety of sustainable designs and technologies to earn credits, LEED encourages broader thinking about sustainability in relation to buildings and design.[25] Finally, LEED periodically updates its credits to keep up with technology, popular design, new building codes, etc. This emphasis on iteration keeps LEED at the forefront of the sustainable building world.[26]

However, there are also several disadvantages to the LEED system. Most prominent is the fact that certification can be prohibitively expensive. Depending on the level of certification, premiums range from 2 to 30 percent.[27] While feasible for larger corporations and wealthier clients, these prices make LEED unobtainable for smaller, lower income businesses and homes. The desire for LEED certification can also restrict the creativity of sustainable building design. Because of finite financial, material, and human capital, placing the emphasis on LEED points and certification can detract from the most sustainable design possible. Finally, our analysis of the LEED credits indicates that they may not be weighted appropriately for our purposes. For example, some credits that are awarded the same number of points have vastly different environmental impacts and or ease of implementation.

Green Globes

We examined Green Globes as an alternative to LEED. Green Globes is a similar sustainability assessment and rating system based on points, which lead to differing levels of certification.

[25] Ibid.

[26] S. Law, "LEED vs Green Globes," Portland Tribune (2013), Web.

[27] SBW Consulting, *Achieving Silver LEED: Preliminary Benefit-Cost Analysis for Two Cities of Seattle Facilities*, Seattle Office of Sustainability and Environment (2003), Web.

Unlike LEED, it is an online tool and is used primarily in Canada and the US.[28] Many studies compare LEED and Green Globes due to their many similarities, and Green Globes purposefully markets itself as a more streamlined, interactive, and affordable system than LEED.[29] However, it is definitely not as well known or as well respected as LEED.

STARS

The Association for the Advancement of Sustainability in Higher Education's (AASHE) Sustainability Tracking and Rating System (STARS) is another LEED alternative. We briefly researched it as it is used by some of our peer institutions (e.g. Pomona) and is tailored specifically for educational institutions. Similar to LEED, it provides a framework for considering and evaluating sustainability. It also awards stars which allow for ranking and benchmarking. Unlike LEED and many other LEED alternatives, the STARS program includes parameters which consider economic and social dimensions such as a Support for Underrepresented Groups credit, as well as credits specifically pertaining to educational institutions such as an Academic Courses credit.[30]

Living Building Challenge

Finally, we examined the Living Building Challenge (LBC) because it is most stringent standards to guide sustainable building design and Williams, one of our peer institutions, is working to certify a Living

ıt of Sustainability in Higher Education (2014), Web.

Building.[31] LBC goes beyond LEED in terms of sustainability considerations by also considering aesthetics and social justice. Some argue that it is the most comprehensive and performance-based sustainable building standard.[32] It markets itself as an advocacy, philosophy, and certification tool.[33] Instead of indicators, LBC evaluates seven 'petals' of sustainability: equity, beauty, health, site, water, energy, and materials.[34] The largest drawback to this standard however, is that it is extremely expensive (even more so than LEED).

[31] Amy Johns, Personal interview, February 28, 2014.

[32] "Home Page," Living Building Challenge (2014), Web.

[33] Ibid.

[34] Ibid.

THE LEED CHECKLIST

After performing this background research, we decided that we wanted to create a new checklist based on an evaluation of the existing LEED checklist in terms of the relevance and importance of each credit to Wellesley. We also wanted to include non-LEED credits which are tailored to Wellesley. The first step towards creating our own checklist was to evaluate the existing LEED checklist. Each LEED credit was evaluated through qualitative environmental, social, and economic impact assessments. While quantitative analyses may have allowed for more accurate assessment of the impacts of each credit, quantitative analyses were not really possible due to the fact that we had no specific building off which to base our analyses. Because of this, we decided that a more generalized, qualitative analysis of each type of impact would give us as accurate as possible information with the data we have available to us.

Environmental Impact Analysis

We decided upon 4 indicators and 17 sub-categories of indicators that cover different aspects of potential environmental impacts.

Indicators

Materials:

We identified 11 different materials and estimated the whether each that would be needed to comply with each LEED criteria. The list of materials examined were determined based on a study that found concrete, water, brass, and aluminum to be, by mass, the most commonly used building materials.[35] To be more all-encompassing, we then decided to include EPDM (a type of synthetic rubber which is commonly used to waterproof roofs[36]), plastic rubber, and Toluene diisocyanate (a liquid chemical used to make foam insulation, adhesives, sealants,

[35] C. Scheuer, "Life cycle energy and environmental performance of a new university building: modeling challenges and design implications," *Energy and Buildings*, Vol. 35 (2003), p. 1049.
[36] "*What is EPDM?*" EPDM Roofing Association (2013), Web.

and coatings for metal products[37]) because each of these are commonly used building materials, and are the most energy intensive to manufacture. Steel, bricks, wood, and PVC were added to the list because they were deemed to be commonly used in buildings.

Extraction/Manufacturing Energy:

We estimated the relative amount of energy that would be needed to extract and/or manufacture the materials used in the credits. Material extraction and manufacturing constitute a significant portion of the lifecycle assessment of any product, so they are an important indicator to include in our environmental impact assessment.

Construction Phase Energy:

We estimated the amount of energy that would be needed in the construction phase of the building to comply with each credit. Construction phase energy was broken down into two sub-categories: energy from construction activities and energy from transportation used during the construction phase. Depending on the size of the project, construction phase energy could be a significant environmental impact and so was important to include in our analysis.

Use Phase Energy:

We estimated the amount of energy that would be consumed in the use phase of the building. Use phase energy was also broken down into four sub-categories: energy used to heat water, energy used to heat or cool air, electricity use, and transportation used during the use phase of the building. Use phase impacts are another major component of a typical environmental impact assessment and it so was important for us to consider not only the planning and construction of a building, but also its impacts in use and over time.

Land Use Change:

[37] "Toluene diisocyanate," Technology Transfer Network – Air Toxics Web Site, EPA (2013), Web.

We estimated the land use change that might occur as a result of complying with the credits. This is a non-conventional assessment metric which allowed us to more comprehensively assess the credits. This was especially important for the Sustainable Sites and Location & Transportation categories, which have fewer material and product needs and more landscape level changes.

Scale

For each credit, we compared the impacts that a LEED building would have in comparison with those a non-LEED building would have and ranked each indicator from -2 to 2. A -2 indicated a guaranteed negative environmental impact associated with that credit. A -1 indicated a potential negative environmental impact. A 0 indicated either that there was no environmental impact (no difference in impact between an LEED and a non-LEED building) or that the negative environmental impact balanced out the positive environmental impact. A 1 indicated a potential positive environmental impact. And a 2 indicated a guaranteed positive environmental impact.

Calculation of Total Points per LEED credit

Because the actual environmental impact of each of our chosen indicators is not equal (e.g. the environmental impact of use phase transportation energy is not the same as that of the presence PVC), we weighed each indicator. Weights were determined by each of us weighing the indicators individually and then averaging our weights.

In order to calculate the total points for each credit, we first calculated the total number of points earned by each credit and then the total number of points that could have been earned for each indicator, which applied to the credit. We then took the total number of points earned and divided it by the total number of points that could have been earned. The resulting score allowed us to numerically compare the credits and to assign priority (discussed further in the LEED+ section).

Social Impact Analysis

As a class, we decided upon 10 indicators that cover different aspects of potential social impacts at Wellesley.

Indicators

Historical or Cultural Preservation:
We estimated how the credit would impact the history and/or aesthetics associated with Wellesley College.

Sense of Community and Unity:
We estimated how the credit would impact the ability of students to come together and interact as a community.

Educational Objectives:
We estimated how the credit would impact the educational environment of the College.

Mental Health:
We estimated how the credit would impact the mental health of people on Wellesley's campus. For example, the creation of a calm, green space could help bring a sense of peacefulness that could have a positive impact on people's mental health.

Pride and Prestige:
We estimated how the credit could impact pride within the Wellesley community and/or the prestige of the College amongst its peers. For example, Wellesley Blue pride unites students and alumna, which also helps enhance the prestige of Wellesley College as an institution by showing Wellesley to be a tight-knit community.

Leadership:

We estimated how the credit could impact Wellesley as a leader in the field of sustainability.

Empowerment, Transparency and Participation:

We estimated how the credit could impact the transparency of a project. For example, a credit with a positive impact would make information more easily accessible. This indicator also estimated how the credit would impact a sense of empowerment in the student body. Finally, it estimated how the credit could impact participation in the building process.

Equity:

We estimated how the credit could impact equality on campus. This was usually in terms of access to a particular resource (e.g. money, a physical object).

Diversity of Functions:

We estimated how the contents of the credit itself could be used for more than one purpose or how the credit might allow the building or project space to be used for multiple purposes.

Safety and Physical Health:

We estimated how the credit could impact the safety and physical health of those on Wellesley's campus.

Scale

For each credit, we compared the impacts that a LEED building would have in comparison with those a non-LEED building would have and ranked each indicator from -2 to 2. A -2 indicated a guaranteed negative social impact associated with that credit. A -1 indicated a potential negative social impact. A 0 indicated either that there was no social impact (no difference in impact between an LEED and a non-LEED building) or that the negative social impact balanced out the positive social impact. A 1 indicated a potential positive social impact. And a 2 indicated a guaranteed positive social impact.

Calculation of Total Points per LEED credit

In order to calculate the total points for each credit, we first calculated the total number of points earned by each credit and then the total number of points that could have been earned for each indicator, which applied to the credit. We then took the total number of points earned and divided it by the total number of points that could have been earned. The resulting score allowed us to numerically compare the credits and to assign priority (discussed further in the LEED+ section).

Wellesley Development Survey

In order to gain further insight into the current knowledge, desires, needs, and concerns of the Wellesley community, we created a simple survey. Survey questions asked people about specific features they might like to see on campus, how much they know about building sustainability, and much more. The ultimate goals was to gather information to aid our social impact analysis. In the end, 298 faculty, students, and staff members responded.

Economic Impact Analysis

As a class, we decided upon 3 indicators and 8 sub-categories of indicators that cover different aspects of potential economic impacts at Wellesley.

Indicators

Capital Cost:

We estimated the magnitude of the upfront, initial monetary investments in the equipment or system associated with achieving the credit. Capital costs were further broken down into the sub-categories of construction, material, transportation, and personnel costs.

Use Cost:

We estimated the magnitude of the costs incurred during the lifetime of the building. Use costs were further broken down into the sub-categories of heating/cooling (air), water (use), electricity (use), and waste management costs.

Indirect/ Intangible Cost:

We estimated the magnitude of the costs that cannot necessarily be operationalized, but that associate value with a credit. For example, managing rainwater decreases flooding risk in the future. Because flood damage costs money to fix, managing rainwater provides cost savings if you do not have to pay those future repair costs.

Time:

We estimated the amount of time it would take to complete the criteria. We wanted to develop some assessment criteria that were not strictly materials or product based because some of the LEED credits are less substantive and needed alternative assessment methodology. Thus, we determined that time for completion would be a good comparison measure.

Scale

For each credit, we compared the impacts that a LEED building would have in comparison with those a non-LEED building would have and ranked each indicator from -2 to 2. A -2 indicated a higher economic cost associated with that credit. A -1 indicated a lower economic cost. A 0 indicated either that there was no economic impact (no difference in impact between an LEED and a non-LEED building) or that the economic costs balanced out the economic benefits. A 1 indicated a lower economic benefit. And a 2 indicated a higher economic benefit.

Calculation of Total Points per LEED credit

In order to calculate the total points for each credit, we first calculated the total number of points earned by each credit and then the total number of points that could have been earned for each indicator, which applied to the credit. We then took the total number of points earned and divided it by the total number of points that could have been earned. The resulting score allowed us to numerically compare the credits and to assign priority (discussed further in the LEED+ section).

We then conducted these analyses on each of the LEED credits. Below is a discussion of each of the credits and the results of our analysis. Unless otherwise noted, all credit information comes from the LEED credit library.[38]

[38] USGBC (2014), Ob. cit.

LOCATION & TRANSPORTATION

LOCATION AND TRANSPORTATION

"The location of a building affects a wide range of environmental factors - as well as other factors such as security, accessibility, and energy consumption, as well as the energy consumed by transportation needs of occupants for commuting, the impact on local ecosystems, and the use/reuse of existing structures and infrastructures."

- Whole Building Design Guide Sustainable Committee[39]

The Location & Transportation category is concerned with the physical location of the building and its potential for interaction with the nearby built environment. It contains eight credits for a total of 20 LEED points (see Figure 1).

LOCATION & TRANSPORTATION		POSSIBLE: 20
Credit	LEED for Neighborhood Development location	16
Credit	Sensitive land protection	2
Credit	High priority site	3
Credit	Surrounding density and diverse uses	6
Credit	Access to quality transit	6
Credit	Bicycle facilities	1
Credit	Reduced parking footprint	1
Credit	Green vehicles	1

Figure 1. The Location and Transportation credits and their LEED points.

LEED for Neighborhood Development Location (up to 16 LEED points)

The intent of the LEED for Neighborhood Development Location credit is to locate a new construction or a renovation in a sustainable site. This means locating it in an insensitive or not prioritized area, within walking distance of a wide variety of activities, and within an environment where interaction and physical activity is promoted. In order to earn this credit, the building must be located within the boundary of another development which has been previously certified by the LEED for Neighborhood Development program.

[39] WBDG Sustainability Committee, "Optimize Site Potential," Whole Building Design Guide, NIBS (2014), Web.

At Wellesley, no building would qualify for this credit because Wellesley is not LEED for Neighborhood Development certified. However, this introduces the idea that Wellesley should look into this certification or at least consider it in the future. Because no building at Wellesley would qualify for this credit, we decided not to conduct environmental, social, or economic impact assessments.

Sensitive Land Protection (2 LEED points)

The intent of the Sensitive Land Protection credit is to not locate a building or choose to renovate a building, which is not currently located on environmentally sensitive land. Underlying this is the intent to minimize the environmental impact of having a building located on a particular site.

There are two options by which to earn this credit. First, the building footprint must entirely be located on previously developed land. Second, the building footprint must not be located on 'sensitive' land. LEED defines 'sensitive' land as being prime, unique, or otherwise important farmland; floodplain; habitat for threatened or endangered species; areas within 100 feet of a water body; and areas within 50 feet of a wetland. In order to earn this credit at Wellesley, buildings simply cannot be located within 100 feet of Lake Waban, within 50 feet of the Paintshop Pond wetlands, or within the floodplain area of either water body.

Because all land at Wellesley College is previously developed, the option that requires buildings to be located on previously developed land would incur no changes between a LEED and a non-LEED building. As such, there are no extra environmental, social, or economic impacts that LEED buildings would incur in regards to this option.

The option that buildings not be located on sensitive land has only one environmental impact that our indicators considered – the positive benefits that would accrue from land use changes. Locating on insensitive land prevents the disturbance of sensitive land and so is a positive environmental impact.

Locating on insensitive land would have significant social benefits as well. It would allow the lake and other wetland areas to remain as they are and so would preserve the history and culture of the college. These efforts could also become a point of pride for the College and would help others to view Wellesley in a positive sustainability light.

The only economic impact that locating the building on insensitive land would have is that it will require someone some time to determine where the sensitive land is and avoid building on those areas.

High Priority Site (up to 3 LEED points)

The intent of the High Priority Site credit is to locate a building or choose to renovate a building in an area which has been identified by the government or other organizations as being of high priority for development. It is also meant to have spillover effects and promote sustainability and health in the surrounding area.

There are three options by which to earn this credit. First, the building must be located on an infill location in a historic district. Second, the building must be located on a 'priority' site. LEED defines a 'priority' site as a site listed on the EPA National Priorities List, a site within a Federal Empowerment Zone, a site within a Federal Enterprise Community, a site within a Federal Renewal Community, a site within a Department of the Treasury Community Development Financial Institutions Fund Qualified Low-Income Community, a site within a US Department of Housing and Urban Development's Qualified Census Tract, or a site within a US Department of Housing and Urban Development's Difficult Development Area. The third option is to locate the building on a brownfield site and then perform any required remediation. A brownfield site is a property which is contaminated and which, if used without remediation, could cause serious environmental and human health harms.[40]

[40] "Brownfields and Land Revitalization," EPA (2014), Web.

It is impossible to earn this credit at Wellesley because no location on Wellesley's campus is an infill in a historic district, a 'priority' site, or a brownfield site. As such, we have not conducted environmental, social, or economic impact analyses on this credit.

Surrounding Density and Diverse Uses (up to 6 LEED points)

The intent of the Surrounding Density and Diverse Uses credit is to encourage developing in areas where infrastructure already exists. This will protect and conserve undeveloped land. A second intent of this credit is to improve public health by promoting walkability which encourages physical activity. Finally, this credit attempts to improve transportation efficiency and reduce the need for vehicular transportation.

There are two options by which to earn this credit. First, the building must be located on a site where the surrounding population density meets the specifications outlined in Table 1. Second, the building's main entrance must be within a half-mile of the main entrance of at least four different, publicly available uses (e.g. grocery, medical, pharmacy, and restaurant).

Table 1. Population density requirements for the Surrounding Density and Diverse Uses credit.

Combined density	Separate residential and nonresidential densities		Points BD&C (Core and Shell)
Square feet per acre of buildable land	Residential density (DU/acre)	Nonresidential density (FAR)	
22,000	7	0.5	2
35,000	12	0.8	4

All of the buildings currently located on Wellesley's campus meet this requirement. Furthermore, most land on the campus would meet this requirement if a new building were

to be constructed. This is because the density of residents living on campus meets the requirements of the above table and every building on campus is located with a half-mile of the library, dorms, dining halls, academic buildings, and a variety of other uses which qualify for the Diverse Use option.

As all buildings on Wellesley's campus currently meet this requirement, there would be no difference between a LEED and a non-LEED building. Therefore, we have not conducted environmental, social, or economic impact analyses on this credit.

Access to Quality Transit (up to 6 LEED points)

The intent of the Access to Quality Transit credit is to encourage developing in areas where there is access to a variety of public transportation such that motor vehicle use can be reduced. The underlying aim is to reduce greenhouse gas emissions, air pollution, and other environmental and health costs which result from vehicle use.

In order to earn these credits, any entrance of the building must be within a half-mile of public transportation stops (e.g. bus, streetcar, rideshare, train, commuter rail, ferry). In addition, the transportation must meet the number of trips shown in

Table 2A and Table 2B.

Table 2. (A) Minimum daily transit service for projects with multiple transit types; (B) Minimum daily transit service for projects with commuter rail or ferry service only.

A.

Weekday trips	Weekend trips	Points BD&C (Core and shell)
72	40	1
144	108	3
360	216	6

B.

Weekday trips	Weekend trips	Points (all projects)
24	6	1
40	8	2
60	12	3

With easy access to the two Peter Pan bus stops, the two stops for the Wellesley-Babson-Olin Shuttle, the Green Line shuttle bus, as well as the commuter rail stop in the center of Town, every building on Wellesley's campus meet these requirements. This means that every building on Wellesley's campus automatically qualifies it for 3 LEED points. As all buildings on Wellesley's campus currently meet this requirement, there would be no difference between a LEED and a non-LEED building. Therefore, we have not conducted environmental, social, or economic impact analyses on this credit.

Bicycle Facilities (1 LEED point)

The intent of the Bicycle Facilities credit is to increase transportation efficiency and reduce the number of motor vehicles by promoting bicycling as an alternative form of transportation. In addition, this credit attempts to improve public health by encouraging physical activity.

In order to earn this credit, four requirements must be met. First, the building must be designed such that any entrance is within 200 yards of bicycle facilities and within 3 miles of at least 10 diverse uses, a school or employment center, or a public transportation stop. Second, there must be short-term bicycle storage for at least 2.5 percent of peak building visitors and no fewer than four storage spaces per building. Third, there must be at least one on-site shower and changing facilities for the first 100 building occupants and one additional facility for every 150 occupants after the first 100. Finally, long-term bicycle storage must be available for at least 30 percent of occupants.

At Wellesley, there are enough bicycle facilities around campus for every building on campus to meet the first, second, and fourth requirements. Similarly, there are enough shower and changing facilities within the area of every building (i.e., in the dorms, sports center, science center, etc.) to meet the third requirement. As such, every building currently on the Wellesley campus and every place on campus where a new building may be built already meets the requirements to obtain this credit. Therefore, we have decided not to conduct environmental, social, or economic impact assessments on this credit.

Reduced Parking Footprint (1 point)

The intent of the Reduced Parking Footprint credit is to minimize the environmental impacts related with parking facilities such as dependence on automobiles, land consumption, and rainwater runoff.

In order to earn this credit, the building cannot exceed any local requirements for parking capacity. In addition, the building must achieve a 20 percent reduction from the Parking Consultants Council base ratios if it has not earned any points under the Surrounding Density and Diverse Uses or the Access to Quality Transit credits. If the building has earned one or more points under either of these two credits, then it must achieve a 40 percent reduction of the same base ratios. In order to earn this credit at Wellesley, the College must achieve a 40 percent reduction of the base ratios given by the Parking Consultants Council. This is because any building project at Wellesley would earn the Surrounding Density and Diverse Uses and the Access to Quality Transit credits. Research was not able to determine if there are any local requirements for parking capacity, so it is assumed that these are not an issue for Wellesley.

The only environmental impact that a reduction in the parking footprint would have on the Wellesley campus based on our indicators is that it could decrease the amount of energy used for transportation in the building's use phase. Because we are not sure exactly how Wellesley would go about complying with this credit's requirements, we simply assumed that it would be a thought-based activity, not a construction activity. If some sort of construction or physical change is necessary to comply with this credit, then an environmental impact would be added that we have not accounted for here. In conclusion, we have determined that reducing our parking footprint would have an overall positive environmental impact on the Wellesley campus.

Overall, reducing the parking footprint on Wellesley's campus would have a social benefit for the college. If cars and their negative environmental and aesthetic impacts were viewed as a detriment to preserving the culture and history of the campus, then a reduction in the number of cars on campus would help preserve the college's culture and history. Similar to the other Location and Transportation credits, being known as a campus that seeks to reduce their parking footprint could be a source of pride for the College and could increase its reputation among its peers.

Reducing the parking footprint on Wellesley's campus would require personnel and time. This may cost a bit in the short term, but, in the long term, it will hopefully reduce costs associated with transportation on campus.

Green Vehicles (1 LEED point)

The intent of the Green Vehicles credit is to reduce the energy footprint of the building by promoting alternatives to conventional, petroleum-fueled automobiles.

There are two requirements, each with multiple options, which must be met in order to earn this credit. First, either 5 percent of all parking spaces used for the project must be clearly identified as preferred parking for green vehicles or green vehicles must be given at least a 20 percent discount parking rate. Second, some sort of alternative fueling facilities must be made available in at least 2 percent of all parking spaces used by the project. These can be electric charging stations, liquid or gas alternative fuel fueling stations, or a battery switching station which is capable of refueling a number of vehicles every day.

At Wellesley, green vehicles are not currently a priority and so the College provides no incentives for faculty, staff, or students to use green vehicles. Currently, there is only one green vehicle used in the campus vehicle fleet, one that belongs to the Office of Sustainability. As such, in order to earn this credit at Wellesley, Wellesley must install fueling or changing facilities and it must either reduce the parking fee by 20 percent or it must designate at least 5 percent of its current parking areas for green vehicles use only.

Each of the options by which to comply with the Green Vehicles credit would have environmental benefits in the Transportation in the Use Phase indicator because hopefully, encouraging the use of green vehicles on campus would decrease the campus' overall transportation energy footprint. Providing charging or fueling facilities for green vehicles

would have added negative environmental costs compared to simply providing green vehicle parking spaces or monetarily incentivizing the use of green vehicles. The actual impacts that the provision of these facilities would have would depend on the type of facilities and their design, but there would potentially be some material impacts, extraction/manufacturing impacts from those materials, and construction and transportation energy impacts from the installation of these facilities. In addition, electric car charging facilities would potentially increase electricity use in the Use Phase of the building. In the end, providing green vehicle charging and/or fueling facilities would have a negative environmental cost on the environment, but this would only be in the short term. In the long term, the benefits of the green vehicles on campus would outweigh these upfront costs and there would be net environmental benefits. However, this long term benefit is outside the scope of our assessment and so we have simply found there to be a negative environmental cost associated with this credit.

Interestingly, while there are definite social costs and benefits to incentivizing the use of green vehicles on campus, these costs and benefits, as evaluated by our indicators balance out such that our analyses find the overall social impact to be zero. Providing green vehicle charging or fueling facilities could change the physical appearance and aesthetics of the campus and negatively impact its culture. However, it could also provide a chance for students to learn about green vehicles and the various types of alternative energies and so could be of educational benefit. All of the Green Vehicles credit options may decrease the sense of community because only some students may be able to afford green vehicles. In general, green vehicles tend to be more expensive than conventional and so some economic disparities may negatively affect the sense of community and unity on the campus. This may also negatively affect the sense of empowerment on campus as well as cross-campus equity. On the other hand, they could also become a source of pride for the College and could increase the College's reputation as a sustainable campus or as a community who cares about their environmental impact.

Providing the green vehicle only parking spaces and financially incentivizing students to use green vehicles would only have economic impacts in the sense that it would require someone some time to determine where these parking spaces should be or what the reduced rate should be. However, providing charging or fueling facilities for green vehicles would have significantly more monetary costs. It will cost money to construct the facilities as the material themselves are costly, they will need to be transported to the college, and they will need to be constructed by specialists to ensure that they will function properly. This will require significantly more personnel and time than the other Green Vehicles credit options. In addition, electric vehicle charging facilities will require more electricity use in the use phase of the building and so will increase electricity costs in the building's use phase. On the other hand, if the users of these charging facilities have to pay for the fuel, then the College may be able to make a small profit from providing these facilities.

Synthesis

The results of these analyses are graphically depicted in Figure 2.

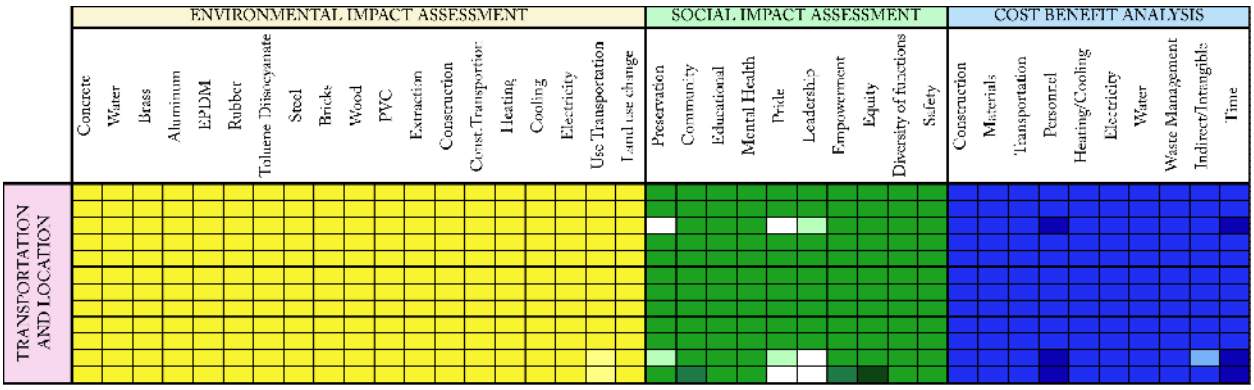


Figure 2. A graphical representation of the analyses results for the Location & Transportation category.

Here are the credits ordered by building process phase:

Pre-Design	
Credit 2	Sensitive Land Protection
Credit 3	High Priority Site
Credit 4	Surrounding Density and Diverse Uses
Credit 5	Access to Quality Transit

Design	
Credit 6	Bicycle Facilities
Credit 7	Reduced Parking Footprint

Construction	
	NA

Use	
Credit 8	Green Vehicles

End of Life	
	NA

Based on the results of our analysis, we have prioritized each of the credits as shown below:

Credit #:	Criteria:	Possible Points:	LEED+ Priority:
Credit 1	LEED for Neighborhood Development Location	20	Not Applicable
Credit 2	Sensitive Land Protection	2	Low
Credit 3	High Priority Site	3	Not Applicable
Credit 4	Surrounding Density and Diverse Uses	6	Always Applicable
Credit 5	Access to Quality Transit	6	Always Applicable
Credit 6	Bicycle Facilities	1	Always Applicable
Credit 7	Reduced Parking Footprint	1	Medium
Credit 8	Green Vehicles	1	Medium

SUSTAINABLE SITES

SUSTAINABLE SITES

"Sustainable buildings start with proper site selection."

- Whole Building Design Guide Sustainable Committee [41]

The Sustainable Sites category is concerned with how features of the site interact with the surrounding natural and built environments. As outlined in Table 3, the category contains one prerequisite and seven credits for a total of 11 LEED points.

Table 3. The Sustainable Sites credits and their LEED points.

SUSTAINABLE SITES		POSSIBLE: 11
Prereq	Construction activity pollution prevention	REQUIRED
Credit	Site assessment	1
Credit	Site development - protect or restore habitat	2
Credit	Open space	1
Credit	Rainwater management	3
Credit	Heat island reduction	2
Credit	Light pollution reduction	1
Credit	Tenant design and construction guidelines	1

Construction Activity Pollution Prevention (Required)

The intent of the Construction Activity Pollution Prevention credit is to minimize pollution stemming from construction activities. The focus should be on controlling soil erosion, waterway sedimentation, and airborne dust.

This credit is actually a prerequisite for LEED and so must be complied with for LEED certification. In order to comply with this prerequisite, an erosion and sedimentation control plan must be created and implemented for all project construction activities. Furthermore, the plan must comply with the requirements of the 2012 US EPA Construction General Permit. Compliance with this prerequisite is no different at Wellesley than it is in any other place.

[41] WBDG Sustainability Committee, Op. cit.

Based on our chosen indicators, there are no environmental impacts associated with this prerequisite. In reality however, this is not true. For example, preventing pollution during construction activities probably has air quality benefits.

Although this is a requirement for LEED certification and so needs to be done anyway, complying with this prerequisite is socially beneficial. Protecting the campus from construction-related pollution preserves the history and culture that the physical campus provides; this preservation maintains the current campus aesthetics and aesthetics are definitely something in which the College takes pride. Preventing pollution would also help to preserve the existing buildings and so will help to preserve the educational facilities on campus. By preventing damage to the landscape, this prerequisite also impacts the total usability of the landscape and the physical environment. Finally, if pollution is reduced or eliminated, then there is no or greatly decreased potential for physical harms from the construction activities.

Based on our chosen indicators for cost benefit analysis, costs associated with this prerequisite will come from having to pay people to create and oversee the implementation of this plan and from the amount of time that it will take people to do this. In addition, there will be indirect/intangible economic benefits from this plan because preventing pollution from occurring will hopefully prevent building managers from having to spend money in the future to clean up any residual impacts from the pollution.

Site Assessment (1 LEED point)

The intent of the Site Assessment credit is to evaluate sustainable options for the site and to make informed decisions about the site and project design before project decision begins.

In order to earn this credit, a site survey or assessment must be completed and documented. The only requirements of the survey or assessment are that it must include information on topography, hydrology, climate, vegetation, soils, human use, and human health effects. Compliance with this credit is no different at Wellesley than it is in any other place.

Based on our indicators, there are no environmental impacts or benefits associated with this credit.

Conducting a site assessment or survey would be beneficial to the college in the categories of educational objectives, pride and prestige, and transparency. If the survey or assessment information is made available either in paper or online, then building and area users would be able to educate themselves on the site. If the survey results in something notable and the results are published, then Wellesley's prestige could be further enhanced. Finally, the release of the results would increase the transparency of the building design and planning process.

Economic costs associated with this credit come from the fact that a contractor will need to be paid to conduct the assessment and this will take both time and money. However, conducting a proper site assessment or evaluation will hopefully prevent future expenditures for siting issues.

Site Development - Protect or Restore Habitat (up to 2 LEED points)

The intent of the Site Development - Protect or Restore Habitat credit is to protect existing natural environments and to restore damaged areas. The underlying intent is to provide habitat for wildlife and to promote biodiversity.

In order to earn this credit, there are two requirements which must be met. First, 40 percent of the greenfield area of the site, if such areas exist, must be protected from all development

and construction activity. A greenfield area is previously undeveloped land.[42] There are two options by which to meet the second requirement of this credit. Either 30 percent of all previously development portions of the site must be restored using native or adaptive vegetation or $0.40 per square foot of financial support must be provided for the total site area.

Wellesley currently has no greenfield area and so does not need to worry about the first part of this credit's requirements. As such, in order to earn this credit, Wellesley must either restore 30 percent of the previously developed area of the project site or pay $0.40 per square foot for the total site area. Because almost all the land on Wellesley's campus is previously developed, simply restoring 30 percent of the project site would allow Wellesley to comply with the requirements of this credit.

Based on our indicators, the only environmental impacts associated with this credit come from the potential use of PVC for irrigation purposes and the use of plants and any other materials that would be needed for the restoration. The PVC, if used, would have some impacts in our material and extraction/manufacturing categories. Depending on the scale of the restoration project, some construction energy may be required. Additionally, all PVC, plants, and other restoration materials will need to be transported to the site during the construction phase. The only environmental benefit of complying with this credit is that the land would revert from a developed condition to an undeveloped condition. Usually, such a change is environmentally better.

As the social impacts of each of the three viable Site Development options are vastly different. Each option will be discussed here individually.

Restoring 30 percent of the previously developed area is the only LEED credit which has a negative social impact score (see Figure 3). This is because currently, all of the Wellesley

[42] Mark Bamford, "Brownfield vs. Greenfield Sites: What are the issues involved?" Geographical Association (2012), Print.

campus is previously developed. In order to comply with this credit, the landscape and aesthetic of the college will be disturbed or even destroyed. This will negatively impact the historical and cultural preservation that is a major development goal of the college.[43] By potentially destroying part of the College's history, this credit could also have a negative impact on the College's pride and prestige. In addition, publicizing the fact that Wellesley's campus is completely previously developed may be disempowering for those who really care about sustainability. On the other hand, publicizing the fact that Wellesley is working to restore the original character of the landscape could increase the College's credibility as a leader in sustainability.

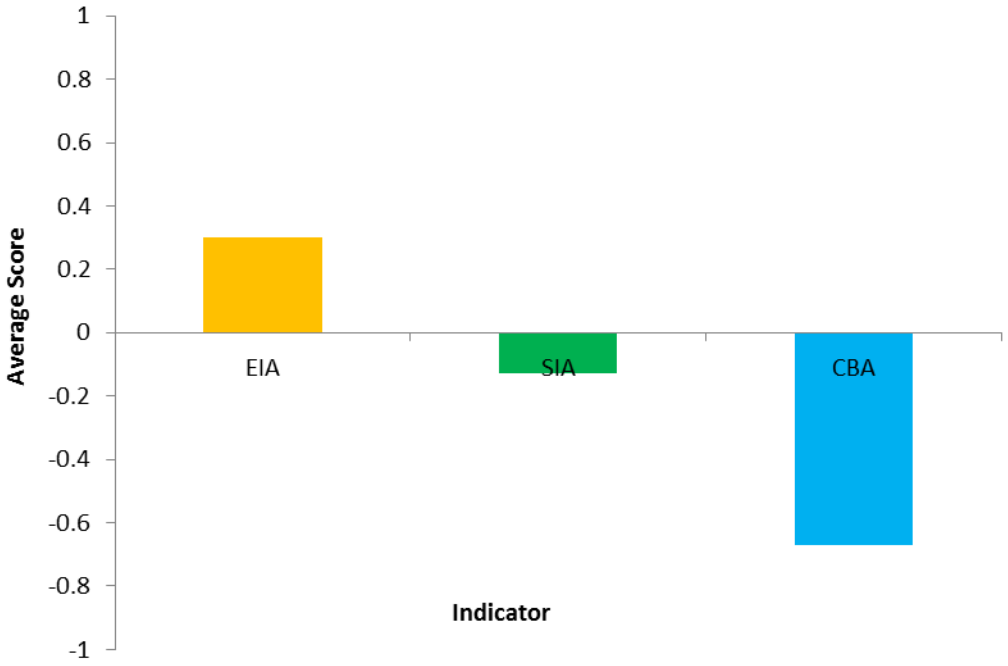


Figure 3. Graph of the indicator scores for the environmental, social, and economic impact analyses.

The restoration of the soils had a completely positive social impact score because restoring soils can protect the future of campus landscape, the revegetated areas may later help

[43] Wellesley College (2013), Op. cit.

increase campus aesthetics, and the fact that Wellesley would be planning for an improved, sustainable future could give the college pride and credibility as a leader in sustainability and forward thinking. On the other hand, the fact that the College can only pay money to compensate for their development impacts may be disempowering because it means that the College cannot actually mitigate or prevent these impacts from occurring, they can only pay for them. Finally, providing financial paybacks for development could also give the College credibility as an institution that cares about its impacts.

For the restoration options of this credit, costs will come from any construction activities that must take place as well as from the materials, their transportation, and the water needed to maintain the new environment. In addition, there will be personnel costs associated with these projects as people will need to be paid to carry out the restoration projects. These two options will also require a potentially significant amount of time for planning, implementation, and maintenance over the longer term. The third option, providing financial support for the area has different cost impacts. Based on the indicators we have chosen for this assessment, the costs of this option are not evaluated, but the fact that this option is a purely financial one must be noted somewhere. As this option is to pay money on a per area basis, financial costs will always be incurred and will depend on the area of the building project.

Open Space (1 LEED point)

The intent of the Open Space credit is to provide open area around buildings which encourages building users to interact with the environment and with each other. Underlying this is the intent for people to form social bonds and to engage in physical activities. Similar to the underlying intents of other credits, LEED is trying to enhance physical and emotional health and well-being.

In order to comply with the requirements of this credit, there must be outdoor space equal to at least 30 percent of the total site area. At least 25 percent of that outdoor space must be vegetated or have an overhead vegetated canopy. Furthermore, that outdoor space must be physically accessible and be a pedestrian-oriented paving or turf area with site elements for outdoor social activities, a recreation-oriented paving or turf area with elements for physical activity, a garden space that has a variety of plants growing year-round, and/or a habitat that meets the Site Development credit and allows for human interaction.

While there is plenty of open space currently available at Wellesley, none of Wellesley's building projects would meet with this requirement. This is because the project boundaries are only a few feet from the building, close enough that 30 percent of the total site area would be at least all the outdoor space around the building.[44] Because walkways must lead to and from the building, it is impossible for any building at Wellesley to meet the requirements for this credit. In order for Wellesley to even consider trying to earn this credit, the boundaries of a building project must be changed.

Because it would be impossible for Wellesley for meet the requirements of this credit, we decided not to perform an evaluation of the environmental, social, and economic impact that this credit could have.

Rainwater Management (up to 3 LEED points)

The intent of the Rainwater Management credit is to reduce rainwater runoff and improve the quality of the runoff water.

There are two options by which to achieve this credit. The first option depends on the percentile of rainfall events. There are three paths to earn LEED points for this option, each path earning a different number of points. The first path is to manage rainwater runoff for

[44] Shane Chase, Personal interview, February 28, 2014.

the 95th percentile of region or local rainfall events using low-impact development and green infrastructure. This earns the project 2 points. The second path is to manage rainwater runoff for the 98th percentile of regional or local rainfall events. This earns the project 3 points. The third and final path is for zero lot line projects only. Here, rainwater runoff is managed for the 85th percentile of regional or local rainfall events. The second option is to manage the annual increase in rainwater runoff from the natural land cover condition to the post-developed condition.

In order to earn this credit, Wellesley would need to install some combination of rainwater management infrastructures (e.g. a rain garden, a rainwater capture system, pervious pavement). Because each of the technologies which could be used to meet the requirements of this credit require different materials and have different environmental, social, and economic implications, we performed separate analyses for each of the technologies that could be used (i.e. rain garden, rainwater capture systems, permeable pavements, green roof).

The environmental impact of this category was rather significant as each of the methods by which this credit could be earned required materials, which in turn required extraction and manufacturing, and some construction and transportation activities. The notable outlier to this common trend was using permeable pavements. This was different from the others in that the impacts of construction and transportation activities are no different in a LEED building in comparison with a non-LEED building. As our evaluations only considered those impacts that were different between a sustainable and a conventional building, and permeable pavements do not require significant differences in construction and material transportation, permeable pavements would have less environmental impacts than the other three rainwater management strategies. All of the rainwater management strategies apart from the use of rainwater capture systems also have positive land use change benefits.

According to our social impact analysis indicators, the social impacts of a rain garden and a green roof are similar, just as the impacts for a rainwater capture system and permeable pavements are similar. As such, the options will be grouped together and evaluated in these two groups. The creation of a rain garden and the green roof are similar because they both act to provide usable green space at the College. In addition, in the survey that was sent out to the community, over 90 percent of respondents stated that they would be interested in these two technologies. Reduced erosion from rainwater runoff can protect the landscape and existing structures, contributing to the historical and cultural preservation of the campus. If people come together to create and maintain these green spaces then they could help to build a sense of community and/or unity and would also encourage participation in the College's stormwater program. Working in a garden can always provide an educational experience both for the workers and for those who are enjoying the space. Having a rain garden or a green roof can instill a sense of pride by giving Wellesley a name for its efforts to provide rainwater management in an interactive and engaging way. Because these green spaces serve education, mental health, and rainwater management, they provide a diversity of uses. By reducing flooding and all the physical health risks that can result from flooding, any attempt to manage rainwater can increase campus safety and physical health.

Managing rainwater through a rainwater capture system or pervious pavement can reduce erosion from rainwater runoff. In turn, this will protect the landscape and existing structures and so preserve the historical and cultural integrity of the college. The reduced erosion and reduced overland flow can also increase campus safety and protect the physical health of the students. Using rainwater capture systems can provide students with information on local and regional precipitation and could aid in the study of the water cycle and precipitation. If Wellesley were to publicize its rainwater management efforts, then these two systems could become points of pride for the College and would give it credibility for sustainability leadership.

Similar to the environmental impacts of the various rainwater management systems, costs associated with this credit will come from construction of the systems, including the necessary materials, transporting said materials, and having to pay people to construct and implement the system. In addition, each of the four options will require time over the longer term for planning, construction, and maintenance. The main difference between the four options come from the fact that using a rainwater capture system will provide a source of water that can hopefully be used elsewhere and so may result in lower water costs in the future. Another difference comes from the fact that there is no difference in terms of construction and transportation of permeable pavements between a LEED and a non-LEED building. Because our assessment only looked at the differences that constructing a sustainable building would have, our analysis considers these construction and transportation costs to be zero.

Heat Island Reduction (up to 2 LEED points)

The intent of the Heat Island Reduction credit is to reduce heat islands and minimize the effects on microclimates as well as human and wildlife habitats.

There are two options by which to earn this credit. First, the area of nonroof measures plus the area of high-reflectance roof plus the area of vegetated roof must be greater than or equal to the total site paving area plus the total roof area. This can be completed by using a variety of roof and nonroof strategies such as installing a green roof or overhanging plants such that paved areas are shaded. The second option is to place at least 75 percent of the building's parking spaces under cover. Compliance with this credit is no different at Wellesley than it is in any other place.

The two options by which to earn this credit have very different impact implications and therefore will be evaluated separately.

The first option, to meet the roof-type requirements, could potentially have environmental impacts depending on the current roof design and the modifications that would be necessary for a building to meet this credit. For example, concrete or aluminum may be used to affect reflectance and each of those would have material impacts, as well as extraction/ manufacturing, construction, and transportation impacts. The environmental impacts of the second option, to place at least 75 percent of parking spaces under cover, also depend on the way in which a building project decides to comply with this credit. The two most common ways that other institutions have complied with this option is to build an underground parking structure or to build some sort of superstructure over existing parking lots. As Wellesley is highly unlikely to build an underground parking structure when the Davis Parking Facility is still relatively new, we assumed that if Wellesley were to try to place 75 percent of her parking spaces under cover, she would raise superstructures. Such superstructures are typically metal or wood and so have material costs leading to extraction/manufacturing and transportation costs.

Based on the indicators we chose to analyze for our social impact analysis, the only social benefit to meeting the LEED dictated roof-type requirements is that compliance could give Wellesley sustainability credibility. On the other hand, placing parking spaces undercover would not only give Wellesley the same credibility, but it would also make the College unique and could therefore become a source of pride. However, this option also has a negative social impact component in that it would disrupt the current physical appearance of the campus and therefore may disturb the history and culture of the campus.

Similar to the previous two credit, there are very different economic impacts for the two options associated with this credit. For the first option, there is no change between a sustainable and non-sustainable building in terms of construction, materials, and transportation. As such, in accordance with our evaluation, there are no extra costs associated with complying with this credit in those categories. However, there will be some personnel costs, as it will take someone some time to make sure that the roof actually meets

this formula. For the second option, there will be small construction, materials, and transportation costs for the construction of parking superstructures. In addition, even more time and personnel costs will be incurred from the fact that someone will need to plan this, as well as implement the plan and construct the structure.

Light Pollution Reduction (1 LEED point)

The intent of the Light Pollution Reduction credit is to improve visibility at night, to increase access to the sky at night, and to reduce harm to wildlife and people.

There are two options by which building projects can earn this credit. The first is to use what it called the backlight-uplight-glare, or BUG, method. According to the BUG method, luminaire uplight ratings cannot exceed the values listed in

Table 4. These ratings are based on the light source installed in the luminaire as defined in IES TM-15-11, Addendum A.

Table 4. Maximum uplight ratings for luminaires under the BUG method

Luminaire mounting	MLO lighting zone				
	LZ0	LZ1	LZ2	LZ3	LZ4
	Allowed backlight ratings				
> 2 mounting heights from lighting boundary	B1	B3	B4	B5	B5
1 to 2 mounting heights from lighting boundary and properly oriented	B1	B2	B3	B4	B4
0.5 to 1 mounting height to lighting boundary and properly oriented	B0	B1	B2	B3	B3
< 0.5 mounting height to lighting boundary and properly oriented	B0	B0	B0	B1	B2
	Allowed glare ratings				
Building-mounted > 2 mounting heights from any lighting boundary	G0	G1	G2	G3	G4
Building-mounted 1–2 mounting heights from any lighting boundary	G0	G0	G1	G1	G2
Building-mounted 0.5 to 1 mounting heights from any lighting boundary	G0	G0	G0	G1	G1
Building-mounted < 0.5 mounting heights from any lighting boundary	G0	G0	G0	G0	G1
All other luminaires	G0	G1	G2	G3	G4

In addition, luminaire backlight and glare ratings cannot exceed the values listed in

Table 4. The second option is the calculation method. This method requires buildings to not exceed the percentages of total lumens emitted above horizontal listed in Table 5.

Table 5. Maximum percentage of total lumens emitted above horizontal for the calculation method.

MLO lighting zone	Maximum allowed percentage of total luminaire lumens emitted above horizontal
LZ0	0%
LZ1	0%
LZ2	1.5%
LZ3	3%
LZ4	6%

The second option is the calculation method. This method requires buildings to not exceed the percentages of total lumens emitted above horizontal listed in Table 6.

Table 6. Maximum vertical illuminances for the calculation method.

MLO lighting zone	Vertical illuminance
LZ0	0.05 fc (0.5 lux)
LZ1	0.05 fc (0.5 lux)
LZ2	0.10 fc (1 lux)
LZ3	0.20 fc (2 lux)
LZ4	0.60 fc (6 lux)

Both of these options also require that these requirements are met for all exterior luminaires located within the boundary of the project and that the internally illuminated signage requirement (e.g. emergency exit signs) is met. This require states that signage cannot exceed a luminance of 200 cd/m^2 (nits) during the night and 2000 cd/m^2 (nits) during the day. Compliance with this credit is no different at Wellesley than it is in any other place.

Based on the indicators examined in this report, complying the requirements of this credit would have no environmental costs or benefits.

The only social impacts that we found were a potential improvement in campus nighttime aesthetics and potential sustainability leadership credibility.

Based on the indicators chosen to evaluate the economic impact of this credit, the only financial costs that would be incurred come from time and personnel. It will take someone some time to plan to meet these requirements and to make sure that the requirements are actually met. In addition, if meeting the light requirements reduces the intensity of our light use, there could also be electricity savings, which would result in cost savings over time.

Tenant Design and Construction Guidelines (1 LEED point)

The intent of the Tenant Design and Construction Guidelines credit is to educate building users about the sustainable design features of the building. It is meant to both show them the features and to inform them of how to use them properly.

In order to earn this credit, an illustrated document must be created containing a description of the sustainable design and features of the building, the sustainability goals and objectives of the building, and recommendations for how to use the building to its fullest sustainability potential. This document must be provided to tenants and building users before a lease is signed. Compliance with this credit is no different at Wellesley than it is in any other place.

Based on the indicators examined in this report, complying with the requirements of this credit would have no environmental costs or benefits. In the long run, proper use of the buildings may reduce electricity, water, and heating/cooling in the use phase and so may eventually have environmental benefits. However, the timeframe of these benefits is outside

the scope of our evaluation and so, for the purposes of this evaluation, there are neither environment costs nor benefits of this credit.

Overall, there were social benefits to complying with this credit. These stem from the fact that the guidelines could facilitate proper use of the buildings and spaces and so may preserve and protect them. This would not only increase the overall usability and life of the buildings, but it would potentially increase the safety of users and force them to participate in the upkeep of the building. Interestingly, the indicators of pride/prestige and leadership were given zeros on our scale of -2 to 2 because the guidelines could either be seen as a source of pride and recognition by making it seem like the College truly cares about its facilities or it could be taken negatively in that the College is overly fussy and overprotective of its facilities.

While the creation and publishing of these requirements will require someone's time and money in the beginning, most of the financial impacts of complying with this credit will result in cost savings. If tenants are able to use these guidelines to improve their use of the building, then, hopefully, there will be reductions in the need for heating/cooling, electricity, water, and waste management in the future. This will, in turn, hopefully result in cost savings in the longer term.

Synthesis

The results of these analyses are graphically depicted in Figure 2.

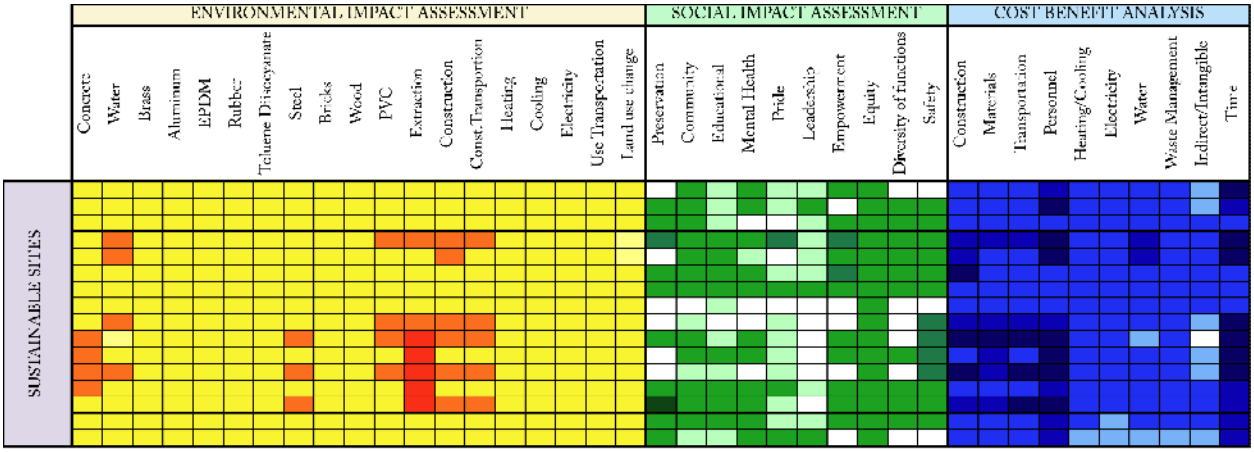


Figure 4. A graphical representation of the analyses results for the Location & Transportation category.

Here are the credits ordered by building process phase:

Pre-Design	
Prereq 1	Construction Activity Pollution
Credit 1	Site Assessment
Credit 2	Site Development – Protect or Restore

Design	
Credit 2	Site Development – Protect or Restore
Credit 3	Open Space
Credit 4	Rainwater Management
Credit 5	Heat Island Reduction
Credit 6	Light Pollution Reduction

Construction	
	NA

Use	
Credit 7	Tenant Design and Construction

End of Life	
	NA

Based on the results of our analysis, we have prioritized each of the credits as shown below:

Credit #:	**Criteria:**	**Possible Points:**	**LEED+ Priority**

Prereq 1	Construction Activity Pollution Prevention	Required	Required
Credit 1	Site Assessment	1	Medium
Credit 2	Site Development--Protect or Restore Habitat	2	Not Applicable
Credit 3	Open Space	1	Not Applicable
Credit 4	Rainwater Management	3	Low
Credit 5	Heat Island Reduction	2	Low
Credit 6	Light Pollution Reduction	1	Low
Credit 7	Tenant Design and Construction Guidelines	1	Medium

WATER EFFICIENCY

WATER EFFICIENCY

"Water is the basis of life, and on this planet only a tiny share—less than one percent of all water—is available for nearly 7 billion people and a myriad of freshwater aquatic ecosystems. It's that tiny share of freshwater that we have to use to meet all of our needs—irrigation, industry, drinking water, and sanitation—and the needs of thousands, if not millions, of other species that we share the planet with. The average American lifestyle demands 2,000 gallons a day to support, with 70 percent of that going to support our diets. If each of us learned how to conserve just a little more water, it could add up to big savings."

–National Geographic[45]

The Water Efficiency category of LEED is based on reduced water consumption, either through landscaping, appliances that will reduce need for potable water use, or systems that monitor water usage. This category is composed of three prerequisites and four credits totaling 11 LEED points (see Figure 5).

WATER EFFICIENCY		POSSIBLE: 11
Prereq	Outdoor water use reduction	REQUIRED
Prereq	Indoor water use reduction	REQUIRED
Prereq	Building-level water metering	REQUIRED
Credit	Outdoor water use reduction	2
Credit	Indoor water use reduction	6
Credit	Cooling tower water use	2
Credit	Water metering	1

Figure 5. The Water Efficiency credits and their LEED points.

Outdoor Water Use Reduction (Required; up to 2 LEED points)

The Water Efficiency category of the LEED checklist has two credits pertaining to Outdoor Water Use Reduction, with intent to reduce outdoor water consumption. The first is a

[45] "What You Can Do," National Geographic (2014), Web.

prerequisite, and offers two options: 1) to show that the landscape does not require a permanent irrigation system beyond a maximum two-year establishment period, or 2) reduce the landscape's water requirement by 30 percent through plant species selection and irrigation system efficiency, calculated by the EPA WaterSense calculation tool.

The second credit is worth up to 2 points and offers the same two options. To achieve these additional points, Wellesley would need to reduce the landscape water requirement by an additional 50 percent. Any additional reductions beyond 30 percent would need to be achieved using any combination of efficiency, alternative water sources, and smart scheduling technologies. The points are awarded per water use reduction, as shown in Table 7.

Table 7. LEED points for reducing irrigation water.

Percentage reduction from baseline	Points (except Healthcare)
50%	1
100%	2

The only indicator for which Outdoor Water Use Reduction has a negative environmental impact is transportation, incurred from transporting the plant species or materials that would be necessary for changing the current landscape and irrigation system. Otherwise, based on our chosen analysis indicators, this credit does not require any material use or construction that would have a significant impact.

Outdoor Water Use Reduction would likely have a positive social impact, because improving the landscape and space around buildings would provide students with more recreational space and could add to or improve the campus aesthetic. Additionally, implementing a kind

of rain garden or garden with educational value would offer an opportunity for the student body to be involved.

The economic impact analysis of Outdoor Water Use Reduction has a net positive impact. This can be explained by the fact that there are no significant costs for implementing the measures necessary for the credit, but these changes would generate huge savings for Wellesley in water costs.

Indoor Water Use Reduction (Required; up to 6 LEED points)

Indoor Water Use Reduction also has two possible credits with the intent of reducing indoor water consumption. The first is a prerequisite, and specifies that aggregate water consumption must be reduced by 20 percent from the baseline through commercial fixtures, fittings, and appliances, as outlined in Table 8. This can be achieved through installing fixtures and fittings (e.g., toilets, lavatories, faucets, & showerheads) and appliances (e.g., clothes washers, dishwashers, spray valves, & ice machines) that have the EPA WaterSense label.

Table 8. Baseline water consumption of fixtures and fittings.

Commercial Fixtures, Fittings, and Appliances	Current Baseline (IP Units)	Current Baseline (SI units)
Water closets (toilets)*	1.6 gallons per flush (gpf)	6 liters per flush (lpf)
Urinal*	1.0 (gpf)	3.8 lpf
Public lavatory (restroom) faucet	0.5 gpm at 60 psi** all others except private applications	1.9 lpm at 415 kPa, all others except private applications
Private lavatory faucet*	2.2 gpm at 60 psi	8.3 lpm at 415 kPa
Kitchen faucet (excluding faucets used exclusively for filling operations)	2.2 gpm at 60 psi	8.3 lpm at 415 kPa
Showerhead*	2.5 gpm at 80 psi per shower stall	9.5 lpm at 550 kPa per shower stall

* WaterSense label available for this product type
gpf = gallons per flush
gpm = gallons per minute
psi = pounds per square inch
lpf = liters per flush
lpm = liters per minute
kPa = kilopascals

Furthermore, the appliances, equipment, and systems must meet the requirements outlined in Table 9 and
Table 10.

Table 9. Standards for appliances.

Appliance	Requirement
Residential clothes washers	ENERGY STAR or performance equivalent
Commercial clothes washers	CEE Tier 3A
Residential dishwashers (standard and compact)	ENERGY STAR or performance equivalent
Prerinse spray valves	≤ 1.3 gpm (4.9 lpm)
Ice machine	ENERGY STAR or performance equivalent and use either air-cooled or closed-loop cooling, such as chilled or condenser water system

gpm = gallons per minute
lpm = liters per minute

Table 10. Standards for processes.

Process	Requirement
Heat rejection and cooling	No once-through cooling with potable water for any equipment or appliances that reject heat
Cooling towers and evaporative condensers	Equip with: ▫ makeup water meters ▫ conductivity controllers and overflow alarms ▫ efficient drift eliminators that reduce drift to maximum of 0.002% of recirculated water volume for counterflow towers and 0.005% of recirculated water flow for cross-flow towers

In order to achieve up to 6 points, the second Indoor Water Reduction credit requires a further reduction in fixture and fitting water use from the aforementioned calculated baseline. The points are awarded according to water use reduction, as shown in Table 11.

Table 11. LEED points for further reductions in water use.

Percentage reduction	Core and Shell Pts
25%	1
30%	2
35%	3
40%	4
45%	5
50%	6

Indoor Water Reduction likely has an initial negative environmental impact, which can be explained by the fact that it would require Wellesley to install appliances with the EPA WaterSense label. The College would have to dispose of all appliances that do not currently have the label and purchase new appliances in order to make the necessary 20 percent reduction. Fixtures like faucets, toilets, and showerheads use a lot of metal, polystyrene, and clay and silica (i.e., for toilet bowls), and our school may be required to generate a lot of waste. On the other hand, the new appliances would guarantee a significant reduction in

water use in the long run, and so, overtime, the environmental benefits of this credit will outweigh these initial environmental costs.

The social impact of Indoor Water Use Reduction is net positive because Wellesley would likely earn a lot of prestige. The College would have the opportunity to become a leading institution in water use reduction when compared to her peers. In a survey sent out to the Wellesley community, a question asked, “Implementing which of the following would earn Wellesley the most prestige?” The second highest answer was “decreasing a building’s water consumption by 20%.” Evidently, students, faculty and staff all perceive water reduction as something that is both good and potentially important.

The economic impact analysis of Indoor Water Use Reduction yielded a result of zero. This implies that choosing to pursue this credit would probably cost the same as choosing to do what Wellesley would have done without LEED. This can be explained by the fact that the cost for implementing the fixtures, fittings, and appliances necessary to achieve the credit would be balanced by the savings that Wellesley would achieve from using less water in the future.

Building-Level Water Metering (Required; 1 LEED point)

Building-Level Water Metering has two parts, both intended to with the intent of improving water management and creating water savings by tracking water consumption. The first is a prerequisite, which requires that each building install permanent, potable water meters that measure water for the building and the grounds surrounding it. The meter readings must be recorded monthly and annually, and a comprehensive summary of water use data must be shared with the US Green Building Council (USGBC) during a five-year period, beginning on the day the building receives LEED certification.

The second credit is worth one point, and requires the installation of permanent water meters for at least two of the following water subsystems as they apply to the building, outlined by the USGBC:

- Irrigation. Meter water systems serving at least 80% of the irrigated landscaped area. Calculate the percentage of irrigated landscape area served as the total metered irrigated landscape area divided by the total irrigated landscape area. Landscape areas fully covered with xeriscaping or native vegetation that requires no routine irrigation may be excluded from the calculation.
- Indoor plumbing fixtures and fittings. Meter water systems serving at least 80% of the indoor fixtures and fitting described in WE Prerequisite Indoor Water Use Reduction, either directly or by deducting all other measured water use from the measured total water consumption of the building and grounds.
- Domestic hot water. Meter water use of at least 80% of the installed domestic hot water heating capacity (including both tanks and on-demand heaters).
- Boiler with aggregate projected annual water use of 100,000 gallons (378 500 liters) or more, or boiler of more than 500,000 BtuH (150 kW). A single makeup meter may record flows for multiple boilers.
- Reclaimed water. Meter reclaimed water, regardless of rate. A reclaimed water system with a makeup water connection must also be metered so that the true reclaimed water component can be determined.
- Other process water. Meter at least 80% of expected daily water consumption for process end uses, such as humidification systems, dishwashers, clothes washers, pools, and other subsystems using process water.

Building-level Water Metering has a slightly negative initial environmental impact because the creation and implementation of the meters requires extraction and consumption of materials, specifically metals. However, during the lifetime of a building, the meters would likely contribute to a net positive environmental impact because the awareness of how much water is being consumed may be an incentive for innovation or for the adoption of new technologies that use less water.

The net social impact of Building-level Water Metering is positive. The meters are tools that can help Wellesley advertise reductions in water consumption, thereby giving our school the opportunity to market itself as a leader in sustainability. Additionally, the meters can serve an educational purpose by providing first-ever complete building water data.

Building-level Water Metering has a net positive economic impact analysis. There are some costs associated with potentially hiring a consultant to make decisions about what kind of meters to install, as well as planners to decide where to place them. However, overall, the

access to data showing water consumption can influence Wellesley to decrease water consumption and therefore, potentially save the College a significant amount of money.

Cooling Tower Water Use (up to 2 LEED points)

The final credit of the water efficiency category is Cooling Tower Water Use. The intent of this credit is to conserve water used in the cooling tower while monitoring microbes, corrosion, and scale in the condenser water system. This can be done through a one-time potable water analysis that should measure the parameters outlined in Table 12.

Table 12. Maximum concentrations for parameters in condenser water systems.

Parameter	Maximum level
Ca (as $CaCO_3$)	1000 ppm
Total alkalinity	1000 ppm
SiO_2	100 ppm
Cl^-	250 ppm
Conductivity	2000 µS/cm

The number of cooling tower cycles can be measured by dividing the maximum allowed concentration of each parameter by the actual concentration of each parameter found in the potable makeup water. Cooling tower cycles should be decreased in order to decrease the values for each parameter. The number of points available for each cooling tower cycle is outlined in Table 13.

Table 13. LEED points for cooling tower cycles.

Cooling tower cycles	Points
Maximum number of cycles achieved without exceeding any filtration levels or affecting operation of condenser water system (up to maximum of 10 cycles)	1
Achieve a minimum 10 cycles by increasing the level of treatment in condenser or make-up water OR Achieve the number of cycles for 1 point and use a minimum 20% recycled nonpotable water	2

The Cooling Tower Water Use credit has a net positive environmental impact, because the potable water analysis can help Wellesley maximize cooling cycles, thereby saving water. The data from the analysis can also influence the amount of energy Wellesley uses for water heating during the use phase.

The net social impact would also be positive, for the same reasons that building level meters are positive (educational purposes), and a potential tool for helping Wellesley to earn prestige as a leader in sustainability.

The economic impact analysis also has a positive net impact, because the potable water analysis would provide important data that could potentially have significant savings in water use and heating/cooling for Wellesley.

Synthesis

The results of these analyses are graphically depicted in Figure 6.

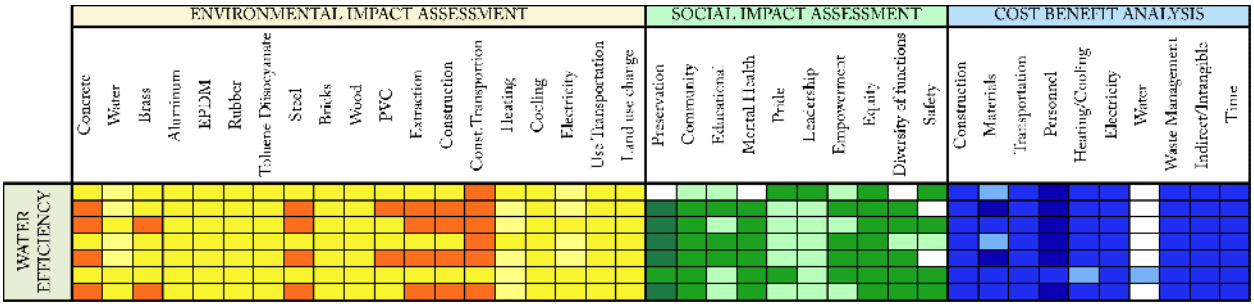


Figure 6. A graphical representation of the analyses results for the Water Efficiency category.

Here are the credits ordered by building process phase:

Pre-Design	
	NA

Design	
Prereq 1	Outdoor Water Use Reduction
Prereq 2	Indoor Water Use Reduction
Credit 1	Outdoor Water Use Reduction
Credit 2	Indoor Water Use Reduction

Construction	
Prereq 2	Indoor Water Use Reduction
Credit 2	Indoor Water Use Reduction

Use	
Prereq 1	Outdoor Water Use Reduction
Prereq 3	Building-Level Water Metering
Credit 1	Outdoor Water Use Reduction
Credit 3	Cooling Tower Water Use
Credit 4	Water Metering

End of Life	
	NA

Based on the results of our analysis, we have prioritized each of the credits as shown below.

Credit #:	**Criteria:**	**Possible Points:**	**LEED+ Priority**
Prereq 1	Outdoor Water Use Reduction	Required	Required
Prereq 2	Indoor Water Use Reduction	Required	Required
Prereq 3	Building-Level Water Metering	Required	Required
Credit 1	Outdoor Water Use Reduction	2	Medium
Credit 2	Indoor Water Use Reduction	6	Low
Credit 3	Cooling Tower Water Use	2	High
Credit 4	Water Metering	1	Medium

ENERGY & ATMOSPHERE

ENERGY & ATMOSPHERE

"All of these requirements are about ensuring that LEED buildings are operating as well as they are capable of, and that they stay optimized and efficient over the long term"

- Brendan Owens, Vice President of LEED Technical Development[46]

One of the core performance areas of LEED is energy efficiency, which is recognized in the Energy and Atmosphere (EA) category of the scorecard. The EA category deals with issues ranging from ensuring the building operates as planned to investing in renewable energy. This category is especially important for Wellesley for three reasons: (1) because a large percentage of the total LEED points are nested in this category, (2) because the Sightlines Report describes Wellesley as being significantly less thermally efficient than our peer institutions, and (3) because dysfunctional and inefficient infrastructure will result in substantial financial costs.

Table 7. The Energy and Atmosphere credits and their LEED points.

ENERGY & ATMOSPHERE		POSSIBLE: 33
Prereq	Fundamental commissioning and verification	REQUIRED
Prereq	Minimum energy performance	REQUIRED
Prereq	Building-level energy metering	REQUIRED
Prereq	Fundamental refrigerant management	REQUIRED
Credit	Enhanced commissioning	6
Credit	Optimize energy performance	18
Credit	Advanced energy metering	1
Credit	Demand response	2
Credit	Renewable energy production	3
Credit	Enhanced refrigerant management	1
Credit	Green power and carbon offsets	2

Success within this category is heavily dependent on sequencing and priority. While the credits are listed separately, in reality, they are very much interconnected. Finally, as with

[46] Katherine Tweed, "5 of the Most Important Changes to the LEED Green Building Rating System," Green Tech Media (2013), Web.

the other LEED categories, the impact potential of the credits of the EA category is very much dependent on the specific circumstances of the building project.

Fundamental Commissioning (Required)

The purpose of Fundamental Commissioning is to make sure that the systems put in place are functioning according to how they are designed to function. Commissioning is important for catching common problems like incorrectly installed equipment, thermal comfort issues, and premature equipment failure. According to Evan Mills, PhD, a researcher at a US Department of Energy (DOE) national laboratory, building enclosure commissioning (commonly abbreviated as BECx) should be viewed as "the single-most cost-effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today."[47] A study conducted at this laboratory found that the typical simple investment payback for commissioning averages 1.8 years, with a range of 0.5 – 3.5 years, which, by most investment standards, are very compelling.[48] Savings from both maintenance and energy associated with using BECx average about 16 percent for existing buildings and 13 percent for new construction. The scope of commissioning should at least include the following: heating, cooling, refrigeration, ventilation, lighting and daylighting controls, domestic hot water systems, renewable energy systems.

Although Fundamental Commissioning is a LEED prerequisite, there are different compliance paths available depending on size of the project. For buildings less than 20,000 square feet, the Commissioning Authority ('C x A') may be involved in the project (i.e. a construction manager, architect, or engineer directly involved). If the area exceeds 20,000 sq feet, the C x A should not be someone who is directly involved in the project. The intent of the "independent consultant" requirement is to ensure that the C x A does not have a conflict of interest with the design and construction of the project that would compromise support of the project owner. It is interesting to note that the project size threshold for allowing a

[47] C.C. Sullivan, "Calculating the ROI of Building Enclosure Commissioning," BDC Network (2013), Web.

[48] Dan Winters, "The Economic Benefits of Building Commissioning," GBIG (2014), Web.

member of the design or construction team to act as the C x A has been reduced from 50,000 sq feet (from the 2009 version of LEED) to 20,000 sq feet.[49]

For buildings under 20,000 sq feet, Wellesley could assign someone from the construction management team to be the C x A. However, this is not recommended by the USGBC and Wellesley should strive to consult someone independent of the design and construction teams.

Commissioning, as an initial source of system control and verification, will likely prevent system defects and inefficiencies. Over time, this will incur significant savings that will outweigh costs associated with hiring a commissioning authority.

Commissioning also has the potential to indirectly garner several social benefits. Although commissioning does not involve the rest of the community, it is a testament to the College's reputation for transparency and accountability. Publicly guaranteeing that the building's systems will work as they are designed to will instill public confidence. Finally, since thermal and indoor air conditions are included in the scoping of Fundamental Commissioning, optimal living conditions can provide better learning environments.

Enhanced Commissioning (3-6 LEED points)

The intent of the Enhanced Commissioning credit (which stipulates that only an independent consultant can be the Commissioning Authority) is to provide valuable objectivity and an outside perspective that someone from the design team cannot offer.
Additionally, Enhanced Commissioning requires the C x A to be involved much earlier in the life phase of the project (at the design stage, instead of at the bid stage), since it requires that the C x A develop an operations manual and verify that relevant staff are trained using it. It also requires the C x A to be involved with the project for a notably longer period of time by requiring the C x A to review operations 8 to 10 months after substantial completion.

[49] Jeff Yirak, "LEED v4: What Does it Mean for Commissioning?" Wood Harbinger Newsletter (2014), Web.

While enhanced commissioning for the 2009 version of LEED is currently worth up to 2 points, the newest version of LEED awards it up to 6 points, demanding special attention.

Options:

- Enhanced Commissioning (3 points) OR Enhanced & Monitoring-Based Commissioning (4 points) AND
- Envelope Commissioning (2 points)

Wellesley can achieve the highest number of LEED points and maximize the benefits received from commissioning by achieving both Enhanced & Monitoring-Based Commissioning and Envelope Commissioning. Monitoring-Based Commissioning refers to the practice of continuously tracking energy data, either from industrial systems or an energy management system (EMS), using each of these control data points to ensure that performance goals are consistently met. The analysis of the next criteria will provide elaboration on EMS.

Envelope Commissioning includes review of walls roofs and foundations (enclosure systems) to ensure the air tightness of the enclosure is above minimum rates recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

While Extended Commissioning will require a higher investment than Fundamental Commissioning, the likelihood that all material defects and installation errors will be discovered and ameliorated will be even greater. The C x A will have a stronger sense of responsibility because they know they will held accountable for any issues that arise during occupancy. Also, permanent monitoring systems can identify previously unrecognizable and unquantifiable savings opportunities.

Again, commissioning helps achieve an optimally safe and comfortable facility, reduces operating costs, ensures sufficient O&M staff orientation and training, and improves installed building systems documentation.

Building-Level Energy Metering (Required)

The intent of Building-Level Energy Metering is to make commissioning and maintaining buildings easier as well as to allow the owner to accurately estimate the return on investment of future efficiency projects. This prerequisite is new to LEED (in earlier versions of LEED, it was only an optional credit). It requires that we install new or use existing base building-level energy meters or submeters that can be aggregated to provide base building-level data representing total building energy consumption. The following must be metered: electricity, natural gas, chilled water, steam, fuel oil, and propane. Utility-owned meters are acceptable as long as they are capable of aggregating base building-level resource use. Additionally, this prerequisite requires that the meter data be shared with USGBC for five years or until the building changes ownership or lessee.

While the Campus Center, Alumnae Hall, Sports Center, and Observatory are metered for water, steam, chill water, electricity, and potable water, metering in most of the older buildings on campus is not as extensive. Also, Wellesley does not currently share any of its energy data with the USGBC (which is a requirement of this prerequisite). Additionally, the rate at which the College receives the information is very slow, which is problematic because this prerequisite requires minimum monthly or utility-billing-period interval data of consumption (kWh) and demand (kW).

Fortunately, the cost of building energy management software has significantly decreased over recent years. There are multiple low-cost companies that arisen in response to complaints about the costs of energy metering platforms. There are even companies like Noesis Energy that offer software applications for free (and provide extra services for additional cost).[50]

[50] "Home Page," Noesis Energy (2014), Web.

Which management system Wellesley decides to implement will have to be carefully considered in light of the College's own needs and available resources. One management system that has enjoyed popularity among educational institutions in Massachusetts and that should be considered is the Enterprise Energy Management System (EEMS), which provides real-time building-level metering for a wide-range of utilities. EEMS is a collaboration between Bunker Hill Community College (BHCC), the Department of Energy Resources (DOER) and EnerNOC, a company that specializes in energy management applications. Multiple institutions have chosen this collaborative management system, including the Massachusetts College of Art (Boston, MA), Bunker Hill Community College (Charlestown, MA), UMass Lowell (Lowell, MA), and Salem State University (Salem, MA). As a rough approximation of cost, it costs Salem State University (a much larger campus than Wellesley in terms of building area) about $440,000 to install real-time building-level metering for electricity and gas in 27 buildings totaling 1,300,000 square feet.[51]

While metering in and of itself does not provide direct energy savings, owning basic tools that crunch crucial data can provide essential ongoing visibility that building managers and owners need to manage energy use.

Updating or expanding our building's meters will come at a cost, but having antiquated systems will likely incur costs that exceed any amount of investment put into updating our systems.

The only possible social cost of extending energy meters is that new or expanded meters could impact the physical/architectural character of a building if they are not strategically placed.

Advanced Energy Metering (1 LEED point)

[51] "Massachusetts Recovery: Clean Energy Dollars at Work," Massachusetts State Website (2013), Web.

The Advanced Energy Metering credit requires a permanent metering system that records data in intervals of one hour or less. In addition to whole-building metering, any particular energy use representing 10 percent or more of the facility total must also be metered. Additionally, meters must transmit data to a remote location and provide data storage for at least 36 months. The intent of this credit is to push for project owners to strive for substantially greater granularity of meter data across a range of facility types. More refined data will allow for more precise calculations.

Currently, the College does not transmit any of its metering data to the USGBC, nor does it record data at the minimum frequency of one hour or less. Thus, achieving this credit will require significant changes or a revamp of the current multiple metering systems (although LEED does specify that utility meters are allowed).

Because this credit is only worth one point in the LEED scorecard, its benefits may be easily overlooked. However, our data and information from our peer institutions suggests that Advanced Energy Metering would be significantly beneficial across the board. This is not surprising, since high-precision metering will not only make commissioning and maintaining buildings easier, but it will also allow us to accurately measure the return on investment of future efficiency projects, which is crucial for the management of the Green Revolving Fund.

Minimum Energy Performance (Prerequisite)

This prerequisite (which has existed in earlier renditions of LEED, but now will be updated to reference ASHRAE 90.1-2010) aims to achieve a minimum level of energy efficiency improvement for the building and its systems. More precisely, it asks that a building demonstrate a 5 percent improvement in the proposed performance rating over the baseline performance rating. For this prerequisite, a minimum of 2 percent out of the 5 percent energy savings must come from building power and cooling infrastructure.

The percentage of improvement is operationalized according to savings calculated through whole-building modeling. The baseline building performance is calculated (according to ANSI/ASHRAE/IESNA Standard 90.1–2010, Appendix G, with errata) using a whole-building simulation model. Then, the power utilization effectiveness (PUE) value of the proposed design is determined.

The strategies used to achieve any margin of improvement will be project-specific since they strongly depend on the types of mechanical equipment involvement. However, it is worth noting that many of the systems need to change on campus in reaction to existing energy codes, so certain changes may need to be made irrespective of this LEED prerequisite.

The 2010 version of the ASHRAE standard referenced in the newest version of LEED features an increased emphasis on lighting controls, such as daylighting controls, automatic shut off controls, occupancy sensors, and plug load controls. In general, these are all post-occupancy measures.[52] Wellesley has already installed automated lighting systems to some degree in some of its buildings (e.g., Clapp Library, Pendleton, the Chapel, the Science Center). However, the majority of lighting on campus (e.g., Green Hall, Founders, dorm clusters) still relies on manual controls, which are often not optimally used. Installing more automated systems (which have increasingly become more sensitive to occupant movement) will cut down on time normally needed for janitorial or administrative staff to walk to various switch locations to manipulate switches.

Another conspicuous measure Wellesley will need to make is to improve the insulation of its buildings. Students and faculty have criticized many of the older buildings on campus (e.g. Tower complex) for being “drafty” and for leaking heat. This creates an uncomfortable dichotomy in which students are often compelled to alternatively turn the heat on full blast to combat leakages and later to open the windows because it got too hot. Addressing the existing leakage issues could require a solution as simple as re-caulking windows and doors,

[52] “LEED v4 Ratchets Up the Role of Technology,” Institute Be (2014), Web.

rather than replacing them. Old, peeling or loose caulk should be replaced regularly to meet existing Massachusetts building codes anyways.

Energy simulation will allow project managers to compare different design or retrofit options through load and cost-benefit calculations. It will also allow for the simulation of complex or site-specific strategies such as daylighting or advanced controls operation.

Negative environmental impacts associated with shell improvements will depend on the particular strategy used. For example, spray foam (associated with Toluene diisocyanate) is commonly used to insulate university buildings. Automated sensors will require some inventory work (to see which switches are readily compatible for conversion) and upfront financial costs. However, the energy savings incurred from improving the performance of the building will justify negative material impacts. Making readily apparent improvements (e.g., fixing conspicuous problems such as leakage or installing automatic sensors) will also greatly benefit Wellesley's reputation (or lessen the griping from students) since they directly tie to improving the learning and living experiences at Wellesley.

Optimize Energy performance (1-18 LEED points)

The intent of this criteria (which notably can reward the project owner up to 18 points), is to achieve levels of energy performance that go beyond the prerequisite standard in order to further reduce the environmental and economic impacts associated with excessive energy use. This credit is particularly crucial in the context of current national regulation trends. In the United States, energy codes are being adopted rapidly throughout the country, and the standards on which they are based are becoming increasingly stringent. Within this decade, all buildings will be required to meet aggressive efficiency goals, which in many cases will exceed what is required by LEED.[53] Table 13 outlines the number of points that are awarded for each percentage of improvement in energy performance.

[53] Carl Sterner, "US Energy Codes Improving Fast," Clean Technica (2013), Web.

Table 13. Correlation between points awarded and percentage improvement in energy performance.

New Construction	Major Renovation	Core & Shell	Points
6%	4%	3%	1
8%	6%	5%	2
10%	8%	7%	3
12%	10%	9%	4
14%	12%	11%	5
16%	14%	13%	6
18%	16%	15%	7
20%	18%	17%	8
22%	20%	19%	9
24%	22%	21%	10
26%	24%	23%	11
29%	27%	26%	12
32%	30%	29%	13
35%	33%	32%	14
38%	36%	35%	15
42%	40%	39%	16
46%	44%	43%	17
50%	48%	47%	18

LEED stipulates that in order to achieve this criterion at any level (project energy and cost savings for all affected systems), whole-building energy simulation is necessary.

Energy models will become increasingly critical for the completion and submission of documents to municipal- or state-reviewing authorities for energy code compliance, so the software should not be mistakenly assumed as an expense made exclusively for LEED certification. Additionally, there are also numerous low-cost and free simulation software tools available. Software that is currently both free and recently updated include Autodesk Green Building Studio, Beopt, Building Design Advisor, BuildingSim, Design Advisor (this one

particularly focuses on whole-building simulation), DeST, EE4 CBIP, EnergyPlus, EnergySavvy, and Zebo.[54]

In terms of prioritization, building insulation tends to offer the most cost-effective method of saving energy. Wellesley's building insulation needs are noticeable, particularly during the winter.

Certain measures (such as replacing windows) that would be normally be prioritized for typical buildings may be less desirable for the College because of the importance of maintaining the aesthetics of the building.

The magnitude of short-term positive and negative environmental impacts will depend on the specific strategies used, though the long-term environmental impact of enhancing energy efficiency will certainly be positive.

As will be illustrated in the analysis of the Indoor Environmental Quality category, there is a particularly strong case for the positive health and social impacts of energy efficiency in buildings. Many respiratory and even mental health issues have been associated with ventilation and indoor temperature-related imbalances.

Demand Response (1-2 LEED points)

Demand Response (DR) is essentially an incentive-based strategy that utilities use to encourage customers to lower demand for electricity during peak usage times (when demand may outstrip capacity). DR customers are essentially paid by DR service providers for cutting their electricity consumption during these "peak" times. There are hundreds of different Demand Response providers that work with local utilities, and they can provide different levels of service, pay rates, and penalties for non-compliance.

[54] "Whole Building Analysis: Energy Simulation," Building Energy Tools Software Tools Directory, U.S. Dep. of Energy (2011), Web.

Normally, there are three benefits of being a demand response customer: (1) It creates a revenue stream; (2) it automatically provides some useful information about energy consumption; and (3) it can encourage reduced energy use. However, since the College generates its own electricity with the cogeneration plant and is able to manipulate its own demand (engines are turned off when the demand is low and an additional engine is turned on when the demand is high), the benefits of taking on a Demand Response contract are not compelling. Another disadvantage of entering a DR contract is that Wellesley could face financial penalties if the College is unable to reduce its demand during peak times.

On the other hand, because peak times frequently occur during seasons of extreme temperatures (the winter and summer), when the College is usually not in session, Wellesley may be in a unique position to reap financial benefit from a DR program. However, from an environmental impact standpoint, Demand Response will not likely be the most useful investment for Wellesley.

As previously stated, entering a Demand Response contract should not be one of Wellesley's top LEED priorities given the potential of many of the other criteria from the same category, though it could be considered or further investigated for financial perks.

Renewable Energy Production (1-3 LEED points)

The intent of this credit is to reduce the negative impacts traditionally associated with fossil fuel energy by shifting reliance to or increasing reliance on renewable forms of energy. To many people, renewable energy is strongly symbolic of the broader environmental movement. However, what is not always recognized is that the economic and environmental benefits of well-known forms of renewable energy (e.g. solar) are strongly site-specific. That is, their geographic location can determine their usefulness. In Massachusetts, solar panels

currently have a seven year payback period.[55] The most optimistic return-on-investment for Massachusetts, assuming that new state incentives will roll out on time, is about 5 years.[56]

As can is outlined in Table **13,** up to 3 points can be earned for this criterion, depending on the percentage of energy use that is achieved via renewable sources.

Table 14. Correlation between points earned and percentage of renewable energy.

Percentage Renewable Energy	Points (CS)
1%	1
3%	2
5%	3

In the past, the College has hired consultants for individual projects, such as for the solar panels by the sports field. There is currently discussion about asking a firm to conduct a complete analysis of renewable energy potential across the campus, which could help streamline and prioritize future renewable energy projects. However, there are also challenges to utilizing a campus-wide survey; namely, a cross-campus study risks becoming too general and possibly even outdated.

In spite of the shining reputation of solar panels, their manufacturing incurs upfront environmental costs because of the toxic compounds and intense amount of energy required to synthesize the panels.[57] This explains the short-term negative environmental impact calculated from our qualitative environmental assessment (Figure 8). Furthermore, achieving the maximum points for this credit only requires a small percentage of diversion from fossil fuel energy; 3 points corresponds to only a 5 percent conversion to renewables. Though criteria like Advanced Energy Metering and Enhanced Commissioning are less tangible, they

[55] Chris Meehan, "Top 10 States for Residential Solar," Solar Reviews (2013), Web.

[56] Ibid.

[57] Dustin Mulvaney, "Hazardous Materials Used In Silicon PV Cell Production: A Primer," Solar Industry Magazine (2012), Web.

would likely have much greater potential for reducing overall energy consumption on campus.

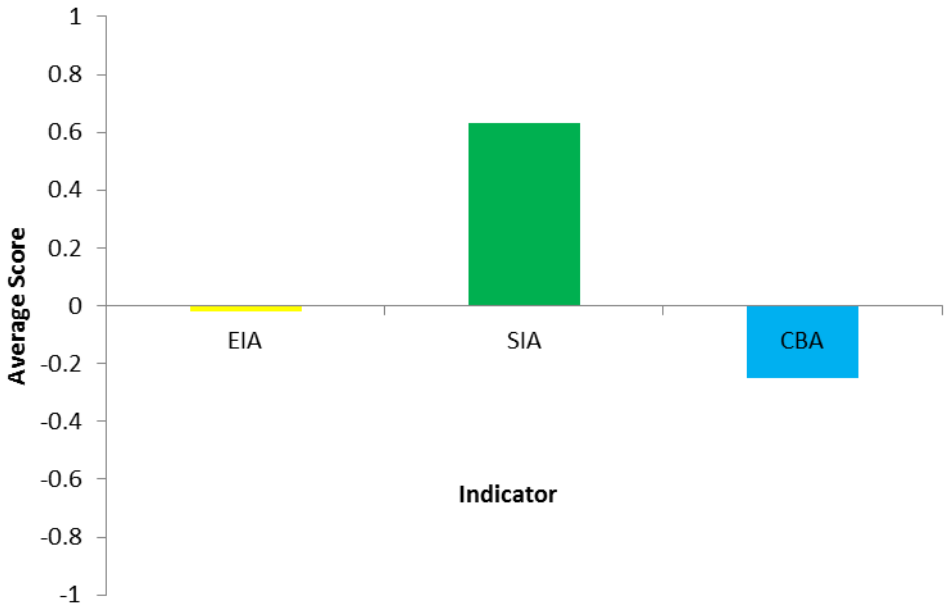


Figure 8. Graph of the average scores for the impact analyses of Renewable Energy Production.

Additionally, there may be concern about the extent to which solar panels could alter the aesthetics of the College's campus. However, solar parents inherently hold great social (and reputational) value. When we asked the community which three green features they would prefer from a long list of options that included installing solar panels, creating green roofs, and passive heating and cooling, 60 percent of respondents included solar panels in their list. In summary, there are both advantages and disadvantages to installing solar panels in locations of high visibility.

Enhanced Refrigerant Management (1 LEED point)

The intent of this credit is to minimize refrigerants' ozone-depleting and global-warning impacts. It also concerns the ratio of coolant charge to cooling capacity for a compressor unit and the refrigerant leakage rate.

There are two paths to achieving the 1 point for this credit. The first option is to eliminate refrigerants with any ozone depletion potential (ODP) or a global warming potential (GWP) greater than 50. Conversely, this can be achieved by only using refrigerants with an ozone depletion potential of zero and a global warming potential of less than 50. The second option (which also rewards 1 point) is to select refrigerants used in heating, ventilation, refrigeration, and air-conditioning equipment to minimize ozone depleting and global warming compounds. The combination must comply with the following formula:

LCGWP (Lifecycle Direct Global Warming Potential) + LCODP (Lifecycle Ozone Depletion Potential) x 105 ≤ 100.

According to Wellesley's Sustainability Coordinator, this criterion was achieved (for LEED 2009) for the Alumnae Hall renovation by updating the cooling equipment. However, the feasibility of a comprehensive equipment update will vary widely from building to building due to the wide range of ages and sizes among existing equipment.

Environmentally, phasing out refrigerants is important since refrigerants negatively impact the ozone layer and contribute to global warming. Financially, phasing out refrigerants is also a valuable decision. Though phasing out outdated equipment will incur some financial costs, phase out schedules are driving up prices for the most common refrigerants such as R-22.[58] Minimizing refrigerants is also key for the College's environmental reputation, since authorities at all levels are increasing requirements for refrigerant reporting and cooling equipment.[59]

[58] "Refrigerant Management," EOS Climate (2013), Web.

[59] Ibid.

Green power and carbon offsets (1-2 LEED points)

The theory behind carbon offsets is that if an institution wants to reduce their emissions but cannot do it themselves due to financial or technological constraints, they can pay someone else to reduce them. The intent of this credit is to promote the reduction of greenhouse gas emissions through the use of carbon mitigation projects and renewable energy sources. It requires that the project engage in a contract for qualified resources that have come online during or since 2005 for a minimum of five years. To achieve 1 point, the contract must provide at least 50 percent of the project's energy use through carbon offsets, green power, or renewable energy certificates. For two points, it must provide 100 percent of the site's energy.

Considering the limited number of points awarded for this credit and the importance of reducing carbon production on-site, a more reliable action than anticipating a reduction elsewhere, this credit should be considered a secondary option to earn additional LEED points.

The environmental benefit of carbon offsets is widely debated. First, the source of pollution is generally not from the same region as the location of the purchased offsets, so there often is a physical disconnect between the reduction and the offsets purchased. Second, investing in carbon offsets might distract from actually reducing carbon output. However, carbon offsets, if well-advertized, have some reputational value.

ENVIRONMENTAL IMPACT ASSESSMENT

At first glance, the positive environmental impacts may not seem as strong one might expect (Figure 9). This is because initially, installing the infrastructure for energy saving systems requires energy and materials, their manufacture, and their transport. However, based on numerous studies and conventional wisdom, one can rest assured that the social, economic,

and long-term environmental impacts will be positive.[60] The ongoing energy use of a building is arguably its single greatest environmental impact, so improving a building's energy efficiency will almost certainly affect the building's sustainability in a fundamental way.[61]

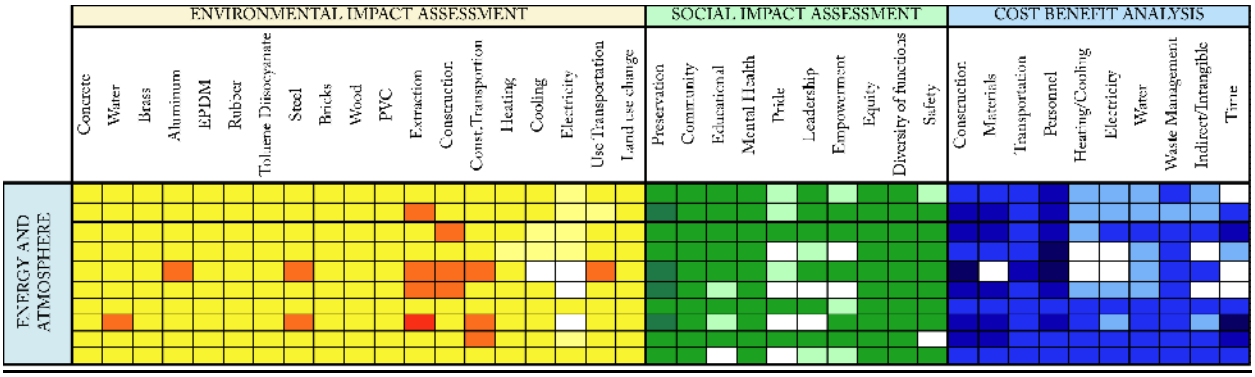


Figure 9. Results of qualitative analysis of the Energy and Atmosphere criteria.

SOCIAL IMPACT ASSESSMENT

The qualitative analysis indicated fairly strong social benefits across many of the Energy and Atmosphere credits (Figure 9). This reflects the reputational value of certain strategies (e.g., renewable energy production and advanced metering). The positive social influences also stem from the potential that improved energy efficiency (through sealing leakages and improving insulation) has to fix the indoor temperature-related problems that detract from the Wellesley experience. Finally, energy conservation is an area of sustainability that students and staff on campus particularly value. 82 percent of respondents to our survey noted that they felt it was important for people to become aware of their on-campus energy usage. 88 percent said that it is either “Important” or “Very Important” for Wellesley to have broader energy goals.

The one social indicator that some of these credits negatively influence is Preservation. Technology like solar panels and meters may or may not affect the aesthetic sensibilities of

[60] WBDG Sustainability Committee, Op. cit.

[61] Martin Holladay, “Energy Use is the Most Important Aspect of Green Building,” Green Building Advisor (2009), Web.

our buildings, though an argument can be made that architects are often skilled at taking seemingly disparate components and fitting them together (e.g. discreetly placing solar panels to minimize their visibility).

COST BENEFIT ANALYSIS

Within a relatively short time span, the Energy and Atmosphere credits feature a range of financial costs (which, to reiterate, will depend strongly on the particular project). Costs come largely from investments on time and personnel, which the above analysis indicates are worthy investments given their long-term rewards. At the same time, because certain measures will almost instantly cut inefficiencies, many of the criteria will incur savings even in the short term (i.e. fundamental commissioning will likely pay for itself after about just one year).

Synthesis

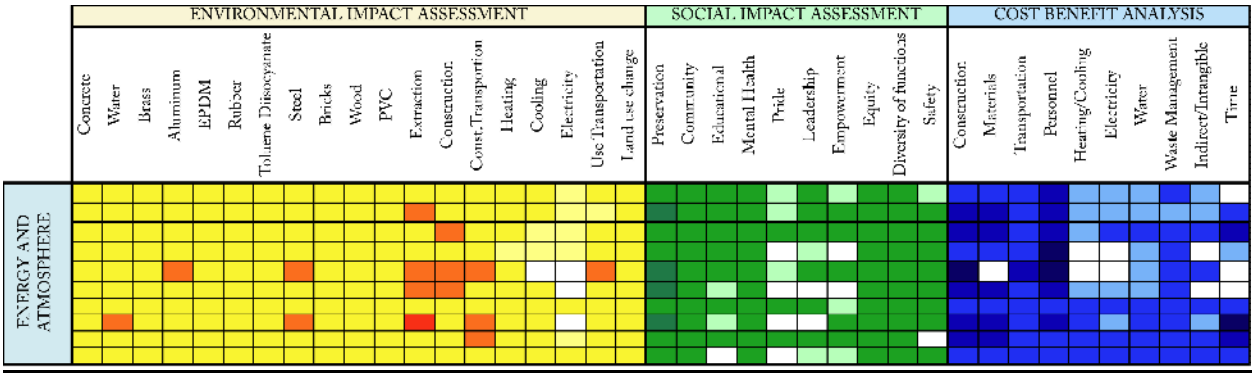


Figure 10. A graphical representation of the analyses results for the Energy and Atmosphere category.

Here are the LEED criteria for the Energy and Atmosphere category ordered by point value in LEED checklist:

Credit #:	Criteria:	Possible Points:
Prereq 1	Fundamental Commissioning and Verification	Required
Prereq 2	Building-level energy metering	Required
Prereq 3	Minimum Energy Performance	Required
Credit 2	Optimize Energy Performance	18

Credit 1	Enhanced Commissioning	6
Credit 5	Renewable Energy Production	3
Credit 4	Demand Response	2
Credit 7	Green Power and Carbon Offsets	2
Credit 3	Advanced Energy Metering	1
Credit 6	Enhanced Refrigeration Management	1

Here are the LEED criteria for the Energy and Atmosphere category ordered by phase:

Pre-Design	
Prereq 1	Fundamental Commissioning and Verification
Prereq 2	Building-Level Energy Metering
Prereq 3	Minimum Energy Performance
Credit 1	Enhanced Commissioning
Credit 2	Optimize Energy Performance
Credit 3	Advanced Energy Metering

Design	
Credit 1	Enhanced Commissioning
Credit 2	Optimize Energy Performance

Construction	
Credit 1	Enhanced Commissioning

Use	
Credit 6	Enhanced Refrigeration Management
Credit 1	Enhanced Commissioning
Credit 5	Renewable Energy Production

End of Life	
	NA

Based on an algorithm derived using the weighted scores from the three analyses, we calculated the Wellesley-specific points for each criterion. The following table shows the order in which we would rank criteria under Energy and Atmosphere:

Credit #:	Criteria:	Possible Points:	LEED+ Priority
Prereq 1	Fundamental Commissioning and Verification	Required	Required
Prereq 2	Building-Level energy Metering	Required	Required
Prereq 3	Minimum Energy Performance	Required	Required
Credit 1	Enhanced Commissioning	6	High
Credit 2	Optimize Energy Performance	18	Medium

Credit 3	Advanced Energy Metering	1	Medium
Credit 4	Demand Response	2	Low
Credit 5	Renewable Energy Production	3	Medium
Credit 6	Enhanced Refrigeration Management	1	Medium
Credit 7	Green Power and Carbon Offsets	2	Low

MATERIALS & RESOURCES

MATERIAL AND RESOURCES

"The composition of materials used in a building is a major factor in its lifecycle environmental impact. Whether new or renovated, federal facilities must lead the way in the use of greener materials and processes that do not pollute or unnecessarily contribute to the waste stream, do not adversely affect health, and do not deplete limited natural resources. As the growing global economy expands the demand for raw materials, it is no longer sensible to throw away much of what we consider construction waste." - Whole Building Design Guide Sustainable Committee[62]

The Material and Resources category is concerned with the different stages in the lifecycle of building materials from extraction to disposal and emphasizes sustainable practices such as reuse and recycling. Benefits of incorporating Material and Resources credits into Wellesley College's sustainable building guidelines include monetary savings, positive impacts on the environment, opportunities for educational research, learning and responsibility of building occupants, could increase pride and prestige of Wellesley as well as make her a leader amongst her peers. As shown in
Table 15, this LEED category contains two prerequisites and five credits for a total of 14 points.

[62] WBDG Sustainability Committee, Op. cit.

Table 15. The Material & Resources categories' criteria and their LEED points.

MATERIAL & RESOURCES		POSSIBLE: 14
Prereq	Storage and collection of recyclables	REQUIRED
Prereq	Construction and demolition waste management planning	REQUIRED
Credit	Building life-cycle impact reduction	6
Credit	Building product disclosure and optimization - environmental product declarations	2
Credit	Building product disclosure and optimization - sourcing of raw materials	2
Credit	Building product disclosure and optimization - material ingredients	2
Credit	Construction and demolition waste management	2

Figure 11 indicates that if Wellesley were to implement all five of the credits and both of the prerequisites, the Material and Resources category would result in positive social and environmental impacts as well as a slight net economic cost.

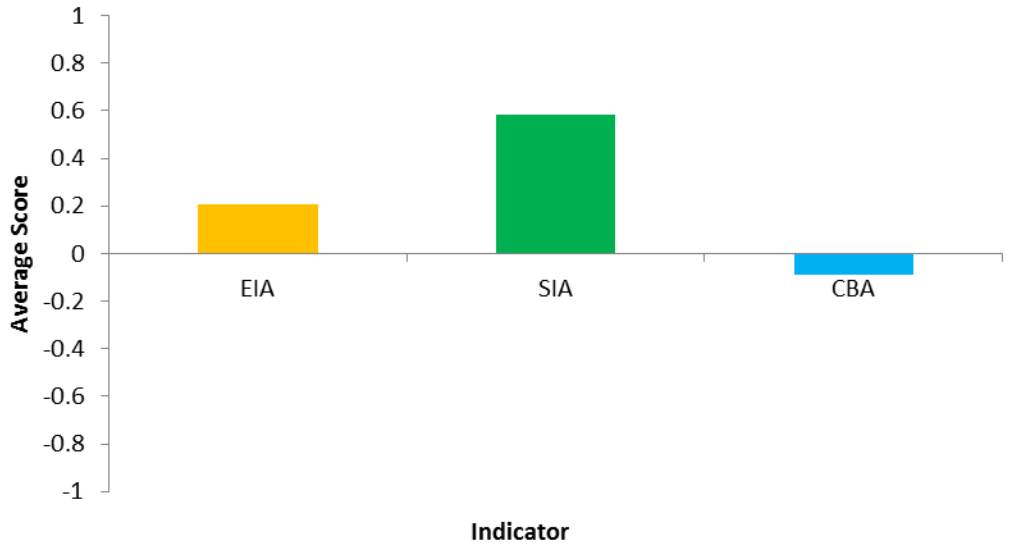


Figure 11. Average EIA, SIA, and CBA scores from all credits.

Prerequisites

The goal of the first prerequisite, Storage and Collection of Recyclables, is to reduce the amount of waste going to landfills from building occupants. In order for Wellesley to achieve this credit, the College must make dedicated areas for recyclables and waste accessible to waste haulers and building occupants. As a part of this credit, Wellesley must include recycling locations for mixed paper, corrugated cardboard, glass, plastics, and metals, as well as two of the following: batteries, mercury-containing lamps, and electronic waste. Current building waste management infrastructure would be able to achieve this credit. According to our Wellesley development survey, the College currently does a good job of making general trash, mixed paper (including corrugated cardboard), and comingled recyclables' (i.e., metal, glass, and plastic) receptacles accessible to building occupants. However, our survey respondents overwhelmingly indicated that Styrofoam, batteries, and electronics' recycling receptacles are not easily accessible (Figure 12). Wellesley does not need to do anything extra to achieve this credit in its buildings, but with the new insights provided by the survey, it could be advantageous to try and increase accessibility to all forms of recycling.

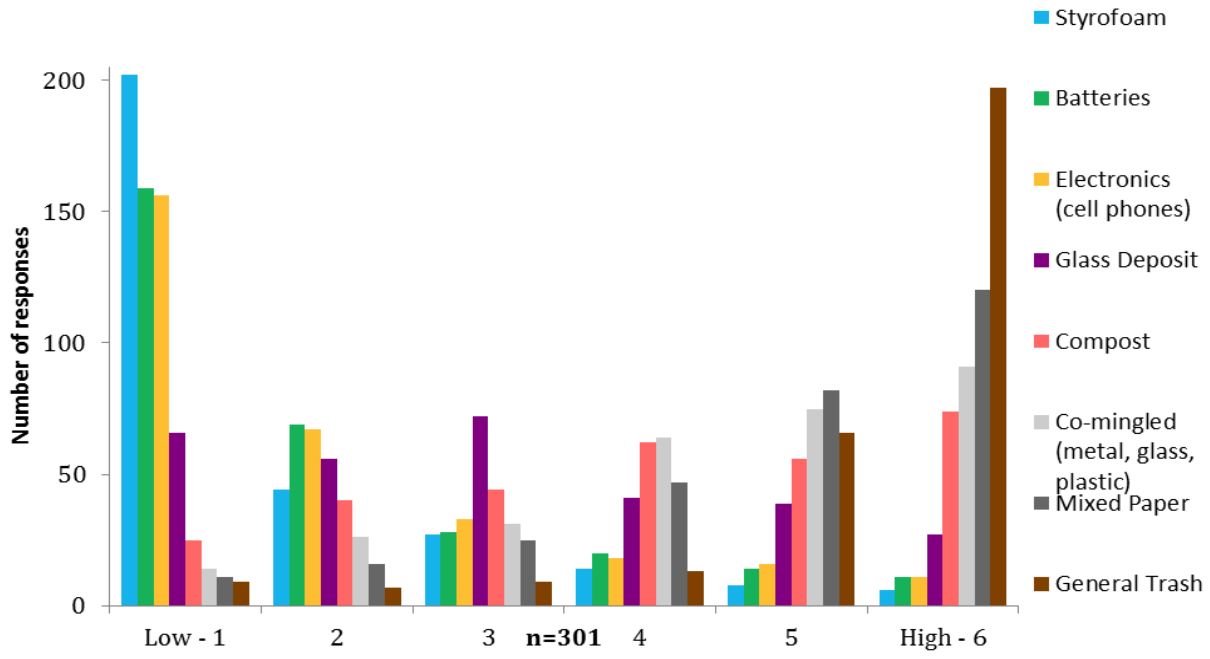


Figure 12. Graph representing accessibility to different waste-type collection areas within buildings.

The goal of the second prerequisite, Construction and Demolition Waste Management Planning, is to reduce the amount of waste from construction and demolition that gets sent to landfills. In order to achieve this credit Wellesley must create a construction and demolition waste management plan that establishes waste diversion goals for five materials. For the five materials to be diverted, a written plan must entail the approximate percentage of waste materials their diversion represents and how they will be separated (i.e., comingled or separated). Research into how the materials are being recycled at the plant or on-site must also be included. Finally, a written report of all major waste streams and their disposal and diversion rates must be included. The following materials are excluded from those that can qualify as materials to be diverted from disposal: alternative daily cover (ADC) and land-clearing debris.

Building Life-Cycle Impact Reduction (6 LEED points)

The intent of LEED's Building Life-Cycle Impact Reduction credit is to encourage reuse and the optimization of products and materials in order to demonstrate reduced environmental effects. There are four possible ways to achieve this credit, only two of which are applicable to Wellesley. Option 1, Historic Building Reuse, is not applicable to Wellesley as it only involves nationally registered historic sites and buildings. While Wellesley's campus has a rich history, we do not see the College certifying its buildings as historic sites because the certification process increases paperwork and does not allow for renovations to the buildings. The second option also does not apply to Wellesley as it involves the renovation of abandoned or blighted buildings, which do not exist on our campus.

Wellesley can implement the third and fourth options offered by this credit. Option 3, Building and Material Reuse, has the potential to earn Wellesley the largest number of LEED points in this credit, as well as making the largest positive economic impact. Option 4, Whole-Building Life-Cycle Assessment (LCA), is considered by our peers to be an essential part of

good building practice and has more positive social and environmental impacts than Option 3 (Figure 13).

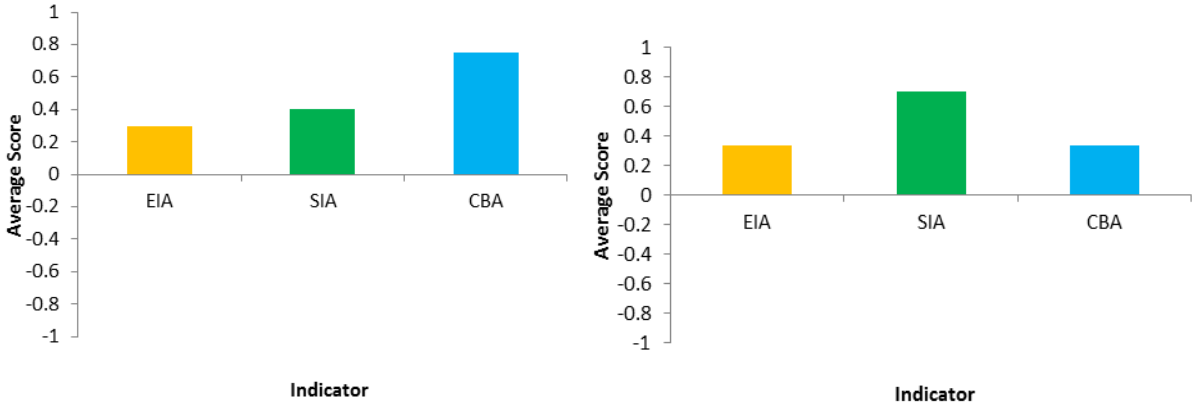


Figure 13. Comparison between the two possible LEED options for Wellesley to pursue from the Building Life-Cycle Impact Reduction credit.

The requirements for both options differ substantially. Option 3, Building and Material Reuse, requires Wellesley to reuse or salvage building materials from on-site or off-site. The number of LEED points achievable (ranging from 2 to 5) depends on the percentage of completed project surface built from reused materials (Figure 17). In order for Wellesley to complete Option 4, Whole-Building Life-Cycle Assessment, the College would have to conduct a life cycle assessment for the building, choosing at least three of the following impact categories for reduction: global warming potential (CO2e), depletion of the stratospheric ozone layer (kg CFC-11), acidification of land and water sources (moles H+ or kg SO2), eutrophication (kg nitrogen or kg phosphate), formation of tropospheric ozone (kg NO_x or kg ethane), and depletion of nonrenewable energy resources (MJ). The reduction impacts must be at least a 10 percent decrease from before construction. Also, none of the impacts can exceed the current outputs by more than 5 percent. Finally, this data must be made compliant with ISO 14044.

Table 16. Number of LEED points credited for reuse of building materials.

Percentage of completed project surface area reused	Points BD&C (Core and Shell)
25%	2
50%	3
75%	5

Building Product Disclosure and Optimization – Env. Product Declarations (2 LEED points)

The Building Product Disclosure and Optimization – Environmental Product Declarations credit was created to incentivize building projects to buy materials and products from manufacturers whose products are certified to have an improved life-cycle impact on the environment. This credit includes two possible options that are each worth 1 point for a total of 2 possible points. Option 1 requires that 20 different permanently installed products be purchased from at least five different manufacturers that meet one of the disclosure criteria. Option 2, Multi-attribute Optimization, can be achieved using products that comply with one criteria below the baseline for 50 percent, by cost, of the total value of permanently installed products in the project. These criteria are similar to those from the Whole Building Life-Cycle Assessment credit with the additions of third-party and USGBC certification. The products in Option 2 should also be sources from with 100 miles of the construction site.

Building Product Disclosure and Optimization- Sourcing of Raw Materials (2 LEED points)

The intent of the credit, Building Product Disclosure and Optimization - Sourcing of Raw Materials, is to encourage purchasing raw materials from extractors who are certified to be responsible to the environment through reporting the material's life cycle information and the safety of their workers. This credit is worth a total of 2 LEED points and has two options available to pursue, each worth 1 point. In order to achieve this credit Wellesley could pursue either or both options for credit. Option 1, Raw Material Source and Extraction Reporting, requires 20 different permanently installed products be purchased from at least five different

manufacturers that have publicly released a report from their raw material suppliers. In this report the supplier includes the raw material extraction locations, as well as commitments to long-term ecologically responsible land use, reducing environmental harms from extraction and/or manufacturing processes, and meeting applicable standards or programs voluntarily that address responsible sourcing. Option 2, requires that projects use products that meet at least one of the responsible extraction criteria for at least 25 percent, by cost, of the total value of permanently installed building products. This option also requires that products be sourced (i.e., extracted, manufactured, purchased) within a 100 miles radius.

Building Product Disclosure and Optimization - Material Ingredients (2 LEED points)

The Building Product Disclosure and Optimization – Material Ingredients credit is worth up to 2 LEED points and has 3 options associated with it, each worth 1 point. This credit focuses on increasing the usage of products and materials by projects teams that have life-cycle impacts reported for them, specifically in regard to the composition of the product. Option 1, Material and Ingredient Reporting, requires that a project use 20 permanently installed products from at least 5 manufacturers that are certified and report on the chemical inventory of their product to 1000 parts per million (ppm). Option 2, Material Ingredient Optimization, requires that products document their material paths, such as Cradle to Cradle certification, for at least 25 percent, by cost, of the total value of permanently installed products in the project. Option 3, Product Manufacturer Supply Chain Optimization, requires the use of building products for at least 25 percent, by cost, of the total value of permanently installed products in the project that meet certain specifications, including the validation that the product is safe to use. In addition to this, Options 2 and 3 are required to be sourced from within a 100 mile radius.

Construction and Demolition Waste Management (2 LEED points)

The intent of the fifth and final credit in Material and Resources, Construction and Demolition Waste Management, is to reduce the amount of construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials. This credit can be achieved through the implementation of 1 out of 2 possible options. Option 1, Diversion, can earn up to 2 LEED points. This option is interesting in that there are two possible sub-options the College must decide between before implementation and management. The first path is less stringent than the second and earns only 1 LEED credit. This path requires that at least 50 percent of wastes be diverted from ending up in landfills and that 3 material streams are entirely diverted. The second path of Option 1 is tougher to achieve and requires that 75 percent of wastes be diverted in general and that 4 specific material streams are entirely diverted from landfills. This second path is worth the full 2 LEED points. However, the Construction and Demolition Waste Management credit has a second option that can be implemented instead of Option 1, Reduction of Total Waste Material. In this option the building cannot generate more than 2.5 pounds of construction waste per square-foot. Option 2 is also worth the full 2 points of LEED credit.

ENVIRONMENTAL IMPACT ANALYSIS

According to our qualitative assessment, the Material and Resources category has, overall, a slightly positive environmental benefit. These benefits general come from the construction materials indicators such as steel, aluminum, and concrete. Many of the LEED credits in the Material and Resources category specifically focus on decreasing the harmful environmental impacts associated with raw or new material extraction. By decreasing these negative impacts, the environmental benefits were realized.

SOCIAL IMPACT ANALYSIS

The results of the social impact analysis were the most positive of the three analyses. The indicators that were often positively scored were: education, pride, leadership, and empowerment. This is consistent with the results from our Wellesley Development survey. Figure 14 shows that survey respondents believed that changes in building-material related items would increase the prestige of the college.

Due to the nature of the Wellesley community, education and Educational Objectives is one of the most important indicators. The positive evaluations of this indicator come from the fact that these credits facilitate opportunities for building occupants to learn about recycling and waste management.

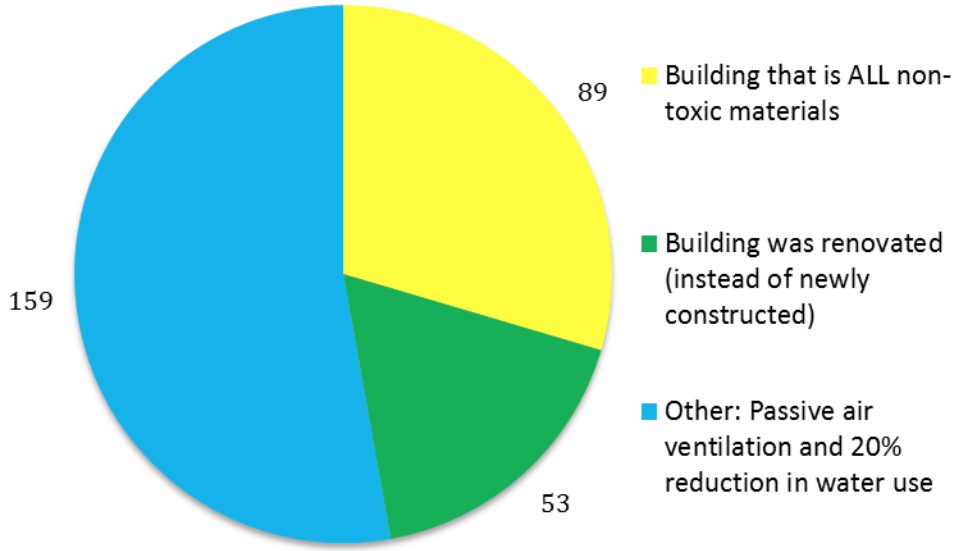


Figure 14. 47% of survey respondents indicated that making certain decisions about materials and resources would make Wellesley's buildings more prestigious.

ECONOMIC IMPACT ANALYSIS

Economic impact analysis is good for building and material reuse. Materials cost money, transporting the materials costs money, and paying for personnel costs money. It is within these indicators of materials, transportation, and personnel that the overall negative score of the economic analysis lies. However, many of the Material and Resources credits aim to eliminate the need to transport materials from far away and to incentivize on-site reuse. If these credits are complied with, then in the long run, the overall economic analysis may

become positive.

Synthesis

The results of these analyses are graphically depicted in Figure 15.

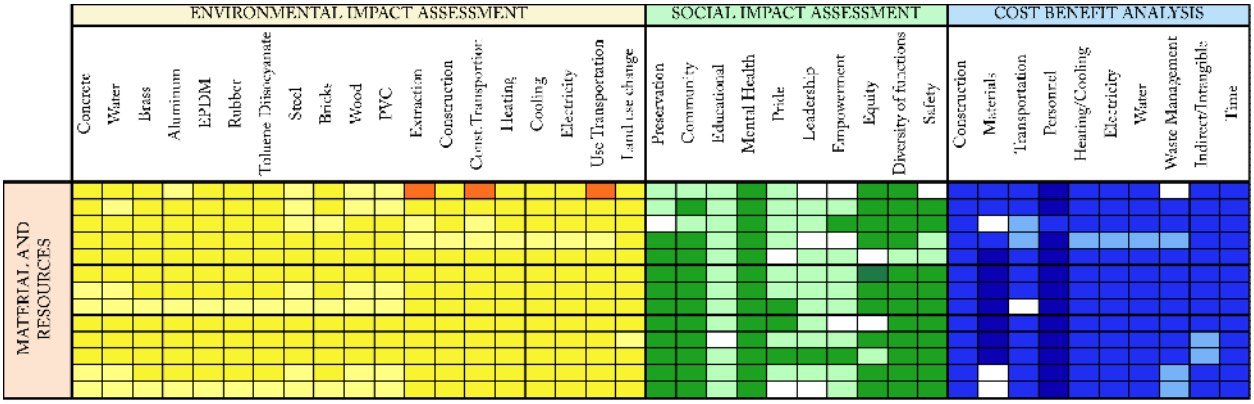


Figure 15. A graphical representation of the analysis results of the Material and Resources category.

Here are the LEED criteria for the Material and Resources category ordered by point value in LEED checklist:

Credit #:	Criteria:	Possible Points:
Prereq 1	Storage and Collection of Recyclables	Required
Prereq 2	Construction and Demolition Waste Management Planning	Required
Credit 1	Building Life-Cycle Impact Reduction	6
Credit 2	Building Product Disclosure & Optimization – Environmental Product Declarations	2
Credit 3	Building Product Disclosure & Optimization – Sourcing of Raw Materials	2
Credit 4	Building Product Disclosure & Optimization – Material Ingredients	2
Credit 5	Construction and Demolition Waste Management	2

Here are the LEED criteria for the Material and Resources category ordered by phase:

Pre-Design	
Prereq 1	Storage & Collection of Recyclables
Prereq 2	Construction & Demolition Waste Management
Credit 1	Building-Life-Cycle Impact Reduction

Design	
Prereq 1	Storage & Collection of Recyclables

Credit 1	Building-Life-Cycle Impact Reduction
Credit 3	Building Product Disclosure & Optimization-Sourcing of Raw Materials
Credit 4	Building Product Disclosure & Optimization-Material Ingredients

Construction	
Prereq 2	Construction & Demolition Waste Management
Credit 1	Building-Life-Cycle Impact Reduction
Credit 2	Building Product Disclosure & Optimization-Environmental Product Declarations
Credit 3	Building Product Disclosure & Optimization-Sourcing of Raw Materials
Credit 4	Building Product Disclosure & Optimization-Material Ingredients Product Declarations
Credit 5	Construction & Demolition Waste Management

Use	
Prereq 1	Storage & Collection of Recyclables

End of Life	
Credit 1	Building-Life-Cycle Impact Reduction
Credit 5	Construction & Demolition Waste Management

Based on an algorithm derived using the weighted scores from the three analyses, we calculated the Wellesley-specific points for each criterion. The following table shows the order in which we would rank criteria under Material and Resources:

Credit #:	Criteria:	Possible Points:	LEED+ Priority
Prereq 1	Storage & Collection of Recyclables	Required	Required
Prereq 2	Construction & Demolition Waste Management Planning	Required	Required
Credit 1	Building Life-Cycle Impact Reduction	6	High
Credit 2	Building Product Disclosure & Optimization – Environmental Product Declarations	2	Medium
Credit 3	Building Product Disclosure & Optimization – Sourcing of Raw Materials	2	Medium
Credit 4	Building Product Disclosure & Optimization – Material Ingredients	2	Medium
Credit 5	Construction & Demolition Waste Management	2	High

INDOOR ENVIRONMENTAL QUALITY

INDOOR ENVIRONMENTAL QUALITY

"Feeling good in our homes or offices isn't just a matter of having a beautiful space. No matter how fabulous your furnishings, a poorly designed indoor environment can literally make you sick. Building green means considering not only the environmental impact of materials and construction, but also the physical and psychological health of the occupants."—InHabitat[63]

Indoor Environmental Quality is concerned with the quality of a building's environment in relation to the health of its occupants. Benefits of emphasizing indoor environmental quality in sustainable building guidelines for Wellesley's buildings include, higher student and staff productivity, fewer sick days and cases of seasonal depression, higher test scores, lower absenteeism, and heightened academic enthusiasm among students.[64] This LEED category contains two prerequisites and nine credits:

Table 17. The Indoor Environmental Quality credits and their LEED points.

INDOOR ENVIRONMENTAL QUALITY		POSSIBLE: 10
Prereq	Minimum IAQ performance	REQUIRED
Prereq	Environmental tobacco smoke control	REQUIRED
Credit	Enhanced IAQ strategies	2
Credit	Low-emitting materials	3
Credit	Construction IAQ management plan	1
Credit	Daylight	3
Credit	Quality views	1

PREREQUISITES

[63] "Green Building 101: Indoor Environmental Quality," InHabitat (2006), Web.

[64] Ibid.

There are two prerequisites in this category: (1) establish a minimum indoor air quality (IAQ) performance that meets the requirements of Sections 4 through 7 of ASHRAE 62.1-2004, and (2) minimize exposure of building occupants, indoor surfaces, and ventilation air distribution systems to Environmental Tobacco Smoke (ETS). The second requirement can be achieved by either prohibiting smoking in the building and locating exterior smoking areas 25 feet away from building edifices, or by designating smoking areas in the buildings that are enclosed spaces. Minimizing exposure to tobacco smoke is already a priority in Wellesley's existing buildings and is therefore rendered irrelevant to our analysis. Minimum indoor air quality measures, however, are currently not being met; as evidenced by the illogical and often toxic ventilation systems in old buildings like Pendleton West.

Enhanced Indoor Air Quality Strategies (2 LEED points)

This credit serves to promote occupants' comfort, wellbeing, and productivity by improving indoor air quality. One point can be achieved by implementing either a mechanically or naturally ventilated system. The other point can be achieved by implementing monitoring strategies like carbon dioxide monitoring and room-by-room calculations. Although later qualitative analyses will show the benefits of incorporating passive strategies over mechanical ones, mechanical ventilation systems could easily be incorporated into the blueprints of Wellesley's building renovations as we have expansive basement and attic areas which can serve as mechanical rooms.

Low-Emitting Materials (3 LEED points)

This credit aims to reduce concentrations of chemical contaminants that can damage air quality, human health, productivity, and the environment. It requires that materials be sourced responsibly from product manufacturers that meet General Emission Evaluation thresholds, and that project teams follow a rigorous protocol during construction and close-out to prevent indoor and exterior emissions. Projects can earn up to three points in this

credit: 1 point if 50-70 percent of materials comply with standards, 2 points if 71-90 percent of materials comply with standards, and 3 points if more than 90 percent of materials comply with standards. Standards cover volatile organic compound emissions from elements such as flooring, insulation, paints and coatings, etc.

At Wellesley, many of our older buildings were constructed out of asbestos, lead paint, and other toxic materials.[65] As we consider ways to salvage and reuse components of our old buildings and to source matching products, considering their volatile organic compound (VOC) emission levels is crucial.

Construction Indoor Air Quality Management Plan (1 LEED point)

This credit considers the wellbeing of construction workers and building occupants by minimizing indoor air quality problems during construction and closeout. The plan must meet guidelines set forth by the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines, require protection from absorptive materials stored on-site from moisture damage, prohibit operating filtration media before occupancy, and prohibit the use of tobacco products inside and around the building during construction. Because Wellesley's building projects will more often be renovations than new construction, this requirement will be important to satisfy because occupants are in such close proximity to construction projects.

Indoor Air Quality Assessment (2 LEED points)

This credit seeks to establish better indoor air quality after construction and during occupancy. This is done either with an air flush-out before or during occupancy, or with air testing. The flush-out earns the project one point, while the air testing earns the project two points; so, air testing is preferable. Tests consider concentrations of formaldehyde,

[65] Willoughby, Op. cit.

particulates, ozone, total volatile organic compounds, carbon monoxide, and other target chemicals. Achieving this credit is important, as it prepares buildings for safe occupancy.

Thermal Comfort (1 LEED point)

This credit promotes occupants' productivity, comfort, and wellbeing by providing quality thermal comfort. Heating and cooling systems must meet requirements of ASHRAE Standard 55-2010, which include providing a permanent monitoring system to ensure that the building performs to the desired comfort level. This credit is relevant throughout the use phase of the building because it allows occupants to have some control over their space. The ability to open and close windows and to adjust the thermostat can, within limits, be the most efficient way of moderating the temperature of a space.

Interior Lighting (2 LEED points)

This credit serves to enhance occupants' productivity, comfort, and wellbeing by providing high-quality lighting. It is also one of the most program-specific credits, requiring flexibility in its guidelines to account for varying uses of spaces within a building. One point is earned by providing occupants with accessible lighting controls for at least 90 percent of spaces. The second point is earned by incorporating four options from a list of strategies relating to lighting certain ratios of space. Because many of Wellesley's buildings' shells limit the amount of daylight coming into spaces, having quality electrical lighting is crucial to maximizing productivity and comfort inside.

Daylight (3 LEED points)

This credit connects building occupants with the outdoors, to reinforce circadian rhythms and to reduce the use of electrical lighting. One point is achieved by providing manual or automatic glare-control devices for all regularly occupied spaces. The other two points can be

achieved by proving that a certain percentage of the space is lit with daylight. If over 75 percent of the floor area is lit, the project earns one point. If over 90 percent of the floor area is lit, the project earns two points. There are three different ways of proving this information: spatial daylight autonomy simulation, luminance simulation, or measurement. While daylight is an important category at Wellesley, it will often require adjustments to the shells of buildings because traditional gothic and neoclassical architecture has less strategic window placements.

Quality Views (1 LEED point)

This credit serves to give building occupants a connection to the outdoor environment. To achieve this point, 75 percent of floor areas must have a direct line of site to the outside. Views must include at least two of the following: (1) flora, fauna, sky; (2) movement; or (3) objects at least 25 feet from the exterior of the window. This is already achieved in almost all of Wellesley's buildings.

Acoustic Performance (1 LEED point)

This credit promotes acoustic design that is appropriate to program needs and occupants' wellbeing, productivity, and communication within buildings. Each programmed space has a different sound transmission class (STCC) requirement. For example, a private office will have an STCC of 45, whereas a mechanical equipment room will have a higher STCC of 60. There are also HVAC background noise limits and reverberation time requirements that are based on ASHRAE 2007 code. Many of Wellesley's newer buildings have failed in this regard, preventing a wider range of building functions from being realized.

ENVIRONMENTAL IMPACT ASSESSMENT

While environmental impact across the board was predominantly neutral, most of the negative impacts were associated with energy and material inputs during construction. This is because many of the construction techniques needed to achieve these credits required greater energy outputs. Heating, cooling, and electricity during the lifetime of the building incurred the most positive environmental impacts. Ultimately, when we weighted our indicator values, the indicators that correlate to the lifetime use phase of the building (e.g., heating, cooling, and transportation) were valued more because they have the potential to produce greater environmental benefits or damage with time.

SOCIAL IMPACT ASSESSMENT

The qualitative analyses revealed that there are more positive social impacts associated with Indoor Environmental Quality than environmental and economic benefits. This is because LEED credits apply more to human health than to promoting sound ecological processes (although these are not mutually exclusive). The survey conducted on campus further illuminated the social value in prioritizing this category. Survey respondents prioritized (1) daylighting and interior lighting, then (2) air ventilation and thermal comfort, and (3) quality views and acoustics. Interestingly, the most socially relevant criteria will not incur greater upfront material costs; rather, they relate more to the design of the building. Ensuring that architects are in touch with occupants' and program needs will be critical.

COST-BENEFIT ANALYSIS

The qualitative analysis shows that for criteria categorized under Indoor Environmental Quality, cost is a potentially inhibitive barrier to achieving these points. Monetary costs are incurred in the construction phase (for materials, energy, transportation, and time). However, an upfront investment in more efficient passive/mechanical ventilation and solar systems will yield longer-term monetary paybacks in energy savings. There are also indirect and intangible cost benefits to earning credits within the Indoor Environmental Quality category. A recent

New Zealand study linked improved air quality to improved general health, which translates into fewer sick days and less cost incurred from sick leave.[66] The study, conducted across 200,000 homes, found that improving indoor environmental quality to LEED-equivalent standards reduced hospital admissions for respiratory problems by 43 percent and sick days by 39 percent.[67]

[66] Christine Patterson, "Multiple Benefits of Energy Efficiency," EECA Energywise (2012), Web.

[67] Ibid.

Synthesis

The results of the qualitative analyses for this category are shown in Figure 16.

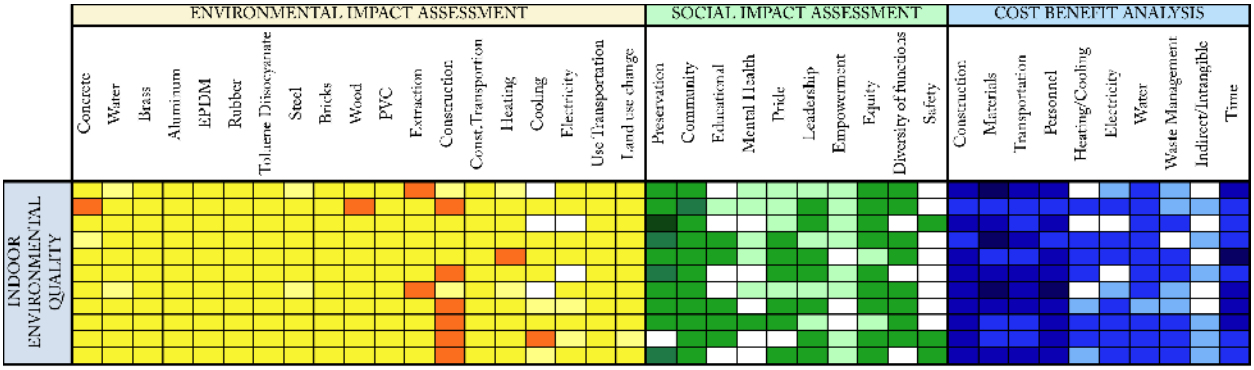


Figure 16. A graphical representation of the qualitative results of the Indoor Environmental Quality category.

Here are the LEED criteria for "Indoor Environmental Quality" ordered by point value in LEED checklist:

Credit #:	Criteria:	Possible Points:
Prereq 1	Minimum Indoor Air Quality Performance	Required
Prereq 2	Environmental Tobacco Smoke Control	Required
Credit 2	Low-Emitting Materials	3
Credit 7	Daylight	3
Credit 1	Enhanced Indoor Air Quality Strategies	2
Credit 4	Indoor Air Quality Assessment	2
Credit 6	Interior Lighting	2
Credit 3	Construction Indoor Air Quality Management Plan	1
Credit 5	Thermal Comfort	1
Credit 8	Quality Views	1
Credit 9	Acoustic Performance	1

Here are the LEED criteria for "Indoor Environmental Quality" ordered by phase:

Pre-Design	
Credit 8	Quality Views

Design	
Prereq 1	Minimum Indoor Air Quality Performance
Prereq 2	Environmental Tobacco Smoke Control

Credit 1	Enhanced Indoor Air Quality Strategies
Credit 5	Thermal Comfort
Credit 6	Interior Lighting
Credit 7	Daylight
Credit 9	Acoustic Performance

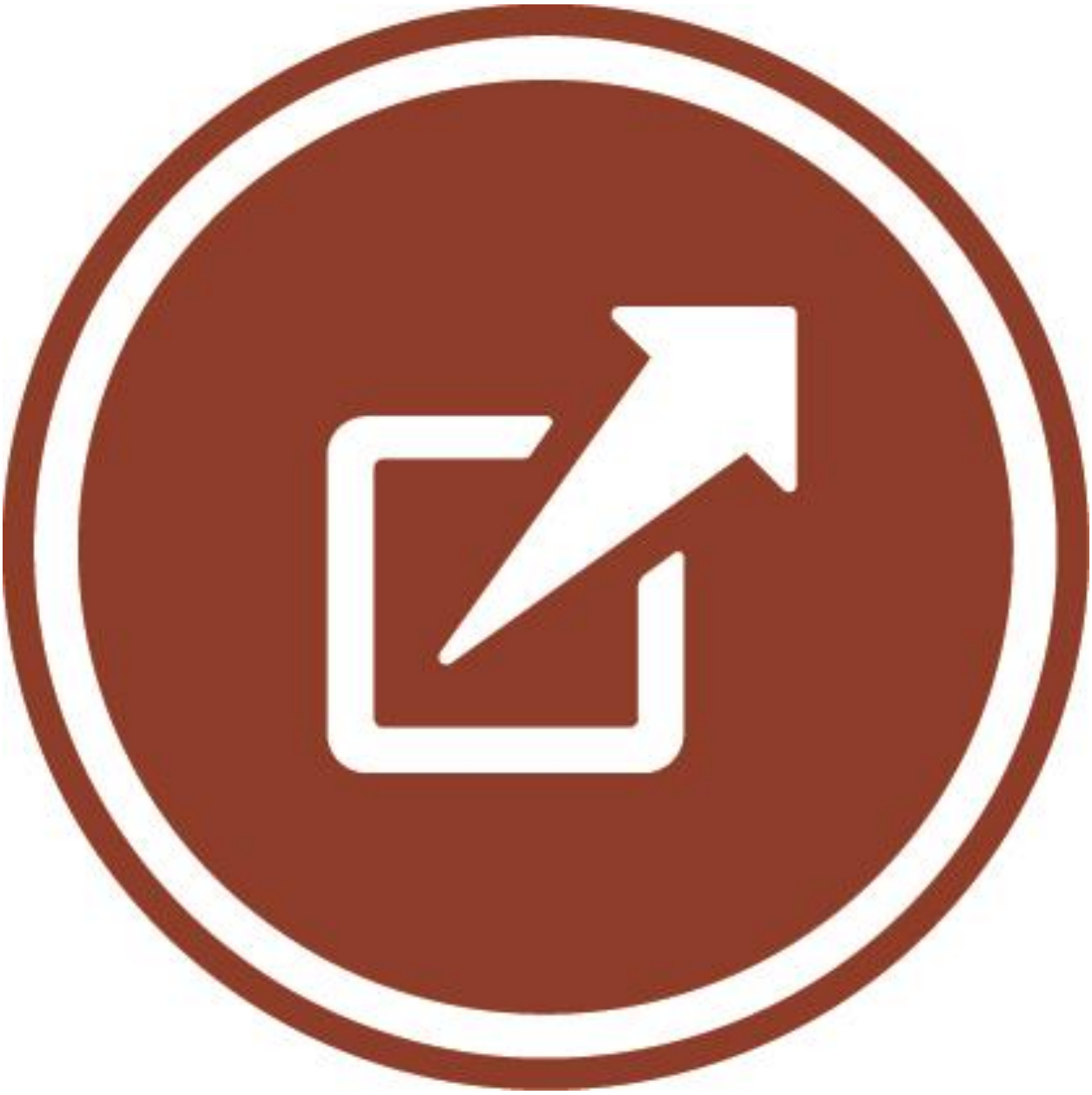
Construction	
Credit 2	Low-Emitting Materials
Credit 3	Construction Indoor Air Quality Management Plan

Use	
Credit 4	Indoor Air Quality Assessment
Credit 5	Thermal Comfort
Credit 6	Interior Lighting

End of Life	
	NA

Based on an algorithm derived using the weighted scores from the three analyses, we calculated the Wellesley-specific points for each criterion. The following table shows the order in which we would rank criteria under Indoor Environmental Quality:

Credit #:	**Criteria:**	**Possible Points:**	**LEED+ Priority**
Prereq 1	Minimum Indoor Air Quality Performance	Required	Required
Prereq 2	Environmental Tobacco Smoke Control	Required	Required
Credit 1	Enhanced Indoor Air Quality Strategies	2	High
Credit 2	Low-Emitting Materials	3	High
Credit 3	Construction Indoor Air Quality Management Plan	1	Medium
Credit 4	Indoor Air Quality Assessment	2	Medium
Credit 5	Thermal Comfort	1	Medium
Credit 6	Interior Lighting	2	High
Credit 7	Daylight	3	Medium
Credit 8	Quality Views	1	High
Credit 9	Acoustic Performance	1	Medium



INNOVATION IN DESIGN

INNOVATION IN DESIGN

"This credit is your project's opportunity to demonstrate leadership in the green building industry and to let your team contribute creative approaches to the field of sustainable design."

– LEEDUser[68]

Table 18. The Innovation category criteria and their LEED points.

INNOVATION		POSSIBLE: 6
Credit	Innovation	5
Credit	LEED Accredited Professional	1

According to the US Green Building Council, Innovation in Design credits for innovative performance are awarded for comprehensive strategies which demonstrate quantifiable environmental benefits not specifically addressed by current LEED Rating Systems. There are two ways to earn the credit. The first is through innovation in design, for example, by adopting green cleaning practices. The second is through exemplary performance. This means going well beyond the performance threshold of an existing LEED credit. "Going well beyond" means either doubling the credit or meeting the next percentage threshold. These credits allow the project to focus on sustainable aspects that the project managers *want* to incorporate, as opposed to implementing credits solely to gain points.

Since LEED does not provide set innovation credits, we chose eight different credits that pertained to each individual category in the LEED Checklist (e.g., water, energy, and air quality). Six of the credits chosen are previous innovation credits approved by LEED. The other two are taken from the Living Building Challenge.

[68] "NC-2009 IDC1: Innovation in Design," LEED User (2014), Web.

Through our three assessments we found that the net average across all three categories (environmental, social, and economic) was positive (see Figure 17). We decided that this positive result was realistic because of the nature of the innovation category. These are additional sustainable actions undertaken; therefore, we would expect them to have positive impacts across the board (see Figure 18).

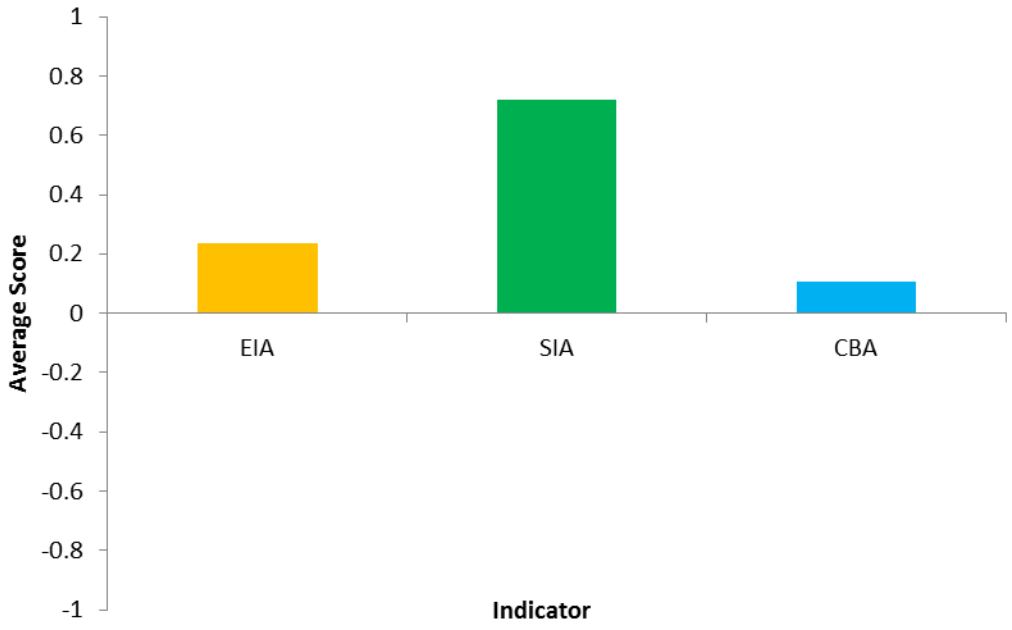


Figure 17. The Innovation in Design category net average scores across all three analyses**.**

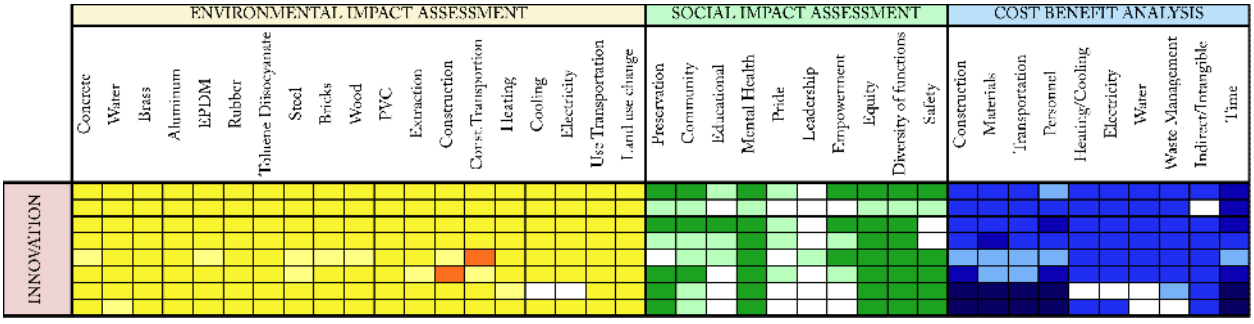


Figure 18. Innovation category breakdown of all credits across all three assessments.

LEED Accredited Professional (AP) (1 LEED point)

The intent of the LEED AP credit is to incorporate a LEED professional into a project from beginning to end. They are meant to oversee and to offer expertise on the LEED rating system and sustainable building practices.

In order to earn this credit, at least one principal participant on the project team must be a certified LEED AP. To become accredited the individual must pay for ($400 for LEED members, $550 for non-members) and take the LEED AP exam.[69]

Currently, Wellesley does not have a LEED AP. It would be in Wellesley's best interest to certify someone who will be a principal participant on all projects. Although most architectural firms have a LEEP AP, or hire one for a LEED project, Wellesley would benefit from having a LEED AP versed both in LEED and in the nuances, needs, and priorities of the College.

Overall, the credit had a net positive impact in the social assessment, no environmental impact, and a negative economic impact. No environmental impact was recorded because this credit merely impacts the number of personnel, which was not an indicator in our environmental impact assessment. It had an overall positive social impact because we found a potential benefit in educational objectives. The LEED AP has the potential to educate a class on LEED as well as to educate other project participants and stakeholders on sustainable practices. Another potential social impact we identified was the pride and prestige given to the College by having a LEED professional on staff. The last positive social impact stems from allowing Wellesley to become a leader in this field. The negative economic impact is due to the cost of the LEED AP exam that must be taken in order to be certified. Other negative economic impacts came from the increased amount of time the LEED AP will add to projects by consulting. Ultimately though, we believe that it would be beneficial for Wellesley to invest in certifying a LEED AP because it adds an easy point to the checklist and he or she can educate the other members of the project team on LEED and sustainable building practices.

[69] "Innovation in Design Credit Catalog," USGBC (2008), Web.

Green Building Education (1 LEED point)

The intent of the Green Building Education credit is to educate the public on green building strategies and solutions. It is also meant to enhance occupant competency by informing users on how to use the building sustainably and in the most efficient way possible.

In order to earn this credit two of three options must be implemented. Option 1: implement a comprehensive signage program built into the building's spaces to educate occupants and visitors on the benefits of green buildings. Option 2: develop a manual or guide to inform the design of future buildings based on the past and present successes. Option 3: create an educational outreach program or guided tour that focuses on sustainable living.[70]

We highly recommend this credit for Wellesley. It expands on the existing Tenant Design and Construction Guidelines credit in the Sustainable Sites category, by providing an everyday, interactive approach to teaching building users about sustainable features rather than just having occupants read a document. Either a signage program or a tour (or both) would be simple options for Wellesley to implement. Tours could be given by one of the environmental groups that already exists at Wellesley, by a specific environmental studies class, or by a new group designated specifically for this. In order to reach the majority of the College, we suggest implementing the tours during orientation, so that all students are aware and competent of sustainable features from the beginning of their Wellesley careers. If implementing signage, making it bold and eye-catching would be the way to do it at Wellesley. It is also important to make the signs easily recognizable so that when people see them they automatically know it is related to some sustainable design feature of a building.

Green Building Education had no environmental impact because, the only materials or energy used are paper and manpower and these are not accounted for in our indicators. If anything, the environmental impact should be positive, but this impact would be felt over

[70] Ibid.

the long term and therefore lay outside the scope of our analysis. In contrast, it had a positive net impact in both the social and economic assessments (Figure 19). The indicators that would have guaranteed social impact are: education because it is explicitly educational, pride and prestige because it would give the College prestige to have this educational system in place and it would be a source of pride for the College, leadership because it would be fixing a current LEED issue of occupant misuse of sustainable buildings, and empowerment and participation because students, faculty, and staff would be directly participating in the learning of the building uses and empowered in the actual use of the building. Economically it would have a net positive impact because the savings due to proper and efficient use of a building would significantly outweigh the loss of time due to implementation.

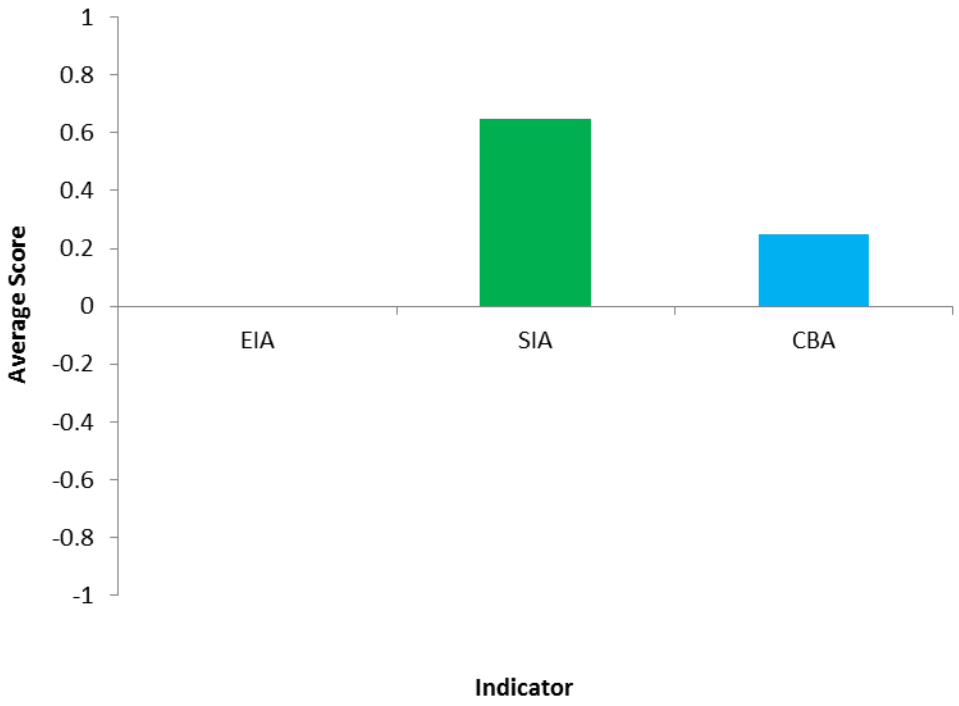


Figure 19. Green Building Education average scores for all three analyses.

Information pulled from the Wellesley development survey further indicates that this credit is needed because 75 percent of students, faculty, and staff said they wanted control over building features (see Figure 20), but 77 percent indicated that they had little to moderate

knowledge on how to operate building features sustainably (see Figure 21). This shows that people really need to be educated about building sustainability.

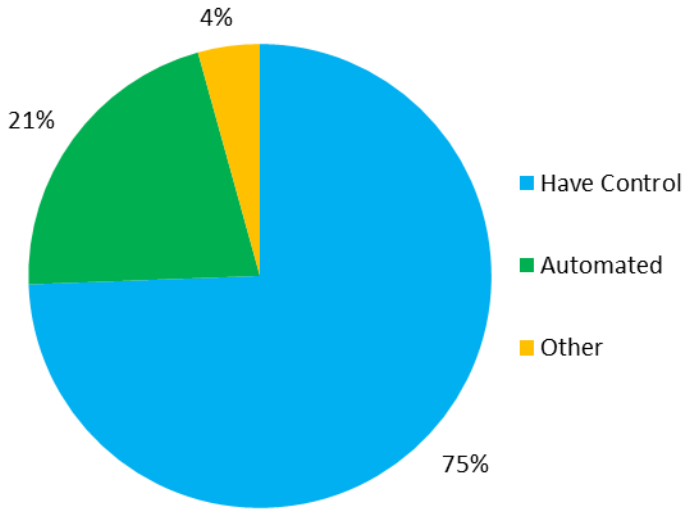


Figure 20. Percentage of survey respondents who indicated they either wanted automated building features, control over building features, or other.

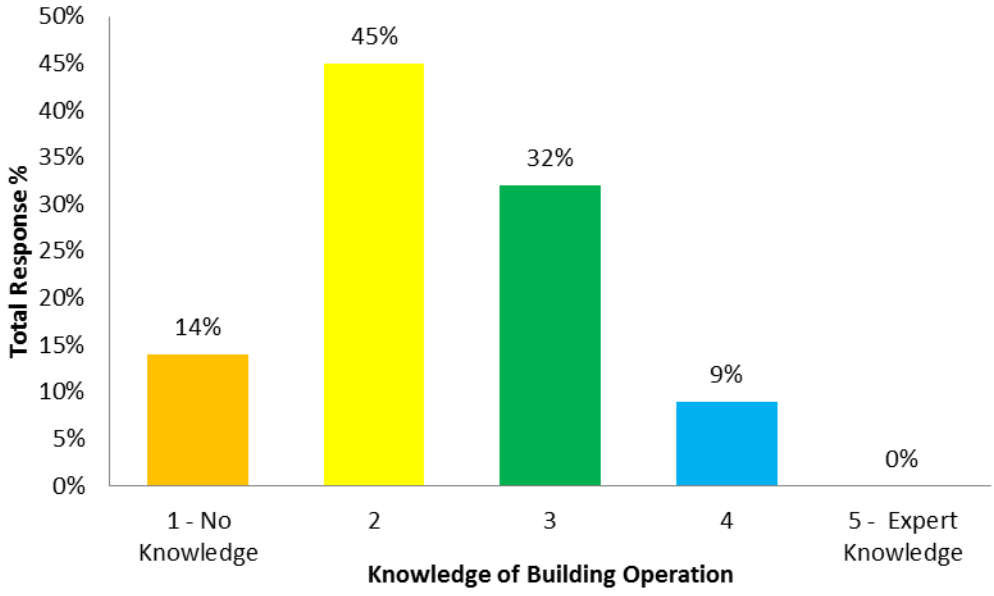


Figure 21. Percentage of survey respondents who indicated their level of knowledge of sustainable building feature operations.

Green Cleaning (1 LEED point)

The intent of this credit is to reduce the exposure of building occupants to contaminants that would negatively impact the indoor environment.

In order to achieve this credit three strategies must be implemented after the completion of building construction and prior to building occupancy: (1) construct an Indoor Air Quality (IAQ) Management Plan, (2) complete a two-week flush out and replace all filters with MERV 13 filtration media, and (3) hire an independent green cleaning service that uses cleaning products that meet the Green Seal GS-37 standard, uses floor cleaners complying with state code of regulations maximum VOC content, and uses disposable paper products, supplies, and trash bags meeting the minimum requirements of US EPA's Comprehensive Procurement Guidelines. In submittal for the credit, one must demonstrate that all of the products used in the project are non-hazardous, have a low environmental impact, and are environmentally preferable.[71]

Green Cleaning is a credit that can be implemented at Wellesley. It will take more time and money, but it has the potential to improve the overall health of the College. While its environmental costs and benefits balance out, it has net positive social impacts. These social impacts stem from the fact that the credit would give Wellesley pride and prestige as well as leadership because of the use of green products, and it would contribute to safety and physical health by eliminating toxic chemicals from indoor cleaning. Economically, it would incur costs because of the capital cost of purchasing the new filters, the hiring of green cleaning personnel, and increased time with the two-week flush out. However, these costs are compensated for by the social benefits.

[71] Ibid.

Organic Landscape Management (1 LEED point)

The intent of the Organic Landscape Management credit is to reduce the use of toxic chemicals, enhance soil health, and reduce human exposure to chemical spraying.

To earn this credit, Wellesley must eliminate the use of synthetic fertilizers and toxic chemical pesticides and herbicides, and must only use natural organic fertilizers, soil amendments, and treatments. Then the College must submit a program description and contractor specifications citing the use of organic products.[72]

This is very doable for Wellesley. It is a small cost with big benefits which is appropriate for a 1-point gain for LEED. This credit has no environmental impact, due to the fact that our chosen indicators limit the scope of environmental impacts. In reality, it would most likely have a positive environmental impact.

Socially, it has a net positive impact with possible impacts in historic preservation if the switch maintains the historic landscape; in an increased sense of community if students are involved with the process, for instance, incorporating student involvement with the compost from the dining halls; in educational benefits if the increase in soil health and reductions in toxins is used as a teaching tool; in pride and prestige because of green landscaping; and in empowerment and participation if students are involved. Guaranteed social benefits are leadership because of the implementation of additional sustainable practices and an increase in health because of the reduction of exposure to contaminants. The negative cost would be the switch to organic products assuming they are more expensive than non-organic products, but these costs could be outweighed by the positive health savings because of the elimination of toxins.

[72] Ibid.

Building Relocation Historic (1 LEED point)

The intent of the Building Relocation Historic credit is to extend the useful life and maintain the historic value of an existing building.

In order to earn this credit, a letter from the construction manager stating that the building relocation was not done because of code requirement must be submitted. The letter must provide narrative, photographs, and a map documenting the relocation.[73]

At Wellesley, this would be extremely important seeing as almost all of our buildings are historic. While it is not presently realistic because there is nowhere we would want to relocate a historic building to, it is something to consider in the future.

Environmentally, there would be a net positive impact for this credit because of the savings that would occur by recycling building materials. Examining Wellesley buildings, we assume that most contain some amount of concrete, EPDM, steel, brick, and wood, which would create a positive environmental impact because of the reuse. Another positive impact would result from construction activities because the building is not being constructed, it is being moved, adding a negative transportation environmental impact.

In the social impact analysis, we found that it would have the possibility of increasing the sense of community on campus because it could give people the sense of being a part of history, it could be educational if the history of Wellesley and the process of preservation is made clear and shared, and it could make the College a leader in preservation and materials recycling. There are two guaranteed social impacts, the first being direct historical and cultural preservation, and the second being pride and prestige for Wellesley because it is aligns with Wellesley goal of maintaining historic integrity while also looking to the future by

[73] Ibid.

recycling materials. The economic benefits come from the assumption that construction, transportation, materials, personnel and time are all reduced or less than what they would be had the building been built rather than recycled.

Efficient Use of Structural Material (1 LEED point)

The intent of the Efficient Use of Structural Material credit is to reduce environmental impacts associated with structural material manufacturing and transportation.

In order to earn this credit, Wellesley must implement a comprehensive design approach to develop a "diagrid" diagonal structural system. This will reduce the use of required raw materials while maintaining structural integrity.[74]

This credit will have an overall positive environmental impact. Because most diagrid systems are built of steel, there will be a positive environmental impact from the reduction in steel use, as well as a positive impact from the reduced extraction and manufacturing energy and transportation impacts. It may have negative construction activities impacts, but these are outweighed by the positive impacts.

Socially, this credit has definite educational possibilities because of the design. The innovative structure could also earn Wellesley pride and prestige, and will definitely make Wellesley a leader in design and efficient materials use, along with possibly leading to increased transparency of the process.

The economic analysis was negative in construction costs, personnel and time because this design may take more time, people, and construction depending on its complexity. However, it had savings in materials and transportation because of the reduction in materials.

[74] Ibid.

Net Zero Energy (1 LEED point)

The intent of the Net Zero Energy credit is to significantly reduce the amount of energy consumed in a given building.

To earn this credit 100 percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis. Renewable energy is defined as passive solar, photovoltaics, solar thermal, wind turbines, water-powered microturbines, direct geothermal or fuel cells powered by hydrogen generated from renewably powered electrolysis. In this case, nuclear energy and combustion of any kind is not an acceptable option.[75]

While this credit is not appropriate for Wellesley at the moment because of cost and difficulty of implementation, we consider it to be the future of sustainable building and so should be kept in Wellesley's goals for the future. Additionally, it would not be worth the one point earned by LEED, but instead would be a better step toward the Living Building Challenge.

For this credit there were positive environmental impacts in all of the use phase energy categories because this credit deals with direct energy reduction and elimination.

Socially it had a net positive impact. It would be able to educate people on renewable energy, it would bring pride and prestige and make Wellesley a leader in the field of sustainability because it would be something to brag about as the ultimate sustainable move in energy, and participation would be implicit because if you live in the building you are participating in using sustainable energy.

Economically it would have a net positive impact. All capital costs (construction, materials, transportation, and personnel) would all be negative because the systems are more

[75] "Living Building Challenge 2.1: A visionary path to a restorative future," International Living Future Institute (2012), Web.

expensive overall to implement. However, we believe the positive savings the building would experience through use costs such as heating and cooling and electricity would outweigh the negative initial costs in the long run.

Net Zero Water (1 LEED point)

The intent of the Net Zero Water credit is to reduce, and eliminate, the additional amount of water consumed in a given building.

To earn this credit 100 percent of occupant water use must come from captured precipitation or a closed loop water system that accounts for downstream ecosystem impacts and that is appropriately purified without the use of chemicals. The idea would be that the building would only purchase water from the city once, and the rest would either be captured or recycled.[76]

While this credit is not appropriate for Wellesley at the moment because of cost and difficulty of implementation, we consider it to be the future of sustainable building and so should be kept in Wellesley goals for the future. Additionally, it would not be worth the one point earned by LEED, but instead would be a better step toward the Living Building Challenge.

Net Zero Water would have no environmental impact because the categories chosen for the assessment do not capture the effects. The credit's social impacts would be identical to those for Net Zero Energy. Economically, the negative capital costs would be the same as Net Zero Energy as well, but the use cost savings would be in water and waste management as opposed to heating, cooling and electricity.

[76] Ibid.

Synthesis

The results of these analyses are graphically depicted in Figure 22

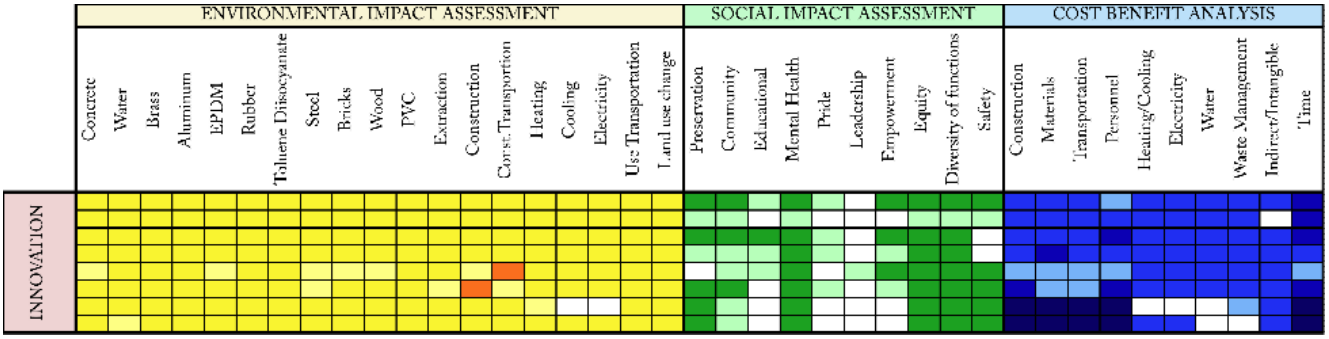


Figure 22. Graphical representation of the results of the Innovation in Design category.

Here are the LEED criteria for "Innovation in Design" ordered by point value in LEED checklist:

Credit #:	Criteria:	Possible Points:
Credit 1	LEED AP	1
Credit 2	Green Building Education	1
Credit 3	Green Cleaning	1
Credit 4	Organic Landscape Management	1
Credit 5	Building Relocation Historic	1
Credit 6	Efficient Use of Structural Material	1
Credit 7	Net Zero Energy	1
Credit 8	Net Zero Water	1

By Phase:

Pre-Design	
Credit 1	LEED AP

Design	
Credit 1	LEED AP

Construction	
Credit 5	Building Relocation Historic
Credit 6	Efficient Use of Structural Material

Use

Credit 2	Green Building Education
Credit 3	Green Cleaning
Credit 4	Organic Landscape Management
Credit 7	Net Zero Energy
Credit 8	Net Zero Water

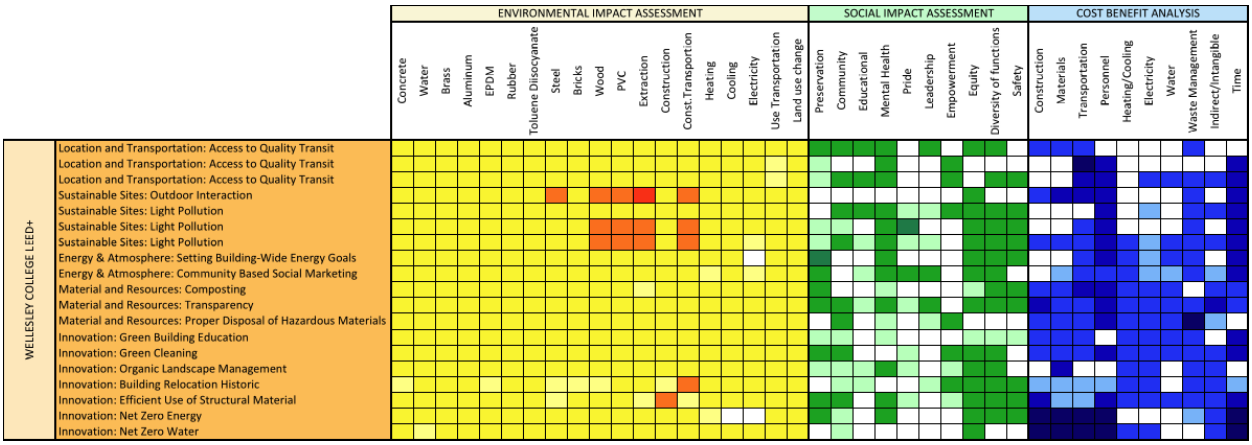
End of Life	
Credit 6	Efficient Use of Structural Material
Credit 7	Net Zero Energy
Credit 8	Net Zero Water

Based on an algorithm derived using the weighted scores from EIA, SIA, and CBA, we calculated the Wellesley-specific points for each criterion. The following table shows the order in which we would rank criteria under Innovation in Design:

Credit #:	Criteria:	Possible Points:	LEED+ Priority
Credit 1	LEED AP	1	High
Credit 2	Green Building Education	1	High
Credit 3	Green Cleaning	1	Medium
Credit 4	Organic Landscape Management	1	High
Credit 5	Building Relocation Historic	1	Medium
Credit 6	Efficient Use of Structural Material	1	Medium
Credit 7	Net Zero Energy	1	High
Credit 8	Net Zero Water	1	High

THE WELLESLEY LEED+ CHECKLIST

LEED+ Credits



Location & Transportation

Because a majority of the Location and Transportation credits either are not applicable to Wellesley or are applicable to every building at Wellesley, we added a few LEED+ criteria to tailor the experience to Wellesley and to push the College in terms of its sustainability.

Access to Quality Transit

<u>Public transportation for students</u>

This LEED+ credit builds on the existing Access to Quality Transit credit by tailoring it to Wellesley. Wellesley already has some public transportation for students, enough to qualify for the LEED points. However, it is not enough. We know from past experience and from commentary among students around campus that while the existing shuttles are good, they could be much improved. One of the main reasons why students bring cars onto campus is because it is too inconvenient to take the bus. The scheduled times and longer and usual transport times force students to look towards individual vehicles if they want to get around. As such, we propose that Wellesley expand the current bus and shuttle system.

Public transportation for commuters

This LEED+ credit continues to build on the Access to Quality Transit credit, this time incentivizing commuter faculty and students to take public transportation to campus everyday rather than individual vehicles. The College already provides small subsides for commuter rail passes, but increased subsidies of more various types of transportation would encourage commuters to take advantage and to reduce the overall vehicle footprint of the college.

As the two "Access to Quality Transit" LEED+ credits are very similar, they will be discussed as a group.

The most obvious impact from these two credit is a reduction in Transportation Energy in the Use Phase provided that the program is set up correctly. Increased access to public transportation will help keep cars off the road and will reduce Wellesley's vehicle footprint.

Because the transportation would be available to everyone, there would also be significant social benefits to these credits. In addition, for a small, suburban college like Wellesley, easy access to nearby areas is a potential draw for prospective students and so there could be some positive impact on the College's prestige.

The only drawback is that increasing public transportation availability and subsizing outside transportation is expensive. Nevertheless, the social and environmental benefits are likely worth this cost.

Green Vehicles in College Vehicle Fleet

This LEED+ credit tries to increase the priority of green vehicles for the College. Currently, alternative transportation does not seem to be a priority. Only one green vehicle is currently within Wellesley's vehicle fleet, the electric car owned by the Office of Sustainability. As such,

we propose that Wellesley introduce green vehicles into its vehicle fleet. This will make them an increasing part of everyday life. The aim is to gradually build up the importance of green vehicles, increasing their presence and priority on campus. We anticipate that this will greatly impact Wellesley's energy footprint.

Based on the indicators used in our Environmental Impact Analysis, there is a positive overall impact due to the fact that energy of Transportation in the use phase should be quite significantly reduced.

There would also be a positive social impact due to the fact that bringing more green vehicles onto campus would increase Wellesley's pride, prestige, and leadership.

Finally, there would be a relatively high cost to starting this because the vehicles themselves would need to be purchased and it takes time and money to put enough infrastructure together for this sort of change.

Sustainable Sites

The Sustainable Sites category covers a broad range of siting issues. However, in an attempt to focus the issues on the Wellesley campus and align with stakeholder needs and goals, we propose three LEED+ criteria.

Light Pollution Reduction

<u>Elimination of Nighttime Lighting near the Observatory</u>

This LEED+ credit only positively impacts a small segment of the Wellesley community, but to the Astronomy Department and all those interested in astronomy, preserving the integrity of the observatory is very important. Current buildings on campus attempt to accommodate the observatory, but we suggest that they plan to right from the start.

The intent of this credit is to completely eliminate nighttime lighting in the vicinity of the observatory. The Science Center has already taken some measures to ensure the darkness of the space behind it, but this proposed credit will help design for this in advance. The credit requires that buildings with windows facing the observatory have some sort of solid blind or shade which would block all exiting light. It also stipulates that no outside lighting allowed in a direction facing the observatory.

Unfortunately, this credit received overall negative impact analyses. This is likely because the benefits are social and they impact only a very small portion of the Wellesley community. Although this low score gives this credit little to no priority according to our prioritization methodology, we still believe it to be of importance to the community.

Light Pollution Reduction – Impact on Wildlife

This LEED+ credit is meant to serve as a reminder that human activities can negatively impact those living in our surrounding environments. Some nocturnal animals (e.g. salamanders), are quite sensitive to light and so nighttime lighting can greatly disturb them. While completely eliminating nighttime light is infeasible, simply becoming aware of the issue and learning about these animals is a starting point.

This credit requires that project managers inform themselves of the nighttime habits of wildlife in the project environment. If there are creatures which are sensitive to artificial light or which have negative reactions to artificial lighting, care must be taken to minimize these impacts.

This credit had overall negative environmental impacts because of the potential for materials used to shade light. However, this is likely just because of the indicators used for the analysis.

Had considerations for surrounding wildlife or something similar been one of the indicators, then this credit would have had a much more positive result.

Overall, this credit has a positive social impact. This is due to the educational aspect of the credit – it forces the project team to learn about the surrounding environment – as well as the leadership potential that this could bring. It may not seem like a significant detail, but protecting sensitive wildlife could put Wellesley in a positive light and increase its sustainability leadership.

The economic impact analysis actually balanced out such that there was no economic impact. Although there might be some costs associated with the planning and implementation of this credit, they are balanced by the small potential for electricity savings from the reduced lighting.

Outdoor Interaction

Outdoor Interaction is a concept that LEED hints at several times in Open Space and Bicycle Facilities. In these credits, LEED aims to encourage people to move outside, get exercise, and interact with other people. Combining this with Wellesley's sense of community, we propose a whole credit just for Outdoor Interaction. Wellesley currently has a significant amount of green space; it's just not used for anything besides aesthetics. However, 95.6% of respondents to the Wellesley development survey stated that they would like to increase he usability of Wellesley's green space.

This credit aims to encourage people to use the space that Wellesley has made available. It is a perfect complement to the Open Space credit, even though the logistics of Wellesley's building projects make that credit infeasible. The credit requires that benches, tables, and other outdoor furniture be provided for campus users in these green spaces. The idea is to maximize utilization of the area, which is already provided.

The environmental and economic impact of this credit is negative because of the materials needed for the furniture. However, the social benefits are significant. This credit can help facilitate interaction with the environment and lead to outdoor education. It allows people to be outside, to enjoy the fresh air, and to improve their mental health. It also could be a source of pride for the College. Wellesley is so known for its beautiful landscape, being known for using it well would only add to the College's prestige. For these and several other reasons, the social benefits far outweigh the environmental and economic costs associated with this credit.

Energy & Atmosphere

Community- Based Social Marketing

A reoccurring criticism towards LEED is that it often presents a building as "green" while taking little to no account of the occupancy of the building. Though the architect(s) involved with major renovation projects should shoulder a significant proportion of the responsibility for designing accessible controls, there are also low-cost but potentially effective strategies for improving occupancy behavior that can be implemented post-construction. Community-Based Social Marketing (CBSM) is a behavioral change approach that has been utilized in a variety of contexts but has been increasingly used for sustainability- related initiatives in recent years.[77]

Basically, a CBSM project involves identifying barriers to desired behaviors through regular, direct surveys and questionnaires or focus groups and then implementing initiatives that target the specific behaviors or obstacles of concern as closely as possible. In order to be successful, it requires a group of dedicated individuals who recognize the importance of the behavioral dimension of sustainability. Many of the individuals included in the projects

[77] Doug McKenzie, "Fostering Sustainable Behavior," Community-Based Social Marketing (2010), Web.

should be students given that the majority of occupants in most of the buildings on campus are students.

CBSM projects require minimal financial expenditure, spark community participation, and can provide valuable insights to shaping occupancy behavior (and reducing energy consumption) if conducted carefully. Though they do require regular participation (time), they help to create a norm of energy conservation.

Setting building-wide energy goals

Currently, Wellesley has no broader energy goals for either its buildings or its campus as a whole. By not committing to energy performance benchmarks, there's less incentive to keep track of energy expenditure to metering -another example of the interconnectedness of different energy-related criteria. It also detracts from seeing energy consumption as a long-term goal. Thus, an additional "credit" for the College to consider is to establish building-wide energy goals for every major renovation. An example of a broader goal is: "Any major renovation must reduce its estimated emissions by at least 10 percent."

Universities commonly select increments of 10 as their reduction goal (i.e. 10, 20 30 percent, etc.). Wellesley should choose a reduction goal that is not too ambitious but is high enough to encourage substantial improvement with each renovation (e.g., 30-40 percent).

Goal-setting, though seemingly an intangible strategy, can help keep energy efficiency included in important discussions related to renovations, particularly if the goals are publicly subscribed and announced. Further, the reputational benefit of theoretically meeting the goal exceeds the detriment of theoretically not meeting the goal.

Material & Resources

COMPOSTING

The Wellesley development survey indicated that the College could greatly increase the accessibility of composting receptacles. In order to resolve this issue, this Composting credit aims to encourage the College to install more receptacles for building occupants to compost their wastes, especially outside of the dining halls. This credit requires that at least one composting receptacle be accessible within each of Wellesley's buildings. For example, the Leaky Beaker, in the Science Center, currently lacks a composting receptacle and the installation of a composting bin in this area would fulfill the requirements of this credit within the Science Center.

While composting has environmental benefits, the indicators chosen for our environmental impact analysis do not cover any of these benefits. As such, according to our analysis, there are no environmental benefits or costs to composting. In reality, this is not the case.

Composting has an overall positive social impact. Large scale composting is a rising theme in sustainability, and if Wellesley were to comply, then she would be given prestige and leadership among her peers. In addition, composting can be used in gardens, which are both educational and bring people together as a community.

Based on our economic impact indicators, there would be an overall negative impact due to the fact that composting in industrial facilities costs money.

TRANSPARENCY

The goals of this LEED+ credit are to make the process of constructing a building understandable and accessible to building occupants. Option 1 requires that documentation about the building, such as the building's materials and manufacturers, are made widely available to the general public. Option 2 has the College keeping possession of building

records, but requires that they provide them to any interested parties. Option 3 is a two-pronged approach. First, art must be placed throughout the building reflecting sustainability-based themes. Second, during construction, parts of the building must be left transparent, see-through, in order to expose the inner structure of the building.

There are no environmental or economic impacts of this category. There are, however, social values concerning prestige, leadership, and participation.

PROPER DISPOSAL OF HAZOURDOUS MATERIALS

The intent of this credit is to ensure appropriate disposal of harmful and hazardous materials at the end of a building's life. This credit requires that proper and planned procedures be implemented to minimize exposure to these materials.

As this credit attempts to reduce pollution impacts, there are environmental benefits; however, these benefits are not captured in the indicators and so our analysis finds there to be only a slightly negative environmental impact due to transportation.

The social impact of this credit is positive because of prestige and reductions in threats to physical health.

Economics-wise, this credit is really expensive, but the monetary expenses are outweighed by the social and actual environmental benefits.

Methods

The above analyses provide insights and considerations about the environmental, economic, and social impacts of achieving different criteria from the multiple LEED categories. However,

as the findings illustrate, not all LEED points are created equal. That is, some criteria bear much greater importance for Wellesley's reputation, environmental footprint, and community than the points assigned might reflect, though it has been argued that LEED is fortunately approaching a more holistic and integrative form of evaluation with every new iteration.[78]

Thus, we sought to distill the complex knowledge about each of these categories into a pair of accessible and pragmatic documents that can be used to meaningfully assist with planning for the Campus Renewal Plan and beyond. Namely, we created a LEED+ guideline that encompasses both the most (environmentally, socially, economically) impactful and potentially achievable criteria.

In attempt to make the knowledge as accessible to as many different stakeholders as possible, two versions of the guidelines were created. The first version simply takes the LEED checklist and adds in our prioritizations based on the three analyses. This is the version that we want to be able to hand to architects along with a short explanation of how we determined prioritization: These points are calculated based on an algorithm derived using the weighted environmental, social, and economic impact analysis scores. These points were then translated into "High" (meaning the criteria accumulated 4-6 Wellesley-specific points), "Medium" (2-3 points), and "Low" (0-1 points) priority. A LEED+ Priority score of "0" could either indicate that the criteria are not applicable to Wellesley (cannot realistically be achieved to any degree) or that it has already been achieved (and will not require future maintenance).

The second version is our full LEED+ checklist. Credits are organized by phase of a building project and include our prioritizations. The LEED+ credits are added as well. This checklist will also be given to architects and those who are interested and will be accompanied by a brief introduction and description. However, this will be presented on a second page such that if

[78] Brendan Owens, "LEED v4 Changes Are Focused On Performance," Facilities Net (2013), Web.

architects just want to use the LEED checklist that they are more familiar with, they can. If they want to go further and use our LEED+ checklist, then it is available for them. Multiple educational institutions have used this type of tailored checklist, including a least a few of our peer institutions. For example, Pomona College's students engineered a similar document, which is now brought to all major planning sessions as a way to prioritize and sequence environmental initiatives early in the planning phase.[79] These documents are meant to be used in a similar manner at Wellesley.

LEED Checklist for Architects

LEED v4 for BD+C: Core and Shell for Wellesley College
Project Checklist

Project Name
Date

Y	?	N				
			Credit 1	Integrative Process	1	
			Location and Transportation	Possible Points:	20	Priority for Wellesley
			Credit 1	LEED for Neighborhood Development Location	20	Not Applicable
			Credit 2	Sensitive Land Protection	2	Low
			Credit 3	High Priority Site	3	Not Applicable
			Credit 4	Surrounding Density and Diverse Uses	6	Always Applicable
			Credit 5	Access to Quality Transit	6	Always Applicable
			Credit 6	Bicycle Facilities	1	Always Applicable
			Credit 7	Reduced Parking Footprint	1	Medium
			Credit 8	Green Vehicles	1	Medium

[79] "Green Building Standards," Pomona College (2013), Web.

			Sustainable Sites		Possible Points:	11	Priority for Wellesley
Y			Prereq 1	Construction Activity Pollution Prevention		Required	Required
			Credit 1	Site Assessment		1	Medium
			Credit 2	Site Development--Protect or Restore Habitat		2	Not Applicable
			Credit 3	Open Space		1	Not Applicable
			Credit 4	Rainwater Management		3	Low
			Credit 5	Heat Island Reduction		2	Low
			Credit 6	Light Pollution Reduction		1	Low
			Credit 7	Tenant Design and Construction Guidelines		1	Medium

			Water Efficiency		Possible Points:	11	Priority for Wellesley
Y			Prereq 1	Outdoor Water Use Reduction		Required	Required
Y			Prereq 2	Indoor Water Use Reduction		Required	Required
Y			Prereq 3	Building-Level Water Metering		Required	Required
			Credit 1	Outdoor Water Use Reduction		2	Medium
			Credit 2	Indoor Water Use Reduction		6	Low
			Credit 3	Cooling Tower Water Use		2	High
			Credit 4	Water Metering		1	Medium

			Energy and Atmosphere		Possible Points:	33	Priority for Wellesley
Y			Prereq 1	Fundamental Commissioning and Verification		Required	Required
Y			Prereq 2	Minimum Energy Performance		Required	Required
Y			Prereq 3	Building-Level Energy Metering		Required	Required
Y			Prereq 4	Fundamental Refrigerant Management		Required	Required
			Credit 1	Enhanced Commissioning		6	High
			Credit 2	Optimize Energy Performance		18	Medium
			Credit 3	Advanced Energy Metering		1	Medium
			Credit 4	Demand Response		2	Not Applicable
			Credit 5	Renewable Energy Production		3	Medium
			Credit 6	Enhanced Refrigerant Management		1	Medium
			Credit 7	Green Power and Carbon Offsets		2	Not Applicable

			Materials and Resources		Possible Points:	14	Priority for Wellesley
Y			Prereq 1	Storage and Collection of Recyclables		Required	Required

Y			Prereq 2	Construction and Demolition Waste Management Planning	Required	Required
			Credit 1	Building Life-Cycle Impact Reduction	6	High
			Credit 2	Building Product Disclosure and Optimization - Environmental Product Declarations	2	Medium
			Credit 3	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2	Medium
			Credit 4	Building Product Disclosure and Optimization - Material Ingredients	2	Medium
			Credit 5	Construction and Demolition Waste Management	2	High

			Indoor Environmental Quality	Possible Points:	10	Priority for Wellesley
Y			Prereq 1	Minimum Indoor Air Quality Performance	Required	Required
Y			Prereq 2	Environmental Tobacco Smoke Control	Required	Required
			Credit 1	Enhanced Indoor Air Quality Strategies	2	High
			Credit 2	Low-Emitting Materials	3	High
			Credit 3	Construction Indoor Air Quality Management Plan	1	Medium
			Credit 5	Daylight	3	Medium
			Credit 6	Quality Views	1	Always Applicable

			Innovation	Possible Points:	6	Priority for Wellesley
			Credit 1	Innovation	5	High
			Credit 2	LEED Accredited Professional	1	High

			Regional Priority	Possible Points:	4
			Credit 1	Regional Priority: Specific Credit	1
			Credit 2	Regional Priority: Specific Credit	1
			Credit 3	Regional Priority: Specific Credit	1
			Credit 4	Regional Priority: Specific Credit	1

			Total	Possible Points:	110

Certified 40 to 49 points
Silver 50 to 59 points
Gold 60 to 79 points

Platinum **80 to 110**

			Wellesley LEED+	Possible Points:	Priority for Wellesley
			Credit 1	Location and Transportation: Public Transportation for Wellesley Students	Medium
			Credit 2	Location and Transportation: Public Transportation for Commuters	Medium
			Credit 3	Location and Transportation: Green Vehicles at Wellesley	Low
			Credit 4	Sustainable Sites: Outdoor Interaction	Medium
			Credit 5	Sustainable Sites: Light Pollution - Impact on Wildlife	Medium
			Credit 6	Sustainable Sites: Light Pollution - Lighting near the Observatory	Low
			Credit 7	Energy & Atmosphere: Setting Building-Wide Energy Goals	High
			Credit 8	Energy & Atmosphere: Community Based Social Marketing	Medium
			Credit 9	Material and Resources: Composting	Medium
			Credit 10	Material and Resources: Transparency	Medium
			Credit 11	Material and Resources: Proper Disposal of Hazardous Materials	Medium
			Credit 12	Innovation: Green Building Education	High
			Credit 13	Innovation: Organic Landscape Management	High
			Credit 14	Innovation: Net Zero Energy	High
			Credit 15	Innovation: Net Zero Water	High
			Credit 16	Innovation: Green Cleaning	Medium
			Credit 17	Innovation: Building Relocation Historic	Medium
			Credit 18	Innovation: Efficient Use of Structural Material	Medium

LEED+ Checklist

Pre-Design		LEED+ Priority
Sustainable Sites	Construction Activity Pollution Prevention	Required
Sustainable Sites	Site Assessment	Medium
Sustainable Sites	Site Development – Protect or Restore Habitat	Not Applicable
Innovation	LEED AP	High
Indoor Environmental Quality	Quality Views	High
Energy and Atmosphere	Fundamental Commissioning and Verification	Required
Energy and Atmosphere	Building-Level Energy Metering	Required
Energy and Atmosphere	Minimum Energy Performance	Required
Energy and Atmosphere	Enhanced Commissioning	High
Energy and Atmosphere	Optimize Energy Performance	Medium
Energy and Atmosphere	Advanced Energy Metering	Medium
Material and Resources	Storage & Collection of Recyclables	Required
Material and Resources	Construction & Demolition Waste Management	Required
Material and Resources	Building-Life-Cycle Impact Reduction	High
Location and Transportation	Sensitive Land Protection	Low
Location and Transportation	High Priority Site	Not Applicable
Location and Transportation	Surrounding Density and Diverse Uses	Always Applicable
Location and Transportation	Access to Quality Transit	Always Applicable
Material and Resources	**Transparency**	**Medium**
Location and Transportation	**Access to Quality Transit: Public Transportation for Wellesley Students**	**Medium**

Location and Transportation	**Access to Quality Transit: Public Transportation for Commuters**	**Medium**

Design		LEED+ Priority
Sustainable Sites	Site Development – Protect or Restore Habitat	Not Applicable
Sustainable Sites	Open Space	Not Applicable
Sustainable Sites	Rainwater Management	Low
Sustainable Sites	Heat Island Reduction	Low
Sustainable Sites	Light Pollution Reduction	Low
Innovation	LEED AP	High
Indoor Environmental Quality	Minimum Indoor Air Quality Performance	Required
Indoor Environmental Quality	Environmental Tobacco Smoke Control	Required
Indoor Environmental Quality	Enhanced Indoor Air Quality Strategies	High
Indoor Environmental Quality	Thermal Comfort	Medium
Indoor Environmental Quality	Interior Lighting	High
Indoor Environmental Quality	Daylight	Medium
Indoor Environmental Quality	Acoustic Performance	Medium
Energy and Atmosphere	Enhanced Commissioning	High
Energy and Atmosphere	Optimize Energy Performance	Medium
Material and	Storage & Collection of Recyclables	Required

Resources		
Material and Resources	Building-Life-Cycle Impact Reduction	High
Material and Resources	Building Product Disclosure & Optimization - Sourcing of Raw Materials	Medium
Material and Resources	Building Product Disclosure & Optimization - Material Ingredients	Medium
Water Efficiency	Outdoor Water Use Reduction	Required
Water Efficiency	Indoor Water Use Reduction	Required
Water Efficiency	Outdoor Water Use Reduction	Medium
Water Efficiency	Indoor Water Use Reduction	Low
Location and Transportation	Bicycle Facilities	Always Applicable
Location and Transportation	Reduced Parking Footprint	Medium
Energy and Atmosphere	**Setting Building-Wide Energy Goals**	**High**
Material and Resources	**Transparency**	**Medium**
Sustainable Sites	**Light Pollution: Impact on Wildlife**	**Medium**
Sustainable Sites	**Light Pollution: Lighting near the Observatory**	**Low**

Construction		LEED+ Priority
Innovation	Building Relocation Historic	Medium
Innovation	Efficient Use of Structural Material	Medium
Indoor Environmental Quality	Low-Emitting Materials	High
Indoor Environmental Quality	Construction Indoor Air Quality Management Plan	Medium
Energy and Atmosphere	Enhanced Commissioning	High
Material and Resources	Construction & Demolition Waste Management	Required
Material and Resources	Building-Life-Cycle Impact Reduction	High
Material and	Building Product Disclosure & Optimization -	Medium

Resources	Environmental Product Declarations	
Material and Resources	Building Product Disclosure & Optimization- Sourcing of Raw Materials	Medium
Material and Resources	Building Product Disclosure & Optimization- Material Ingredients Product Declarations	Medium
Material and Resources	Construction & Demolition Waste Management	High
Water Efficiency	Indoor Water Use Reduction	Required
Water Efficiency	Indoor Water Use Reduction	Low
Material and Resources	**Proper Disposal of Hazardous Materials**	**Medium**

Use		LEED+ Priority
Sustainable Sites	Tenant Design and Construction Guidelines	Medium
Innovation	Green Building Education	High
Innovation	Green Cleaning	Medium
Innovation	Organic Landscape Management	High
Innovation	Net Zero Energy	High
Innovation	Net Zero Water	High
Indoor Environmental Quality	Indoor Air Quality Assessment	Medium
Indoor Environmental Quality	Thermal Comfort	Medium
Indoor Environmental Quality	Interior Lighting	High
Energy and Atmosphere	Enhanced Commissioning	High
Energy and Atmosphere	Renewable Energy Production	Medium
Energy and Atmosphere	Enhanced Refrigeration Management	Medium
Material and Resources	Storage & Collection of Recyclables	Required
Water Efficiency	Outdoor Water Use Reduction	Required

Water Efficiency	Building-Level Water Metering	Required
Water Efficiency	Outdoor Water Use Reduction	Medium
Water Efficiency	Cooling Tower Water Use	High
Water Efficiency	Water Metering	Medium
Location and Transportation	Green Vehicles	Medium
Material and Resources	**Composting**	**Medium**
Material and Resources	**Transparency**	**Medium**
Material and Resources	**Proper Disposal of Hazardous Materials**	**Medium**
Location and Transportation	**Green Vehicles at Wellesley**	**Low**
Sustainable Sites	**Outdoor Interaction**	**Medium**
Energy and Atmosphere	**Community Based Social Marketing**	**Medium**

End of Life		LEED+ Priority
Innovation	Efficient Use of Structural Material	Medium
Innovation	Net Zero Energy	High
Innovation	Net Zero Water	High
Material and Resources	Building-Life-Cycle Impact Reduction	High
Material and Resources	Construction & Demolition Waste Management	High
Material and Resources	**Proper Disposal of Hazardous Materials**	**Medium**

CONCLUSION

The task given to the Environmental Decisionmaking class to create sustainable building guidelines for Wellesley provided a unique opportunity to evaluate our campus' strengths and weaknesses in building design over the years. Examining past and present goals for improving Wellesley was important in forming a unique set of guidelines specific to our campus. This report, composed of Environmental Decisionmaking's comprehensive research and analysis, provides the foundation for successfully integrating sustainability in our campus buildings, for both redevelopment and new construction, now and in the future.

Wellesley's history shows that outcomes from decisions on campus have always been intended. This can be said for early architectural decisions made during the inception of the college, and quick reconstruction following the great fire of 1914. Wellesley's resilience in response to historical setbacks has allowed our school to remain a leading academic institution for women. If Wellesley makes the same type of commitment to sustainability, Wellesley can become a proactive leader in green building among peer institutions.

Presently, Wellesley faces shortcomings in our application and management of sustainability. This report emphasizes the need to involve more people in sustainable decision-making on campus, whether through sustainable education or through engaging a wider range of community members in renovation initiatives. Sustainability can often be thought of as a challenging initiative to implement, when in fact there are many ways that it intrinsically ties in with already existing goals on campus. Wellesley should engage students, faculty, and staff to adopt a mindset that inherently includes sustainability.

Our analysis of the LEED v4 for BD+C: Core and Shell for Wellesley College checklist shows how achievable it is for Wellesley to pursue sustainability goals through LEED certification. The sum of the points from credits that are always applicable to Wellesley, with the points from the credits we have deemed to be of high priority, are already enough to earn LEED certification. The addition of some credits we have determined to be of medium priority to

Wellesley would earn a project LEED silver certification. Earning LEED gold requires just a few more of these medium priority credits. Most important to note—if a project includes all credits that are always applicable, of high priority, and of medium priority, then the combined points are enough to earn LEED platinum certification. Even if Wellesley continues to seek only LEED silver, this exemplifies the feasibility and potential of pursuing higher levels of LEED certification. If the College makes sustainability a larger development goal, then these higher levels of certification will be inherent in the trajectory of Wellesley's long-term building decisions.

This report reflects a thorough study of select peer institutions, as well as various methods for measuring sustainable building on campuses. Environmental Decisionmaking is confident that the decision to pursue the LEED+ checklist was the most holistic and comprehensive set of guidelines for Wellesley. LEED+ combines the integrity associated with attaining LEED credits, with unique aspects of Wellesley's campus and community. Additionally, LEED+ will allow Wellesley the most room to make viable and impactful improvements in the future.

LEED+ monitoring and enforcement will be integral to ensuring that LEED+ criteria are being properly implemented. Committees overseeing specific building renovations should be required to adhere to the LEED+ checklist, distribute it to architects and contractors, and ultimately report back to the Advisory Committee on Environmental Sustainability with questions and updates on progress. Additionally, all members of renovation committees should be briefed on the sustainable building guidelines and the process inherent to achieving them. Sustainability representatives should be assigned to each committee; their role would include engaging with the broader Wellesley community, and liaising between different stakeholders throughout the building project.

Regular re-evaluations of this report and the LEED+ checklist will also be essential to ensuring that campus buildings are meeting the needs of an ever-changing community. We recommend that the College reconsider the priority of credits and the effectiveness of our

process for participation, monitoring, and enforcement every three to five years. In following these easy steps, we can ensure that Wellesley lives on - adhering to its legacy of excellence - in a way that is environmentally sustainable, socially inclusive, and economically viable.

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