



The Humboldt Energy Independence Fund Proposal Request

Relight Redwood Bowl: Saving Energy,
Mitigating Climate Change, and Greening
Humboldt State University

HSU Green Campus Program

4/1/2009



Table of Contents

GREEN CAMPUS PROJECT TO RETROFIT HSU’S REDWOOD BOWL STADIUM LIGHTS TO REDUCE ENERGY USE, MITIGATE CLIMATE CHANGE AND GREEN HSU

COVER PAGE.....3
PROPOSAL..... 4
BUDGE BREAKOUT 10
TIMELINE 12
SIGNED AGREEMENT TO GRANT TERMS..... 14
APPENDICES.....INDEX

HEIF RFP Spring 2008 Cover Page

Proposal Title: Relight Redwood Bowl: Saving Energy, Mitigating Climate Change and Greening Humboldt State University

Applicants: HSU Green Campus Program

Primary Contact Kale Roberts **E-mail** buffalokale@gmail.com **Tel:** 707-496-5001
Indicate: Student / Faculty / Staff *Anticipated date of graduation:* Spring 2009

Name Jamila Ghoul **E-mail** jghoul@gmail.com **Tel:** 707-616-3335
Indicate: Student / Faculty / Staff *Anticipated date of graduation:* Fall 2009

Name Sarah Schneider **E-mail** sys2@humboldt.edu **Tel:** 702-238-6216
Indicate: Student / Faculty / Staff *Anticipated date of graduation:* Spring 2010

Proposal Narrative

Project Description

The Alliance to Save Energy's Green Campus Program (GC) at Humboldt State University is proposing an energy efficiency retrofit of the existing stadium lighting system in the Redwood Bowl. The proposed project, entitled *Relight Redwood Bowl* (RRB), will produce significant and measurable energy and cost savings for the University, while simultaneously reducing the light pollution.

Through extensive research into energy efficient stadium lighting, GC has determined that the Musco Lighting® (Musco) Sportscluster Green™ system will result in the largest amount of energy and cost savings for HSU. Customized to the stadium's specifications, the system will be comprised of (60) specialized 1500-watt metal halide lamps (lamps), rendering a **40 percent reduction in the number of lighting fixtures**. Each cluster of lights is factory-aimed and assembled and will be installed on the existing pole tops by a contracted team under the direction of HSU Plant Operations (PO). To ensure that the system will be correctly installed and the lights precisely aimed onto the track and field, a Musco representative will be on site during the installation. Furthermore, the new system includes the Control Link® Control and Monitoring System that allows PO flexible control and solid management of the lighting system (see Appendix A: *Musco Budget Estimate*).

The proposed lighting retrofit is projected to reduce energy usage **by 1,525,000 kilowatt-hours** over a 25-year period, yielding an estimated **energy cost-savings of \$186,221** for the University. Moreover, the RRB project will help the University achieve its greenhouse gas reduction targets, pursuant to Executive Order (EO) 987 (see Appendix B: *Executive Order 987*) by eliminating **796,525 pounds (361 metric tons) of carbon dioxide gas emissions** over 25 years.

The proposed project will cost a total of \$255,770 (capital and labor). GC is requesting funding from the HEIF in the amount of **\$75,000** (see budget breakout worksheet). The remaining funding will be provided by HSU Plant Operations (PO) (see Attachment C: *Tim Moxon Letter of Support*). Furthermore, GC will facilitate PO's application to the UC/CSU/Investor-Owned Utilities (IOU) Partnership for rebate funding in the amount of \$14,593 for the project's resulting energy savings¹.

Need Statement

The RRB project meets all five of the HEIF's primary goals:

- The idea for the RRB project came from GC student interns; and since then, students have been involved in *every* aspect of project development. Project ownership and committed involvement is necessary for follow-through and implementation, as well as for continued monitoring and evaluation of project success.
- The project presents great potential for generating demonstrable energy savings and associated carbon dioxide reduction. In addition, the project will deliver qualitative metrics based on improved light quality and the reduction of light pollution.

¹ The UC/CSU/IOU Partnership offers a rebate of \$0.24/kWh for implementing projects that yield significant energy savings. GC has received initial commitment of the rebate funding from Carmen King, Energy Analyst at Newcomb, Anderson and McCormick. .

- The RRB project has and will continue to integrate class projects into the implementation of the project (i.e. Engineering students will monitor energy consumption; NRPI students will create interpretive signs).
- Future work will be done by Natural Resources Planning students to create interpretive displays that will highlight the lighting retrofit while explaining HEIF's role in the project and opportunities for future student involvement.
- The RRB project will bring positive exposure to HEIF due to the highly visible nature of the project. Audiences HEIF may otherwise have difficulty reaching, such as athletes, coaches and fans, will experience first-hand the successes of a HEIF project and learn about opportunities for implementing projects of their own. By way of games, campus events and tours, and press releases written by students the project will promote HEIF and its mission.

Outcome

The RRB project will produce a number of tangible results and benefits for the University and outlying communities. In addition to the generation of measurable energy savings, reduction in greenhouse gas emissions, and reduction in energy costs, the proposed lighting system will also decrease the amount of light pollution currently created by the existing stadium lighting system.

Furthermore, the project provides a venue for student involvement and learning outcomes that benefit students far into the future. The RRB project provides an educational opportunity for the campus community to become engaged in the promotion of energy efficiency and conservation. The following sections briefly discuss the project's benefits.

Lighting Discussion

A view east from the Arcata Bottom reveals HSU and the Redwood Bowl perched on the hillside and shrouded in a halo of radiating luminescence. On foggy nights this effect is amplified, and while quantitative data to assess light pollution was cost prohibitive to obtain, it is safe to qualitatively state the light pollution is significant.

Redwood Bowl's light pollution is attributed to light spillage as a result of misdirected lighting fixtures. The Musco Lighting® Sportscluster Green™ system addresses the light pollution issue by guaranteeing 50 percent less light spillage. These lighting structures are factory-aimed and assembled and will be precisely aimed to re-direct spilled light back onto the field and track. Furthermore, Musco's 1500-watt metal halide lamps are designed with "smart lamp" technology, guaranteeing a life of 5,000 hours versus standard 1500-watt metal halide lamps that have a life span of approximately 3,000 hours. Additionally, the new lighting system also guarantees a constant light level of 60 footcandles² (FC) for the football field and 25 FC for the track over the life of each lamp. To ensure that the FC levels for the new system are compatible with the existing system, GC student interns measured FC levels of the Redwood Bowl (see Appendix I: *Footcandle Measurements*).

According to HSU electrician Jim Long, some of the lamps in the existing system burn out sooner than the rated 5,000 hour lifespan. Due to the high cost of replacing individual lamps -- including renting a hydraulic lift (\$1400), purchasing new lamps (\$125 each) and billing for labor -- a number

² A footcandle is a unit of illuminance, equal to one lumen falling on one square foot of surface area (Morgan King).

of lamps go un-replaced until a quantity of burnt out lamps accrues to make it financially feasible to replace multiple lamps. Because the University cannot allow the field to fall into complete darkness before re-lamping we assume, based on information provided by Mr. Long, that half of the lamps are replaced every 3 years. In the interim, however, the lamps' lumen³ output is in a constant state of depreciation. The RRB project aims to improve the level of light quality necessary for safe and enjoyable nighttime use of the stadium.

In addition to the requirement of fewer lamps and a guaranteed 5,000 hour life, each "smart lamp" is less costly to purchase than the current system's lighting. Musco's smart lamps will cost \$75 each in contrast to the \$125 the University is currently paying per replacement lamp. Considering both the costs of current lamps and the maintenance and labor associated with re-lamping, we calculate PO pays \$10, 232 each re-lamping period. The proposed retrofit, in contrast, will cost an estimated \$8,900 each re-lamping period, resulting in a \$1,332 savings each re-lamping period. (See Appendix F: Economic Analysis).

Effects on Wildlife Communities & Human Health

Some research on the effects of artificial light pollution exists to suggest ecosystems, and especially individual species, are adversely affected by outdoor lighting systems. For further discussion on the adverse impacts of light pollution please refer to Appendix D: *Light Pollution effects on wildlife and human health*).

Promoting the HEIF's Mission

Athletes, coaches and fans will experience the visual impact of the Redwood Bowl lighting retrofit with state of the art lighting technology. Thousands of Arcata residents, including our campus community, will visually take note of the reduction in light pollution, and the higher quality darkness pervading the night sky. The HEIF will be recognized for the project's inception and achievements.

Interpretive signs located strategically at stadium entrances will promote HSU's dedication to a healthy environment (i.e. the artificial playing fields made of recycled tires and the Kinesiology and Athletics building designed and constructed to LEED® Silver standards) and will prominently feature the HEIF's role. By means of a highly visual project, the HEIF's message will reach and inspire hundreds of fans and athletes, effectively connecting athletics to environmental stewardship. Campus tours, graduation and a host of other events utilizing the stadium will provide further opportunities for outreach.

In addition, press releases to newsletters and papers at HSU and other universities will be circulated to inform the public of the project's achievements. The HEIF's history, goals, and past achievements will also be highlighted so that students elsewhere may be inclined to replicate such a fund on their own campuses, proliferating the HEIF's spirit and carrying its mission further. Marketing opportunities abound for students wanting to gain experience in environmental promotion and attracting interested prospective students to the University.

³ A lumen is a unit of measurement of light. (<http://www.theledlight.com/lumens.html>).

Economic Analysis: Discussion on energy and cost-savings

By retrofitting the existing stadium lighting with the Sportscluster Green™ system, the University will save approximately \$186,221 in energy costs over a 25-year period. This is an energy reduction of 1,525,000 kWh. Moreover, the new system will result in 796,525 pounds of avoided carbon dioxide gas emissions over 25 years.

The upfront cost of the proposed lighting system is \$255,770⁴. This includes the quoted price of the Sportscluster Green™ system in the amount of \$124,200 (see Appendix A: *Musco Budget Estimate*), the installation quote of \$120,392 (see Attachment E: *Kneaper Electric Contractor's Quote*) and sales tax. The total cost of operating and maintaining the proposed system, including the capital cost and initial installation, is approximately \$468,714 over 25 years. However, if the existing system is to stay in place, the repair of the catwalks and cross arms will cost an estimated \$110,000 (conservative estimate), with overall maintenance and operating costs over a 25 year period totaling to \$540,755, a total savings of \$72,421.

The simple payback period for this project is 11 years, while the discounted payback period (at a 3 percent real discount rate) is 15.6 years. The project's internal rate of return⁵ (IRR) is 5.56 percent, making it a solid investment relative to other investments such as bonds or money market funds (see Appendix F: Payback and IRR worksheet).

Student Involvement

The RRB project is entirely student-led. From the project's genesis, GC student interns have researched energy efficient stadium lighting technologies, worked with Musco Sports Lighting® and RLL Design Lighting (still waiting to receive quote) to obtain budget estimates on equipment costs, developed a comparative cost and energy use analysis, and have rigorously worked to secure funding sources. Also, the Green Campus Energy Efficiency Internship course (ENVS 480) provided a venue for a student intern to assist GC in writing the proposal submitted to the HEIF in April 2008. In the fall of 2008, the Relight Redwood Bowl webpage was created as a student project for Engineering 115 (<http://www.humboldt.edu/~greenhsu/cms/gc/main/relight-redwood-bowl-project>).

This semester (Spring 2009), the HEIF grant proposal has been integrated into two different grant proposal-writing courses, AIE 430 and NRPI 435. By working with students to create the interpretive displays, monitoring and evaluating the new lighting system, and reporting the project's successes to the campus community, GC ensures that student involvement will play a predominant role in the project process well into the future.

The RRB project presents many great opportunities for both HSU faculty and students to integrate project components into class curricula. Following the proposed retrofit, GC will involve Natural Resource Interpretation students in the creation of interpretive displays. These permanent signs will

⁴ Once the project officially goes out to bid, the quote prices for capital and labor should decrease by 10-15% (Moxon).

⁵ The internal rate of return (IRR) is the interest rate received for an investment consisting of payments (negative values) and income (positive values) that occur at regular intervals. The rate of return calculated by the IRR is the interest rate corresponding to a net present discount rate of zero. In this analysis, a discount rate of 3 percent and an IRR of 16 percent are used.

be displayed on site and will outline the history of the project, the associated energy and greenhouse gas reductions, and will also highlight the HEIF as a source of the project's inspiration and funding. GC has also contacted the chair of the Industrial/Applied Technology Department, Dr. Saeed Mortazavi, about involving Construction Management students in the installation stage of the lighting retrofit. Furthermore, Environmental Resources Engineering faculty has been contacted regarding the involvement of engineering students in the tracking and monitoring of the new system's energy consumption.

Partners

GC fully recognizes the paramount importance of building strong working relationships with stakeholders on and off campus in order for this project to take place. The GC team has been working closely with members of the campus community (students, staff, faculty, and administrators) in the design and implementation of this energy efficiency project. In particular, we have partnered with PO on this project and have been meeting with Mr. Moxon regularly over the past year to discuss the project's progress. As a leading partner on the project, Mr. Moxon has confirmed that PO will be covering the remaining project costs after requested HEIF funds are approved and administered.). For a comprehensive list of all 22 parties involved in the development of the RRB project, please refer to Appendix H: *List of Partners and Parties Consulted*.

Timeline *Please refer to the Timeline Attachment*

Sustainability

GC student interns will work with PO to ensure that the project is maintained over the next 25 years. GC will oversee preparation of annual reports on the system's performance and condition, and, based on these reports, PO will consider whether maintenance is in order to maximize the lighting and energy efficiency of the stadium. After 5,000 hours of system use or by year 10, the first re-lamping of the entire facility will be conducted by Musco at no cost under the Musco Constant 10™ warranty. Additional visits by Musco technicians will only occur if significant damages to the system take place. However, PO will be in charge of the removal and disposal of expired and/or damaged lamps and all other basic maintenance and repairs of the system, as this is PO's jurisdiction and thus responsibility is bestowed upon its staff. Maintenance and repairs of the existing system are handled by PO staff.

Assessment

Once the new lighting system is installed, students will track and monitor its energy consumption with the ElitePro™ Recording Poly-phase energy meter⁶ (written into proposal budget). The collected data will be analyzed and compiled by GC student interns and reported to PO. Evaluation of the project's overall effectiveness will be based on energy savings. A survey distributed around the community will be used to evaluate the qualitative benefits from the reduction in light pollution.

⁶ ELITEpro™ Recording Poly-Phase Power Meter measures, logs and analyzes electrical loads on all types of devices (<http://www.dentinstruments.com/detailsElitePro.htm>).

Signed Agreement to Grant Terms

(Adapted from the Humboldt Area Foundation RFP)

By signing this application form, the applicant enters into an agreement with HSU and HEIF that would take effect should the grant be awarded. The applicant attests that:

1. **Accuracy:** The information contained in this application and in any attachments thereto is true and correct to the best of your knowledge.

2. **Use of Funds:** Understands and agrees that, where applicable, all grant funds will be applied to the project in accordance with the description and budget provided in this application as set forth in the award letter. Any significant change in the use of these funds will require prior approval by HEIF. Requests for changes must be submitted in writing. If the revisions are not accepted or funds are not expended for the purpose and the manner agreed to by the grantee, HEIF reserves the right to cancel the grant and any further payments and said funds must be returned to the Foundation. All funds must be spent in accordance with State financial rules and regulations.

3. **Expiration:** Understands and agrees that, where applicable, grants must be paid within one year, unless otherwise specified. Any requests for extensions of time must be submitted in writing prior to the expiration date. Grants not paid or granted an extension can be cancelled without notice after the expiration date.

4. **Grant Report(s):** Understands and agrees that, where applicable, report(s) will be submitted to HEIF by the phase or date specified in the grant award letter. Report guidelines will be forthcoming.

To indicate acceptance of the foregoing terms and conditions, please sign below. Please retain a copy of this agreement for your files.

Applicants:

Print Name _____ Signature _____ Date 4/1/09

Print Name _____ Signature _____ Date 4/1/09

Print Name _____ Signature _____ Date 4/1/09

Support Material including Index

Appendix A	Musco Budget Estimate
Appendix B	Executive Order 987
Appendix C	Tim Moxon's Letter of Support
Appendix D	Light Pollution Effects on Wildlife and Human Health
Appendix E	Kneaper Electric Quote
Appendix F1	Economic Analysis
Appendix F2	Economic Analysis Summary
Appendix F3	Relight Redwood Bowl Stadium Lighting Analysis Worksheet
Appendix F4	Estimated Energy Savings and Reduction in Carbon Dioxide Emissions
Appendix F5	Payback Period (Internal Rate of Return) Worksheet
Appendix G	President Richmond's Letter of Support
Appendix H	List of Partners, Consultants, and Contributors
Appendix I	Redwood Bowl Light Meter Readings
Appendix J	Redwood Bowl Stadium Light Schedule
Appendix K	Photographs

HEIF Budget Template

See RFP for further information. Individual proposals can contain activities in both project categories, but the proposal budget should be divided so that funding requirements for activities in each category are listed separately.

Project Title: Relight Redwood Bowl

Awardee Implemented Project Budget

Category (list n etc.)	Unit (e.g. miles, each, etc.)	Cost per unit	Total cost	Amount requested from HEIF	Matching contribution to be provided by applicant or other source	Who/what is the other source?	Is the matching contribution confirmed or potential?
Durable equipment							
Sign materials			\$4,000	\$4,000			
Consumable supplies							
Wages for student participants							
Professional services							
Travel							
Other							
			TOTAL:	\$4,000			

HSU Implemented Project Budget

Category (list n etc.)	Unit (e.g. miles, each, etc.)	Cost per unit	Total cost	Amount requested from HEIF	Matching contribution to be provided by applicant or other source	Who/what is the other source?	Is the matching contribution confirmed or potential?
Durable equipment							
Sportscluster Green™		\$124,200 +tax	\$135,378	\$69,400	\$45,785.04	HSU Plant Ops	Yes
ElitePro		\$1,600		1,600	\$14,592.96	HSU Plant Ops	Potential
Consumable supplies							
Other							
sign materials							
(see Awardee Implementation Budget)					\$4,000		
			TOTAL:	\$135,378.00	\$75,000	\$60,378.00	

Note: amounts in column E and column F should add up to total in column D

HEIF Timeline and Outcome Template

Project Title *Relight Redwood Bowl*

Activity	Expected number of weeks to complete	Expected outcome	Responsible party
Musco Inspection of RWB lighting	Feb-09	Occurred in Feb 2009	GC
Circulate press releases	May 2009 - 11	Articles published	GC
Put project up for contractor official bid	30-Apr-09	Receive competitive quotes	Plant Ops
Confirm contractor bid	30-May-09	Receive reasonable quote	Plant Ops
Payment of 25% with purchase order (see Musco budget estimate page 2)	1-Jun-09	Payment made & order confirmation	Plant Ops
Payment of remaining balance	within 30 days	Full payment is made	Plant Ops
Delivery and Installation of system	30-Jun-09	Installation will take 3 weeks	Contractor
Submit Partnership Rebate application	30-Jun-09	Installation completed	Plant Ops/GC
Project Inspection by Partnership	15-Jul-09	Approve project	
Install monitoring device on system	22-Jul-09	Start tracking and monitoring energy consumption	Plant Ops/GC
Design and create interpretative signs	Fall 2009		GC/NRPI students
Enlist ERE students	Fall 2009	Students will track and monitor	
Compile energy data and evaluate project	Fall 2009 - 2035	Completed at end of each semester	GC
Submit UC/CSU/CCC Sustainability Best Practices application	March of 2010	First place winner	GC



**Humboldt State University
Arcata, CA
Date: March 30, 2009
To: Sarah Schneider**

Equipment Description

Sportscluster Green™ System delivered to your site

- Factory aimed and assembled poletop luminaire assemblies
- (60) 1500-watt metal halide fixtures
- UL Listed remote electrical component enclosures
- Mounting hardware for the pole top units and electrical component enclosures
- Pole length wire harness
- Disconnects

Also includes:

- Energy savings of more than 50% over a standard lighting system
- 50% less spill and glare light than Musco's prior industry leading technology
- Musco Constant 10™ product assurance & warranty program that eliminates 100% of your maintenance costs for 10 years, including labor and materials on Musco manufactured product. Musco's Constant 10 Warranty is contingent upon Musco's inspection and approval of existing structure and electrical wiring.
- Guaranteed constant light level of 60 footcandles for the football field and 25 footcandles for the track for 10 years, +/- 10% per IESNA RP-06-01
- One (1) group re-lamp at the end of the lamps' rated life, 5000 hours
- Reduced energy consumption with an average of 93.84 kW per hour
- Control Link® Control & Monitoring System for flexible control and solid management of your lighting system
- Lighting Contactors sized for the voltage and phasing at the site

Poles, sales tax, labor and unloading of the equipment is **not** included as part of this budget estimate.

Budget Estimate

Sportscluster Green™ as described below and delivered to the job site \$124,200.00.

Payment Terms

Option A

Payment of 25% of the contract price is required with order. The contract balance is due no later than 30 days after invoice date.

Option B - Wholesalers Only

100% of the contract price is due and payable no later than 20 days after invoice date.

Musco will attempt to coordinate shipment so that delivery corresponds with the customer's payment schedule. It will be the responsibility of the wholesaler to ensure that Musco is aware of this delivery timeframe. We will expect payment within the terms described above unless there is a written statement from Musco's corporate headquarters stating the acceptance of different terms.

Delivery to the job site from the time of order, submittal approval, and confirmation of order details including voltage and phase, pole locations is approximately 30-45 days. Due to the built-in custom light control per luminaire, pole locations need to be confirmed prior to production. Changes to pole locations after the product is sent to production could result in additional charges.

Notes

Estimate is based on:

- Shipment of entire project together to one location
- Field size of 360' X 160' for football
- System will be manufactured to existing voltage and phasing at site
- Musco's Constant 10 Warranty is contingent upon Musco's inspection and approval of existing structure and electrical wiring

Thank you for considering Musco for your sports-lighting needs. Please contact me with any questions.

Jasen Deniz
Sales Representative
Musco Sports Lighting, LLC
Phone: 530/741-9536
E-mail: jasen.deniz@musco.com
Fax: 530/673-9583

THE CALIFORNIA STATE UNIVERSITY
OFFICE OF THE CHANCELLOR



August 2, 2006

BAKERSFIELD

CHANNEL ISLANDS

MEMORANDUM

CHICO

To: CSU Presidents

DOMINGUEZ HILLS

From: Charles B. Reed
Chancellor

EAST BAY

Subject: Executive Order No. 987 – Policy Statement on Energy Conservation, Sustainable Building Practices, and Physical Plant Management for the California State University

FRESNO

FULLERTON

The attached Executive Order No. 987 delegates to each president, or his/her designee, the implementation of the California State University Board of Trustees' energy conservation, sustainable building practices, and physical plant management policy. This executive order reaffirms the need to conserve energy in order to achieve the goal originally set in 2001 and reevaluated in 2005. Our new goal is to reduce consumption by 15% by the end of FY 2009/10, as compared to 2003/04. The trustee policy is consistent with Governor Arnold Schwarzenegger's Executive Order S-12-04, which requests the CSU's active participation in statewide energy conservation and reduced electrical demand.

HUMBOLDT

LONG BEACH

LOS ANGELES

MARITIME ACADEMY

This executive order retains general operational provisions and sustainable building practices while adding the CSU Sustainable Measurement Checklist process. It encourages campuses to continue to adopt an integrated design approach that includes sustainable materials and practices. It also requires new goals for energy conservation, and the purchase and generation of renewable power.

MONTEREY BAY

NORTHRIDGE

In accordance with the policy of the California State University, the campus president has the responsibility for implementing executive orders, where applicable, and for maintaining the campus repository and index for all executive orders.

POMONA

SACRAMENTO

Should you have any questions regarding this executive order, please contact Ms. Elvyra F. San Juan, Assistant Vice Chancellor, Capital Planning, Design and Construction, at (562) 951-4090.

SAN BERNARDINO

SAN DIEGO

CBR:lf

SAN FRANCISCO

Attachment

SAN JOSÉ

cc: Vice Presidents, Administration
Executive Deans
Directors, Physical Plant
Energy Managers
Executive Vice Chancellor and Chief Academic Officer
Executive Vice Chancellor and Chief Financial Officer
Chancellor's Office Department Heads

SAN LUIS OBISPO

SAN MARCOS

SONOMA

STANISLAUS

THE CALIFORNIA STATE UNIVERSITY
Office of the Chancellor
401 Golden Shore
Long Beach, California 90802-4210
562.951.4090

Executive Order No: 987
Effective Date: August 2, 2006
Supersedes: Executive Order No. 917
Title: Policy Statement on Energy Conservation, Sustainable Building Practices, and Physical Plant Management for the California State University

This executive order is issued pursuant to Section II of the Standing Orders of the Board of Trustees of the California State University.

I. Delegation of Authority

Authority is hereby delegated to each president, or his/her designee, to implement the following Board of Trustees' Energy Conservation, Sustainable Building Practices, and Physical Plant Management goal and policy, as adopted by the Board during its September 20-21, 2005 meeting subject to the conditions stated in this executive order. To the extent that some of the provisions contained herein involve coordination with the Chancellor's Office staff, each president shall take whatever steps are necessary to coordinate and provide input to the department of Capital Planning, Design and Construction, Office of the Chancellor, to assist in formulation and implementation of this policy.

II. Energy Conservation Goal

Each campus will continue to reduce energy consumption as established previously by Executive Order 917. The five-year goal of reducing energy consumption by 15% will be evaluated at the end of fiscal year 09/10 and reported to the trustees in July 2011. The baseline for this goal is fiscal year 03/04, and is measured by BTU/GSF (British Thermal Unit per gross square foot) for both state and nonstate supported areas of the campuses. The report will also assess the campuses' ability to achieve additional energy conservation.

III. Energy Independence Goal

The CSU shall develop a strategic plan for energy procurement and production to reduce energy capacity requirements from the electricity grid, and to promote energy independence using available economically feasible technology (solar, wind, biomass) and for on-site generation. The CSU shall endeavor to increase its self-generated energy capacity from 26 to 50 megawatts (MW) by 2014. (05-Adopt)

1. Campuses will consider installing and operating clean and ultra-clean cogeneration plants and proven renewable energy generation technologies in order to reduce greenhouse gas emissions, and to improve campus energy efficiency, utility reliability, and service diversity to increase production from 24 to 40 megawatts (MW).
2. Campuses will pursue cost effective renewable generation in order to increase production from 2 to 10 megawatts (MW).
3. As the cost effectiveness of a project may change based on the (1) development of new technologies, (2) market forces on energy prices, (3) availability of subsidies for projects, and (4) changes in state regulations, campuses may consider the most economically feasible and cost effective self-generation method to support the systemwide 50 MW goal.

IV. Renewable Energy Procurement

The CSU will endeavor to meet or exceed the State of California and California Public Utilities Commission Renewable Portfolio Standard (RPS) that sets a goal of procuring 20% of its electricity needs from renewable sources by 2010 subject to the constraints of program needs and standard budget parameters. (05-Adopt)

V. Policy on Energy Conservation, Sustainable Building Practices and Physical Plant Management.

1. Energy Conservation

1. All CSU buildings and facilities, regardless of the source of funding for their operation, will be operated in the most energy efficient manner without endangering public health and safety and without diminishing the quality of education. (78-Adopt; 88-Revise; 01-No Change; 04-No Change)
2. All CSU campuses will continue to identify energy efficiency improvement measures to the greatest extent possible, undertake all necessary steps to seek

funding for their implementation and, upon securing availability of funds, expeditiously implement the measures. (78-Adopt; 88-Revise; 01-No Change; 04-No Change)

3. The CSU will promote the use of cost effective renewable non-depleting energy sources wherever possible, both in new construction projects and in existing buildings and facilities. The campuses will consider the implementation of load shifting technologies such as thermal energy storage. (78-Adopt; 88-Revise; 01-Revise; 04-Revise)
4. The CSU will take the necessary steps to provide adequate, reliable, and cost effective utilities infrastructure at all campuses for meeting the needs of present and planned buildings and facilities. (78-Adopt; 88-Revise; 01-No Change; 04-Revise)
5. The CSU will actively seek all available sources of funding for implementing energy efficiency improvement and utilities infrastructure renewal projects. Funding sources will include federal and state budget appropriations, federal, state and private sector grant opportunities, and other unique public/private sector financing arrangements, which have been made available through legislative actions in California and the United States Congress. In the event these funding sources are unable to meet the requirements for an approved energy program, priorities within the existing support appropriations will be examined to determine if funds could be made available for project development purposes. (78-; 88-Adopt; 01-No Change; 04-No Change)
6. The CSU will cooperate with federal, state, and local governments and other appropriate organizations in accomplishing energy conservation and utilities management objectives throughout the state; and inform students, faculty, staff and the general public of the need for and methods of energy conservation and utilities management. (78-Adopt; 88-Revise; 01-No Change, 04-No Change)
7. Each CSU campus will designate an energy/utilities manager with the responsibility and the authority for carrying out energy conservation and utilities management programs. The Chancellor's Office will have the responsibility to coordinate the individual campus programs into a systemwide program. (78-Adopt; 88-Revise; 01-No Change; 04-No Change)
8. The CSU will monitor energy usage monthly on all campuses and the Chancellor's Office, and will prepare a systemwide annual report on energy utilization. The Chancellor's Office will maintain a systemwide energy database in which monthly campus data will be compiled to produce systemwide energy reporting. Campuses will provide the Chancellor's Office the necessary energy and utility data for the systemwide database in a timely manner. (78-; 88- Adopt; 01-Revise; 04-No Change)

9. Each CSU campus will develop and maintain a campuswide integrated strategic energy resource plan, which will include tactical recommendations in the areas of new construction, deferred maintenance, facility renewal, energy projects, water conservation, solid waste management, and a structured energy management plan. This plan will drive the overall energy program at each campus. (78-Adopt; 88-Revise; 01-Revise; 04-Revise)
10. Each campus energy/utilities manager shall solicit and evaluate feedback from faculty, staff, and students to monitor the effects of energy conservation efforts on instructional programs and the environment. Training on new energy management concepts and programs will be provided as necessary. (78-; 88-Adopt; 01- Revise; 04- No Change)
11. A component of each campus's emergency plan shall address action required to respond to short-term electrical outages, large-scale grid failures, natural gas curtailments, and other utility shortages or failures. (78-; 88-; 01-Adopt; 04-Revise)
12. All major capital projects starting design beginning in the FY 2006-2007 shall meet the following requirements: new construction projects shall at a minimum outperform the 2005 Title 24 Standards (California Energy Code) by at least 15% and all major renovations projects shall at a minimum outperform the current Title 24 Standard by at least 10%. These efforts will help to reduce the BTU/square foot consumption of the projects. (05-Adopt)

2. Sustainable Building Practices

1. All future CSU new construction, remodeling, renovation, and repair projects will be designed with consideration of optimum energy utilization, low life cycle operating costs, and compliance with all applicable energy codes (enhanced Title 24 energy codes) and regulations. In instances where a project's current funding does not include energy or sustainable design features consistent with low life cycle costing, augmentations may be sought, when warranted. In the areas of specialized construction that are not regulated through the current energy codes, such as historical buildings, museums, and auditoriums, the CSU will ensure that these facilities are designed to consider energy efficiency. Energy efficient and sustainable design features in the project plans and specifications will be considered in balance with the academic program needs of the project within the available project budget. (78-Adopt; 88-Revise; 01-Revise; 04-Revise)
2. Capital planning for state and nonstate facilities and infrastructure shall consider features of a sustainable and durable design to achieve a low life cycle cost. Principles and best practices established by leading industry standards or professional organizations shall be implemented to the greatest extent possible. The CSU is supportive of campuses pursuing third-party accreditation for campus

facilities, however current Department of Finance (DOF) policy does not permit the use of state capital funds for such administrative costs. Therefore, campuses considering outside accreditation shall identify alternative means of funding for associated costs. (04-Adopt)

3. Sustainable design for capital projects is a process of balancing long-term institutional needs for academic and related programs with environmental concerns. In the context of designing to provide for university and academic needs, the following attributes will be considered "sustainable:" (04-Adopt)
 - a. Siting and design considerations that optimize local geographic features to improve sustainability of the project, such as proximity to public transportation and maximizing use of vistas, microclimate, and prevailing winds;
 - b. Durable systems and finishes with long life cycles that minimize maintenance and replacement;
 - c. Optimization of layouts and designing spaces that can be reconfigured with the expectation that the facility will be renovated and re-used (versus demolished);
 - d. Systems designed for optimization of energy, water, and other natural resources;
 - e. Optimization of indoor environmental quality for occupants;
 - f. Utilization of environmentally preferable products and processes, such as recycled-content materials and recyclable materials;
 - g. Procedures that monitor, trend, and report operational performance as compared to the optimal design and operating parameters.
4. In order to implement the sustainable building goal in a cost effective manner, the process will: identify economic and environmental performance measures; determine cost savings; use extended life cycle costing; and adopt an integrated systems approach. Such an approach treats the entire building as one system and recognizes that individual building features, such as lighting, windows, heating and cooling systems, or control systems are not stand-alone systems. (04-Adopt)
5. The CSU encourages the use of materials and systems with reduced environmental impacts. The design team (architect/engineer) shall recommend building materials and methods with life cycles (manufacture, installation, maintenance, repair, and replacement) of reduced environmental impacts. Considerations shall include energy efficiency, energy required in the manufacturing process, life cycle duration, and maintenance and replacement costs. (04-Adopt)

6. Capital Planning, Design & Construction of the CSU Office of the Chancellor shall develop a CSU Sustainability Measurement System and self-verification standard. The system shall be based on LEED™ principles with consideration to the physical diversity and microclimates within the CSU. The Sustainability Measurement System shall support the energy efficiency goals and guidelines of this policy. (05-Adopt)
7. The CSU shall design and build all new buildings and major renovations beginning in the FY 2006-2007 to meet or exceed the minimum requirements of the CSU Sustainability Measurement System, which shall be equivalent to LEED™ “Certified.” Each campus shall strive to achieve a higher standard in the CSU Sustainability Measurement System equivalent to LEED™ “Silver” within project budget constraints.

Each campus may pursue external certification through the LEED™ process. Campuses that elect to pursue LEED™ certification shall seek nonstate funding sources to support that effort. (05-Adopt)

8. The CSU shall incorporate appropriate training programs for CSU facilities personnel with the aim of promoting and maintaining the goals of this policy. (05-Adopt)

3. Physical Plant Management

1. Purchased energy resources on CSU facilities will not be used to heat above 68°F or cool below 78°F. Domestic hot water temperatures will not be set above 115°F. These limits will not apply in areas where other temperature settings are required by law or by specialized needs of equipment or scientific experimentation. (78-; 88-Adopt; 01-Revise; 04-No Change)
2. Each campus shall operate and maintain a computerized energy management system that will provide centralized reporting and control of the campus energy related activities. (78-Adopt; 88-Revise; 01-Revise; 04-No Change)
3. Campus energy/utilities managers will make the necessary arrangements to achieve optimum efficiency in the use of natural gas, electricity, or any other purchased energy resources to meet the heating, cooling, and lighting needs of the buildings and/or facilities. Except for areas requiring special operating conditions, such as electronic data processing facilities, or other scientifically critical areas, where rigid temperature controls are required, building and/or facility temperatures will be allowed to fluctuate between the limits stated above. Simultaneous heating and cooling operations to maintain a specific temperature in work areas will not be allowed unless special operating conditions dictate such a scheme to be implemented. (78-; 88-Adopt; 01-No Change; 04-No Change)

4. Scheduling of building and/or facility usage will be optimized consistent with the approved academic and non-academic programs to reduce the number of buildings operating at partial or low occupancy. To the extent possible, academic and non-academic programs will be consolidated in a manner to achieve the highest building utilization. Further, the scheduling of buildings will be implemented in a manner to promote central plant and individual building air conditioning system shutdown to the greatest extent possible during the weekend and other holiday periods. Campus energy/utilities managers will make all attempts to change or update building operating schedules to match the changes in the academic programs on a continuing basis. (78-; 88-Adopt; 01-No Change; 04-No Change)
5. All air conditioning equipment, including supply and return air fans, are to be shut off on weekends, holidays, and for varying periods each night, except where it would adversely affect instruction, electronic data processing installations, or other scientifically-critical or 24-hour operations. (78-; 88-Adopt; 01-No Change; 04-No Change)
6. Campuses will participate in state sponsored demand reduction programs, where practical, during periods of CAISO (*California Independent System Operator*) Stage Alerts. Reductions in non-critical loads will be made in an effort to aid in the state electrical grid integrity. (78-; 88-; 01-Adopt; 04-No Change)
7. Outdoor air ventilation will be set at 10 cfm/person or such other higher limits as prescribed by state law or regulations. This restriction does not apply to situations where 100% outside air is called for by properly installed and tuned economizer cycles. (78-; 88-Adopt; 01-Revise; 04-Revise)
8. All windows in buildings and/or facilities that are air-conditioned will be kept closed and as secure as possible to prevent loss of conditioned air, unless facilities are equipped with an air-conditioning and heating interlock that shuts off mechanical cooling or heating when windows are opened. (78-; 88-Adopt; 01-No Change; 04-No Change; 05-Revise)
9. Portable electric heaters and fans are not to be used in CSU facilities unless specifically required by occupants because of medical conditions, failure of the building heating, ventilating or air conditioning systems, or when building heating, ventilating or air conditioning systems cannot be adjusted to achieve minimum comfort levels within the provisions established under Item No. 1. Campus energy/utilities managers will grant such exemptions on a case-by-case basis. Use of refrigerators for non-instructional purposes should be consistent with good energy management practices. Each campus will prepare its own guidelines to discourage proliferation of personal refrigerators. (78-; 88-Adopt; 01-No Change; 04-Revise)

10. All lighting, except what is required for security purposes, will be turned off when buildings and facilities are unoccupied, such as at the end of the workday. Custodial personnel will turn lights back on only for the time actually required for custodial work. (78-; 88-Adopt; 01-No Change; 04-No Change)
11. All CSU campuses will, to the greatest extent possible, change custodial hours from evening/night shifts to day shifts to reduce custodial energy usage. Any revisions to the custodial shift schedule will be made in consultation with the energy/utilities manager. Building ventilation and lighting systems will not be operated any more or longer than what is required under health and safety codes during the low load custodial occupancy periods. (78-; 88-Adopt; 01-No Change; 04-No Change)
12. Indoor lighting will be reduced in number and/or wattage, wherever possible, to provide for the minimum but adequate lighting levels consistent with the needs of instructional programs and state-mandated standards for the efficient and effective use of the space. Existing incandescent lamps for general-purpose lighting will be phased out and future incandescent lamps will not be allowed unless exempted for very limited and specialized tasks by the campus energy/utilities managers. New lighting systems will be in the form of the latest energy saving technology. (78-; 88-Adopt; 01-Revise; 04-No Change)
13. Outside lighting on building exteriors and campus grounds will be maintained at levels necessary to provide security and safety to promote confidence within the campus community. Good energy management practices shall be observed within this guideline. (78-; 88-Adopt; 01-No Change; 04-No Change)
14. Purely decorative lighting on CSU campuses beyond reasonable display lighting, inside or outside, will not be added. Existing decorative lighting beyond reasonable display lighting will be eliminated on a continuing basis. In general, decorative lighting will not be used for commercial or holiday purposes unless specifically exempted by the campus president. (78-; 88-Adopt; 01-No Change; 04-No Change)
15. All natural gas fired boilers on the campuses will be tuned at least twice annually and brought up to maximum efficiency unless automated combustion controls are installed. In the case of automatic controls, verification of combustion efficiency shall be conducted routinely or at least monthly for central plant and quarterly for decentralized boilers. A permanent record of these readings will be maintained on each campus. (78-; 88-Adopt; 01-No Change; 04-Revise)
16. All CSU campuses will maintain their energy plant and utilities infrastructure improvements in good working order and will undertake preventive maintenance

schedules to maintain the highest possible system efficiencies and, hence, the lowest operating costs. (78-; 88-Adopt; 01-No Change; 04-No Change)

17. When replacing energy consuming and/or utilities infrastructure equipment, the most cost effective models will be selected. Life cycle costing procedures, instead of first capital cost only, will be utilized as the basis for all future equipment selection. All possible efforts will be made to secure additional funding if required to effect lowest life cycle procurement. (78-; 88-Adopt; 01-No Change; 04-No Change)
18. All CSU campuses will implement a utilities charge back system to recover costs of utilities provided to self-supporting and external organizations. (78-; 88-Adopt; 01-No Change; 04-No Change)
19. All CSU campuses will take every necessary step to conserve water resources, including such steps as installing controls to optimize irrigation water, reducing water usage in restrooms and showers, and promoting the use of reclaimed water. The use of decorative fountains should be minimized. In the event of a declaration of drought, the CSU will cooperate with the state, city, and county governments to the greatest extent possible to effect additional water conservation. (78-; 88-Adopt; 01-No Change; 04-No Change)
20. The CSU will encourage continued energy conservation and lowest utilities operating costs on its campuses by instituting incentive plans designed to recognize and reward meritorious achievements by campus staff, faculty, and students beyond normal expectation. These incentive plans will be designed in such a fashion that they are adaptable to changing budget constraints from year to year. (78-Adopt; 88-Revise; 01-No Change; 04-Revise)



Charles B. Reed
Chancellor

Dated: August 2, 2006



HUMBOLDT STATE UNIVERSITY

Senior Director of Facilities Management

voice 707.826.5909

fax 707.826-5888

Humboldt Energy Independence Fund

Dear Members of the HEIF Committee:

I am writing to express my support for the *Relight Redwood Bowl* project, as proposed by the Alliance to Save Energy's Green Campus Program (GC) at Humboldt State University. HSU Plant Operations (PO) acknowledges the environmental and cost-savings benefits associated with the retrofit of the existing system and has partnered with GCP on the project.

Furthermore, we have agreed to pay the remaining costs for equipment and installation after the requested HEIF funds are approved and administered. Furthermore, PO is currently responsible for the maintenance of the existing lighting system, and thus, will be responsible for the maintenance of the proposed system, including the removal and disposal of expired equipment, i.e. bulbs.

Relight Redwood Bowl project total: \$ 255,770 (capital + installation + labor)

GC requested HEIF funds: \$ 75,000

UC/CSU/IOU Partnership Rebate funding: \$ 14,592.96

PO will contribute the remaining: \$ 166,177.04

Sincerely,

Tim Moxon
Director, Plant Operations
1 Harpst Street
Arcata, CA 95521
707.826.3646

Appendix D: Light Pollution effects on wildlife and human health

Of particular interest are forest mammals that reside in the adjacent redwood forest surrounding Redwood Bowl. Colonies of *Rhinolophus ferrumequinum*, *Myotis emarginatus* and *M. oxygnathus* bats in illuminated and non-illuminated buildings found in close proximity to each other were investigated in a 2007 study by Boldogh and Deobrosi in the journal *Acta Chiropterologica*. The onset and timing of nocturnal emergence was studied, as well as the body mass and forearm length of juvenile bats. Results show that bright artificial lighting delays the onset or significantly prolongs the duration of emergence and, in the worst cases, may destroy the whole colony. Juveniles studied near illuminated buildings were significantly smaller than ones in non-illuminated areas. The differences in length of forearm and in body mass may suggest that the parturition time starts later and/or the growth rate is lower in bats living in or near illuminated buildings. Thus, artificial lighting could have serious setbacks in the conservation of house-dwelling bat colonies. For our purposes, we assume stadium lighting to be comparable to building illumination.

Redwood Bowl's proximity to oceanic ecosystems is important to consider. Marianne Moore, a limnologist at Wellesley College, is studying artificial light on zooplankton. Zooplankton reside below the surface during the day to avoid predators, then rise to graze on algae at night. Artificial light discourages these organisms from venturing toward the surface at night. "If their grazing is inhibited . . . effects will cascade up the food chain," Moore says in *Conservation*. Algae populations could explode in response to reduced predation, and those blooms would deplete oxygen levels critical to fish, crowd out other photosynthesizers, and cast unwanted daytime shade on submerged aquatic vegetation that provides habitat for juvenile fish. When Moore and her colleagues experimentally blocked light from filtering into the depths, they found that some small taxa of zooplankton ascended two to three meters more than they had done under typical unnaturally bright conditions.

NOTE: The claims stated in this section are largely speculative for this proposal and may not be entirely applicable to regional ecological systems. However, these statements should be considered based on their relevancy, if only qualitatively.

Sources:

Boldogh, Sander and Denes Dobrosi. "The Effects of the Illumination of Buildings on House-dwelling bats and its Conservation Consequences." *Acta Chiropterologica*; 2007, Vol. 9 Issue 2, p527-534.

Harder, Ben. "Degraded Darkness." *Conservation Magazine*. Spring 2004, Vol. 5, No. 2.

Lighting Effects on Human Communities

Major cities can broadcast sky glow as far as 250 to 300 kilometers, perpetually illuminating a sector of the sky everywhere within that radius. While Arcata is not a metropolitan area, our skies are not immune to the light pollution produced by Redwood Bowl's current stadium lighting system. Artificial light has a range of effects on human physiology and behavior, and can therefore alter human physiology when inappropriately timed.

One example of potential light-induced disruption is the effect of light on circadian organization, including the production of several hormone rhythms. Changes in light-dark exposure shift the

timing of the circadian system such that internal rhythms can become desynchronized from both the external environment and internally with each other, impairing our ability to sleep and wake at the appropriate times and compromising physiologic and metabolic processes.

Light can also have direct effects on human neuroendocrine systems, for example, in suppressing melatonin synthesis or elevating cortisol production. For these reasons, the National Institute of Environmental Health Sciences convened a workshop of a diverse group of scientists to consider how best to conduct research on possible connections between lighting and health.

Source: Dark Skies Ordinances. International Dark Skies Association.
<<http://www.darksky.org/mc/page.do?sitePageId=62906&orgId=idsa>>.



March 30, 2009

Humboldt State University
Green Campus Program
#1 Harpst Street
Arcata, CA 95521

Attention: Sarah Schneider

Dear Sarah:

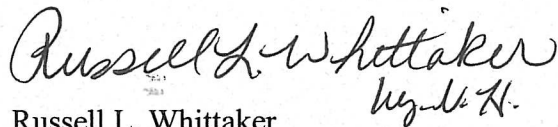
It is our pleasure to submit a labor and materials quotation to remove the existing light structures and re-install campus supplied light structures on eight (8) poles at the Redwood Bowl Sports Field at Humboldt State University.

Our Quotation \$120,392.00
Good for 30 days

This quotation is based on being allowed to drive a 64,000 lb. crane on the track. Included in this quotation is labor and materials to lay down a double layer of 3/4" plywood for track protection.

Thank you for the opportunity to assist with your electrical lighting needs. If you have any questions regarding this quotation, please call our office or you may try me on my cell at 707-499-2018.

Sincerely,



Russell L. Whittaker
Kneaper Electric
Contractors License #405518

Appendix F1: Economic Analysis of *Relight Redwood Bowl* Project

NOTE: This economic analysis compares the energy usage and associated maintenance and labor costs for the existing and proposed systems over a 25-year period. All figures are calculated in 2009 dollars. Please see following worksheets.

The stadium lights in the Redwood Bowl were used a total of 1,126 hours between June 1, 2007 and May 31, 2008 (see Appendix J: *Stadium light schedule*). To calculate the annual energy usage of the existing system in kilowatt-hours (kWh), we used the 2007-2008 figure and multiplied it by the existing system's total number of lamps and the lamp wattage, and then divided this number by 1000 watts (96 lamps x 1500 watts x 1126 hours/1000 hours = 162,144 kWh). The same equation is used to calculate the annual energy usage for the proposed system (60 lamps x 1500 watts x 1126 hours/1000 hours = 101,340 kWh). The annual energy cost of each system is found by multiplying the annual kWh by \$0.13 (the kWh rate that HSU pays for electricity from Constellation Energy).

Based on information provided by Jim Long (PO electrician), we estimate that maintenance and labor costs for the existing system will occur on average every 3.5 years during the 25-year period [(\$125 per lamp + \$59 labor) 96 lamps x 0.5 average lamp life span + \$1400 man lift rental = \$10,232 each re-lamping period].

Furthermore, Tim Moxon (Director of Plant Operations) projects that repairs of the catwalks and cross arms for all eight of the existing light structures will cost at minimum \$110,000, and would need to occur in at least five years time. By removing the current lighting structures and replacing them with the Sportscluster Green™, maintenance and labor costs would instead occur on average every 4.5 years at a cost of \$8,900 [(\$75 cost of new lamp + \$50 labor by Musco) 60 lamps + \$1400 man lift rental = \$8,900 each relamping period].

Additionally, under the Musco Constant 10™ warranty¹, the first re-lamping of the entire stadium, including labor provided by Musco, will be free of charge. With a net present value (NPV)² rate of 3 percent, total energy plus maintenance costs for the existing system will total \$173,708 over 25 years. Whereas total energy plus maintenance costs for the proposed system will total \$32,119³ over 25 years, a savings of \$141,589.

¹ HSU is eligible for the Musco Constant 10™ product assurance and warranty program that eliminates 100 percent of the maintenance costs for 10 years, including labor and materials. This includes one free re-lamping of the entire facility after 5000 hours or by year 10 of the initial installation.

² NPV is a standard method for using the time value of money to appraise long-term projects.

³ UC/CSU/IOU Partnership Rebate of ~\$14,500 is subtracted from year one (see Appendix F3 for cash flow table).

Appendix F2: Summary of Economic Analysis

Green Campus (GC) at Humboldt State University is working along with HSU Plant Operations to propose a retrofit of the existing stadium lighting system in the Redwood Bowl. The purpose of the proposed project is to maximize the energy and cost savings for the University, thereby reducing HSU's carbon footprint. Additionally, the new lighting system will also reduce light spillage by redirecting it onto the field. We have extensively researched lighting technologies and have found that Musco's Sportscluster Green™ is the most energy efficient system on the market today. The new system is projected to **save the University \$182,221 in energy costs** over a 25-year period. The project will yield an annual energy savings of **61,000 kilowatt-hours (kWh)** and a reduction of 31,861 pounds of carbon dioxide annually. The new lighting system is estimated to cost **\$255,770** (capital + installation). GC is requesting grant funding from the the Humboldt Energy Independence Fund (HEIF) in the amount of \$75,000 to cover partial cost of the new lighting system, ElitePro™ power meter, and materials for the project's interpretative signs. GC is also applying for UC/CSU/IOU Partnership rebate funding in the amount of \$14,592.96 for the annual kWh savings that will result from this lighting retrofit project. The remaining costs will paid by HSU Plant Operations.

* GC has been working with Steve Hackett (HSU Dept. of Economics) to develop the comparative cost and energy analysis the above mentioned figures are referenced from. Please see following worksheets.

Comparative Analysis Summary (costs and kWh)

	Existing System	Proposed System	Savings
Total 25-year Lifecycle Cost (In constant 2009 dollars)	\$540,755.24	\$468,714.34	\$72,040.90
Lifecycle Energy Use (2009 dollars)	\$367,046.86	\$180,825.72	\$186,221.14
Annual Energy Use (kWh)	162,144	101,340	60,804
Annual Energy Cost (2009 dollars)	\$21,078.72	\$11,198.07	\$9,880.65

Project Budget

	Cost	Requested Funds	Matching Funds	Funding Source
Sportscluster Green™ (materials)	\$135,378	\$ 69,400		Humboldt Energy Independence Fund
Interpretive signs (materials)	\$4,000	\$ 4,000		
			\$14,593	PG&E Partnership Rebate
ElitePro™ monitoring device	\$1,600	\$1,600.00		
Initial installation + labor	\$120,392		\$171,777	HSU Plant Operations
Totals	\$261,370	\$ 75,000	\$186,370	

\$ 71,000

Appendix F4: Estimated Energy Savings and Reduction in Carbon Dioxide Emissions

Annual kWh reduction		
Old System Energy Use (kWh/yr):		162,144
New System Energy Use: (kWh/yr)		101,340
Annual kWh reduction:		60,804
Partnership Rebate (\$0.24/kWh):	\$	14,592.96

Pounds of Co2 per kWh	0.524	PG&E figure
Short ton (in pounds)	2000	
CO2 reduction in lbs	31861	
CO2 reduction in tons	15.931	

Appendix F5 : Payback Period (Internal Rate of Return) Worksheet

Net cash flow analysis: Cost Savings (Cost of old system minus cost of new system). All in constant 2009 dollars

Year	Real Net Cash Flow	Accumulated Cash Flow	Real Discounted Cash Flow @ 3%	Accumulated Discounted Cash Flow
0	(\$255,770)	(\$255,770)	(\$255,770)	(\$255,770)
1	\$24,473.61	(\$231,296)	\$23,760.79	(\$232,009)
2	\$9,880.65	(\$221,416)	\$9,313.46	(\$222,696)
3	\$20,112.65	(\$201,303)	\$18,405.92	(\$204,290)
4	\$9,880.65	(\$191,422)	\$8,778.83	(\$195,511)
5	\$119,880.65	(\$71,542)	\$103,410.10	(\$92,101)
6	\$20,112.65	(\$51,429)	\$16,844.03	(\$75,257)
7	\$9,880.65	(\$41,548)	\$8,033.87	(\$67,223)
8	\$9,880.65	(\$31,668)	\$7,799.88	(\$59,423)
9	\$11,212.65	(\$20,455)	\$8,593.56	(\$50,830)
10	\$9,880.65	(\$10,575)	\$7,352.13	(\$43,477)
11	\$9,880.65	(\$694)	\$7,137.99	(\$36,339)
12	\$20,112.65	\$19,419	\$14,106.61	(\$22,233)
13	\$980.65	\$20,399	\$667.77	(\$21,565)
14	\$9,880.65	\$30,280	\$6,532.27	(\$15,033)
15	\$20,112.65	\$50,393	\$12,909.54	(\$2,123)
16	\$9,880.65	\$60,273	\$6,157.29	\$4,034
17	\$9,880.65	\$70,154	\$5,977.96	\$10,012
18	\$11,212.65	\$81,367	\$6,586.25	\$16,598
19	\$9,880.65	\$91,247	\$5,634.80	\$22,233
20	\$9,880.65	\$101,128	\$5,470.68	\$27,704
21	\$20,112.65	\$121,241	\$10,811.54	\$38,515
22	\$980.65	\$122,221	\$511.79	\$39,027
23	\$9,880.65	\$132,102	\$5,006.44	\$44,034
24	\$20,112.65	\$152,215	\$9,894.09	\$53,928
25	\$9,880.65	\$162,095	\$4,719.05	\$58,647

IRR = 5.56% Over 25 year lifetime

Payback = 11.03 Years Note: This is simple payback

Discounted Payback = 15.59 Years Note: At 3% real discount rate

Payback function algorithm: =COUNTIF(D5:D29,"<0")+1-INDEX(D5:D29,COUNTIF(D4:D29,"<0")+1)/INDEX(B5:B29,COUNTIF(D5:D29,"<0")+1)

Explanation:

- First, count number of years the accumulated cash flow is negative using the COUNTIF-function. Add one year when the accumulated cash flow turns positive.
- Second, deduct the fraction of that year that has a positive accumulated cash flow. Pick the «turnaround» year by using the INDEX-function.
- Third, this fraction is defined as that year's accumulated cash flow divided by that year's cash flow.



HUMBOLDT STATE UNIVERSITY

Office of the President

April 1, 2009

Humboldt Energy Independence Fund
Humboldt State University

Dear Members of the HEIF Committee:

I am writing to express my support for the *Relight Redwood Bowl Project*, as proposed by the Alliance to Save Energy's Green Campus Program at Humboldt State University.

The Green Campus Program (GCP) is working ardently to reduce HSU's energy consumption, and thus our carbon footprint. In the past year, Green Campus has implemented and supported campus projects that have helped prevent approximately 65 tons of carbon dioxide emissions. GCP student interns have explained to me that the new lighting system is expected to reduce the University's annual energy consumption by nearly 61,000 kWh and an average of \$16,000 in energy and maintenance costs each year. Furthermore, the new system will decrease light spillage and glare by 50 percent.

In addition, Executive Order 987, Policy Statement on Energy Conservation, Sustainable Building Practices, and Physical Plant Management for the CSU as mandated by the Chancellor's Office, calls for "the five-year goal of reducing energy consumption by 15% [and] will be evaluated at the end of fiscal year 09/10." Pursuant to efficiency mandates, I recognize relighting Redwood Bowl as an excellent energy improvement measure. Furthermore, I believe this project will be an invaluable educational opportunity for the campus community to see energy efficiency in action as there will be interpretive signs, created by HSU students, highlighting the project's energy saving features. This project is also a collaborative effort, and thus aligns with HSU's goal to incorporate stronger shared governance. Finally, it is a wonderful example of the role that students play in helping us to move this campus towards energy independence and thus reinforces my support for the HEIF Program. Thank you for your careful consideration of this proposal.

Sincerely,

Rollin C. Richmond
President

Appendix H: List of Partners, Consultants and Contributors

Many students, faculty, staff, administrators and community members contributed to Relighting Redwood Bowl. A list of each contributor and the capacity to which they helped follows (listed alphabetically by surname):

Mark Baker (PO Maintenance Manager and Director of Construction Management) assisted GC in obtaining and converting Redwood Bowl stadium layout which were used in obtaining a budget estimate from Musco Lighting® and RLL Design.

Dan Collen (Athletic Director, HSU) has provided support, approval and contact information for members of City of Arcata's retrofit for the Crabs baseball field.

TallChief Comet (HSU Sustainability Coordinator) has been supportive of GC's goals and objectives.

Jasen Deniz (Musco Lighting® Sales Representative) has been consulted frequently regarding the specifications of the Sportscluster Green™ lighting system. Mr. Deniz is the sales representative on this project.

Dan Diemer (City of Arcata Parks & Recreation Supervisor) has provided important information regarding City of Arcata stadium lighting installed by Musco Lighting®.

Richard Engel (Senior Engineer, Schatz Energy Research Center) is the GCP faculty campus advisor and has contributed to this project by providing feedback and support.

Chris Escarcega (Former GCP Program Coordinator) has contributed research and analysis, served as a contact with Musco Lighting®, provided feedback and editing.

Justin Fricker (GCP 2009 Intern) measured current field lighting.

Jamila Ghaul (GCP Program Coordinator) co-authored the HEIF proposal and developed the RRB project webpage for the Green Campus website

<<http://www.humboldt.edu/~greenhsu/cms/gc/main/relight-redwood-bowl-project>>.

Steve Hackett (Professor in the Economics Department). Professor Hackett has been instrumental in assisting GC in developing the economic analysis, specifically calculating the lifecycle costs of both systems, the payback period for the proposed system, and the energy savings associated with the proposed retrofit.

Carmen King (Energy Analyst for Newcomb, Anderson and McCormick, HSU Alum, previous GCP coordinator,) assisted with research and analytical methodologies, as well as consultation regarding the application for UC/CSU/IOU Partnership Rebate funding.

Morgan King (Co-chair of Energy Committee for the City of Arcata, Program Manager for Strategic Energy Innovations and Campus Lead for GC) has been an invaluable source of support and knowledge throughout the proposal process.

Kneaper Electric (Contractor) has provided GC with the cost estimate for installing the new lighting system.

Jim Long (PO Electrician in charge of RWB lights) provide information on the current stadium lighting system.

Beckie Menten (City of Arcata Energy Specialist) has also been a reliable contact for questions about proposal.

Tim Moxon (Director of Plant Operations) has been instrumental in the development and promotion of the RRB project. Mr. Moxon is also the primary project partner (see Attachment C: *Tim Moxon Letter of Support*).

Burt Nordstrom (HSU Vice President of Administrative Affairs) was consulted by GC student interns.

Rollin Richmond (University President) GC has also received support for the RRB project from (see Appendix G: *President Richmond's Letter of Support*).

Kale Roberts (GCP Program Coordinator) co-authored the HEIF proposal, measured current field lighting, marketed the project, conducted research, and coordinated the proposal process.

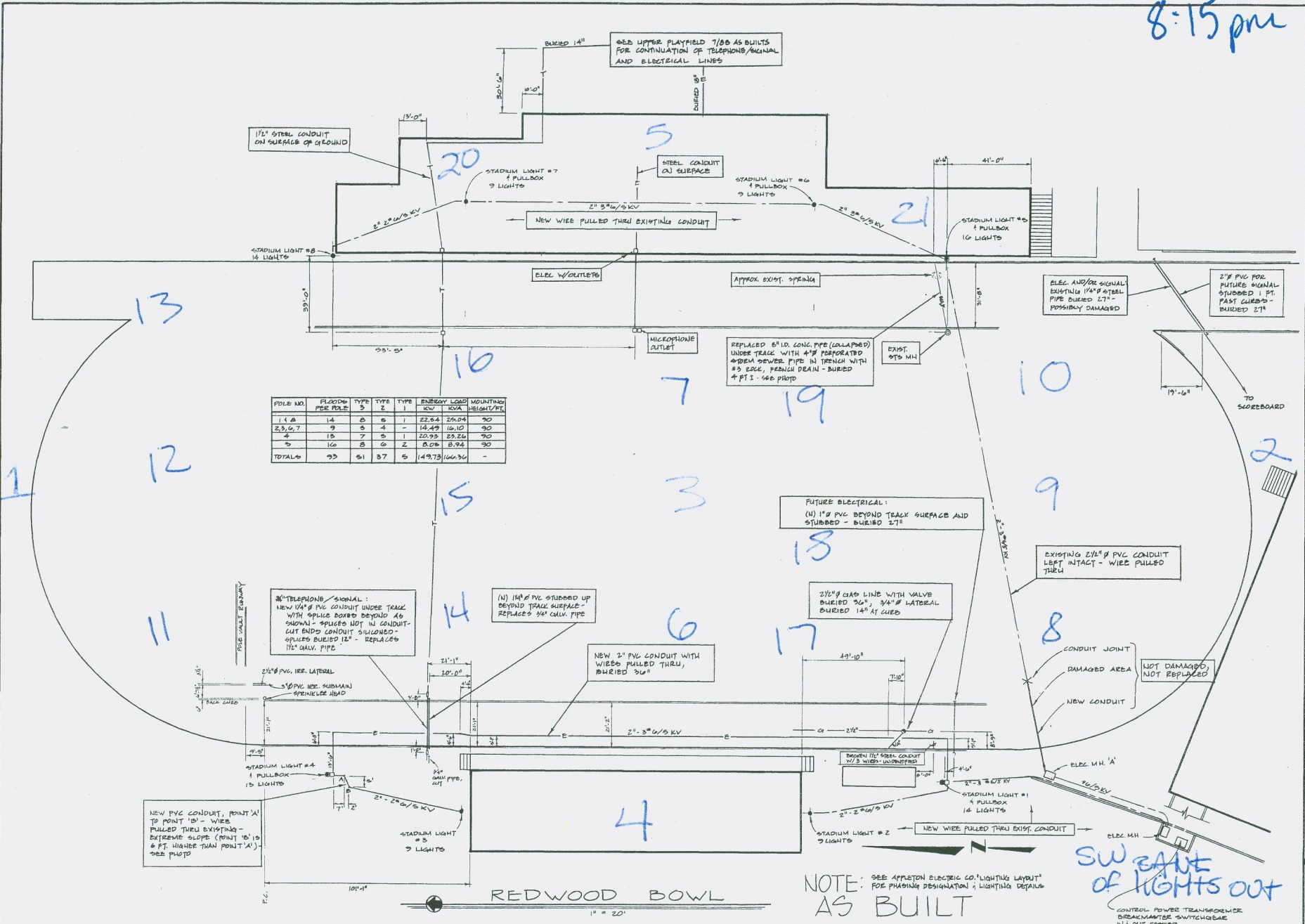
Sarah Schneider (GCP Program Coordinator) co-authored the HEIF proposal, developed the economic analysis for the project, garnered support for the project from staff and administered, measured current field lighting, conducted research, obtained quotes from Musco Lighting® and Kneaper Electric, and coordinated the proposal process.

Adrienne Spitzer (GCP Intern) measured current field lighting and collected information regarding light pollution effects on wildlife from the HSU Wildlife Department.

Aydee Virgen (Graduated GCP intern) wrote the 2008 proposal draft and did some preliminary research on stadium lighting hours of operation.

Carolyn Weddle (GCP Intern) measured current field lighting and promoted the project during tabling events.

02/26/09
8:15 pm



FILE NO.	FLOODS PER FILE	TYPE 3	TYPE 2	TYPE 1	ENERGY LOAD KW	KVA	MOUNTING HEIGHT/FT.
1 & 4	14	3	3	1	22.84	29.04	30
2, 3, 6, 7	9	3	4	-	14.49	18.10	30
4	13	7	3	1	20.93	23.24	30
5	16	3	6	2	5.08	6.94	30
TOTALS	52	31	37	5	149.73	166.34	-

NOTE: SEE APPLETON ELECTRIC CO.'S LIGHTING LAYOUT FOR PHASING DESIGNATION & LIGHTING DETAILS

SW EAST of LIGHTS OUT
CONTROL POWER TRANSFORMER BREAKMASTER SWITCHGEAR IN OUT PROCESS

CROSS CHECKED: NAME: POLLE HAWKINS, OFFICE: PLANT OPERATIONS, PHONE: 707-826-3646
 SCALE: 1" = 20'
 DATE: 11 MARCH 1985
 DRAWN: WASHLEY-HOPKINS
 DESIGN: APPROVED: APPROVED: PROJECT: SE 84/85
 HUMBOLDT STATE UNIVERSITY
 REDWOOD BOWL
 STADIUM FLOODLIGHTS
 ELECTRICAL PLAN
 SHEET NO. 1
 04.11 of 31 Redwood_bowl_electrical_plan_1985_03-11-09 ONE

I

Redwood Bowl Light Meter Readings

Green Campus, Feb 26th, 2009

Weather Conditions:

mostly cloudy,
NO RAIN 50°F

Time:

8:15pm

<u>Field Location</u>	<u>Footcandles</u>	<u>Lux</u>
1	29.7	11 67.3
2	6	12 44.9
3	42.1	13 78.8
4		14 66.4
5	9.2	15 49.3
6	51	16 67.0
7	40.9	17 54.0
8		18 56.0
9		19 56
10		20 20.0
		21 11.6

AVG: 45.88 FC.

Appendix J: Redwood Bowl Stadium Light Schedule

June 1, 2007 - May 31, 2008

Date	Night Activity	Start Time	End Time	Hours	kW *	kWh
June	<i>Sundown at 8:45 PM (PDT)</i>					
6/1/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/2/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/3/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/4/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/5/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/6/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/7/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/8/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/9/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/10/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/11/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/12/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/13/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/14/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/15/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/16/07	HOP	8:45 PM	10:00 PM	1.25	115.92	144.90
6/17/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/18/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/19/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/20/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/21/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/22/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/23/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/24/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/25/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/26/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/27/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/28/07	HOP	8:45 PM	10:00 PM	1.25	115.92	144.90
6/29/07		8:45 PM	10:00 PM	1.25	19.32	24.15
6/30/07		8:45 PM	10:00 PM	1.25	19.32	24.15
	Add'l Safety Hours			0.00		
	Totals			37.50		966.00
July	<i>Sundown at 8:45 PM (PDT)</i>					
7/1/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/1/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/2/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/3/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/4/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/5/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/6/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/7/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/8/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/9/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/10/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/11/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/12/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/13/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/14/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/15/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/16/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/17/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/18/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/19/07	HOP	8:45 PM	10:00 PM	1.25	115.92	144.90
7/20/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/21/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/22/07	Football Camp	8:45 PM	9:00 PM	0.25	115.92	28.98
7/23/07	Football Camp	8:45 PM	9:00 PM	0.25	115.92	28.98
7/24/07	Football Camp	8:45 PM	9:00 PM	0.25	115.92	28.98
7/25/07	Football Camp	8:45 PM	9:00 PM	0.25	115.92	28.98
7/26/07	Football Camp	8:45 PM	9:00 PM	0.25	115.92	28.98
7/27/07	Football Camp	8:45 PM	9:00 PM	0.25	115.92	28.98
7/28/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/29/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/30/07		8:45 PM	10:00 PM	1.25	19.32	24.15
7/31/07		8:45 PM	10:00 PM	1.25	19.32	24.15
	Add'l Safety Hours			6.00	19.32	115.92
	Totals			40.00		1038.45
August	<i>Sundown at 8:15 PM (PDT)</i>					
8/1/07	Soccer Camp	8:15 PM	9:00 PM	0.75	115.92	86.94
8/2/07		8:15 PM	10:00 PM	1.75	19.32	33.81
8/3/07		8:15 PM	10:00 PM	1.75	19.32	33.81
8/4/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/5/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/6/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/7/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/8/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/9/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98

8/10/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/11/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/12/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/13/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/14/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/15/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/16/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/17/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/18/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/19/07	Football Practice	8:15 PM	8:30 PM	0.25	115.92	28.98
8/20/07		8:15 PM	10:00 PM	1.75	19.32	33.81
8/21/07	PE 324	8:15 PM	10:00 PM	1.75	115.92	202.86
8/22/07	PE 323	8:15 PM	10:00 PM	1.75	115.92	202.86
8/23/07	Soccer	8:15 PM	11:00 PM	2.75	115.92	318.78
8/24/07		8:15 PM	10:00 PM	1.75	19.32	33.81
8/25/07		8:15 PM	10:00 PM	1.75	115.92	202.86
8/26/07		8:15 PM	10:00 PM	1.75	19.32	33.81
8/27/07	PE 315	8:15 PM	10:00 PM	1.75	115.92	202.86
8/28/07	PE 324	8:15 PM	10:00 PM	1.75	115.92	202.86
8/29/07	PE 323	8:15 PM	10:00 PM	1.75	115.92	202.86
8/30/07	Soccer	8:15 PM	11:00 PM	2.75	115.92	318.78
8/31/07		8:15 PM	10:00 PM	1.75	19.32	33.81
	Add'l Safety Hours			25.00	19.32	483.00
	Totals			56.25		3091.20

September *Sundown at 7:30 PM (PDT)*

9/1/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/2/07	Ultimate	7:30 PM	8:00 PM	0.50	115.92	57.96
9/3/07	PE 315	7:30 PM	10:00 PM	2.50	115.92	289.80
9/4/07	PE 324	7:30 PM	10:00 PM	2.50	115.92	289.80
9/5/07	PE 323	7:30 PM	10:00 PM	2.50	115.92	289.80
9/6/07	Soccer	7:30 PM	11:00 PM	3.50	115.92	405.72
9/7/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/8/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/9/07	Ultimate	7:30 PM	8:00 PM	0.50	115.92	57.96
9/10/07	PE 315	7:30 PM	10:00 PM	2.50	115.92	289.80
9/11/07	PE 324	7:30 PM	10:00 PM	2.50	115.92	289.80
9/12/07	PE 323	7:30 PM	10:00 PM	2.50	115.92	289.80
9/13/07	Soccer	7:30 PM	11:00 PM	3.50	115.92	405.72
9/14/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/15/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/16/07	Ultimate	7:30 PM	8:00 PM	1.50	115.92	173.88
9/17/07	PE 315	7:30 PM	10:00 PM	2.50	115.92	289.80
9/18/07	PE 324	7:30 PM	10:00 PM	2.50	115.92	289.80
9/19/07	PE 323	7:30 PM	10:00 PM	2.50	115.92	289.80
9/20/07	Soccer	7:30 PM	11:00 PM	3.50	115.92	405.72
9/21/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/22/07		7:30 PM	10:00 PM	2.50	19.32	48.30
9/23/07	Ultimate	7:30 PM	8:00 PM	0.50	115.92	57.96
9/24/07	PE 315	7:30 PM	10:00 PM	2.50	115.92	289.80
9/25/07	PE 324	7:30 PM	10:00 PM	2.50	115.92	289.80
9/26/07	PE 323	7:30 PM	10:00 PM	2.50	115.92	289.80
9/27/07	Soccer	7:30 PM	11:00 PM	3.50	115.92	405.72
9/28/07	Ultimate	7:30 PM	8:00 PM	0.50	115.92	57.96
9/29/07	Football Game	7:30 PM	10:00 PM	2.50	231.84	579.60
9/30/07	Ultimate	7:30 PM	8:00 PM	0.50	115.92	57.96
	Add'l Safety Hours			12.00	19.32	231.84
	Totals			80.00		6713.70

October *Sundown at 6:30 PM (PDT)*

10/1/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
10/2/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
10/3/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
10/4/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
10/5/07		6:30 PM	10:00 PM	3.50	19.32	67.62
10/6/07	Football Game	6:30 PM	10:00 PM	3.50	231.84	811.44
10/7/07	Ultimate	6:30 PM	8:00 PM	1.50	115.92	173.88
10/8/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
10/9/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
10/10/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
10/11/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
10/12/07		6:30 PM	10:00 PM	3.50	19.32	67.62
10/13/07	Football Game	6:30 PM	10:00 PM	3.50	231.84	811.44
10/14/07	Ultimate	6:30 PM	8:00 PM	1.50	115.92	173.88
10/15/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
10/16/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
10/17/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
10/18/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
10/19/07	AHS Football Game	6:30 PM	11:00 PM	4.50	231.84	1043.28
10/20/07		6:30 PM	10:00 PM	3.50	19.32	67.62
10/21/07	Ultimate	6:30 PM	8:00 PM	1.50	115.92	173.88
10/22/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
10/23/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
10/24/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76

10/25/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
10/26/07		6:30 PM	10:00 PM	3.50	19.32	67.62
10/27/07		6:30 PM	10:00 PM	3.50	19.32	67.62
10/28/07	Ultimate	6:30 PM	8:00 PM	1.50	115.92	173.88
10/29/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
10/30/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
10/31/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
	Add'l Safety Hours			17.50	19.32	338.10
	Totals			113.50		11109.00
November	<i>Sundown at 5:00 PM (PST)</i>					
11/1/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
11/2/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/3/07	Football Game	5:00 PM	10:00 PM	5.00	231.84	1159.20
11/4/07	Ultimate	6:00 PM	8:00 PM	2.00	115.92	231.84
11/5/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
11/6/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
11/7/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
11/8/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
11/9/07	AHS Football Game	5:00 PM	11:00 PM	6.00	231.84	1391.04
11/10/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/11/07	Ultimate	6:00 PM	8:00 PM	2.00	115.92	231.84
11/12/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
11/13/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
11/14/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
11/15/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
11/16/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/17/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/18/07	Youth Football / Ultimate	5:00 PM	8:00 PM	3.00	115.92	347.76
11/19/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
11/20/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
11/21/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
11/22/07	Soccer	7:00 PM	11:00 PM	3.00	115.92	347.76
11/23/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/24/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/25/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/26/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/27/07	Rugby	5:00 PM	6:00 PM	1.00	115.92	115.92
11/28/07		5:00 PM	10:00 PM	5.00	19.32	96.60
11/29/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
11/30/07		5:00 PM	10:00 PM	5.00	19.32	96.60
	Add'l Safety Hours			40.00	19.32	772.80
	Totals			155.00		10548.72
December	<i>Sundown at 4:45 PM (PST)</i>					
12/1/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/2/07	Ultimate	6:00 PM	8:00 PM	2.00	115.92	231.84
12/3/07	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
12/4/07	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
12/5/07	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
12/6/07	Soccer	7:00 PM	11:00 PM	4.00	115.92	463.68
12/7/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/8/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/9/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/10/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/11/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/12/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/13/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/14/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/15/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/16/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/17/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/18/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/19/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/20/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/21/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/22/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/23/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/24/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/25/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/26/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/27/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/28/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/29/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/30/07		4:45 PM	10:00 PM	5.25	19.32	101.43
12/31/07		4:45 PM	10:00 PM	5.25	19.32	101.43
	Add'l Safety Hours			12.25	19.32	236.67
	Totals			163.75		4612.65
January	<i>Sundown at 5:15 PM (PST)</i>					
1/1/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/2/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/3/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/4/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/5/08		5:15 PM	10:00 PM	4.75	19.32	91.77

1/6/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/7/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/8/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/9/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/10/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/11/08	Rugby	5:15 PM	6:00 PM	0.75	115.92	86.94
1/12/08	Rugby	5:15 PM	6:00 PM	0.75	115.92	86.94
1/13/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/14/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/15/08	Rugby	5:15 PM	6:00 PM	0.75	115.92	86.94
1/16/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/17/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/18/08	Rugby	5:15 PM	7:00 PM	1.75	115.92	202.86
1/19/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/20/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/21/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/22/08	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
1/23/08	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
1/24/08	Intramurals	7:00 PM	11:00 PM	4.00	115.92	463.68
1/25/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/26/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/27/08		5:15 PM	10:00 PM	4.75	19.32	91.77
1/28/08	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
1/29/08	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
1/30/08	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
1/31/08	Intramurals	7:00 PM	11:00 PM	4.00	115.92	463.68
	Add'l Safety Hours			27.25	19.32	526.47
	Totals			149.25		5491.71

February	<i>Sundown at 5:45 PM (PST)</i>					
-----------------	---------------------------------	--	--	--	--	--

2/1/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/2/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/3/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/4/08	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
2/5/08	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
2/6/08	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
2/7/08	Intramurals	7:00 PM	11:00 PM	4.00	115.92	463.68
2/8/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/9/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/10/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/11/08	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
2/12/08	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
2/13/08	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
2/14/08	Intramurals	7:00 PM	11:00 PM	4.00	115.92	463.68
2/15/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/16/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/17/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/18/08	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
2/19/08	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
2/20/08	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
2/21/08	Intramurals	7:00 PM	11:00 PM	4.00	115.92	463.68
2/22/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/23/08		5:45 PM	10:00 PM	4.25	19.32	82.11
2/24/08	Soccer Game	5:45 PM	11:00 PM	5.25	231.84	1217.16
2/25/08	PE 324	7:00 PM	10:00 PM	3.00	115.92	347.76
2/26/08	PE 323	7:00 PM	10:00 PM	3.00	115.92	347.76
2/27/08	PE 315	7:00 PM	10:00 PM	3.00	115.92	347.76
2/28/08	Intramurals	7:00 PM	11:00 PM	4.00	115.92	463.68
2/29/08		5:45 PM	10:00 PM	4.25	19.32	82.11
	Add'l Safety Hours			20.00	19.32	386.40
	Totals			128.25		8616.72

March	<i>Sundown at 7:15 PM (PDT)</i>					
--------------	---------------------------------	--	--	--	--	--

3/1/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/2/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/3/08	PE 324	7:15 PM	10:00 PM	2.75	115.92	318.78
3/4/08	PE 323	7:15 PM	10:00 PM	2.75	115.92	318.78
3/5/08	PE 315	7:15 PM	10:00 PM	2.75	115.92	318.78
3/6/08	Intramurals	7:15 PM	11:00 PM	3.75	115.92	434.70
3/7/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/8/08	Disc	7:15 PM	10:00 PM	2.75	115.92	318.78
3/9/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/10/08	PE 324	7:15 PM	10:00 PM	2.75	115.92	318.78
3/11/08	PE 323	7:15 PM	10:00 PM	2.75	115.92	318.78
3/12/08	PE 315	7:15 PM	10:00 PM	2.75	115.92	318.78
3/13/08	Intramurals	7:15 PM	11:00 PM	3.75	115.92	434.70
3/14/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/15/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/16/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/17/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/18/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/19/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/20/08		7:15 PM	10:00 PM	2.75	19.32	53.13
3/21/08		7:15 PM	10:00 PM	2.75	19.32	53.13

3/22/08 Soccer	7:15 PM	11:00 PM	3.75	115.92	434.70
3/23/08	7:15 PM	10:00 PM	2.75	19.32	53.13
3/24/08 PE 324	7:15 PM	10:00 PM	2.75	115.92	318.78
3/25/08 PE 323	7:15 PM	10:00 PM	2.75	115.92	318.78
3/26/08 PE 315	7:15 PM	10:00 PM	2.75	115.92	318.78
3/27/08 Intramurals	7:15 PM	11:00 PM	3.75	115.92	434.70
3/28/08	7:15 PM	10:00 PM	2.75	19.32	53.13
3/29/08	7:15 PM	10:00 PM	2.75	19.32	53.13
3/30/08	7:15 PM	10:00 PM	2.75	19.32	53.13
3/31/08 PE 324	7:15 PM	11:00 PM	3.75	115.92	434.70

Add'l Safety Hours			0.00	19.32	0.00
Totals			90.25		6211.38

April	<i>Sundown at 8:00 PM (PDT)</i>				
--------------	---------------------------------	--	--	--	--

4/1/08 PE 323	8:00 PM	10:00 PM	2.00	115.92	231.84
4/2/08 PE 315	8:00 PM	10:00 PM	2.00	115.92	231.84
4/3/08 Intramurals	8:00 PM	11:00 PM	3.00	115.92	347.76
4/4/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/5/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/6/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/7/08 PE 324	8:00 PM	10:00 PM	2.00	115.92	231.84
4/8/08 PE 323	8:00 PM	10:00 PM	2.00	115.92	231.84
4/9/08 PE 315	8:00 PM	10:00 PM	2.00	115.92	231.84
4/10/08 Intramurals	8:00 PM	11:00 PM	3.00	115.92	347.76
4/11/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/12/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/13/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/14/08 PE 324	8:00 PM	10:00 PM	2.00	115.92	231.84
4/15/08 PE 323	8:00 PM	10:00 PM	2.00	115.92	231.84
4/16/08 PE 315	8:00 PM	10:00 PM	2.00	115.92	231.84
4/17/08 Intramurals	8:00 PM	11:00 PM	3.00	115.92	347.76
4/18/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/19/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/20/08 Mad River Soccer	8:00 PM	9:00 PM	1.00	115.92	115.92
4/21/08 PE 324	8:00 PM	10:00 PM	2.00	115.92	231.84
4/22/08 PE 323	8:00 PM	10:00 PM	2.00	115.92	231.84
4/23/08 PE 315	8:00 PM	10:00 PM	2.00	115.92	231.84
4/24/08 Intramurals	8:00 PM	11:00 PM	3.00	115.92	347.76
4/25/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/26/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/27/08	8:00 PM	10:00 PM	2.00	19.32	38.64
4/28/08 PE 324	8:00 PM	10:00 PM	2.00	115.92	231.84
4/29/08 PE 323	8:00 PM	10:00 PM	2.00	115.92	231.84
4/30/08 PE 315	8:00 PM	10:00 PM	2.00	115.92	231.84

Add'l Safety Hours			1.00	19.32	19.32
Totals			64.00		5197.08

May	<i>Sundown at 8:30 PM (PDT)</i>				
------------	---------------------------------	--	--	--	--

5/1/08 Intramurals	8:30 PM	11:00 PM	2.50	115.92	289.80
5/2/08 PE 324	8:30 PM	10:00 PM	1.50	115.92	173.88
5/3/08 PE 323	8:30 PM	10:00 PM	1.50	115.92	173.88
5/4/08 PE 315	8:30 PM	10:00 PM	1.50	115.92	173.88
5/5/08 Intramurals	8:30 PM	11:00 PM	2.50	115.92	289.80
5/6/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/7/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/8/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/9/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/10/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/11/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/12/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/13/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/14/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/15/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/16/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/17/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/18/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/19/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/20/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/21/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/22/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/23/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/24/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/25/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/26/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/27/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/28/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/29/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/30/08	8:30 PM	10:00 PM	1.50	19.32	28.98
5/31/08	8:30 PM	10:00 PM	1.50	19.32	28.98

Add'l Safety Hours			0.00	19.32	0.00
Totals			48.50		1854.72

Appendix F3: Relight Redwood Bowl Stadium Lighting Analysis Worksheet
Spring 2009 HEIF Proposal

Brief Project Description:

Green Campus (GC) at Humboldt State University is working along with HSU Plant Operations to propose a retrofit of the existing stadium lighting system in the Redwood Bowl. The purpose of the proposed project is to maximize the energy and cost savings for the University, thereby reducing HSU's carbon footprint. Additionally, the new lighting system will also reduce light spillage by redirecting it onto the field. We have extensively researched lighting technologies and have found that Musco's Sportscluster Green™ is the most energy efficient system on the market today.

Parameter Set

Hours per year lights are used:	1126 Stadium lighting schedule (hours of use) from 6/1/07 - 5/31/08
Number of fixtures, old system:	96
Energy consump, old bulbs (kW):	1.5
Number of fixtures, new system:	60 60 fixtures (from Musco) 0.57901
Energy consump, new bulbs (kW):	1.5 Smart lamp technology with capacitors that are able to control light output to provide a guaranteed constant 50 footcandles and 5000 hours of use.
Cost of old bulb (per fixture) plus labor, excluding ManLift:	\$184 Old \$75.00 New bulb \$125.00 New (includes installation cost by Musco)
Electricity price to HSU (\$/kWh):	\$0.13
Old lighting fixture replacement cycle (hours):	5,630 Jim Long indicated that bulbs have to be replaced on average every 5 years.
New lighting fixture replacement cycle (hours):	5,000
New lighting system installation cost:	\$120,392 Quote from Kneaper Electric on 3/30/09. Once project is officially out to bid, cost could lower by 10-15%
Up-front cost of system (not installed cost) plus 9% Arcata sales tax:	\$135,378 April 1, 2009 min. state sales tax will be 8.25%. City of Arcata sales tax will be 9% starting April 1, 2009.
Cost of ManLift rental, maintaining existing system:	\$1,400 \$1100 rental per day plus \$300 cost of transport round trip from United Rentals in Eureka
Efficiency gain, computer controls (% of electricity use):	15%
Reduction in emissions (CO2 lbs)	31861 Avoided CO2 analysis using PG&E figures (0.524 lbs CO2 per kWh)
Cost of repairing existing catwalks and cross arms on poles	\$110,000 Very low estimate of repair (inc. labor) provided by Tim Moxon for the 8 existing poles if new lighting system not installed.

Lifecycle cost, existing system

Year	Energy Cost (real 2009 dollars)	Maint & Repair Cost (2009 dollars)
1	\$21,078.72	
2	\$21,078.72	
3	\$21,078.72	\$10,232.0
4	\$21,078.72	
5	\$21,078.72	\$110,000 **
6	\$21,078.72	\$10,232.0
7	\$21,078.72	
8	\$21,078.72	
9	\$21,078.72	\$10,232.0
10	\$21,078.72	
11	\$21,078.72	
12	\$21,078.72	\$10,232.0
13	\$21,078.72	
14	\$21,078.72	
15	\$21,078.72	\$10,232.0
16	\$21,078.72	
17	\$21,078.72	
18	\$21,078.72	\$10,232.0
19	\$21,078.72	
20	\$21,078.72	
21	\$21,078.72	\$10,232.0
22	\$21,078.72	
23	\$21,078.72	
24	\$21,078.72	\$10,232.0
25	\$21,078.72	

These costs will be the following: (i) energy consumption; (ii) periodic repair/maintenance (relamping, catwalk repair, etc)
 **Tim Moxon says repair would need to take place in 5 years.
 We will use today's costs and leave out inflation in the NPV formula

Relamping cycle in years = (hours/year):

5

Note: Some bulbs have been burning out sooner than 5 years. Bbecause of the high cost of replacing bulbs (man lift rental, new bulb and labor) a number of bulbs are allowed to go unreplaced. However, The university cannot allow the field go completely dark before it relamps thus you used a conservative figure of relamping 1/2 of the bulbs every 3 years. Since the field can't get dark, we assume we relamp half the bulbs every 3 years.
 (See email from Jim Long).

Present value of costs, existing system: (Based on a 3% real discount rate)

\$367,046.86	Energy Costs
\$173,708.38	Maintenance plus labor
\$540,755.24	Total Lifecycle Cost, Constant 2009 Dollars

Lifecycle cost, new system

Year	Energy Cost (real 2009 dollars)	Maint & Repair Cost (2009 dollars)
0	\$255,770	
1	(\$3,394.89)	Partnership Rebate of ~\$14,500 for energy savings is subtracted from year 1
2	\$11,198.07	
3	\$11,198.07	
4	\$11,198.07	\$0.00
5	\$11,198.07	
6	\$11,198.07	
7	\$11,198.07	

These costs will be the following: (i) energy consumption; (ii) periodic repair/maintenance (relamping, catwalk repair, etc)

We will use today's costs and leave out inflation in the NPV formula

8	\$11,198.07	
9	\$11,198.07	\$8,900.00
10	\$11,198.07	
11	\$11,198.07	
12	\$11,198.07	
13	\$11,198.07	\$8,900.00
14	\$11,198.07	
15	\$11,198.07	
16	\$11,198.07	
17	\$11,198.07	
18	\$11,198.07	\$8,900.00
19	\$11,198.07	
20	\$11,198.07	
21	\$11,198.07	
22	\$11,198.07	\$8,900.00
23	\$11,198.07	
24	\$11,198.07	
25	\$11,198.07	

Relamping cycle in years = 5,000/(hours/year): 4.4 Thus alternating 4 and 5 year replacement cycle

Musco maintenance cost, not including any relamping: \$500 visit
 Estimated relamping of facility by Musco: ~\$8000 (60 fixtures * \$125/fixture + \$500 maintenance visit fee)

Present value of costs, new system: (Based on a 3% real discount rate)	
\$180,825.72	Energy Costs
\$32,118.62	Maintenance plus labor
\$468,714.34	Total Lifecycle Cost, Constant 2009 Dollars