CITY OF LOS ANGELES
CALIFORNIA

DEPARTMENT OF
PUBLIC WORKS

BUREAU OF
ENGINEERING

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The Los Angeles City Council

Honorable Ed P. Reyes, Chair
Planning & Land Use Management Committee
Los Angeles City Council

c/o Barbara Greaves
City Clerk
City Hall Room 350

Dear Councilmember Reyes and Honorable Members:

INCORPORATE ROOFTOP GREEN SPACES AS AN ENERGY EFFICIENCY MECHANISM - COUNCIL FILE 04-0074

The following is a report in response to the Council Planning and Land Use Management (PLUM) Committee's direction on May 2, 2006 to prepare a proposal for a pilot program to demonstrate green roof technology on City buildings. This report was prepared following an oral report to the PLUM Committee on August 8, 2006.

Recommendations:

1. Direct the City Engineer to report back to the PLUM Committee on the progress of the projects chosen for a pilot green roof program.
   - Include the South Los Angeles Neighborhood City Hall in Council District 9 as part of the green roof pilot program (new construction).
   - Select one or more additional projects from the list of potential buildings as pilot projects. (new construction or retrofit construction).

2. Direct the Environmental Affairs Department (EAD) to apply for appropriate sources of grant funding for use in green roof design, planting, monitoring, maintenance, and other activities to support the pilot program. Direct EAD to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

3. Direct the City Administrative Officer to identify additional funding for the selected projects.

4. Direct the City Engineer to work with EAD and the Green Roofs Task Force on project elements as they move forward.

A. Options for New City Projects With a Green Roof

The PLUM Committee requested one or more options for new City projects that could incorporate a green roof. The following objectives have been identified to guide the decision on the pilot projects. While all objectives may not be met in a single project, this list is intended to assist with the decision:

Objectives for Pilot Project:

1. Clear environmental benefits.
2. Visible although not necessarily accessible to the public.
3. Fundable, with maintenance dollars identified.
4. Technically feasible.
5. Accessible for monitoring.
6. Over an inhabited and conditioned space.
7. Achievable in the near term.
8. Possibly identify two similar projects for comparison, such as: a) one intensive[1] roof and one extensive[1] roof; b) one with a green roof and one without a green roof; c) green roof on new construction and a green roof retrofit to an existing building in order to compare the performance.
9. Possibly identify a green roof to replace lost ground level green space.

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[1] 1. *"**Intensive** **roofs** are essentially conventional gardens that happen to be located on the roof of a building. They may include moderate sized trees, shrubs, ornamentals and even crops planted in at least 12 inches (30 cm) of soil and are designed for traditional garden uses including recreation, relaxation and food production. Intensive green roofs add a considerable weight load (typically from 80 to 150 lb/ft2 or 391 to 732 kg/m2) to a structure and usually require intensive maintenance. As such, they are designed to be routinely accessible in keeping with their intended use (Scholz-Barth, 2001) and may only cover a small fraction of the roof surface. ***Extensive*** **green roofs,** on the other hand, are not meant to be accessible except for occasional maintenance. Extensive green roofs consist of a blanket of low vegetation planted in just a few inches of a specialized, lightweight growing medium that covers a considerable portion of a roof. Extensive green roofs are primarily designed to achieve an array of environmental benefits as discussed below. While many of the benefits of extensive green roofs apply to intensive green roofs as well, extensive roofs are strictly designed with these benefits in mind, while intensive roofs are generally built for other reasons."
From the **City of Los Angeles Green Roofs Resource Guide**, 2006.

10. Possibly locate where storm water concerns are greatest (such as Sun Valley).

11. Tailor the project to the potential funding sources, both City and grant funding. Work with the City Administrative Officer's staff to identify City funding. Also, with assistance from the Environmental Affairs Department, identify other potential funding sources such as:

    - Los Angeles Department of Water and Power
    - United States Department of Energy
    - United States Environmental Protection Agency
    - California Environmental Protection Agency
    - California Energy Commission
    - South Coast Air Quality Management District
    - Metropolitan Water District
    - A corporate sponsor
    - Foundations and non-profit organizations

Approach

- The Bureau of Engineering (BOE) spoke with each of the Council offices in whose district the proposed projects are located, and with the operating departments for the potential building sites.

- BOE met with American Institute of Architects Los Angeles Committee on Environment (COTE) and discussed options for green roofs for City projects. COTE is very supportive of green roof projects and made a number of useful suggestions. COTE expressed support in particular for the South Los Angeles Neighborhood City Hall that is in design, and support for the Reptile and Insect Center at the Zoo as pilot projects.

- BOE arranged a tour of the green roof on the Los Angeles Unified Theodore Alexander Jr. Science Center School in Exposition Park. In attendance were representatives from the Mayor's office, General Services Department, and BOE. The tour was very informative on maintenance issues, as well as on the selection of plants. First year maintenance is crucial for plant establishment, perhaps requiring hand watering during hot summer months. After the first year, as the roof surface may not be readily visible, it is important to monitor the functioning of the irrigation system on a regular basis.

- BOE arranged for a visit by Sarnafil (green roof vendor for the Chicago City Hall green roof) to investigate the possibility of placing a green roof atop City Hall's low rise wings.

Options for City Projects

BOE solicited project nominations from:

- Building Programs Managed by BOE:
  - Proposition F: Fire Stations and Animal Care Facilities.
  - Proposition Q: Police Facilities.
  - Los Angeles Zoo.
  - Recreation and Cultural Facilities: Recreation and Parks Facilities.
  - Municipal Facilities Program: Facilities for Various Departments
- Port of Los Angeles.
- Los Angeles Department of Water and Power (LADWP).
- Los Angeles Department of Recreation and Parks.

List of Potential Projects – New Construction:

South Los Angeles Neighborhood City Hall

Location: 4301 S. Central Avenue – CD9
Description: 7,400 sq.ft. field office with green roof, 1,900 sq. ft. training room with metal roof
Construction Budget: $7.3M
Completion: January 2009
Consultant: Paul Murdoch Architects
Status: 98% Design Completed
Project Manager: BOE
Client: Council District 9

Comments: This is already being designed with an intensive green roof that will be accessible to the public. BOE has sought and received a proposal for monitoring the performance of the green roof for this project (approximately $100,000), although funds for monitoring have not yet been identified. As available, additional funding could be applied to monitoring the performance of the green roof. EAD is pursuing funding interest from a nonprofit organization. Monitoring tasks could include measuring temperatures on the roof and the underside of the roof deck; affects of soil moisture on temperature; ambient air temperature; and other factors deemed relevant.

Reptile and Insect Interpretive Center - the HISS Center

Location: 5333 Zoo Drive – CD4
Description: Approximately 9,000 sq. ft.
Construction Budget: $7.8M
Completion: September 2009

Consultant: Portico Group
Status: 15% Design Completed
Project Manager: BOE
Client: Zoo Department

Comments: The Reptile & Insect Interpretive Center is a new exhibit that will replace the Los Angeles Zoo and Botanical Garden's current Reptile House. This exhibit will accommodate the current reptile, amphibian, and invertebrate collections. The approximately 30,000 square foot site for the proposed display of both indoor and outdoor animal exhibits is located within the Aquatic Region of the Zoo.

The Mayor's office has expressed interest in placing a green roof on this project. COTE considered this a very strong candidate for a green roof. A green roof could be an additional element of the botanical collection at the Zoo, and add to the display of the significant link between plants, animals, and people – an ecosystem approach. The green roof would be designed to minimize any potential negative impacts on the animals that will be on display. Also, this roof would be visible to visitors of the Zoo from an elevated public walkway and the Tree Top Terrace where special Zoo events are held. Additional funding will need to be identified for the green roof.

Mar Vista Garden Center and Child Care Center
Location: CD-11
Description: 4000 sq. ft. Childcare center for low-income housing
Construction Budget: $2.0 M
Completion: December 2009
Consultant: Not yet identified.
Status: On hold awaiting site acquisition.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is strongly in favor of a green roof for this project. The base project, however, is under funded. Funding for the green roof could be pursued via a grant.

Trans Pacific Container Terminal - Maintenance and Repair Building
Location: 500 W. Water Street. – CD 15
Description: 40,000 sq. ft. Maintenance & Admin (5,000 sq. ft. green roof space)
Construction Budget: $13M
Completion: March 2009
Consultant: Port of Los Angeles in-house design
Status: 70% Construction Documents

Client: Port of Los Angeles

Comments: Not visible to the public.

Fire Station #82
Location: Somewhere in CD-4
Description: Fire Station
Construction Budget: $8.7M
Completion: Approximately December 2009, depending on site acquisition
Consultant: From the Proposition F Approved List
Status: On hold awaiting site acquisition
Project Manager: BOE
Client: Fire Department

Comments: The project site is not yet identified. If it is decided that the green roof is an important sustainability component of the project, contributing to meeting the Council mandate for LEED Certified, this feature would need approval from the Proposition F Administrative Oversight Committee. With approval of the Oversight Committee and concurrence from the City Attorney's office, funds from the Proposition F Program contingency could be applied to this project for the green roof. The Council Office is supportive of the green roof for this project. The Fire Department expressed support for exploring the green roof option, if it can be done cost effectively. As the pre-design has not yet started, the incremental cost increase for a heavier structure and the green roof components can be considered early in the design process. The project will likely be multi-story, and the community room could be located to have a direct line-of-sight to the green roof. The green roof should be considered only over a conditioned space for optimum long term benefit.

Robertson Recreation Center
Location: CD 5
Description: 12,000 sq. ft. gym and support areas (4,000 sq ft green roof)
Construction Budget: $4.5M - $5M
Completion: Not known.
Consultant: Not yet identified.
Status: On hold awaiting additional funding.
Project Manager: BOE
Client: Recreation and Parks

Comments: Council office is very supportive of adding a green roof to this project. However, the base project is short funded. Also, previously prepared plans may be used for the site which would make it difficult for a green roof on this project.

East Valley Multi-Purpose Center
Location: 5056 Van Nuys Blvd, Sherman Oaks – CD 2
Description: 17,000 sq. ft. gym and support areas
Construction Budget: $13M
Completion:
Consultant: Rios and Associates
Status: 20% Design Completed
Project Manager: BOE
Client: Recreation and Parks

Comments: This project is in the middle of the Van Nuys/Sherman Oaks Park, and the Council office is in favor of a green roof for the project. The design team has suggested a portion of the building be covered with a green roof, a roof area that would be visible from the entire park. Construction funding has not yet been appropriated. Construction funds will be allocated in fiscal year 2007-2008, and additional funding will have to be identified for the green roof.

Ascot Park Educational Center
Location: CD14
Description: 10,000 -15,000 sq. ft. educational center
Construction Budget: $10M - $12M
Completion: Not yet established.
Consultant: Not yet identified.
Status: Programming
Project Manager: Recreation and Parks Advance Planning Group
Client: Recreation and Parks

Comments: Recreation and Parks has suggested that this project would be a good location for an earth-sheltered building, partially buried in the hillside. Ascot Park is a former LADWP property that has been opened to the public as new open space. Recreation and Parks is discussing the requirements for the Educational Center. This project may be eligible for State Bond funding.

List of Potential Projects – Existing Buildings:

City Hall
Location: 200 N. Main Street
Construction Budget: $1M
Completion: Approximately 2 years from initiation.
Consultant: NA
Status: NA

Project Manager: NA
Client: General Services Department

Comments: This would be a high profile retrofit opportunity to install a green roof on the low-rise wings of City Hall, as was done with the existing Chicago City Hall. Approximately 24,000 sq. ft. of roof area is available for a green roof.

The installation of a green roof would require an investigation of the capacity of the roof to carry the additional weight. It would also require a historic structure review as City Hall is listed as a historic landmark by the City of Los Angeles, and is eligible for listing on the federal registry of historic structures. In an initial conversation with the structural engineer for the City Hall seismic upgrade, he indicated that a light weight (extensive) green roof was probably feasible, but a more detailed analysis will be required.

A Sarnafil representative visited the building with BOE, and has prepared a report detailing the requirements of placing an extensive green roof on the low-rise wings of the City Hall. The proposed extensive green roof would be placed over the existing roof which is approximately 3 years old. Excluding the areas allocated to the mechanical systems, there is approximately 24,000 sq. ft. available for the green roof. The cost of installation would be approximately $1,000,000. If structural upgrades are required, BOE would not recommend proceeding. Based on the investigation to date, pending the structural review, a green roof for City Hall is feasible.

Environmental Learning Center - West
Location: Hyperion Treatment Plant, 12000 Vista Del Mar - CD11
Description: 20,300 sq.ft., 2-story Learning Center with green roof
Construction Budget: $8.5M
Completion: July 2009 (Construction)
Consultant: Camp, Dresser & McKee, Inc. (CDM)
Status: 10% Design Completed
Project Manager: BOE
Client: Bureau of Sanitation

Comments: This project will renovate an existing, unoccupied Administration Building into the Environmental Learning Center - West (ELC-W). The ELC is being developed to address the need for increased public education about how urban activities affect the evironment. The building will be an example of environmentally sensitive engineering through the use of solar photovoltaic panels, skylights, and a green roof. This project is being designed with an extensive green roof.

Other Project Possibilities

- The Los Angeles Unified School District (LAUSD) is preparing working drawings for a new high school in Taylor Yard, High School #13, and is pursuing the addition of an ancillary environmental learning center which could have a green roof. Council District 1 is interested in assisting LAUSD in identifying funds for this green roof.
- Other existing City buildings.
- LADWP Projects: LADWP has initiated an effort to pilot a LEED building, and might consider a green roof.
- California Redevelopment Agency/Los Angeles (CRA/LA): The CRA/LA has demonstrated a commitment to sustainable design and to LEED on various projects.
- Airport projects.
- City funded affordable housing projects.
- Non-city projects in partnership with the City (such as Los Angeles Unified School District, Los Angeles Community College District, or a facility for a non-profit).

B. Cost of Design, Construction, Operation, and Maintenance of Green Roofs

The following cost estimates are for a typical green roof installation in our area. The estimates include vegetation, a growing medium, growing containers, and waterproofing. Specific costs will need to be developed for the identified pilot project, and each cost analysis will have to add additional building elements as required, such as a heavier structural system, access/egress stairs, walkways, an elevator, lighting, or exterior furniture. The design of green roofs is a specialty expertise, and the City Engineer recommends soliciting proposals from green roof consultants to execute the pilot project.

Extensive Roof

	New Bldg *	Existing Bldg *
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$30-$40 per sq ft	$35-$45 per sq ft
Maintenance	$0.25 / sq ft / year	$0.25 / sq ft / year

* The information is based on bids received for a Department of Recreation & Parks building in the new Taylor Yard park.

Intensive Roof

	New Bldg	Existing Bldg **
Design	$2-$3 per sq ft	$3-$4 per sq ft
Installation	$35-$45 per sq ft	$45-60 per sq ft
Maintenance	$0.40 / sq ft / year	$0.40 / sq ft / year

** It is rare an existing building could support an intensive green roof.

The prices for a green roof installation will likely drop as demand increases and more installers exist.

In terms of maintenance, a green roof installation would either need guardrails for or another approved fall protection system to protect employees who would be performing maintenance. Safe access would also have to be provided to the green roof areas. Also, employees will need to be training on proper maintenance procedures.

C. Procedures to Collect and Analyze Data From the Pilot Program

Savings and Benefits – Measures to Consider

The following is an initial listing of the characteristics of green roofs that should be considered in a monitoring program for this pilot effort. Depending on the

specifics of the pilot project, this list would be refined to identify appropriate characteristics to monitor in the project.

- Protection of the roof membrane results in a longer material lifespan (it is estimated that green roofs will last up to twice as long as conventional roofs), resulting in savings in replacement costs.

- Lower ambient air temperatures directly reduces the urban heat island effect and slows the formation of ozone pollution.

- A green roof could result in savings on energy heating and cooling costs, depending on the ratio of height to width of the building, the climate, and the type of green roof. Using a Micro Axess Simulation model, Environment Canada found that a typical one story building with a grass roof and 10 cm (3.9 inches) of growing medium would result in a 25% reduction in summer cooling needs. Field experiments by Karen Liu in Ottawa Canada, found that a 6 inch extensive green roof reduced heat gains by 95% and heat losses by 26% compared to a reference roof.

- Soil, plants and the trapped layer of air can be used to insulate for sound. Sound waves that are produced by machinery, traffic or airplanes can be absorbed, reflected or deflected. The substrate tends to block lower sound frequencies and the plants block higher frequencies.

- Cost savings from increased stormwater retention and filtration and decreased need to expand or rebuild related infrastructure.

- Less impervious surface, as calculated for Standard Urban Stormwater Management development permits by the Bureau of Sanitation, which reduces stormwater needing to be mitigated.

- Contributes to meeting greenhouse gas emissions reductions and to climate change concerns by reducing building energy needs.

D. Plan to Identify Funding Opportunities for Design, Construction and Data Collection

With the identification of the pilot project, the City Administrative Office along with the Department of Environmental Affairs (EAD) and the Bureau of Engineering can develop potential funding opportunities for design, construction, maintenance, and data collection and analysis, and report back to the PLUM Committee.

To date, EAD has contacted organizations and groups it deals with on a regular basis. While there is increasing interest in green roof projects, specific funding opportunities targeting green roofs are limited. EAD has expanded its search to include green building, stormwater reduction, and other related funding programs

that might consider funding a green roof project. EAD staff also coordinates with groups involved with urban heat island issues and green roofs, and is active in sharing funding ideas with staff at other cities. We are also utilizing eCivis to locate grants for the development of green roofs through water mitigation, improvement of energy efficiency, public education, CEQA mitigation measures, and replacement of open space.

Once pilot projects are identified by City Council, there may be a short turnaround time to apply for funds once an appropriate opportunity is identified. Thus, EAD requests the authority to submit grant applications for any of the approved/recommended projects as described in this report. EAD will come back to City Council for approval prior to accepting any funds.

E. Green Roof Activities in Other Cities

Chicago, Illinois

As of October 2006, there are more than 250 public and private green roofs totaling more than 1 million square feet that are under design or construction in Chicago. These include private, not-for-profit, and public developments receiving financial or other types of public assistance from the City, as well as Planned Developments and Lakefront Protection Ordinance Developments.

The Chicago City Hall began as a demonstration project - part of the City's Urban Heat Island Initiative - to test the benefits of green roofs and how they affect temperature and air quality. The garden consists of 20,000 plants of more than 100 species, including shrubs, vines and two trees. The plants were selected for their ability to thrive in the conditions on the roof, which is exposed to the sun and can be windy and arid. Most are prairie plants native to the Chicago region.

Like all green roofs, the Chicago City Hall rooftop garden is intended to improve air quality, conserve energy, reduce stormwater runoff, and help lessen the urban heat island effect.

The rooftop garden mitigates the urban heat island effect by replacing what was a black tar roof with green plants. The garden absorbs less heat from the sun than the tar roof, keeping City Hall cooler in summer and requiring less energy for air conditioning. The garden also absorbs and uses rain water. It can retain 75% of a 1 inch rainfall before there is stormwater runoff.

Chicago has recently begun the "Green Roof Grants Program" for residential and small commercial building owners. Applicants can qualify for $5,000 for a Green Roof Project. This new grant program will enable home owners and small businesses to install green roofs.

Milwaukee, Wisconsin

The Milwaukee Metropolitan Sewage District (MMSD) is investing in green infrastructure projects to reduce combined sewage/stormwater overflow discharges and mitigate stormwater runoff. One approach is the installation of green roofs. Seven green roofs have been installed throughout the region, including atop a housing project for senior citizens and a facility for people with disabilities. The green roof at the housing project is 20,000 square feet and is expected to retain 85% of a 2-inch rainfall. Rain gardens and retention basins used for on-site irrigation receive the remaining 15%.

MMSD has financially assisted four other green roofs for the purpose of stormwater reduction. The four roofs are as follows:

- The roof of MMSD's headquarters (3,500 sq. ft. structure).
- The University of Wisconsin-Milwaukee's Great Lakes Water Institute (10,000 square foot structure).
- The Urban Ecology Center.
- The Milwaukee County Zoo.

Toronto, Canada

Toronto has initiated a Green Roof Incentive Pilot Program. Sixteen successful applicants were approved as part of the pilot program. The goal of this program is to encourage green roof construction in the City. In 2006, the Toronto City Council approved the Green Roof Pilot Program, allocating $200,000 from Toronto Water's budget to encourage green roof construction. Eligibility for this program was opened to any private property owner in the City of Toronto, regardless of building size and type, as long as the building is capable of supporting a green roof that meets the specifications and requirements, and has a water account with the City. Additionally, it is hoped that the program will:

- Result in the construction of a variety of green roof types which could be used for education and promotional purposes.
- Provide an opportunity to showcase various green roof technologies and planting styles.
- Provide a grant of $10 per square meter of eligible green roof area up to a maximum of $20,000.

Other Locations

Located in Pacific Palisades, the Getty Villa has an extensive green roof on the top of a parking garage.

Located in Pasadena, the Art Center has an extensive green roof on their South Campus building.

Thank you to the Environmental Affairs Department for their assistance with this report. If you have any questions, please contact Deborah Weintraub, Deputy City Engineer, at (213) 485-5499.

Sincerely,

Gary Lee Moore

Gary Lee Moore, P.E.
City Engineer

DJW:tlw