GEOS NET-ZERO ENERGY MIXED-USE NEIGHBORHOOD ARVADA, CO

DATA

PROJECT STATEMENT

GEOS will be the largest net-zero energy, urban mixed-use neighborhood in the United States. Earth and sun power will completely sustain the community's energy needs, and replace all fossil fuels. The passive solar urban fabric is intertwined with natural systems, stormwater fed landscapes, and civic places. Rain and snow melt feed street tree rain gardens, percolation parks, plazas, and community gardens. GEOS received final development approval from the City of Arvada and will begin construction in the winter of 2010.

The GEOS neighborhood incorporates symbiotic relationships between urban design, landscape architecture, and architecture at all scales in order to achieve resource conservation. Urban density is optimized with passive solar access. Stormwater is integrated and omnipresent within the neighborhood layout. Energy is generated from ground source loop fields and photovoltaics on every rooftop. The architecture utilizes high performance building envelopes and super-efficient mechanical systems. The overall urban design aims to foster bio-civic relationships with natural processes, neighborhood ecology, and environmental stewardship.

PROJECT DATA

TOTAL ACREAGE:	25.3 acres
PRIVATE PARCELS:	12.1 acres
# OF RESIDENTIAL UNITS:	282
NET DENSITY:	23.3 dwelling units/acre
COMMERCIAL SF:	12,000 SF
CIVIC BUILDINGS:	Co-Housing community house on central square
PARKS + OPEN SPACE:	8.5 acres (34% of site); includes fruit tree co-ops, gardens, play areas, percolation parks, town squares, event spaces, mixed-use meadows with native habitat, active + passive areas, and agriculture
ENERGY SYSTEMS:	1.3 megawatt PV system. 5,000,000 BTU geothermal system
	CARBON FREE - NO FOSSIL FUELS
IMPLEMENTATION SCHEDULE:	2005-2007, Four public meetings, preliminary development plan approval from planning commission and city council
	2007-2009, Final development plan and infrastructure construction document approval from city
	2010, Groundbreaking
	2010-2012, Phase 1 construction
	2012-2014, Phase 2 + 3 construction

NARRATIVE

NET-ZERO ENERGY

Net-Zero refers to energy production equal to the amount consumed. The key to creating a dense net-zero energy neighborhood in Colorado's climate is to maximize passive solar access to all buildings and dwellings. This begins with the layout of streets, alleys, blocks, and parcels, followed by buildings and trees.

During the urban design process many different street-block-parcel-building layouts were analyzed comparatively for their ability to both harvest and conserve energy. Each layout was evaluated using 3-D modeling of seasonal sun and shade patterns to discern the most efficient patterns. Energy modeling (with assistance from the National Renewable Energy Lab in Golden, Colorado) of each building and landscape design provided data on unit loads and production.

CIVIC STORMWATER

Stormwater is both precious and dangerous in Colorado's arid climate. Conventional Colorado developments typically detain flash flood and monsoon runoff in large unusable detention basins, fenced off from the public realm. The key to integrating stormwater with public experience is to mimic predevelopment conditions by distributing runoff throughout the site. Decentralized detention allows for the design of a tributary system of site specific, multiple use environments.

During the design process many models of stormwater management were analyzed for the ability to detain the 100 year flood on site, and slowly release it in 24 hours. With assistance from the Denver Regional Urban Drainage & Flood Control District, and the Jefferson County Stormwater Quality Coordinator, each layout was evaluated for its capability to combine both stormwater and civic functions. The morphology of water quality, detention volumes, and reduced time of concentration would form the armature for the community's pedestrian, park, and plaza network.

COMMUNITY STEWARDSHIP

EMPOWERING RESIDENTS TO 'BE THE RESOURCE'

The aims of Net-Zero Energy and Civic Stormwater serve a larger goal - to foster stewardship in the neighborhood, and enable residents to take active roles in managing their resources and environment. This can fold into participation in the social life and governance of the community.

Urban design for GEOS involves many socially oriented features. A dense layout of varied housing options provides for diversity and affordability. A prolific pedestrian network of pathways, parks, and civic spaces is anchored by mail box kiosks, play areas, and gathering spaces for all occasions, large and small. All paths lead to the Ralston Creek Regional Greenway that connects to schools, recreation centers, and urban centers.

Processes of nature and agriculture are interwoven with civic and community life. Common greens are surrounded by fruit tree terraces, to be maintained and harvested by the adjacent homeowners. Community gardens and composting areas are dispersed throughout the site. All private yards receive great sunlight and are semi-enclosed like courtyards. Gutters and downspouts form tributaries to rain gardens in each resident's landscape.

NARRATIVE

NET-ZERO ENERGY

KEY STRATEGIES:

- Optimize Urban Density with Passive Solar Access – The street, lot, and block layout permits buildings to be stretched-out east to west, apertures to the north to be minimized, and east and west apertures to be controlled and shaded. This reduces energy demands by one third. Many homes are placed in a checkerboard pattern.
- Geothermal Ground Source loop fields are integrated with open space and utility networks.
- Photovoltaic Panels on every roof.
- Deciduous tree species, heights, and placement are selected to assure both winter solar access to homes, year-round solar access to photovoltaic panels, and passive microclimate cooling in summers.
- High performance passive solar homes have air tight envelopes and heat recovery ventilators. (aka "The Passive House.")
- A property line planting strip, written into the design regulations, unifies the innovative building placement and south-facing outdoor spaces.
- **No fossil fuels, no natural gas, provided to the site.**

CIVIC STORMWATER

KEY STRATEGIES:

- Conceive of stormwater management holistically and at all scales.
- Permeable paving for water infiltration is used for all pedestrian ways and plazas.
- Street Tree Rain Gardens receive, detain, and filter surface runoff from streets, alleys, and the surrounding environment, while irrigating streetscape plantings. They reduce time of runoff concentration, while utilizing infiltration, evaporation, and evapotranspiration.
- Percolation Parks are stormwater detention basins designed as mixed-use parks and plazas. By mimicking predevelopment stormwater dispersal patterns they reduce the size and extent of the storm sewer system. Percolation Parks feature neighborhood amenities, urban agriculture, and wildlife habitat. They are placed prominently in the neighborhood and provide ease of access, human scale, and a diversity of uses.
- Localized Rain Gardens are integrated on every parcel through out the neighborhood, from mixed-use courtyards to residential yards. They receive runoff from paving and rooftops, providing an intimate experience of storm water management.
- Level Outlet Spreaders slowly release outflows to the floodway, mimicking predevelopment sheet flow, and eliminating the need for riprap erosion control.

COMMUNITY STEWARDSHIP

KEY STRATEGIES:

- Integrate natural systems and processes within the fabric of everyday life. Mix stormwater management, food production, and biotic habitat with public pathways, parks, and civic spaces. Create complex mutually beneficial networks of unique ecosystems, each adapted for specific conditions.
- Give residents opportunities to play active roles in managing their resources, and caring for their environments.
- Provide agricultural opportunities throughout the neighborhood, and at a diversity of scales; from pocket community gardens and orchards in each sub area, to larger Community Supported Agriculture.
- Fruit Tree Terraces, Property Line Planting Strips, and Landscape Foyers unite the pedestrian realm while enfranchising residents to personalize their environment.
- An Energy Systems Guide and Xeriscape Plant and Landscape Maintenance Manuals provide residents with detailed information on indoor and outdoor stewardship.

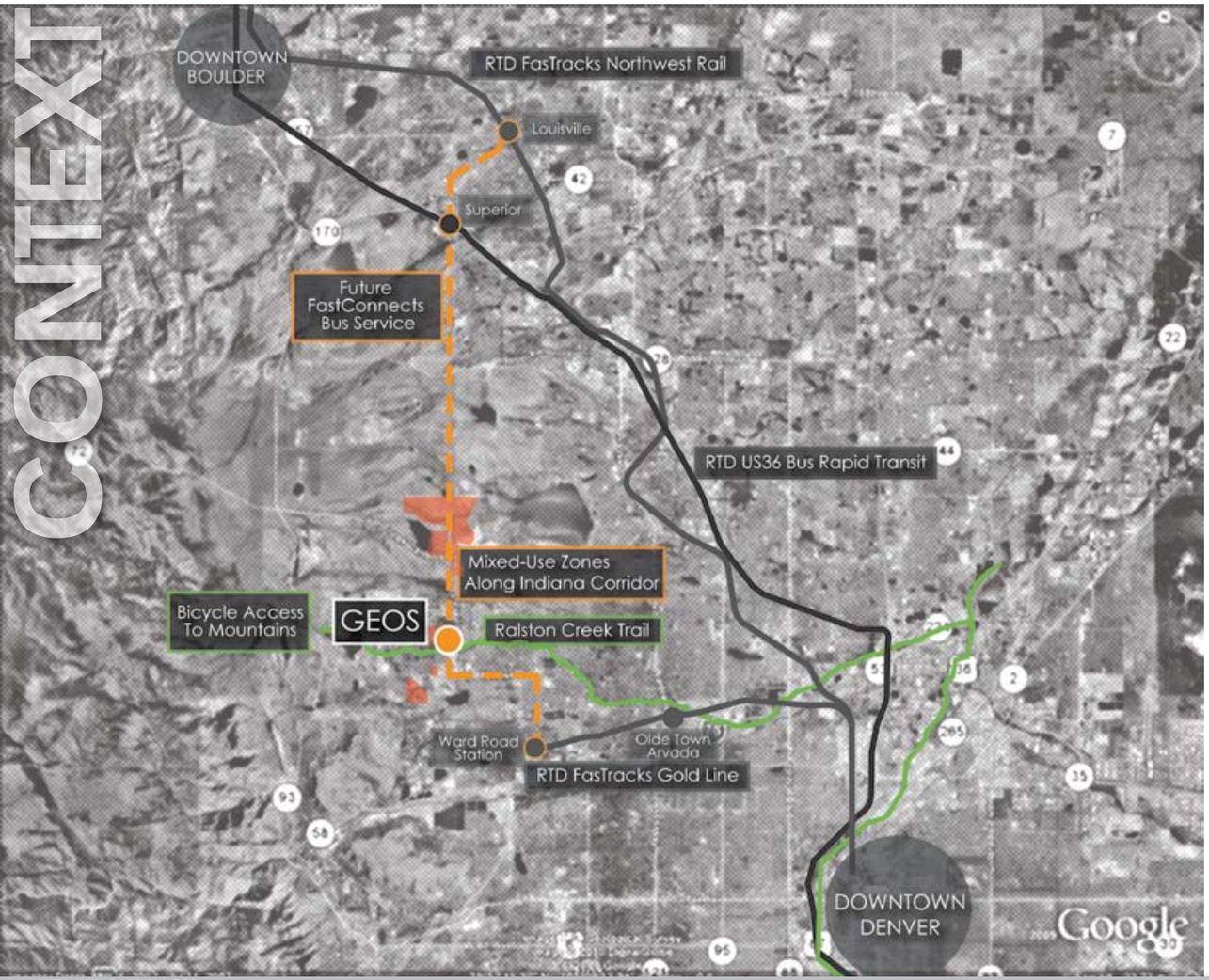
Denver regional context map

Left: View from Ralston Creek Trail

GEOS is to be built on underutilized industrial land in an area surrounded by older suburbs. It is part of a north-south corridor that has been identified, through a comprehensive planning process, for suburban intensification in the form of transit supported residential mixed-use. Frequent north-south bus service will connect these mixed-use areas to the Denver region's new commuter rail system, called FasTracks.

Arvada context map

CONTEXT



NET-ZERO ENERGY

CIVIC STORMWATER

COMMUNITY STEWARDSHIP

LAND USE

LAND USES

- 282 Dwelling units; 12,000 SF commercial
  - Residential condos over commercial
- Live/Work
  - Attached and detached along E/W streets
- Residential
  - Compact homes, 600 - 2,000 SF
  - Home types include small-lot single family, duplexes, townhomes, live/work, condos, and carriage units
  - Inter-generational and senior co-housing with common house shared with community

SINGLE FAMILY
LIVE/WORK TOWNHOMES OR ATTACHED DWELLINGS
ATTACHED DWELLINGS
APARTMENTS OR ATTACHED DWELLINGS
COMMON HOUSE WITH RESIDENTIAL ABOVE
GARAGE

SITE SYSTEMS

Geothermal Loops
Rooftop Photo Voltaic Panels
Passive Solar Surfaces
Summer Shade Trees

Street Tree Rain Gardens
Percolation Parks
Private Rain Gardens
Level Outlet Spreaders

Street Tree Rain Gardens
Percolation Parks
Private Rain Gardens
Level Outlet Spreaders
Cottonwood Riparian Zone
Ralston Creek
Croke Canal

ENERGY

STORMWATER

ENERGY AND WATER

Community Gardens and Fruit Tree Terraces
Mixed-Use Meadows: "Kids, Crops, and Critters"
Property Line Planting Strip "Hedgerow Geneity"

Pedestrian percolation
Civic Space: Eat, Drink, and be Merry

Pedestrian percolation
Mixed-Use Meadows: "Kids, Crops, and Critters"
Property Line Planting Strip "Hedgerow Geneity"
Civic Space: Eat, Drink, and be Merry
Community Gardens and Fruit Tree Terraces

AGRICULTURE

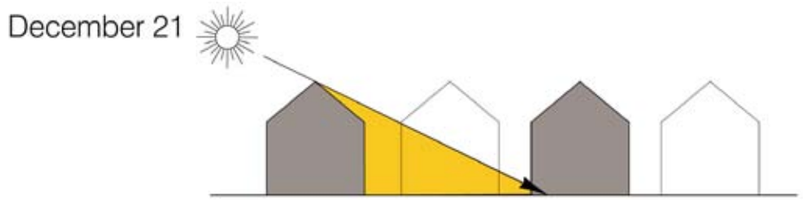
BIO-CIVIC REALMS

NET-ZERO ENERGY

CIVIC STORMWATER

COMMUNITY STEWARDSHIP

OPTIMIZE DENSITY + SOLAR ACCESS



Homes spaces to allow winter passive solar gain

DENSITY SUPPORTS:

- Energy conservation
- Mixed-use urbanism
- Affordability

OPTIMUM SOLAR ORIENTATION SUPPORTS:

- Passive heating + cooling
- Net-zero energy consumption

HISTORIC DENVER DEVELOPMENT PATTERNS FORMED THE BASIS FOR SOLAR INNOVATIONS

INTERNATIONAL PRECEDENTS PROVIDED ALTERNATIVE TYPOLOGIES

DENVER, USA

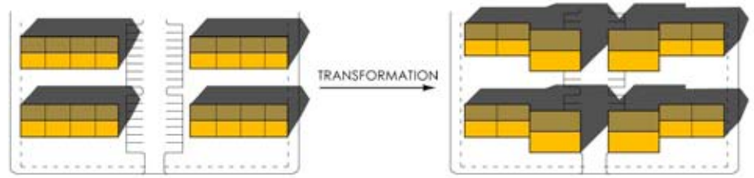
The Denver alley house

ASUNCION, PARAGUAY

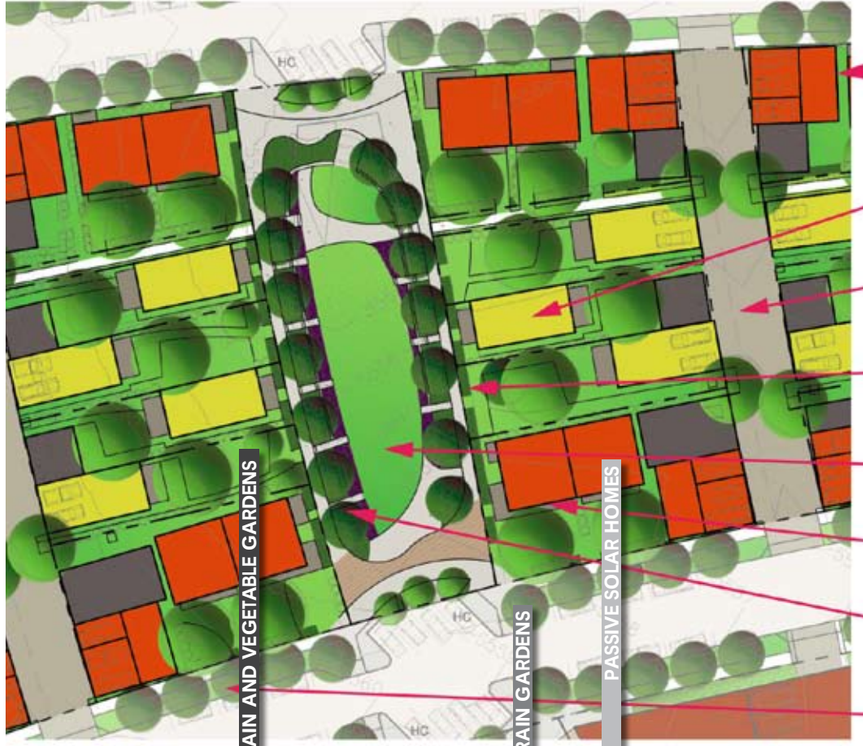
The South American zero lot line house

BERLIN, GERMANY

The Northern European wide townhouse with remote parking and sunny yards facing the public



NET-ZERO ENERGY



CHECKERBOARD LIVE/WORK

CHECKERBOARD SINGLE FAMILY

NORTH-SOUTH ALLEYS
SUPPORT SNOW MELT

PROPERTY LINE PLANTING STRIP

PERCOLATION PARKS
REPLACE STREETS

CHECKERBOARD LIVE/WORK

FRUIT TREE TERRACES

STREET TREE RAIN GARDENS

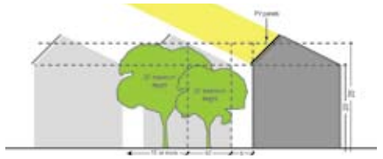
RAIN AND VEGETABLE GARDENS

STREET TREE RAIN GARDENS

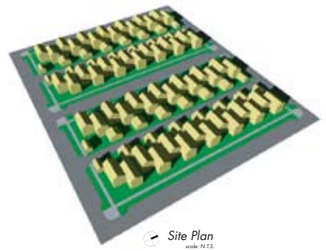
PASSIVE SOLAR HOMES

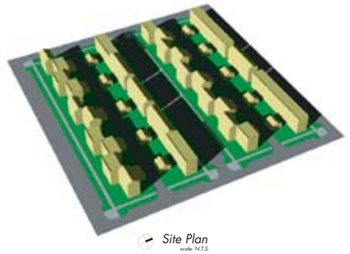
OPTIMIZE DENSITY + SOLAR ACCESS

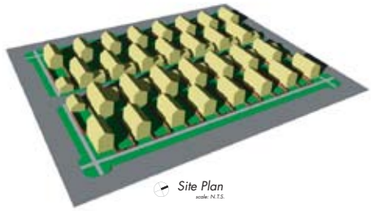
With assistance from NREL (National Renewable Energy Laboratory) dozens of development patterns were comparatively evaluated for solar orientation, passive heating and cooling, overall energy conservation, interior daylighting, snow-melt on streets and alleys, and gross urban density.

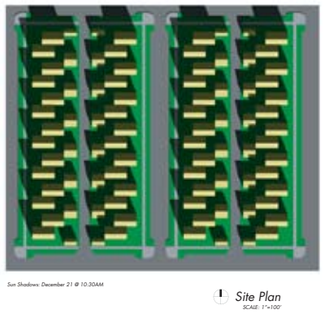


The shadow cast by one tree branch in winter can drop the performance of an entire string of photovoltaic panels. Design regulations coordinate tree heights with preservation of active solar access.

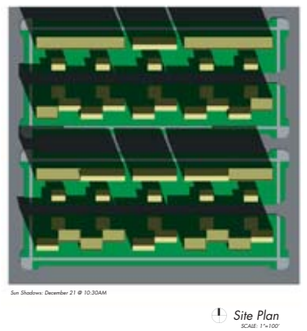




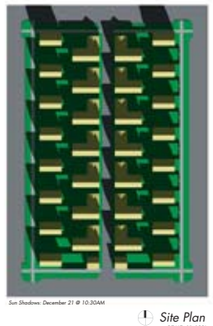




20' Duplex, North-South alleys



35' 3-story townhouse or live/work or 2-story townhouse over flat



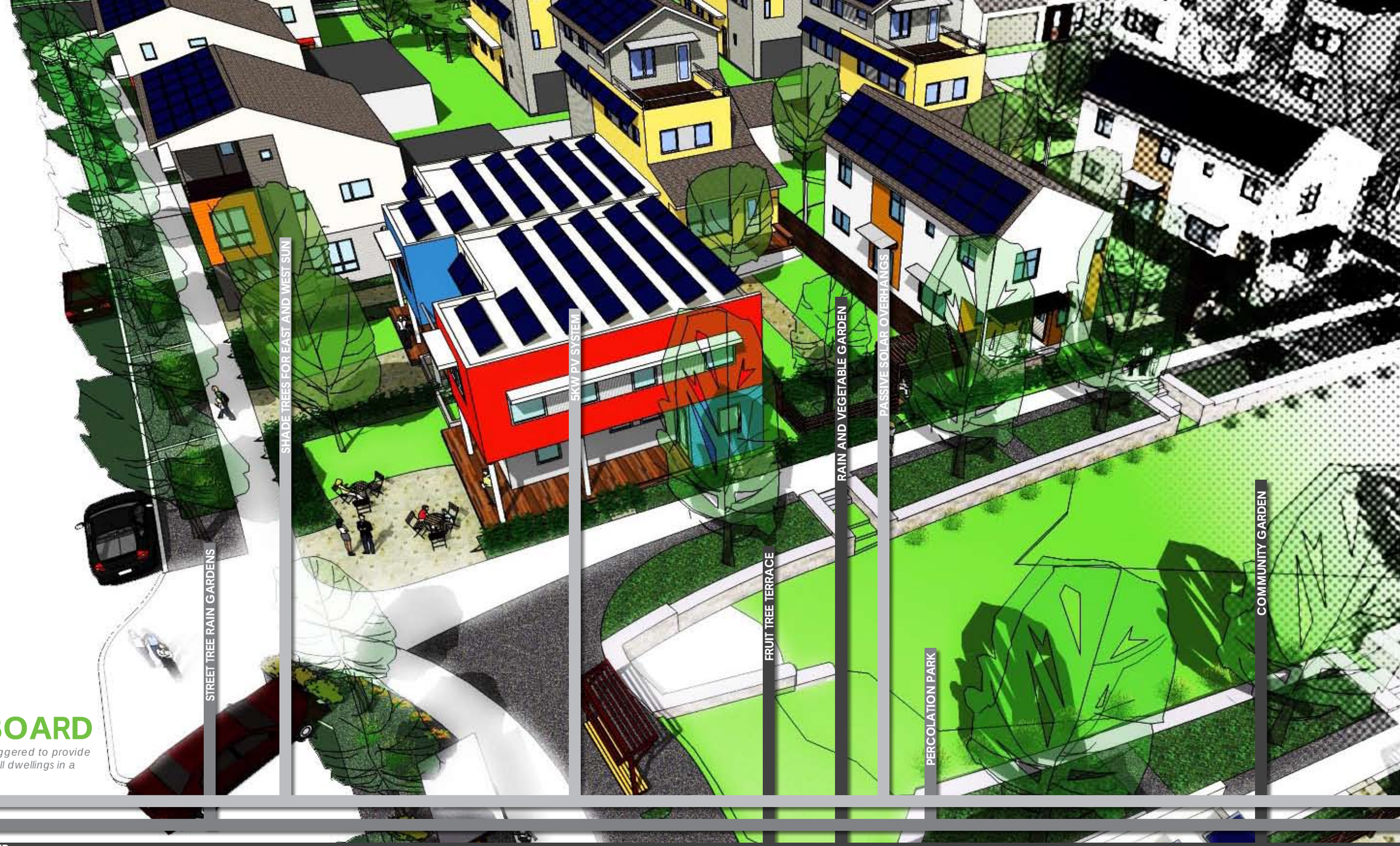
Checkerborad single family

NET-ZERO ENERGY

CIVIC STORMWATER

COMMUNITY STEWARDSHIP

NET-ZERO ENERGY



CHECKERBOARD

Checkerboard homes are staggered to provide optimum solar orientation to all dwellings in a dense layout

The passive solar checkerboard live/work duplex, showing street tree rain gardens that filter stormwater runoff.

NET-ZERO ENERGY

CIVIC STORMWATER

COMMUNITY STEWARDSHIP

NET-ZERO ENERGY

CHECKERBOARD SINGLE FAMILY

- For solar access, every other home is either an alley house or at the street front
- Alternating front and back yards are shaped like courtyards
- Yards contain rain gardens that receive roof runoff
- Service spaces are to the north
- Doors and windows to the north are minimized
- Windows and overhangs are optimized for passive solar heating and cooling

CHECKERBOARD LIVE/WORK

- Live/Work homes with ground level work spaces
- Wide floor plan layout permits solar gain to side-by-side bedrooms or living spaces
- Homes open to sunny, south-facing yards
- Doors and windows to the north are minimized
- Windows and overhangs are optimized for passive solar heating and cooling

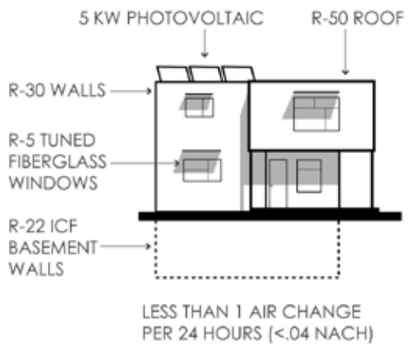
NET-ZERO ENERGY

1/3

ENERGY USE REDUCTION THROUGH **PASSIVE SOLAR ORIENTATION**

1/3

ENERGY USE REDUCTION THROUGH **HIGH PERFORMANCE SHELL**



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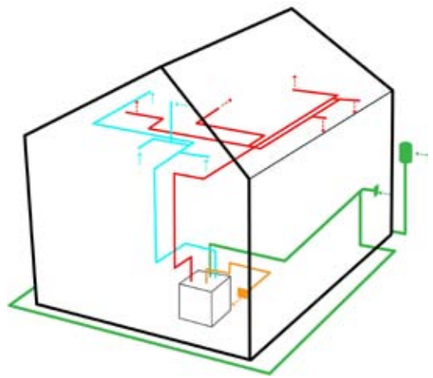
ENERGY USE REDUCTION THROUGH **ERV MECHANICAL SYSTEM**



A FOSSIL FUEL FREE, CASH FLOW POSITIVE PASSIVE HOUSE

Passive Solar Orientation Reduces Natural Gas Use by 1/3

- Stretch buildings and homes out east to west
- Minimize apertures to north
- Solar overhangs on south
- Deep porches and deciduous trees at east and west

High Performance Building Shell Reduces Natural Gas Use by 1/3

- Air Tight -- less than 0.04 Natural Air Changes per Hour
- SIPs construction with R-50 Roofs, R-30 Walls, R-5 Windows

ERV Mechanical System Reduces Natural Gas Use by 1/3

- No Furnace needed for the passive house.
- Geo-Assisted Energy Recovery Ventilation (ERV)
- Constant Fresh Air with minimal energy loss
- Earth Tubes further temper incoming fresh air and provide cooling
- Ground-Source Loop with Heat Pump provides Heating, Hot Water

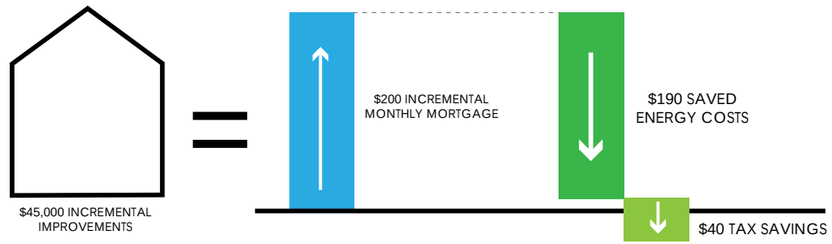
No Natural Gas Needed; Therefore, No Natural Gas Lines

Solar Photovoltaic Panels Generate 100% of Electricity Needs

- 5KW system per home
- The passive home uses 35% less electricity
- Photovoltaics panels offset the remaining 65% of consumption
- Neighborhood is grid-tied. Electricity Consumption is Net-Zero.

Making Net-Zero Cash Flow Positive

- Green Technologies add $200 to monthly mortgage
- Energy Savings $190/month
- Tax savings on mortgage interest $40/month



COMMUNITY STEWARDSHIP

HOUSING TYPES

CHECKERBOARD SINGLE FAMILY

- For families and extended families
- 1,800 - 2,000 SF, 3 - 4 BR
- Optional ground level accessible bedroom
- Extra bedrooms in basement

CHECKERBOARD LIVE/WORK

- For small families with work at home parent
- 1,600 - 1,800 SF, 1 - 4 BR
- Work space can range from 100 SF to 700 SF
- Optional ground level accessible bedroom
- Extra bedrooms in basement

CHECKERBOARD SOLAR TOWNHOUSE

- For small families
- 1,050 SF, 2 - 3 BR
- Extra bedroom in basement

SENIOR COHOUSING

- For seniors, singles, couples, small families
- 600 SF, 1 BR to 1,200 SF, 3 BR

THE 'NOT-SO-BIG HOUSE'

- Smaller, smarter homes save significant amounts of energy, save money, and can bind a family closer together.
- GEOS homes range in size from 600 SF to 2,000 SF and have one to six bedrooms including those in basements.
- Basements provide affordable flex space, and room for a growing family.

MIXING IN THE NON-NUCLEAR FAMILY

- Single parent families need support from relatives and neighbors.
- Extended families: the grandmother moves in to help, or the grandmother moves in to be helped.
- Ground level bedrooms support aging in place and people who cannot climb stairs.
- Singles and seniors want smaller homes that are easier to maintain.
- Live/Work homes eliminate commutes, and keep working parents close to the kids.

COMMUNITY STEWARDSHIP

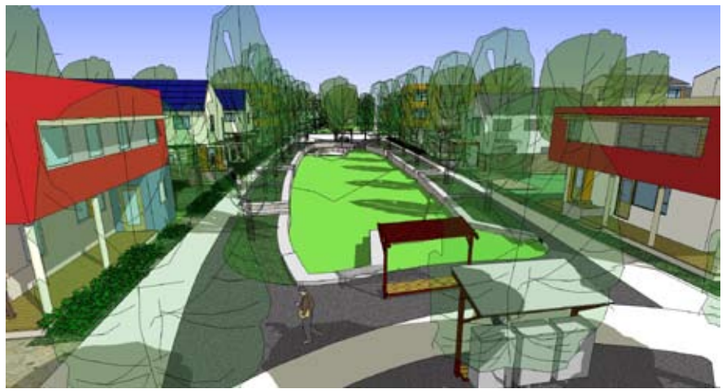
INTERTWINED CIVIC SPACE

The central square is ideally located to host farmers markets and other neighborhood festivals.

COMMUNITY STEWARDSHIP

STORMWATER MANAGEMENT + CIVIC LIFE

Clustering community gardens, fruit tree co-ops, and post office boxes near the central green provides for informal meetings between neighbors.



Bounded by retail space and the senior co-housing common house, the central square supports public events and child's play.

NET-ZERO ENERGY

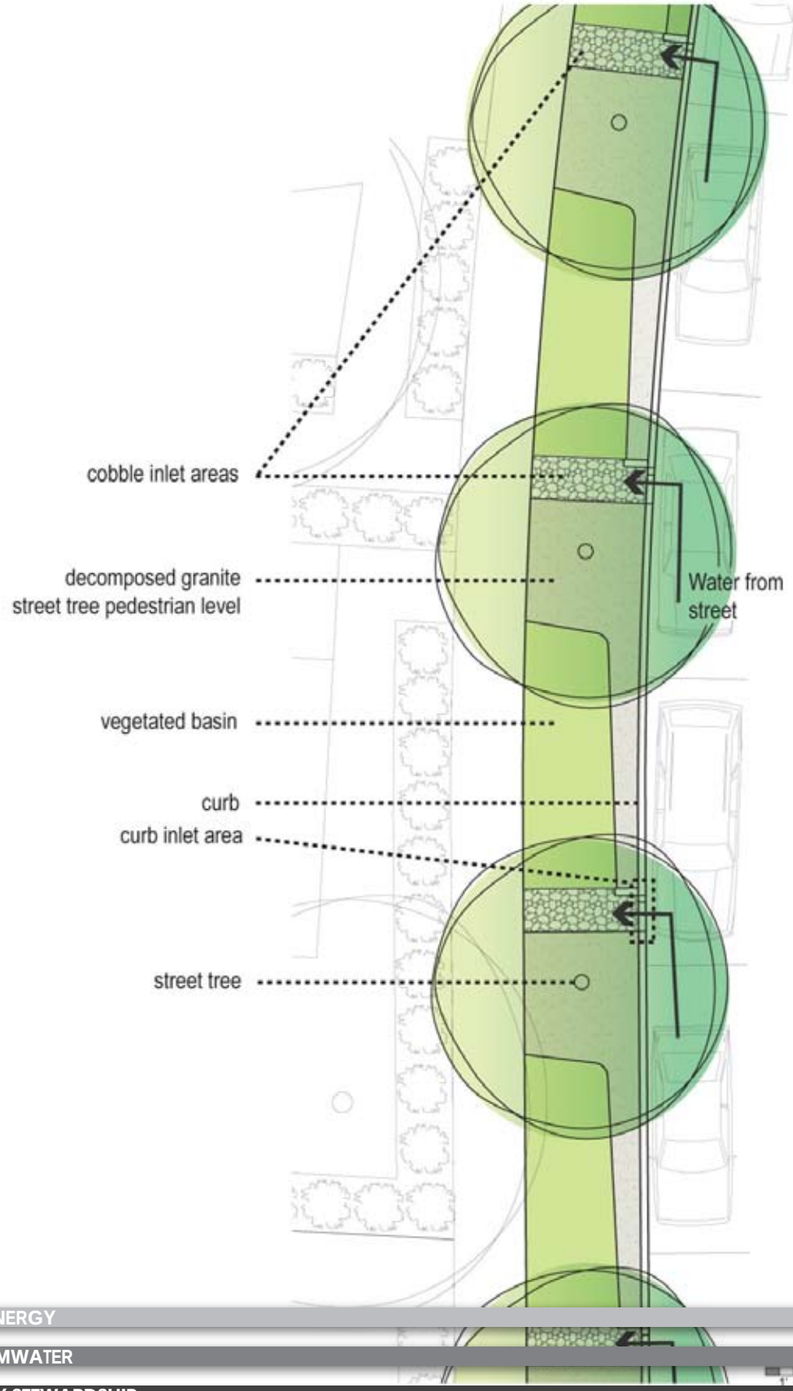
CIVIC STORMWATER

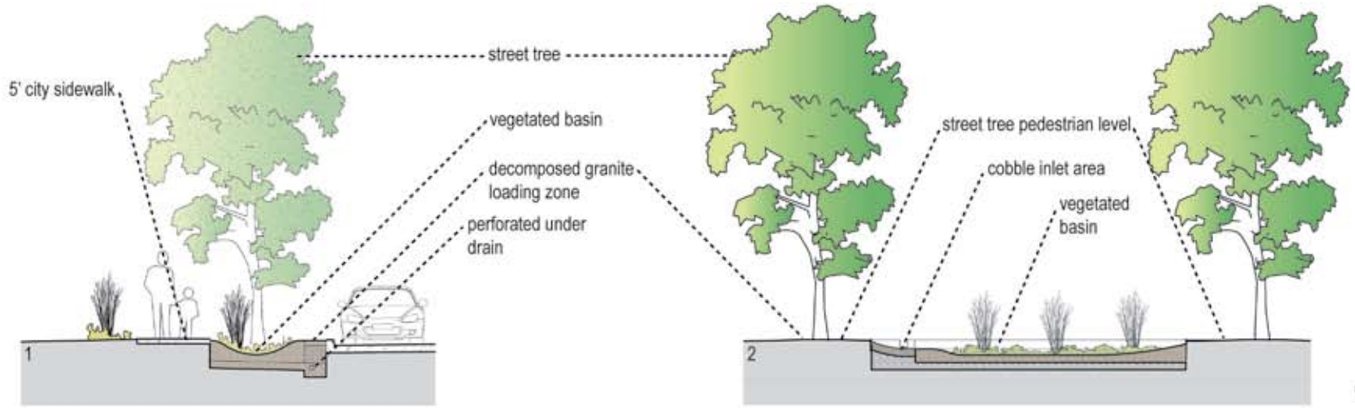
COMMUNITY STEWARDSHIP

CIVIC STORMWATER

STREET TREE RAIN GARDENS

Street Tree Rain Gardens filter stormwater while passively irrigating trees.





Integrated seamlessly into the street/sidewalk zone, Street Tree Rain Gardens provide an aesthetically pleasing and technologically feasible solution to stormwater management.

PERCOLATION PARKS: GREENS

Community garden serves as neighborhood amenity and provides stormwater management.

The Checkerboard Greens combine the functions of storm water detention basins and community parks. Each green receives, detains, and outlets run-off from city streets, Street Tree Rain Gardens, and adjacent properties. In addition they provide a variety of outdoor spaces and gardens for residents of the community.

Each Green includes a pedestrian oriented upper level and a vegetated lower basin level. Recycled concrete retaining walls form terraced transitions between these levels. Concrete stairs and grass ramps provide access points.

Upper Level / Fruit Tree Terraces :

The upper level extends to the property lines of the adjacent checkerboard parcels on the east and west, and to the curbs of streets to the north and south. It provides decomposed granite plaza spaces at each end, connected by walkways around its perimeter. The plaza areas contain seating, lighting, vegetation, and mail kiosks. Along the perimeter walkways are Fruit Trees Terraces that will be under-planted and maintained by adjacent property owners.

Lower Level / Play Area and Vegetable Gardens :

The lower level forms a basin that receives storm water runoff, which is conveyed along a flow line to an engineered outlet structure. The perimeter is planted with hardy shrubs and ornamental grasses. The bottom of the basin is a dry land grass mix. Cobble outlet gardens at each end feature moisture adapted plantings.

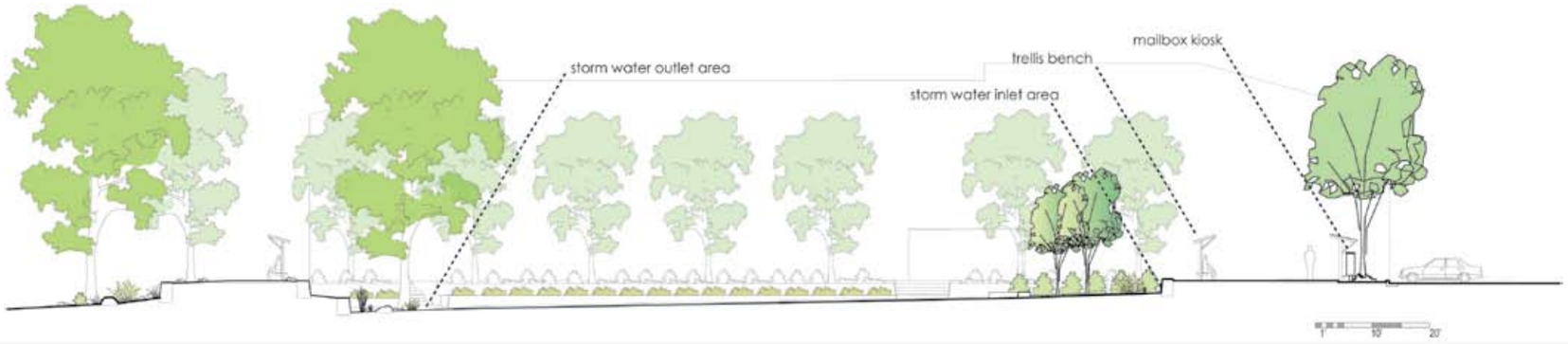
PERCOLATION PARKS: SQUARES

Squares provide space to play or relax in the center of the neighborhood.

The Squares, like the Checkerboard Greens, are a combination neighborhood park and storm water detention basin. They must function to receive, detain, and outlet run-off from city streets, Street Tree Rain Gardens, and adjacent properties. They also function to provide informal outdoor spaces for residents of the community.
Each Square includes a pedestrian oriented upper level and a vegetated lower basin level. Recycled concrete retaining walls form terraced transitions between these levels. Concrete stairs and ADA accessible decomposed granite ramps provide access points.

Upper Level / Mixed-Use Promenade:
The upper level extends to the property lines of surrounding parcels on the east and west, and from the curbs of Street G to the north to the Beach Front Promenade to the south. It provides plaza spaces at each end, connected by walkways around its perimeter. The plaza areas contain seating, lighting, vegetation, mail kiosks, and bike racks. The upper planting terrace includes perennials, shrubs, roses, ornamental grasses, and ornamental trees.

Lower Level / Event and Play Area:
The lower level forms a basin that receives storm water runoff, which is conveyed along a trickle channel to an engineered outlet structure. The perimeter is planted with hardy shrubs and ornamental grasses. The bottom of the basin is a dry land grass mix. Cobble outlet gardens at each end feature moisture adapted plantings.



Greens are ringed by fruit tree co-ops, and contain community gardens and places for unstructured child's play.