



CODE AND REGULATORY BARRIERS TO THE LIVING BUILDING CHALLENGE FOR SUSTAINABLE, AFFORDABLE, RESIDENTIAL DEVELOPMENT

REPORT #1: FINDINGS

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CLARK COUNTY, WA

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GREEN BUILDING COUNCIL



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I. INTRODUCTION

GOALS

Green building is gaining momentum both locally and nationally. As more building and development projects strive to meet stringent sustainability goals such as increased water efficiency, use of renewable energy, and less toxic alternatives to conventional building materials, the more challenging it can become for these project to navigate their way through the current regulatory system.

The goal of this project is to evaluate City of Vancouver and Clark County regulations and codes to identify and address barriers to sustainable, affordable, residential development (SARD). The project is funded through the Washington State Department of Community, Trade and Economic Development. By assessing code and regulatory barriers across the two jurisdictions, Vancouver and Clark County can leverage efforts to identify barriers, assess solutions, and harmonize outcomes so that innovative green projects are not only allowed but encouraged within each jurisdiction.

The City of Vancouver, on behalf of itself and Clark County, has contracted with the Cascadia Region Green Building Council to facilitate and carryout the code study. Cascadia's Living Building Challenge is used as the benchmark performance standard for analyzing code and regulatory obstacles. The Living Building Challenge represents the most stringent standard established for green building projects across the country.

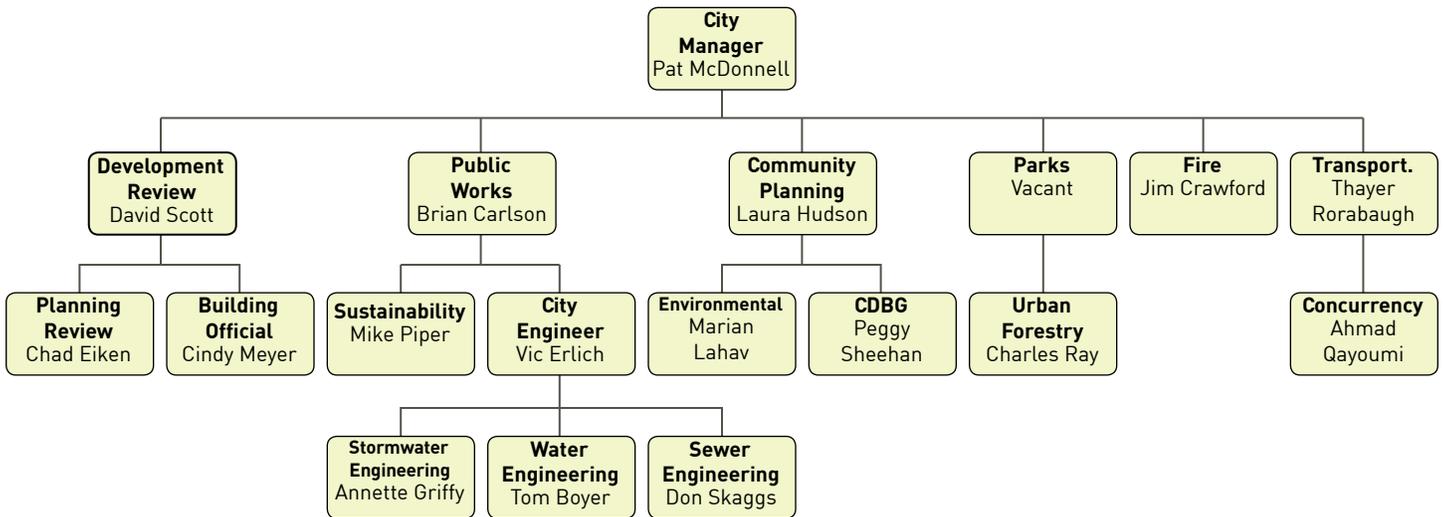
This report identifies sustainable design strategies for various types of residential development projects and highlights the obstacles project teams may encounter when seeking approval for a Living Building project. The focus for this study is specifically on affordable housing development. By concentrating on designs and building systems appropriate for affordable housing projects, this study seeks to help eliminate the barriers that currently exist within codes and regulations for projects seeking to push beyond minimum requirements. The intent of this study is not to make recommendations for raising the code-minimum level of performance for all building projects, but rather to address the obstacles that may exist for affordable housing project teams interested in pursuing the highest level of sustainability for their projects.

This report summarizes the process and findings of Tasks 1 and 2 under the Sustainable, Affordable, Residential Development contract between the City of Vancouver and Cascadia.

PARTICIPANTS

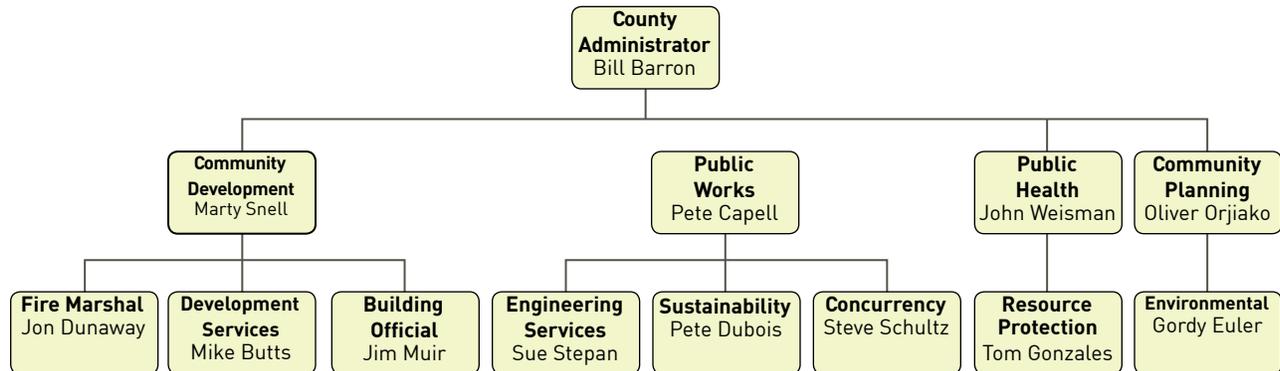
City of Vancouver

The City of Vancouver manages the SARD contract and is the primary coordinator between the City, County, Vancouver Housing Authority and Cascadia. Staff from Development Review, Public Works, Community Planning, Parks, Fire, and Transportation departments participated in evaluating the City's codes and regulations to identify barriers to the Living Building Challenge.



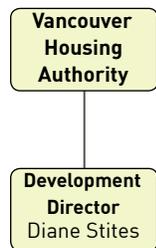
Clark County

Staff from Clark County's Community Development, Public Works, Public Health and Community Planning departments were active participants in evaluating the County's codes and regulations to identify barriers to the Living Building Challenge.



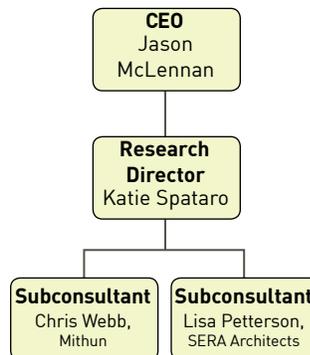
Vancouver Housing Authority

Staff from the Vancouver Housing Authority provided feedback on the opportunities and challenges faced by affordable housing projects related to green building.



Cascadia Region Green Building Council

Cascadia is the primary consultant for the project, managing the flow of work under the SARD contract and providing expertise on the requirements of the Living Building Challenge. Cascadia has subcontracted with Mithun and SERA Architects to provide technical design expertise and code analysis research.



II. OVERVIEW OF THE LIVING BUILDING CHALLENGE

Conventional building and development practices can pose significant impacts on our natural resources and on global climate change. According to the U.S. Green Building Council, buildings in the U.S. alone account for:

- 72% of electricity consumption,
- 39% of energy use,
- 38% of all carbon dioxide (CO₂) emissions,
- 40% of raw materials use,
- 30% of waste output (136 million tons annually), and
- 4% of potable water consumption.

Over the last 10-15 years, a number of programs, standards, and policies have emerged in response to the growing awareness and concerns of these serious impacts. Most prevalent has been the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating Systems which establish tiered levels of benchmarks for minimizing the negative environmental impacts of buildings. As of November 2008, over 2,020 building and development projects have been certified under the LEED Rating Systems, with more than 15,600 projects pending certification.¹

The growing market demand for certified green buildings and the need for ever-evolving standards for the design and construction of these buildings has resulted in the evolution of the Living Building Challenge (LBC). The Living Building Challenge was developed by the Cascadia Region Green Building Council to inspire higher levels of sustainability in the built environment. The LBC provides benchmarks for project teams seeking to move beyond the levels of the LEED Rating Systems into a region-specific, performance-based, post-occupancy evaluation of a project's sustainability efforts.

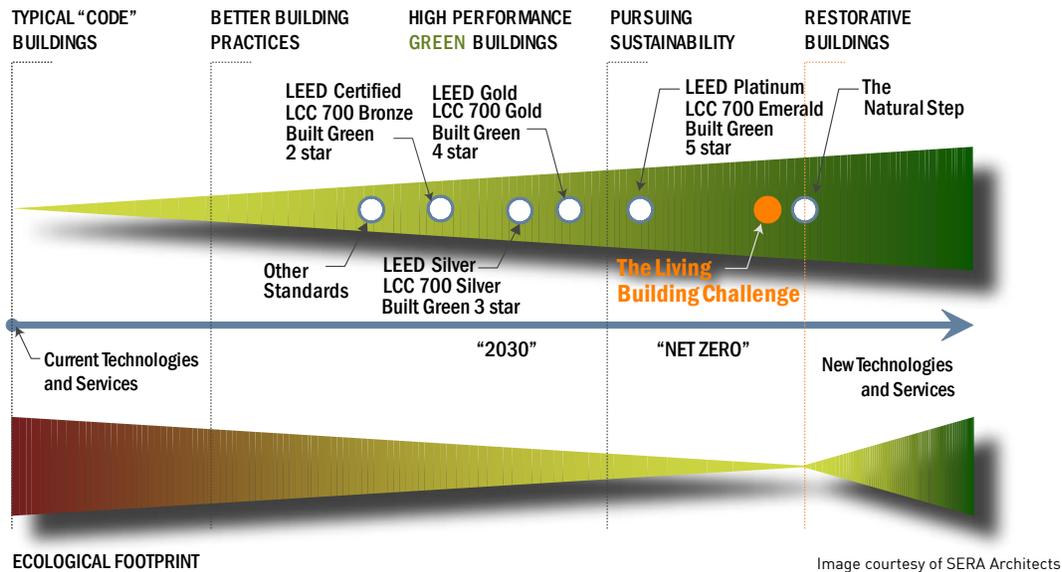
The Living Building Challenge was established to purposely push the envelope on the current level of green building practices while acknowledging current market conditions and realities. In the continuum of building practices that extend from code-compliance to those of the Living Building Challenge and beyond, the ultimate goal moves towards greater restorative designs and systems that provide more benefit than harm across the spectrum of their impacts. Mainstream green buildings are intended to help minimize negative impacts on building sites, optimize building performance to increase energy, water and resource efficiencies, and improve indoor environmental quality. By contrast, restorative or regenerative systems work towards improving the ability of a whole system to continually co-evolve toward greater health, vitality, and integrity.²

1 Green Building by the Numbers. USGBC. November 2008.

2 Code and Regulatory Barriers to the Living Building Challenge Report. David Eisenberg, et al. 2008.

The diagram below shows the incremental shift from typical code buildings to those approaching restorative goals.

SHADES OF GREEN



The LBC was chosen as the benchmark performance standard in this study because of its focus on a set of standards that represent the next evolution of green building practices. The Living Building Challenge is comprised of sixteen prerequisites within six performance areas: Site, Energy, Materials, Water, Indoor Quality, and Beauty and Inspiration. For a project to earn the Living Building designation, all prerequisites must be met. LBC projects harvest and store their own water and generate their own energy on a net annual basis. They are built from regionally-sourced, responsibly-harvested building materials free from persistent toxic chemicals. They are built on previously developed sites, offset the negative environmental impacts of their development, and support healthy indoor environments for all building occupants.

Where current building codes and regulations pose barriers to the LBC prerequisites, Cascadia's goal is to identify those barriers and work with a community of leaders towards solutions and incentives. It is recognized that not every project will be able to meet the LBC prerequisites and that every project will need to assess the level of scale at which accomplishing the goals of the LBC makes the most sense. For instance in dense urban locations, water, wastewater, and energy systems may be more beneficially accomplished on a neighborhood or district scale than on an individual site scale. Similarly, affordable housing projects may find that implementing LBC strategies on a community-wide scale is more cost-effective. For example, a 100-unit housing development may collect and treat its wastewater through one centrally-located onsite treatment system rather than a hundred individual onsite treatment systems for each house. Where public or private utilities provide energy and water systems from low-impact, clean technology, LBC projects may opt to connect to these utilities rather than provide individual onsite systems. At any scale, the intent of the LBC is to recognize that those involved in the design, construction and operation of buildings have a responsibility for addressing serious environmental impacts, such as natural resource depletion and climate change, beyond what is required by current regulations, and to provide project teams with a tangible set of standards for accomplishing this goal.

III. PROCESS

The types of codes that were analyzed as part of this project included both land use and development codes in addition to a suite of building codes. Separate processes were used to analyze these two different types of codes, as described below.

SELECTION OF CASE STUDIES

In order to assess code and regulatory barriers to sustainable, affordable, residential development, Cascadia identified 10 residential projects from across the region as potential case studies. These ten projects, some of which were completed and occupied and others that were still under construction, represented the best examples of innovative green design across a spectrum of different project types- from a small duplex project on an urban site in Seattle, WA, to a 175-unit master planned development in Salem, OR. By selecting projects that had already gone through permit review in the jurisdiction where they are located, the potential case studies were likely to represent project examples that the market would be likely to support.

Vancouver and Clark County reviewed the potential case study list and selected the following six projects to include in the code study:

Project Name	Architect	Permitting Jurisdiction	Zoning	# of Units	Description
Molnick Cottages	Living Shelter Design	King County, WA	Single Family Residential	11 single family houses using cottage density bonus	Existing single family house on a lot zoned for 6 residential units. The developer used King County's Cottage Housing Density Bonus to subdivide into 11 lots. The super insulated houses feature small footprints, passive solar design, and healthy indoor environments. This project type provides a replicable example of increased density for single family housing in both suburban and urban locations targeted to be affordable to first time home buyers. The project is currently in the final stages of permitting and is targeting Built Green* 4-star certification.
Cascade Built Duplex	OPA Design	Seattle, WA	Multifamily: Duplex	2 Attached Units	A LEED for Homes** Pilot Project, this project includes 2 units on a small urban site formerly occupied by one single family home. Green features include use of advanced stick framing and structural insulated roof panels, rainwater detention planters, and pervious parking surfaces. The project completed construction in Spring of 2008.
Patton Park Apartments	SERA Architects	Portland, OR	Mixed-Use	54 Apartments	The Patton Park project is an affordable and transit oriented development consisting of 54 apartments priced to serve families earning 60% or less of the median family income in Portland. The project includes 4,500 square feet of commercial space at street level, with four floors of apartments above. The variety of unit types range from studios to family-sized 3-bedroom apartments. The project is currently under construction planned for completion in the winter of 2008/9.
Lopez Island Zero Net Energy Project	Mithun	San Juan County, WA	Rural Residential	10 Single Family Houses and 2 Rental Units	The Lopez Community Land Trust is finishing construction on this 10-unit mixed-income, rural, zero-net energy project located on a 7-acre parcel on Lopez Island. The homes will be affordable for low- and middle- income families. The homes promote energy and water independence while preserving the rural character and ecological diversity of the site. Low Impact Development practices include rain gardens in parking areas, reduced impervious surfaces, and rainwater harvesting for clothes washing, toilet flushing, and irrigation. The small footprint homes range from 740 – 890 square feet. Zero-net energy strategies include installing a wind generator and solar collectors to produce on-site energy and using a solar hot water pre-heat system.
Corvallis Co-Housing	SERA Architects	Corvallis, OR	Multifamily: Townhomes and Stacked Flats	34 Units	The Corvallis Cohousing project is a completed 34- unit housing project including a 3,200 sq. ft. commons building, 8 private garages and a bike barn. Unit types include two-story townhouses and two-level stacked flats that vary between 850 - 1425 sq. ft. The community was designed in connection with Willamette Neighborhood Housing Services to be affordable for persons with incomes 80% or less of the median family income. The project offers an alternative to the traditional subdivision with an emphasis on pedestrian circulation and cycling rather than the automobile. Green features include onsite stormwater management through swales and ponds, and separate piping for future graywater reuse. The community established a goal of eventual zero net energy use, reinvesting savings from energy efficiency measures back into photovoltaic and solar thermal systems. Buildings are designed for a 50% reduction in energy use relative to the Oregon Energy code.
Pringle Creek Community	Opis Architecture	Salem, OR	Master Planned Community	175 units in Phase 1	Pringle Creek is a 32-acre sub-division development designed with principles of conservation, restoration, community connectivity, and green building in mind. Phase 1 includes 175 market rate housing lots currently for sale or under construction. When completed, the Pringle Creek Community will feature walkable neighborhoods, a meandering creek and wetlands, a community plaza of preserved and re-purposed historical buildings, community gardens and open green space. Housing types include detached single family, small cottage housing, row houses, live work studio lofts, and attached multifamily units. The project includes restoration of the creek and wetlands (nearly 15% of site) and restores the bordering riparian zone. Over 1/3 of site will be dedicated to community open space (parks, trail system, gardens) and natural green space (creek, wetlands, existing trees). A ""Zero-Impact"" stormwater design eliminates impact to the watershed using street and path infiltration swales, rainwater harvesting and storage, and improved interflow movement to creek. Some of the single-family homes are planned for net zero energy consumption.

*Built Green is a local residential green building program developed by Home Builders Associations and community stakeholders, and is available in various areas throughout Washington State. Built Green programs use a checklist that offers builders a prescriptive menu of green building strategies with point values attributed to them. Projects earn a Built Green rating of one to five Stars based on the number of points achieved. Programs vary by location. For more information see www.builtgreenwashington.org.

**LEED for Homes is a national residential green building program developed by the US Green Building Council. LEED for Homes also uses a checklist of prescriptive and performance strategies with point values attributed to them. Projects earn a LEED for Homes certification of Certified, Silver, Gold, or Platinum based on the number of points achieved. For more information see www.usgbc.org

APPLYING AFFORDABLE DESIGN CONCEPTS

For each of the six projects, Cascadia assessed possible design strategies the project teams could have incorporated to meet the requirements of the Living Building Challenge. Design strategies and systems were selected that are reasonably low-tech and readily available, such as design strategies and systems such as composting toilets, greywater drip irrigation systems, rainwater collection and filtration systems, and membrane bioreactors for handling wastewater onsite. These systems were favored over higher tech, newer or more experimental systems available in the marketplace due to the accessibility and feasibility for affordable housing projects to utilize them. Cascadia then met with each project team and drafted site design concepts to facilitate the analysis of code obstacles during the review process. Site designs and systems for each of the six case study projects documenting the Living Building design concepts are located in Appendix C & D.

LAND USE & DEVELOPMENT CODE ANALYSIS

City and County staff were charged with providing a thorough review of the case study projects against their land use and development codes in place in 2008. Cross-disciplinary review teams at both the City and County worked together to identifying sections of codes that might present obstacles to the potential development of these projects in their jurisdictions. Codes reviewed included:

Code Description	Vancouver Municipal Code Section	Clark County Code Section
Zoning	VMC Title 20	CCC Title 40
Land Divisions	VMC 20.320	CCC 40.540
Planned Unit Development	VMC 20.260	CCC 40.520
Site Plan	VMC 20.270	CCC 40.520
Grading	VMC 17.12	CCC 14.07
Erosion Control	VMC 14.24	CCC 40.380
Stormwater Management	VMC 14.25	CCC 40.380
Parking Standards	VMC 20.945	CCC 40.340
Street Standards	VMC Title 11	CCC 40.350

BUILDING CODE ANALYSIS

Simultaneously, Cascadia provided a detailed analysis of the building codes to identify similar obstacles faced by projects interested in pursuing the Living Building Challenge. Prior to commencing this analysis, Cascadia met with building officials from both the City and County to agree upon applicable codes for review. The following codes were selected:

Code	Description
International Building Code – 2006 Edition	Standards and Amendments WAC 51-50
International Mechanical Code – 2006 Edition	Standards and Amendments WAC 51-52
International Fire Code – 2006 Edition	Standards and Amendments WAC 51-54
Uniform Plumbing Code – 2006 Edition	Standards and Amendments, WAC 51-56, 51-57
Washington State Energy Code – 2006 Edition	WAC 51-11
Washington State Ventilation and Indoor Air Quality Code – 2006 Edition	WAC 51-13

The International Residential Code was not selected for review because it was anticipated that the same code-related obstacles would be found in the International Building Code, and that the International Building Code would likely contain additional barriers, specifically pertaining to townhome and stacked-flat construction.

In collaboration with Cascadia's subconsultant, SERA Architects, a matrix of identified barriers was compiled (see Appendix B).

IV. FINDINGS

LAND USE AND DEVELOPMENT CODE BARRIERS

Both the City and the County identified numerous land use and development code obstacles to the Living Building Challenge case study projects. A listing of the barriers identified, along with their corresponding code sections and potential solutions, is found in Appendix A. For the purpose of this study, the following types of code barriers were identified by staff but were EXCLUDED from analysis:

- Any code conflicts not associated with green building or the Living Building Challenge. For example, several case study project drawings did not show the appropriate number of fire hydrants required by city and county code. The number of hydrants required by code would have been included for an actual project and was therefore excluded from analysis.
- Zoning issues such as density and use subject to interpretation for each case study project. City and County staff selected the most appropriate zoning classification within their jurisdictions from which to analyze and review each case study. Density and use variations between the selected city and county zoning requirements and the requirements of the jurisdiction where the project was actually permitted were not taken into consideration.
- Issues that could be resolved by simple re-design. For example, where a stormwater infiltration feature encroached upon required setback areas, if the issue could be resolved by simply modifying the design to comply with the code requirement without encountering obstacles then these types of hurdles were excluded from analysis.
- City and County regulations that posed more stringent requirements for wetland setbacks and protection of existing vegetation than the jurisdictions where the case study projects were permitted and approved.

Because of the similarities in systems analyzed, consistent barriers arose across each of the six case study projects. The key barriers identified in the City and County's land use and development codes are summarized below.

SUMMARY OF KEY FINDINGS

Minimum Parking Requirements

Several of the case study projects featured a reduction in onsite parking from what was required by code. This strategy is most applicable to dense urban areas where access to alternative transportation modes exists. While the Living Building Challenge does not establish criteria for minimizing parking on a project site, allowing reductions in required parking, in particular surface parking, can help free up areas for onsite systems common to LBC projects. Such systems include greywater drip irrigation and rainwater harvesting systems that assist with meeting the LBC net zero water goals. Additionally, minimizing parking reduces impervious surfaces and assists with managing stormwater through onsite infiltration.

Connection to Public Water

Connection to the public water system is currently required for all potable and nonpotable water needs where municipal service is available. LBC projects seeking to provide all their water needs through captured rainwater or another closed-loop onsite system would require a public water waiver from the City or County in addition to a Water Adequacy Verification Evaluation (WAVE) and approval from Clark County Public Health. Any variances to these regulations would also need to be coordinated with the departments or agencies providing water service (City of Vancouver and Clark Public Utilities).

Connection to Public Sewer

Connection to the public sewer system is required within the urban growth area as a condition of building permit issuance. LBC projects seeking to handle all wastewater onsite would need to obtain a public sewer waiver from the City or County, in addition to a septic permit from Clark County Public Health. Any variances to these regulations would also need to be coordinated with sanitary sewer service purveyors (City of Vancouver and Clark Regional Wastewater District).

Sewer Service Charges

Building customers are currently charged for public sewer service based on the building's water usage. If an LBC project were not connected to the public sewer, under current regulations residents would still be charged for sewer service. Any revisions to these regulations to allow credit for not connecting to the sewer system would need to be coordinated with the public sewer providers.

Setbacks for Cisterns

For small urban lots, above-ground rainwater harvesting cisterns must meet property line setback requirements. On constrained sites, these setbacks could pose a barrier to LBC projects with above-ground cisterns in meeting their net zero water goals. Reducing setbacks for cisterns, within a certain height limit, can increase the onsite area available for rainwater collection systems.

Stormwater BMPs

Both the City and County currently implement outdated stormwater codes. Efforts are underway in both jurisdictions to adopt the Washington State Department of Ecology 2005 Stormwater Manual which allows and provides credit for low impact development (LID) strategies employed on the building site. Opportunities to increase requirements or incentives for LID practices even further could be explored by both the City and County to optimize adoption of standards that match current research and technologies.

Driveway Width Requirements

Clark County requires 12' width for residential driveways. On small lots, minimizing impervious surfaces allows for more area available for onsite systems and stormwater mitigation similar to the parking issue described above. Opportunities to reduce typical width requirements coupled with incentives for using pervious pavements would help address this barrier.

Common Areas

Many residential development projects require onsite common areas, such as pedestrian-oriented open space for residents. On constrained sites, using these open space areas for greywater subsurface systems or stormwater infiltration swales can assist LBC projects with meeting their net zero water and zero water discharge goals.

Fire Access Road Width

Both the City and County codes require 20' minimum width for fire access roads on the property. Assessing requirements of fire apparatuses may offer opportunities to reduce road widths, allowing additional area for onsite systems. Establishing an approved list of permeable pavement options for fire access roads can provide incentives for managing stormwater onsite.

Alternative Fuel Storage

While the Living Building Challenge does not have requirements for onsite storage of alternative fuels, this study considered placing biodiesel and hydrogen storage tanks on the project site for resident's vehicle use. Currently, no requirements for onsite storage of these fuels exist within the City and County codes. The development of standards or guidelines for alternative fuel storage on a project site can address this barrier.

Treatment of Group A Water Systems

For one of the LBC case study projects a Group A water system was required based on the size of the project. For Group A systems, the authority having jurisdiction is the Washington State Department of Health (DOH) rather than Clark County Public Health. DOH does not allow point-of-use treatment systems, and chlorination is mandatory for all surface water systems. The LBC requires treatment without the use of chemicals.

Rural Cluster Development

Cluster developments group buildings and other disturbed areas of the project site such as roads, driveways, and walkways so that a larger portion of the site can be left as undisturbed open space. In Clark County, rural cluster developments are allowed only where environmental critical areas exist. Providing guidelines and incentives for this type of development in other areas, while preserving rural character, will help limit impact to wildlife and assist LBC projects with meeting their habitat exchange goals.

Solar and Wind Standards

Currently the land use and development codes do not address onsite energy systems such as photovoltaics and wind turbines, two systems likely to be proposed for projects seeking net zero energy goals. Common issues that arise include height restrictions for photovoltaic panels mounted on roofs, and height and setback restrictions for onsite wind turbines. Additionally, the code does not currently address solar access. Pilot projects and the development of guidance documents for project teams seeking to design solar and wind systems into their projects could help establish new standards.

Light Pollution Standards

The path to net zero energy requires that design teams address energy efficiency throughout all aspects of the project. Over-lighting or improper lighting of a project site can waste large quantities of energy and contribute to light pollution. Currently the land use and development codes do not address light pollution. Developing standards for site lighting that establish limits on light intensities, require automatic controls to eliminate lighting during daytime hours, and eliminating unnecessary lighting at night while still maintaining safety and security can help address light pollution while also increasing energy efficiency.

BUILDING CODE BARRIERS

A thorough review of the 2006 International Codes (Building, Mechanical, and Fire) as well as the Uniform Plumbing Codes and the Washington State Energy and Ventilation Codes resulted in identification of fifty possible code obstacles Living Building projects may encounter. A matrix of these barriers is presented in Appendix B and is organized by code, type of barrier, and the LBC prerequisite affected. The barriers are further categorized by the level of difficulty project teams may face in addressing and seeking approvals in order to meet the requirements of the Living Building Challenge. Absolute barriers (labeled as brick walls in the matrix) are those that prevent a designer from meeting the LBC unless the code language is changed or modified. There are very few absolute barriers, as most projects can apply for approval of any given system or material using the alternative means and methods compliance path. Those barriers that are labeled as hurdles in the matrix represent barriers that can be overcome with some level of effort by the project team but these would result in additional cost or impacts to a project schedule. While there are various ways for project teams to address such hurdles, they are, nonetheless, barriers particularly for affordable housing projects where cost and schedule impacts can deter innovative green solutions. The matrix of code barriers is applicable to both the City and County as they enforce the same building codes.

SUMMARY OF KEY FINDINGS

Toxic Materials

Many conventional building materials contain toxins and other harmful substances listed in the Living Building Challenge's Materials Redlist. Where material requirements are called out in the building codes (such as the use of preservative and fire treated wood, vapor retardants, and plumbing materials like PVC), it can be more costly for an LBC project to source non-toxic alternatives and to assume the burden of proof that these alternative materials meet the intent of the code.

Energy Efficiency

In order for LBC projects to reach zero net energy goals, efficiency measures are the most important step for the design team. Several hurdles associated with maximizing a building's energy efficiency were identified in both the International Building Code and the Washington State Energy Code including:

- restrictions on design temperatures for heating and cooling that do not allow for expanded thermal comfort ranges ;
- insulation clearance requirements that restrict the overall amount of insulation possible for wall or roof cavities;
- passive crawl space ventilation requirements that conflict with conditioning these spaces; and
- definition of advanced framing that requires double top plate construction.

Water Supply & Discharge

The LBC's zero net water and sustainable water discharge prerequisites encounter several challenges in the 2006 Uniform Plumbing Code. Similar to the City and County municipal code barriers described above, supply of non-potable water to plumbing fixtures and disconnection of systems from the sewer or storm systems also present code barriers in the Uniform Plumbing Code. Additionally, the Uniform Plumbing Code requires the use of antiquated fixture performance data for regulations related to pipe sizing and greywater discharge.

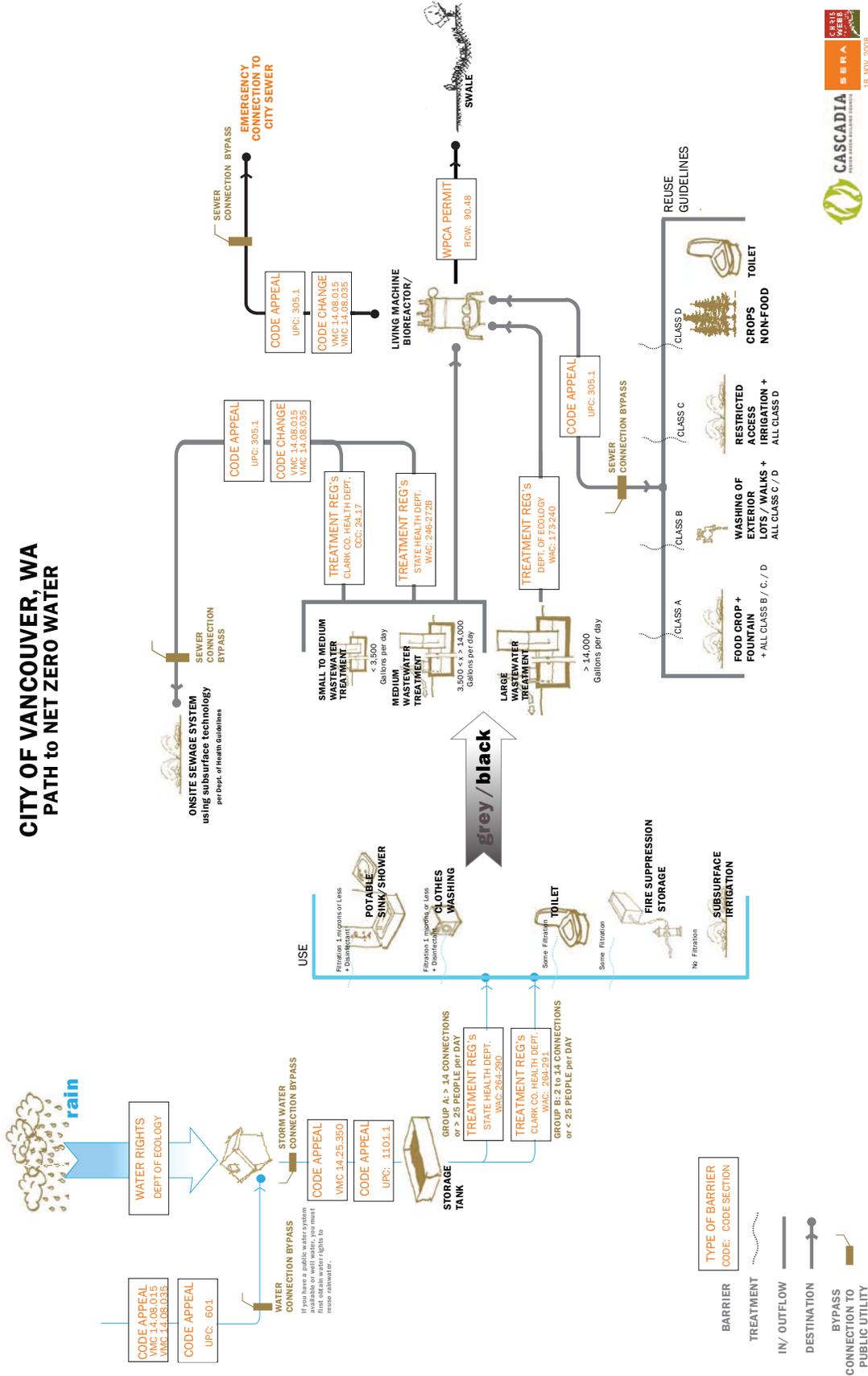
BARRIERS TO NET ZERO WATER

Living Building Challenge projects seek to source 100% of occupants' water use from captured precipitation or closed-loop water systems, while also managing 100% of storm water and building water discharge onsite. The most complex code barriers encountered by LBC projects are those that regulate the use of water supply and discharge. As noted above, these obstacles span varying codes, from development codes to building codes, and require myriad permit approvals, appeals and waivers from several different jurisdictions. The Water Diagrams below attempt to graphically portray the level of complexity for residential building projects within the City of Vancouver and Clark County to gain approval for net zero water design strategies. By mapping out the approval process for net zero water, opportunities to identify and successfully address the barriers become simpler. In Portland, Ore., where a similar water diagram has been developed, design teams and regulators have successfully eliminated two of the barriers encountered by LBC projects seeking zero net water use.

The pathway through the approvals and appeals process for net zero water will vary based on the project type and size. For all scenarios, it is assumed in the diagrams that a public water supply and sewer connection are available to the project. The path is similar for projects located in Vancouver and Clark County. First, a water rights permit is necessary from the State of Washington in order to legally harvest rainwater for use inside the building, and a code appeal is required on the local level for eliminating a connection to the public water supply and stormwater system. Approval from the local fire official is required for an onsite storage tank for fire suppression. Various treatment levels are required of the captured rainwater depending on its use and appeals may be necessary where chlorination is required. Small to medium size residential projects will then require a variance granted through Clark County Public Health for eliminating connection to the public sewer and treating wastewater onsite through systems such as composting toilets coupled with greywater drip irrigation or a membrane bioreactor. All of the case study projects would fall into this category with the exception of the 175-unit Pringle Creek development which would more likely be permitted through the State Department of Health and require similar variances. Large scale projects such as high rise residential and large commercial buildings require permits through the State Department of Ecology for onsite wastewater treatment systems. For this size project, water reuse is most likely necessary to meet zero net water goals and the State provides guidelines for how and where water reuse is permitted.

The following diagrams map out the pathway to net zero water for both the City of Vancouver and Clark County.

CITY OF VANCOUVER, WA PATH TO NET ZERO WATER



AFFORDABILITY BARRIERS

Feedback from the Vancouver Housing Authority indicated that while many hurdles exist from a financing perspective for any affordable housing project, upfront funding for design and higher first costs for systems that have financial returns over the life of the project are not a major barrier. One area of concern is that projects with onsite building systems may require added operations and maintenance, requiring an additional financial burden for staffing, training and ongoing maintenance. These additional costs should be evaluated by potential savings realized through efficient design and minimal or no utility bills. The affordable housing participants also indicated that the largest barriers are encountered in the approval of nonconventional projects and noted that public-funded housing might be a good arena for pilot projects that showcase innovative sustainable design.

INSTITUTIONAL BARRIERS

Any building project utilizing unconventional design strategies is bound to encounter some level of difficulty navigating through the regulatory system, and innovative green building projects are no different. While it is possible to design and construct a Living Building project without running into absolute regulatory barriers, the types of hurdles that exist for these projects can sometimes be attributed to the institutional framework of regulatory agencies themselves.

Alternative Materials & Methods

The administrative sections of the building codes allow for alternative materials and methods. The 2006 International Building Code states:

104.11 Alternative materials, design and methods of construction and equipment

"The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety."

However, some green building strategies such as strawbale construction have been seeking approval under this code provision for years without formal guidance or recognition of past approvals. For many building departments, approvals for an alternative material or method are rarely accessible as a resource for future projects. The burden of proof therefore lies on the project team and, in the case of smaller, affordable housing projects, using anything but conventional materials and methods can prove costly on project budgets. Instead of placing the burden of proof entirely on project teams, the City and County building departments may benefit from efforts to provide formal guidance and assistance to green building projects to help streamline the approvals process for alternative materials and methods.

Linear Approval Process

In recent years, the growing awareness and increased use of the integrated design process has opened a way for design and construction teams to view their projects in terms of whole systems or sets of interrelated systems, a key component to meeting the Living Building Challenge. In contrast, most regulatory agencies are set up to permit projects through a linear approvals process which typically maintains disciplinary and jurisdictional silos.

This linear process of approvals poses significant challenges. A project that has successfully endured the integrated design process relies heavily on the relationships between many design elements to meet its sustainability goals—including orientation, fenestration, overhangs, massing, thermal envelope, roof design, daylighting, mechanical systems and more. If any of those interdependent features is not approved, significant redesign of other systems or parts of the building may be required in addition to the feature that is rejected. This presents significant risks for design teams and project owners when pursuing deeply integrated designs. Involving regulatory officials very early on and throughout the integrated design process is one way for to help overcome this obstacle.

Lack of Information, Education, Training

Limited budget and staff time available to support green building efforts can be a challenge for jurisdictions. However, there is an ongoing need for more reference information, training and staff development regarding new or innovative technologies, changes in codes, and new understandings about conflicts between building codes and building science. Collaboration between jurisdictions can not only help leverage resources for education and information sharing, but can also help eliminate code barriers consistently across jurisdictions. The efforts by the City and County to work collaboratively to address barriers to the Living Building Challenge for sustainable, affordable residential development are more effective than on an individual basis.

Limitations for Code Changes

Due to the relationship between the national, state, and local levels concerning how codes are developed and adopted, the City of Vancouver and Clark County will be limited by the types of codes they may be interested in addressing to seek solutions to the barriers identified in this report. The International Codes are established on a national level, adopted by the State of Washington, and enforced, with amendments, by local jurisdictions. Any jurisdiction may amend the State Building Code provided the amendments do not reduce the minimum performance standards of the codes. There are three areas where local amendments are limited or prohibited:

1. Residential provisions of the State Energy Code cannot be amended.
2. The Ventilation and Indoor Air Quality Code cannot be amended.
3. Amendments by local jurisdictions which affect the construction of single-family and multi-family (four or less units not to exceed two stories in height) residential buildings must be reviewed and approved by the State Building Code Council.

Only one local jurisdiction in the State of Washington, the City of Seattle, has adopted more stringent amendments to the Washington State Energy Code. The State Building Code Council reviews and updates the codes on a 3-year cycle with the next revisions scheduled for 2009. Proposals to amend these codes are due by March 1, 2009. This may present opportunities for the City and County to provide input on code changes that address code barriers to sustainable, affordable, residential development for the 2009 updates. Any efforts that would require changes to codes on the national level would be too difficult to tackle as part of this project.

V. OTHER EFFORTS UNDERWAY

ICC 700-2008 NATIONAL GREEN BUILDING STANDARDS

International Code Council's ICC 700 is currently under development as a national standard for residential green buildings approved by the American National Standards Institute (ANSI). The standard is based on the 2005 Model Green Home Building Guidelines developed by the National Association of Home Builders (NAHB). NAHB is leading the efforts for the development of the standard which is scheduled to be released in 2009. The intent of the standard is to serve as a voluntary, point based rating tool for all types of residential projects. Any adopting agency, such as a local municipality, a nonprofit organization or other public or private entity, can choose to administer the rating tool and enforce the requirements of the standard. While the ICC 700-2008 National Green Building Standards will be written in enforceable language intended to coordinate with the requirements of the International Codes, ICC 700-2008 is not written as a green code and is not intended to be adopted as such. Rather, its intent is to provide an evaluation tool, much like other green building standards currently available (e.g. LEED and Built Green). If the City of Vancouver or Clark County is interested in assessing the applicability of this standard for future adoption, Cascadia recommends that a side-by-side comparison of ICC 700-2008, the Built Green programs already available in Washington State, and the LEED rating system (both for Homes and New Construction) be evaluated to select the most appropriate tool for adoption. Furthermore, based on the efforts of this study, Cascadia recommends the performance levels outlined in the Living Building Challenge as the most stringent and direct pathway to encouraging sustainability in the built environment.

ASHRAE/USGBC/IESNA 189.1 STANDARD FOR HIGH PERFORMANCE GREEN BUILDINGS

This standard is also currently under development by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE); the U.S. Green Building Council (USGBC); and the Illuminating Engineering Society of North America (IESNA). The standard applies to all buildings except low-rise residential buildings of three stories or less. ASHRAE/USGBC/IESNA 189.1 is intended to establish a new minimum code baseline, equivalent to the requirements for earning LEED certification, which can be adopted directly by governmental jurisdictions. The standard was expected to be released in 2008, however, the development committee has recently been halted and it is unclear at this time when the standard will be available.

VI. NEXT STEPS

The identification of barriers to the Living Building Challenge within the land use, development, and building codes in Vancouver and Clark County, serves as a solid foundation for assessing solutions for overcoming these barriers. A key strategy for moving forward in this effort will be the involvement of a variety of stakeholders — across departments, between regulatory agencies and utility providers, amongst council members, board members, and planning commissions, and from the design and building community — to champion efforts for removing barriers to sustainability in the built environment.

Cascadia's next steps as part of this project will be to:

- Work collaboratively with the City and County to prioritize efforts to remove the barriers identified. Identify responsible agencies and staff.
- Research possible solutions and provide suggestions to the City and County for overcoming these barriers, including examples of code language and incentives from other jurisdictions.
- Meet with stakeholders to describe barriers and options for addressing them.
- Develop a resource package of alternative materials and methods common to Living Building Challenge projects including a discussion of the issues, potential solutions, supporting materials, documentation, and "track record" identifying where each alternate has been approved.
- Provide recommendations for establishing a regional program that would improve collaboration and consistency among building officials and facilitate permitting of alternate methods and materials with the goal that they become mainstream.

These important strategies for addressing code barriers to sustainable, affordable, residential development are expected to commence in November 2008 and are scheduled to be completed in March 2009. A public outreach component and a financial evaluation of code and policy recommendations will be developed in future phases of this project.

APPENDIX A: LAND USE AND DEVELOPMENT CODE BARRIERS MATRIX

CITY OF VANCOUVER COMPILED CASE STUDY FEEDBACK

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
1	VMC Table 20.945.070-2 Parking and loading	Multiple family developments require 1.5 parking spaces per dwelling unit.	No exemptions for parking spaces apply. Additionally the lot dimensions would not allow for adequate room for required parking and maneuvering dimensions.	Yes and No	<ul style="list-style-type: none"> Code allows off-site parking within 300 feet. Possible joint use parking within 300 feet. On street parking through transit overlay district provisions. 25% reduction in parking through transit overlay district provisions. 	Code change to allow reduction in parking.
2	VMC 14.08.035 Connection required. VMC 14.08.015 Sewer availability.	Each residential or commercial water customer either within or without the city shall connect his or her premises to a city sewer if a city sewer is available thereto, as defined in VMC 14.08.015. (Ord. M-1956 § 6, 1979).	There is no exemption to connection when sewer available to the site.	Yes and No	Code change to allow alternatives as approved by the public works director.	Code change to allow alternatives as approved by the public works director.
3	VMC 14.04.230 Sanitary sewer service--User charges.	Sewer charges for each single family or multifamily residential customer shall be based upon that customer's water usage.	Even though not connected to sewer residents will be charged for sewer service.	No	N/A	Possible code revision to allow credit for not connecting to the City sewer system.
4	VMC 14.25.350 Small residential projects. VMC 14.25.350 Small residential projects.	Treatment and Runoff Control Requirements. (1) As an alternative to meeting all the water quality treatment and quantity control requirements specified in Sections 14.25.210 and 14.25.220, small residential projects can utilize the following methods for treating and controlling stormwater runoff: (A) Use of roof downspout systems for residential structures; (B) Use of one of the standard BMPs listed in Section 14.25.210(b) for treating runoff other than the runoff from roofs.	Cistern does not meet technical code requirement for small residential development stormwater treatment.	No		Possible pilot project or code amendment to allow rain water capture and reuse.
5	VMC 20.740.140 C Wetland performance standards	Development activities shall protect the functions of the wetlands and wetland buffers on the site.	Grey water drip system may contain damaging chemicals that would be discharged into the wetland and buffers.	No	Remove grey water system from wetland buffer.	None identified.
6	VMC 16.04.160 Water supply and hydrants (IFC 508)	Private fireflow adequacy not acceptable.	Public safety codes not made to trust private maintenance and fluctuating water supply variables.	No	A public system for fire protection must be provided.	None identified.

CITY OF VANCOUVER COMPILED CASE STUDY FEEDBACK (continued)

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
7	VMC 16.04.150 Fire Apparatus Access (IFC 503)	20 feet of paved width required for access	The parking area has pinch points that restrict required access width.	No	<ul style="list-style-type: none"> Redesign parking area. 	None identified.
8	VMC 16.04.150 Fire Apparatus Access (IFC 503):	Required dimensions for fire apparatus turnaround.	The parking area turnaround does not meet the local required dimensions	No	<ul style="list-style-type: none"> Redesign to meet local requirements 	None identified.
9	VMC 20.410.030 Uses.	Vehicle fuel sales are prohibited.	We do not want a commercial destination in a purely residential zone. Further permits and review may be required by DOE and SWCAA.	<p>Trip reduction is a comprehensive plan policy in the City.</p> <p>I don't have enough information on building department or outside agency requirements to determine.</p>	May be allowed if no public commercial sales are involved with the fueling station.	On site private distribution only no public sales.
10	VMC 16.04.150 Fire Apparatus Access (IFC 503):	Provide information showing proposed paving can meet weight requirements for emergency apparatus.	No information provided on whether the pervious concrete can withstand the weight of emergency vehicles	Yes and No	Provide pervious pavement data.	Redesign interior pedestrian way to meet emergency access standards. Combination of permeable pavement and Grass-crete
	VMC 20.430.030	Vancouver does not allow manufactured homes, agricultural or most industrial uses in the MX district.	The Vancouver MX is written broadly to cover changes from other zoning districts to the MX district. The intent of the Vancouver MX is more density and FAR driven that is why AG uses are out.	Yes and No		Code changes to allow certain uses that may benefit sustainable development like smaller agricultural uses and artisan bakeries.
12	VMC 14	N/A	The MBR system discharge may adversely affect concrete sewer lines. Pipe lining may be necessary.			

CLARK COUNTY COMPILED CASE STUDY FEEDBACK

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
1	CCC 40.210.020(D) - Purpose of Rural Cluster Development	The purpose of this section is to provide for small lot residential development in the rural zoning districts (R-5, R-10 and R-20) which maintains rural character, maintains and conserves larger remainder parcels, protects and/or enhances sensitive environmental and wildlife habitat areas, and minimizes impacts to necessary public services. These goals are achieved by allowing the placement of homes on a small portion of the property while maintaining the majority of the site in a remainder parcel.	Cluster developments generally occur on those parcels where environmentally sensitive areas limit potential development under standard rural residential design criteria. It is also intended to promote and protect open space and resource (farm and forest) activity on the larger remainder parcel. Environmentally sensitive areas are those lands classified as habitat areas, any wetland category and associated buffers, landside hazard areas, lands subject to the Shoreline Management Act, and lands within a designated 100-year flood plain.	No, there are no environmentally sensitive areas identified on this parcel. In addition, intent of the County's cluster development is to retain the rural character to the maximum extent possible.		
2	Live Work Units	The County code does not include provisions for this type of dwelling unit.	The definition for a Live Work Unit included in the Refinement Plan indicates the work space can be used for retail use. The County does allow use of a property for a home business provided certain standards are satisfied. However, retail sales are specifically precluded.			
3	Table 40.340.010-4 - Minimum Required Parking Spaces AND CCC 40.340.010(4)(a) - Location of Parking Facilities	For multi-family developments containing 4 or more dwelling units – 1½ space/dwelling unit is required. For 1, 2, and 3-unit family dwellings – 2 spaces/dwelling unit are required. Single-family and duplex parking may be tandem. Off-street parking spaces shall be located on the same lot as the dwelling.	Not enough parking provided.	No	The review authority may allow parking credits established through a neighborhood parking plan to meet the number of required spaces. The number of credits for an individual parcel is established in the approved parking plan in accordance with guidelines in CCC 40.340.030(B).	Project site needs to be in a highly urbanized area with ready access to transit providing service to not only Clark County but the Portland metro area.
4	Table 40.220.020-3 - Minimum Setbacks	Front – 20 feet; Street Side – 10 feet; Interior Side – 10 feet; Rear – 20 feet; 8-foot separation between buildings on site;	Generally, cisterns and pumps are located underground. If they are located above ground, however, they must comply with setback and height limitations of the zone. In addition, if the cistern is not physically connected to the duplex, there must be an 8-foot separation.	Not enough information to determine.		
5	CCC 40.350.030(4)(b)(2) - Driveways	Driveways shall have a minimum width of twelve (12) feet of clear unobstructed all weather driving surface and an overhead clearance of thirteen (13) feet, six (6) inches.	Provide an unobstructed vertical clearance of not less than 13.5 feet, with an all-weather driving surface and capable of supporting the imposed loads of fire apparatus.			

CLARK COUNTY COMPILED CASE STUDY FEEDBACK (continued)

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
6	CCC 40.370.010(C) – Connection to Public Sewer	Inside UGAs, connection to public sewer is required as a condition of building permit issuance for any new structure unless certain exceptions apply, then a sewer waiver can be granted.	Connection to public sewer is required unless a sewer waiver can be granted.	No		Any change to this requirement needs to be coordinated with sanitary sewer service purveyors – City of Vancouver and Clark Regional Wastewater District.
7	CCC 40.370.010(B) – Definition of Public Sewer CCC 40.370.010(C)(1) – (3) – Sewer Waiver Requirements	"Public Sewer" means extension of a public sewer system operated by a public entity, or where such extension is impractical, connection to an alternative public sewer system operated by the designated public sewer purveyor. One of the following must apply in order for a sewer waiver to be granted: 1. The new structure is an alteration, expansion or replacement of an existing structure which will not entail a material increase in sewage effluent production. 2. The new structure lawfully incorporates no on-site sewage system. 3. The new structure is for single-family detached residential use, or a non-residential use, generating a projected effluent flow of not more than seven hundred (700) gallons per acre per day, if: a. Such use does not generate hazardous/dangerous waste, as defined by applicable federal, state or local law; and b. Extension of public sewer is impractical based upon the following criteria: (1) Public sewer would have to be extended more than three hundred (300) feet; or (2) Necessary permission cannot be obtained from intervening landowner(s); or (3) Intervening property contains natural or manmade obstructions, such as deep canyons, elevation changes, and solid rock impediments, which make public sewer extension prohibitively expensive or undesirable; and c. A covenant to the county surveyor or purveyor is recorded which commits the current future property owner(s) to connect to public sewer within twelve (12) months of sewer becoming available. The covenant shall also contain a provision that commits the current future property owner(s) to participate in a future local improvement district if this is the method used to extend sewer.	The project does not qualify for a sewer waiver.	No		
8	CCC 24.17.010(2) – On-site Septic Systems	Inside UGAs, connection to public sewer is required as a condition of building permit issuance for any new structure unless one (1) of the following exceptions applies: a. The new structure is an alteration, expansion or replacement of an existing structure which will not entail a material increase in sewage effluent production. b. The new structure lawfully incorporates no on-site sewage system. c. The new structure is for single-family detached residential use, or a non-residential use, generating a projected effluent flow of not more than seven hundred (700) gallons per acre per day, if: (1) Such use does not generate hazardous/dangerous waste, as defined by applicable federal, state or local law; and (2) Extension of public sewer is impractical according to Section 40.370.010 (see #9 above); and (3) A covenant to the county surveyor or purveyor is recorded which commits the current and future property owner(s) to connect to public sewer within twelve (12) months of sewer becoming available. The covenant shall also contain a provision that commits the current and future property owner(s) to participate in a future local improvement district if this is the method used to extend sewer.	A septic permit cannot be issued by Public Health unless a sewer waiver is granted by Community Development. If a waiver was issued by Community Development, Public Health would have concerns of the small lot size. The lot must be big enough to support both an initial and reserve drainfields. The proposal indicates only 12 inches of soil vertical separation. Treatment level 'A' is required with only 12 inches of vertical separation.	No- 11 small lots on septic systems pose a public health concern. Treatment level A septic systems require electric pumps, alarms, filters, disinfection and etc. which maybe less sustainable than connecting to the sanitary sewer. Yes for compost toilets.		

CLARK COUNTY COMPILED CASE STUDY FEEDBACK (continued)

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
9	CCC 40.370.020(C)(2) – Connection to Public Water	In areas located inside urban growth boundaries, where the public agency purveyor is willing and able to provide safe and reliable service, connection to public water is required as a condition of building permit issuance for all new residential uses of less than four (4) units when public water is within 750 feet of the lot.	Connection to public water system is required. Any changes to this requirement will need to be coordinated with those agencies providing water service – City of Vancouver and Clark Public Utilities.	No		Code changes to this requirement will need to be coordinated with those agencies providing water service – City of Vancouver and Clark Public Utilities.
10	CCC 40.370.020(A) – Definition of Public Water System	"Public Water System" means a potable water supply system operated by a designated public agency including a city, town or Clark Public Utilities.				
11	CCC 40.370.020(C)(2)(a) – (2)(c) – Conditions Required for Not Connecting to Water	The responsible official may conclude that public water is not available to the developer with reasonable economy and efficiency, within 750 feet of the lot, based on the following considerations: a. Permission cannot be obtained from intervening property; b. Intervening property contains natural or manmade obstructions which make extension extraordinarily expensive, such as a deep canyon, solid rock or reconstruction of a road or sidewalk; c. Intervening changes in elevation make adequate service to the property extraordinarily expensive.	Based on available information, it does not appear that any of these conditions apply to these projects.			Code changes to this requirement will need to be coordinated with those agencies providing water service – City of Vancouver and Clark Public Utilities.
12	RCW 19.27.097 <i>At this time Public Health does have a local ordinance for wells and onsite drinking water systems. However, RCW 19.27.097 requires that applicants for a building permit for a building necessitating drinking water shall provide evidence of an adequate and safe supply for the intended use of the building.</i>	Public Health would conduct a Water Adequacy Verification Evaluation (WAVE) on the proposed water system ONLY if Community Development issued a connection to public water waiver. Washington State Department of Health requires rainwater harvesting systems to be designed with adequate storage and equipped with filtration and disinfection (UV or Chlorine). The proposed filter is approved for swimming pool applications. The proposed filter must meet ANSI or NSF drinking water standards for 1-micron filtration.	Public Health would need a waiver from Community Development before a WAVE could be reviewed and completed.	Yes if a waiver was issued by Community Development.		
13	CCC 40.350.030(B)(5) – Frontage Roads/Improvement	Right of way dedication and frontage improvements - "a partial-width road shall be established and constructed to the applicable right-of-way or easement and improvement standards set out in Section 40.350.030 to that portion of a frontage public or private road which abuts a parcel being developed as a condition of development approval."	Right-of-ways for the frontage roads have been dedicated and frontage improvements have been performed in accordance with the jurisdiction's transportation standards.	Yes, the design meets the conceptual intent of the code. No, it does not meet the technical intent.	Depending on the classifications of the frontage roads, generally Clark County standards require larger pavement section.	Clark County transportation standards allow narrower pavement sections for roads serving local traffic. Narrower roads may be allowed if justified through traffic analysis.

CLARK COUNTY COMPILED CASE STUDY FEEDBACK (continued)

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
14	WAC 246-290 - Group A Public Water Systems	Community water system - by definition, a Group A system serves 15 or more residential connections or 25 or more people per day for 60 or more days per year.	As described below, rainwater is considered a surface water source. Both Group A and Group B water systems using surface water sources must meet the requirements of WAC 246-290 Part 6 for us to consider them adequate. The treatment, monitoring, record keeping and certification requirements for surface water systems make surface water treatment for these small systems unfeasible in almost all circumstances.	Not as submitted	The micron filter may do a good job, but there are numerous complications with the regulations (state and federal) as they stand today, including: 1. Washington State DOH does not approve point of use treatment systems 2. Surface water systems require a certified operator 3. Surface water systems must have continuous turbidity and chlorine residual monitoring Chlorination is mandatory for surface water systems	
15	CCC 40.380.040(B)(4)(b) - Standard BMPs CCC 40.380.040(B)(9) - Experimental BMPs	Acceptable standard treatment BMPs may, depending upon circumstances and site characteristics, include the following from the BMP manual (Chapters III-3, III-4, and III-6): (1) R1.05 - WQ Infiltration basin; (2) R1.10 - WQ Infiltration trench; (3) R1.15 - Roof downspout system; (4) RD.09 - Constructed wetland; (5) RD.06 - Wet pond with marsh; (6) RD.05 - Wet pond without marsh; (7) RB.05 - Biofiltration swale; (8) RB.10 - Vegetative filter strip; (9) RE.05 - Sand filtration basin; (10) RF.10 - Sand filtration trench; (11) Cartridge filters using compost, perlite, and geolite. Experimental BMPs. a. Experimental best management practices are those which have not been fully tested and evaluated by the county or the Washington Department of Ecology and are not included as accepted practices in this code or the BMP Manual. Experimental BMPs that are adequately tested and proven effective shall be incorporated into this section as standard or accepted BMPs in the future. b. Experimental BMPs may be allowed if all the following conditions are met: (1) The experimental BMP usage is part of a Washington Department of Ecology or Clark County research project; (2) Monitoring of the effluent quality produced by the BMP, as well as influent quality, will be conducted for at least two (2) years; (3) Results of the research will be published; (4) Financing is available to construct the BMP, conduct the testing and publish the results. c. The responsible official may approve use of alternative water quantity and/or water quality treatment devices that are acceptable for projects meeting the eligibility requirements of Section 40.260.110 with evidence from the applicant that water quality, water quantity control, and maintainability are not affected.	The project proposes to manage a large portion of the stormwater runoff by utilizing rain gardens, pervious pavement, and cisterns. The current code references the Puget Sound Stormwater Manual (1992) as the BMP Manual. In accordance with the county current stormwater code stormwater control via rain gardens and pervious pavements are not accepted outright. Furthermore, no credits are given for utilizing compost amended soils. However, these methods used for this project may be accepted as experimental BMPs pursuant to CCC 40.380.040(B)(4)(b)(9).	Water quality and quantity control methods used for this project may be accepted as experimental BMPs pursuant to CCC 40.380.040(B)(4)(b)(9).	The county is planning to update and adopt a new stormwater ordinance which references the DOE 2005 Stormwater Management Manual for Western Washington. Once the new ordinance is in effect, the BMPs used for this project would be accepted outright as standard BMPs.	The stormwater control methods utilized for this project can be used on an experimental basis. Most of the control methods used will be accepted outright upon adoption of the new stormwater code.

CLARK COUNTY COMPILED CASE STUDY FEEDBACK (continued)

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
16	2006 IFC 503.2.5 - Required Turn-arounds AND CCC 40.350.030(B)(12)(b) - Turnaround Design	Fire apparatus turnarounds are required and as indicated do not meet the requirements of the Road Standards.	No.	No.		
17	2006 IFC 503.1.1.5 - Fire Access Road	Fire apparatus access roads shall maintain an unobstructed width of not less than 20 feet to within 150 feet of all exterior points of all buildings. Access roads shall have an unobstructed vertical clearance of not less than 13.5 feet, with an all weather driving surface and capable of supporting the imposed loads of fire apparatus.	No.	No.		
18	2006 IFC 105.6.16 - Fuel Dispensing Permits		The Biodiesel fuel station will require permits and approval from the Fire Marshal.			
19	CCC 24.17 and WAC 246-272A WAC 246-272B	Onsite Septic Systems (OSS) Large Onsite Septic Systems (LOSS)	"Grey Water Systems" and sizing of Onsite Septic Systems (OSS)	No	The code requires each unit to be sized with a minimum of 2-bedrooms. For combined black and grey water system the sizing used is 120 gallons per bedroom. However, the RS&G's for Water Conserving On-Site Wastewater Treatment Systems allows design flows for greywater systems to be reduced by 37.5% for units with two bedrooms and 50% for units with 3 or more bedrooms from the minimum design flows for combined wastewater systems. The proposed grey water system indicates only 12" soil vertical separation in soil type 5. The LOSS Rule requires a minimum of 24" soil vertical separation. Therefore, this proposed LOSS would not meet the code to protect public health and environment.	Work with the Washington State Department of Health to change the LOSS requirements.

CLARK COUNTY COMPILED CASE STUDY FEEDBACK (continued)

#	Specific Code Section	Code Language	Discussion of Issue	Does design meet the conceptual intent of the code? Does it meet the technical intent?	Under what conditions or circumstances does the design meet the code intent?	Potential solutions to addressing code obstacles: Short term & longer term solutions
20	CCC 24.17.010(2) - Onsite Septic Systems	<p>Inside UGAs, connection to public sewer is required as a condition of building permit issuance for any new structure unless one (1) of the following exceptions applies:</p> <p>a. The new structure is an alteration, expansion or replacement of an existing structure which will not entail a material increase in sewage effluent production.</p> <p>b. The new structure lawfully incorporates no on-site sewage system.</p> <p>c. The new structure is for single-family detached residential use, or a non-residential use, generating a projected effluent flow of not more than seven hundred (700) gallons per acre per day, if:</p> <p>(1) Such use does not generate hazardous/dangerous waste, as defined by applicable federal, state or local law; and</p> <p>(2) Extension of public sewer is impractical according to Section 40.370.010; and</p> <p>(3) A covenant to the county surveyor or purveyor is recorded which commits the current and future property owner(s) to connect to public sewer within twelve (12) months of sewer becoming available. The covenant shall also contain a provision that commits the current and future property owner(s) to participate in a future local improvement district if this is the method used to extend sewer.</p>	<p>A septic permit cannot be issued by Public Health unless a sewer waiver is granted by Community Development.</p> <p>If a waiver was issued by Community Development, Public Health would have concerns of the small lot size. The lot must be big enough to support both an initial and reserve drainfields.</p>	No.		
21	WAC 246-290 - Group A Public Water Systems	Community water system - by definition, a Group A system serves 15 or more residential connections or 25 or more people per day for 60 or more days per year.	<p>As described below, rainwater is considered a surface water source. Both Group A and Group B water systems using surface water sources must meet the requirements of WAC 246-290 Part 6 for us to consider them adequate. The treatment, monitoring, record keeping and certification requirements for surface water systems make surface water treatment for these small systems unfeasible in almost all circumstances.</p> <p>The micron filter may do a good job, but there are numerous complications with the regulations (state and federal) as they stand today,</p> <p>including:</p> <ol style="list-style-type: none"> 4. Washington State DOH does not approve point of use treatment systems 5. Surface water systems require a certified operator 6. Surface water systems must have continuous turbidity and chlorine residual monitoring 7. Chlorination is mandatory for surface water systems 	Not as submitted		

APPENDIX B: BUILDING CODES BARRIERS MATRIX

Type of Barrier

- Brick Wall (Hard) Barrier completely prevents a designer from meeting the LBC, unless the section is changed or modified.
- Hurdle (Soft) Barrier can be overcome if you jump high enough (added effort on the part of the design team). These are areas of the code to look at to see if code issue is of significant importance to warrant the extra effort.
- ~ Monetary (Financial) Barrier can be overcome if additional money is spent.
- ~ Site (Financial) Barrier can be overcome if additional land area is provided.
- ~ Constructability (Time) Barrier can be overcome if additional time is spent to appeal code or present alternate means.
- ~ Energy Efficiency (Time) Barrier can be overcome if additional time is spent to appeal code or present alternate means.

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
1	5 Materials Redlist / 6 Construction Carbon Footprint	Hurdle / Monetary	Building	509.5	Group R-2 Buildings of Type IIIA construction	The height limitation for buildings of Type IIIA construction in Group R-2 shall be increased to six stories and 75 feet where the first floor construction above the basement has a fire-resistance rating of not less than 3 hours and the floor area is subdivided by 2 hour fire resistance fire walls into areas not less than 3000 sf.	Code incentivizes steel buildings over wood due to fire resistance requirements. Wood is better choice for LBC projects based on regional availability, renewable resource, less embodied energy, and better U-value. For wood construction, this code requires the use of fire resistant plywood, some of which contains toxins on the materials redlist. Fire resistant plywood products that do not contain redlist materials are more costly.	Fire protection
2	5 Materials Redlist	Hurdle / Monetary	Building	704.11	Fire retardant wood	Walls that terminate at roofs of not less than 2-hour fire-resistant-rated construction or where the roof, including the deck and supporting construction, is constructed entirely of noncombustible materials.	Code requires the use of fire resistant plywood, some of which contains toxins on the materials redlist. Fire resistant plywood products that do not contain redlist materials are more costly.	Fire protection
3	4 Net zero Energy	Hurdle / Energy Efficiency	Building	1203.2	Attic Spaces - required insulation	Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof framing members shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain and snow. Blocking and bridging shall be arranged so as not to interfere with the movement of air. A minimum of 1 inch of airspace shall be provided between the insulation and the roof sheathing. The net free ventilating area shall not be less than 1/150 of the area of the space ventilated, with 50 percent of the required ventilating area provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents.	Vented roof in this climate not necessary. By requiring vent, cannot maximize insulation in rafter cavity making it more difficult to achieve net zero energy requirement. This is targeted to change in the 2009 Washington State Energy Code updates.	Prevent mold growth
4	4 Net zero Energy	Hurdle / Energy Efficiency	Building	1203.3.2	Under Floor Ventilation	The min. net area of ventilation opening shall not be less than 1 square foot for each 150 sf of crawl space areas.	Grey areas in code around best practice for energy efficiency and indoor air quality which is to mechanically condition crawl space and eliminate passive venting of cold outdoor air.	Prevent mold growth

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
5	4 Net zero Energy	Hurdle / Energy Efficiency	Building	1205.2	Window area required for Natural Light	The minimum net glazed area shall not be less than 8 percent of the floor area of the room served.	Why mandate 8%? Some projects may be designed to use less while also ensuring adequate light and increasing energy efficiency.	Adequate Light-Addressed in commentary as a 10% floor area rule of thumb that was reduced
6	4 Net zero Energy	Hurdle/ Energy Efficiency	Building	1205.3	Artificial Light - average of 10 fc	Artificial light shall be provided that is adequate to provide an average illumination of 10 foot-candles over the area of the room at a height of 30 inches above the floor level.	Mandatory Fc requirement does not address needs of space. For instance, a bedroom might need less artificial lighting. Over-lighting spaces encourages higher energy use.	Adequate light
7	4 Net zero Energy	Hurdle/ Monetary	Building	1604.8.1	to use of Straw bale as a lateral element	Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed loads.	Straw bale is highly insulated, low-cost wall material. Structural strength of straw bale not known and testing is expensive.	Structural strength of straw bale
8	4 Net zero Energy	Hurdle/ Monetary	Building	Table 602	to use of Straw bale where fire rating is required	Table 602.provides fire rating requirements for exterior walls.	Straw bale is highly insulated, low-cost wall material. Not cost effective if additional fire protective material is required and testing is expensive.	Fire protection
9	5 Materials Red list / 8 Appropriate Materials Radius	Hurdle / Construct-ability	Building	2303.1	Preservative -treated Wood.	Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.11 to be preservative treated shall conform to the requirements of the applicable AWPA standard U1 and M4 for the species, product, preservative and end use. Preservatives shall be listed in Section 4 of the AWPA U1. Lumber and plywood used in wood foundations systems shall conform to Chapter 18.	Most wood preservatives approved by code are on the materials redlist. Natural species within the materials radius requirements would be a better option for LBC projects. Burden of proof is put on the design team to come up with a product that gets approved.	Prevent decay of wood structures and thus potential collapse of the building.
10	5 Materials Red list / 8 Appropriate Materials Radius	Hurdle / Construct-ability	Building	2303.4	Wood supported by Exterior Foundation	Wood framing members and furring strips attached directly to the interior of exterior masonry or concrete walls below grade shall be of approved naturally durable or preservative treated wood.	Most wood preservatives approved by code are on the materials redlist. Natural species within the materials radius requirements would be a better option for LBC projects. Burden of proof is put on the design team to come up with a product that gets approved.	Prevent decay of wood structures and thus potential collapse of the building.
11	5 Materials Red list / 8 Appropriate Materials Radius	Hurdle / Construct-ability	Building	2304.11	Wood used above ground, wood supported by exterior foundations, exterior walls below grade on inside of masonry, sleepers and sills, wood siding	Wood used above ground in the locations noted shall be naturally durable wood or preservative treated wood using water borne preservatives, in accordance with AWPA U1 for above ground use.	Most wood preservatives approved by code are on the materials redlist. Natural species within the materials radius requirements would be a better option for LBC projects. Burden of proof is put on the design team to come up with a product that gets approved.	Prevent decay of wood structures and thus potential collapse of the building.

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
12	4 Net zero Energy	Hurdle / Energy Efficiency	Energy	201	Definition: Design Heating and Cooling Conditions	The heating or cooling outdoor design temperatures shall be selected from 0.6% column for winter, and 0.5% column for summer from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE."	Is this the right temperature reference to use for Vancouver and Clark County? Allowing wider design temperatures may result in higher efficiency. Larger projects can demonstrate this through energy modeling, smaller projects and affordable housing would benefit from prescriptive approach. ASHRAE 55-2004 provides expanded comfort criteria for naturally ventilated spaces.	Thermal comfort
13	4 Net zero Energy	Hurdle / Energy Efficiency	Energy	201	Definitions: Advanced Framing	Advanced Framed Walls: Studs framed on 24 inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and one stud is used to support each header. Headers consist of double 2x material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall. [See Standard Framing and Section 1005.2 of this Code.] Advanced Framed Ceilings: Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls. [See Standard Framing and Section 1007.2 of this Code.]	Other definitions of advanced framing include single top plate allowing decreased use of materials and increased energy efficiency.	Structural integrity?
14	4 Net zero Energy	Hurdle/ Energy Efficiency	Energy	301.2	Heating & Cooling - more stringent envelope reqs	A building that is designed to be both heated and cooled shall meet the more stringent of the heating or cooling requirements as required in this code when requirements of the exterior envelope differ.	This code option doesn't allow for energy programming, or maximizing efficiencies between areas of the building which might provide waste heat. Reduced opportunities for design team to design most appropriate envelope to meet net zero energy goals.	Precedent for more stringent requirements
15	4 Net zero Energy	Hurdle/ Energy Efficiency	Energy	302.2.1	Indoor Design Temperature - 70 F Heating 78 F Cooling	Indoor design temperature shall be 70° F for heating and 78 degrees F for cooling. Exception: Other design temperatures may be used for equipment selection if it results in a lower energy usage.	Exception doesn't address how to prove lower energy usage. Possible financial burden for smaller projects and affordable housing projects. ASHRAE 55-2004 provides expanded comfort criteria for naturally ventilated spaces.	Thermal comfort
16	4 Net zero Energy	Hurdle	Energy	302.1	Exterior Design Conditions	The heating or cooling outdoor design temperatures shall be selected from 0.6% column for winter, and 0.5% column for summer from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE." [See also Washington State Energy Code Manual.]	May be too stringent; consider 1, 2, or 4% data with expanded interior design conditions	why these?
17	4 Net zero Energy	Hurdle/ Energy Efficiency	Energy	502.1.4.3	Insulation Clearances	Where required, insulation shall be installed with clearances according to manufacturer's specifications. Insulation shall be installed so that required clearances shall be maintained through installed of a permanent retainer.	Similar to IRC issue. In this climate, can't maximize insulation so more difficult to achieve net zero energy.	Mold growth

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
18	5 Materials Red List	Hurdle / Construct-ability	Energy	502.1.6.2	Floors: Vapor retarders	Floors separating conditioning space from unconditioned space shall have a vapor retarder installed. The vapor retarder shall have a one perm dry cup rating or less (i.e. four mil [0.004 inch thick] polyethylene or Kraft faced material).	Conventional materials contain toxins on the materials redlist. Alternative products carry a cost premium.	Moisture protection
19	5 Materials Red List	Hurdle / Construct-ability	Energy	502.1.6.6	Walls: Vapor retarders	Walls separating conditioned space from unconditioned space shall have a vapor retarder installed. Faced batt insulation shall be face stapled. Exception: For Climate Zone 1, wood framed walls with a minimum of nominal R-5 continuous insulated sheathing installed outside of the framing and structural sheathing. For Climate Zone 2, wood framed walls with a minimum of nominal R-7.5 continuous insulated sheathing interior cavity insulation for this exception shall be a maximum of nominal R-21.	Conventional materials contain toxins on the materials redlist. Alternative products carry a cost premium.	Moisture protection
20	4 Net zero Energy	Hurdle / Construct-ability	Energy	502.1.4.8	Slab on Grade insulation	Slab-on-grade insulation, installed inside the foundation wall, shall extend downward from the top of the slab for a minimum distance of 24 inches or downward and then horizontally beneath the slab for a minimum of 24 inches. Insulation installed outside the foundation shall extend downward to a minimum of 24 inches or to the frost line. Above grade insulation shall be protected. Exception: For monolithic slabs, the insulation shall extend downward from the top of the slab to the bottom of the footing.	Where insulation is located inside the foundation wall, connection between foundation and slab not addressed.	Thermal break
21	5 Materials Red List	Hurdle / Monetary	Energy	502.1.6.7 1313.5	Ground cover of black polyethylene	A ground cover of 0.006 inch thick black polyethylene or approved equal shall be laid over the ground within crawl spaces. The ground cover shall be overlapped 12 inches minimum at the joints and shall extend to the foundation wall. Exception: The ground cover may be omitted in crawl spaces if the crawl space has a concrete slab floor with a minimum thickness of 3 1/2 inches.	Conventional ground cover materials contain toxins on the materials redlist. Alternative products carry a cost premium.	Moisture protection
22	4 Net zero Energy	Hurdle / Energy Efficiency	Indoor Air Quality	502.1.2	Ventilation	All crawl spaces shall be ventilated as specified in 1203.3 of the International Building Code.	This requirement in the IBC adds extra outside air and potential energy loss, doesn't account for heated crawl spaces.	Mold growth
23	4 Net zero Energy	Hurdle / Energy Efficiency	Energy	505.3	Outdoor Lighting	Luminaires providing outdoor lighting and permanently mounted to a residential building or to other buildings on the same lot shall be high efficacy luminaires.	Definition does allow for new technology like LEDs unless it is put on a motion sensor- LEDs not currently conducive to a motion sensor. Code could identify maximum wattage as opposed to fixture type.	
24	11 Water Discharge	Brick Wall	Plumbing	305.1	Sewers Required - every bldg. must have a connection to a public sewer	Every building in which plumbing fixtures are installed shall have a connection to a public or private sewer except as provided in Section 305.2.	Only exception is for projects without sewer available for use	Public Health

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
25	5 Materials Red List	Hurdle / Construct-ability	Plumbing	311.8	Screwed fittings options do not include green materials	Screwed fittings shall be ABS, cast iron, copper alloy, malleable iron, PVC, steel, or other approved materials. Threads shall be tapped out of solid metal or molded in solid ABS or PVC.	Some newer materials are more environmentally sensitive choices (PEX). What level of proof and approval required for materials not list in code language?	
26	10 Net zero Water	Hurdle / Construct-ability	Plumbing	405.3	Urinals that don't have a wash at each discharge are prohibited	Fixed wooden or tile wash trays or sinks for domestic use shall not be installed in any building designed or used for human habitation. No sheet metal-lined wooden bathtub shall be installed or reconnected. No dry or chemical closet (toilet) shall be installed in any building used for human habitation, unless first approved by the Health Officer.	Conflicts with UPC section 601 exemption for waterless fixtures.	Cleaning
27	10 Net zero Water	Hurdle / Monetary	Plumbing	409	Water supply to Urinal	Every water supply to a urinal shall be protected by an approved-type vacuum breaker or other approved backflow prevention device as described in Section 603.3.	For waterless urinals, extra cost for redundant system.	
28	10 Net zero Water	Hurdle / Monetary	Plumbing	601	Running Water Required	Except where not deemed necessary for safety or sanitation by the Authority Having Jurisdiction, each plumbing fixture shall be provided with an adequate supply of potable running water piped thereto in an approved manner, so arranged as to flush and keep it in clean and sanitary condition without danger of backflow or cross-connection. Water closets and urinals shall be flushed by means of an approved flush tank or flushometer valve. In jurisdictions that adopt Chapter 16, water closets, urinals, and trap primers in designated non-residential buildings may be provided with reclaimed water as defined and regulated by Chapter 16 of this code. Exception: Listed fixtures that do not require water for their operation and are not connected to the water supply.	Requiring potable water supply to all fixtures undermines ability of a LBC project to use harvested rainwater or reclaimed greywater for toilet flushing to meet zero water goals. Dual piping may be necessary which provides a financial barrier for affordable housing projects.	Public health
29	10 Net zero Water	Hurdle	Plumbing	610.1	Size of Potable Water Piping	The size of each water meter and each potable water supply pipe from the meter or other source of supply to the fixture supply branches, risers, fixtures, connections, outlets, or other uses shall be based on the total demand and shall be determined according to the methods and procedures outlined in this section. Water piping systems shall be designed to ensure that the maximum velocities allowed by the code and the applicable standard are not exceeded.	Water sizing regulations based on older fixtures - resulting in water losses.	

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
30	11 Water Discharge	Hurdle/ Site	Plumbing	1101.1	Storm Drainage - code requires storm drainage system	All roofs, paved areas, yards, courts, and courtyards shall be drained into a separate storm sewer system, or into a combined sewer system where a separate storm system is not available, or to some other place of disposal satisfactory to the Authority Having Jurisdiction. In case of one- and two-family dwellings, storm water may be discharged on flat areas such as streets or lawns so long as the storm water shall flow away from the building and away from adjoining property, and shall not create a nuisance.	Standard requires AHJ to independent evaluate - rather than providing standards. LBC projects manage stormwater onsite where feasible so connection to storm sewer would require an appeal.	Standing water
31	10 Net zero Water/ 11 Water Discharge	Hurdle	Plumbing	1602	Gray Water definition	Gray water is untreated household wastewater that has not come into contact with toilet waste. Gray water includes used water from bathtubs, showers, and bathroom wash basins, and water from clothes washers and laundry tubs. It shall not include wastewater from kitchen sinks or dishwashers.	Definition doesn't include wastewater from mechanical systems or other commercial uses.	
32	10 Net zero Water/ 11 Water Discharge	Hurdle/ Site	Plumbing	1606	Procedure for Estimating Gray Water Discharge	(A) The number of occupants of each dwelling unit shall be calculated as follows: First bedroom = 2; Each additional bedroom = 1. (B) The estimated gray water flows for each occupant shall be calculated as follows: Showers, bathtubs and washbasins = 25 GPD (95LPD); Laundry = 15 GPD (57 LPD). (C) The total number of occupants shall be multiplied by the applicable estimated gray water discharge as provided above, and the type of fixtures connected to the gray water system. Example 1: Single-family dwelling; three bedrooms with showers, bathtubs, washbasins, and laundry facilities all connected to the gray water system: Total number of occupants = 2 + 1 + 1 = 4; Estimated gray water flow = 4 x (25 + 15) = 160 GPD, metric = 4 x (95 + 57) = 608 LPD. Example 2: Single-family dwelling; four bedrooms with only the clothes washer connected to the gray water system: Total number of occupants = 2 + 1 + 1 = 5; Estimated gray water flow = 5 x 15 = 75 GPD, metric = 5 x 57 = 285 LPD.	Overestimates gray water by a factor of 4, requiring more area required for subsurface drip irrigation systems. Calculations should use more efficient fixture performance.	

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
33	10 Net zero Water	Brick wall	Plumbing	1614	Definitions	Reclaimed water is water that, as a result of tertiary treatment of domestic wastewater by a public agency, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. The level of treatment and quality of the reclaimed water shall be approved by the public health Authority Having Jurisdiction. For the purpose of this chapter, tertiary treatment shall result in water that is adequately oxidized, clarified, coagulated, filtered, and disinfected so that at some location in the treatment process, the seven (7) day median number of total coliform bacteria in daily samples does not exceed two and two-tenths (2.2) per one hundred (100) milliliters, and the number of total coliform bacteria does not exceed twenty-three (23) per one hundred (100) milliliters in any sample. The water shall be filtered so that the daily average turbidity does not exceed two (2) turbidity units upstream from the disinfection process. Specifically excluded from this definition is gray water, which is defined in Part 1 of this chapter.	Exception does not allow gray water, which may be necessary to achieve net zero water.	Gray water excluded from reclaimed water definition
34	5 Materials Redlist	Hurdle / Construct-ability	Plumbing	1617	Pipe Material - Reclaimed water pipe marked by tape fabricated by poly vinyl chloride	Reclaimed water piping and fittings shall be as required in this code for potable water piping and fittings. All reclaimed water pipe and fittings shall be continuously wrapped with purple-colored Mylar. The wrapping tape shall have a minimum nominal thickness of five ten-thousandths (0.0005) inch and a minimum width of 2 inches. Tape shall be fabricated of poly(vinyl chloride) with a synthetic rubber adhesive and a clear polypropylene protective coating or approved equal. The tape shall be purple (Pantone color #512) and shall be imprinted in nominal 1/2 inch high, black uppercase letters, with the words, "CAUTION: RECLAIMED WATER, DO NOT DRINK." The lettering shall be imprinted in two parallel lines, such that after wrapping the pipe with a 1/2 width overlap, one full line of text shall be visible. Wrapping tape is not required for buried PVC pipe manufactured with purple color integral to the plastic and marked on opposite sides to read, "CAUTION: RECLAIMED WATER, DO NOT DRINK" in intervals not to exceed three feet. All valves, except fixture supply control valves shall be equipped with a locking feature. All mechanical equipment that is appurtenant to the reclaimed water system shall be painted to match the Mylar wrapping tape.	Code definition of marking tape violates materials redlist prerequisite. Expand definition of what types of materials can be used for marking.	Need to identify pipe

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
35	11 Water Discharge	Hurdle/ Site	Plumbing	1101.5.6	Subsoil drains - must be 10' from property line	Nothing in Section 1101.5 shall prevent drains that serve either subsoil drains or areaways of a detached building from discharging to a properly graded open area, provided that: 1. They do not serve continuously flowing springs or groundwater; 2. The point of discharge is at least 10 feet from any property line; and 3. It is impracticable to discharge such drains to a storm drain, to an approved water course, to the front street curb or gutter, or to an alley.	LBC projects attempt to manage all water on site. Adequate site area required to manage all storm drainage.	
36	11 Water Discharge	Brick Wall	Plumbing	1601.A	Gray Water allowed for single family only for underground landscape irrigation	The provisions of this chapter shall apply to the construction, alteration, and repair of gray water systems for underground landscape irrigation. Installations shall be allowed only in single-family dwellings. The system shall have no connection to any potable water system and not result in any surfacing of the gray water. Except otherwise provided for in this chapter, the provisions of this code shall be applicable to gray water installation.	Code does not allow greywater subsurface drip irrigation systems for multifamily buildings.	Contamination
37	10 Net zero Water	Brick Wall	Plumbing	1618.0(A)	Hose Bib installation	Hose bibs shall not be allowed on reclaimed water piping systems.	Hose bibs should be allowed on the reclaimed water system to meet zero water goals.	Contamination
38	10 Net zero Water	Hurdle/ Monetary	Plumbing	1618.0(B)	Installation - requires devices to allow for deactivation	The reclaimed water system and the potable water system within the building shall be provided with the required appurtenances (valves, air/vacuum relief valves, etc.) to allow for deactivation or drainage as may be required by this chapter.	Cost issues for deactivation drainage.	Contamination
39	10 Net zero Water	Hurdle/ Site	Plumbing	1618.0(C)	Trenching - reclaimed can't be in same trench - must be 10' away	Reclaimed water pipes shall not be run or laid in the same trench as potable water pipes. A ten foot horizontal separation shall be maintained between pressurized, buried reclaimed and potable water piping. Buried potable water pipes crossing pressurized reclaimed water pipes shall be laid a minimum of 12 inches above the reclaimed water pipes. Reclaimed water pipes laid in the same trench or crossing building sewer or drainage piping shall be installed in compliance with Sections 609.0 and 720.0 of this code. Reclaimed water pipes shall be protected similar to potable water pipes.	Requires very large lot to make reclaimed water supply systems feasible.	Contamination
40	5 Materials Red list	Hurdle / Construct-ability	Plumbing	Appendix	Pipe Standards	UPC provides standards for PVC and CPVC only.	No standards for alternative plumbing materials not listed on materials redlist (i.e. PEX).	
41	10 Net zero Water	Hurdle/ Site	Plumbing	Table 16-1	Location of Gray Water System	Table 16-1 provides setback requirements for greywater holding tanks and disposal fields.	Requires very large lot to handle greywater. Allowing greywater for reuse can help LBC projects meet LBC goals for net zero water.	Contamination

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
42	11 Water Discharge	Hurdle / Construct-ability	Mechanical	307.2.1	condensate disposal	Condensate from all cooling coils and evaporators shall be conveyed from the drain pan outlet to an approved place of disposal. Condensate shall not discharge into a street, alley or other areas so as to cause a nuisance.	Water source to drainage system - needs to be dealt with on site for LBC projects. Consider allowing reuse of condensate.	
43	4 Net zero Energy	Hurdle/ Energy Efficiency	Mechanical	403.2	Outdoor Air Required	The minimum ventilation rate of required outdoor air shall be determined in accordance with Section 403.3.	Ventilation rates based solely on occupancy tend to supply more outside air than necessary by other methods. Allowing air quality sensors for measuring minimum ventilation can help save energy.	Indoor Air Quality
44	4 Net zero Energy	Hurdle/ Energy Efficiency	Mechanical	403.3	Ventilation Rate	Ventilation systems shall be designed to have the capacity to supply the minimum outdoor airflow rate determined in accordance with table 403.3 based on the occupancy of the space and the occupant load or other parameter as stated therein. The occupant load utilized for design of the ventilation system shall not be less than the number determined from the estimated maximum occupant load rate indicated in Table 403.3. Ventilation rates for occupancies not represented in Table 403.3 shall be determined by an approved engineering analysis. The ventilation system shall be designed to supply the required rate of ventilation air continuously during the period the building is occupied, except as otherwise stated in other provisions of the code. Exception: The occupant load is not required to be determined, based on the estimated maximum occupant load rate indicated in Table 403.3 where approved statistical data document the accuracy of an alternate occupant density.	Table over predicts occupancy by basing maximum on egress levels rather than design occupancy.	Indoor Air Quality
45	4 Net zero Energy	Hurdle/ Energy Efficiency	Mechanical	514.2	Energy Recovery Ventilation Systems - prohibited applications	Energy recovery ventilation systems shall not be used in the following systems: 1. Hazardous exhaust systems covered in Section 510. 2. Dust, stock, and refuse systems that convey explosive or flammable vapors, fumes or dust. 3. Smoke control systems covered in Section 513. 4. Commercial kitchen exhaust systems serving Type I and Type II hoods. 5. Clothes dryer exhaust systems covered in Section 504.	Losing opportunities for heat reclaim.	Contamination
46	10 Net zero Water	Hurdle	Mechanical	1005.2	Potable Water Supply (Boilers)	The water supply to all boilers shall be connected in accordance with the International Plumbing Code.	Nonpotable water supply such as reclaimed water can assist with meeting net zero water goals.	Legionnaires disease
47	11 Water Discharge	Hurdle/ Site	Mechanical	1009.3	Open-type expansion tank (drainage)	Open-type expansion tanks shall be located a minimum of 4 feet above the highest heating element. The tank shall be adequately sized for the hot water system. An overflow with a minimum diameter of 1 inch shall be installed at the top of the tank. The overflow shall discharge the drainage system in accordance with the International Plumbing Code.	Water source to drainage system - needs to be dealt with on site, consider defining overflow as greywater allowed for toilet flushing.	Contamination

BUILDING CODES BARRIERS MATRIX (continued)

#	LBC Prereq. Affected	Type of Barrier	Code	Code Section	Description	Code Language	Project Concern	Code Issue
48	11 Water Discharge	Hurdle/ Site	Mechanical	1206.2	System Drain Down	Hydronic piping systems shall be designed and installed to permit the system to be drained. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of the International Plumbing Code.	Water source to drainage system - needs to be dealt with on site, consider allowing for drainage to a greywater reuse system.	
49	3 Habitat Exchange 11 Water Discharge	Hurdle/ Site	Fire	503.1.1	Fire Apparatus Access Roads	Approved fire apparatus access roads shall be provided for every facility, building, or portion of a building and shall extend to within 150' of all portions of the facility.	More land required to achieve fire access for residential development.	To allow fire trucks to easily enter and exit the site to assist in fire fighting
50	3 Habitat Exchange 11 Water Discharge	Hurdle/ Site	Fire	D106.1	Fire Apparatus Access Roads	Multi-Family residential projects having more than 100 dwellings units shall be equipped throughout with two separate and approved fire apparatus access roads.	More land required to achieve fire access for residential development.	To allow fire trucks to easily enter and exit the site to assist in fire fighting

APPENDIX C: LBC OVERLAY SITE DESIGNS FOR SIX CASE STUDY PROJECTS

LOPEZ COMMUNITY LAND TRUST ZERO NET ENERGY PROJECT

Architect: Mithun
Jurisdiction: Lopez Island, WA
Zoning: Rural Residential
of Units: 10 Single Family Houses and 2 Rentals

Project Description:

The Lopez Community Land Trust is finishing construction on a 10-unit affordable, rural, zero-net energy project on a 7-acre parcel on Lopez Island. Development is clustered around 2 of the 7 acres and pre-development conditions included forest and meadow with good southern solar exposure. The homes promote energy and water independence while preserving the rural character and ecological diversity of the site. The original low impact development design includes rain gardens in parking areas, reduced impervious surfaces, and rainwater harvesting for clothes washing, toilet flushing, and irrigation. The project utilized an existing well onsite.

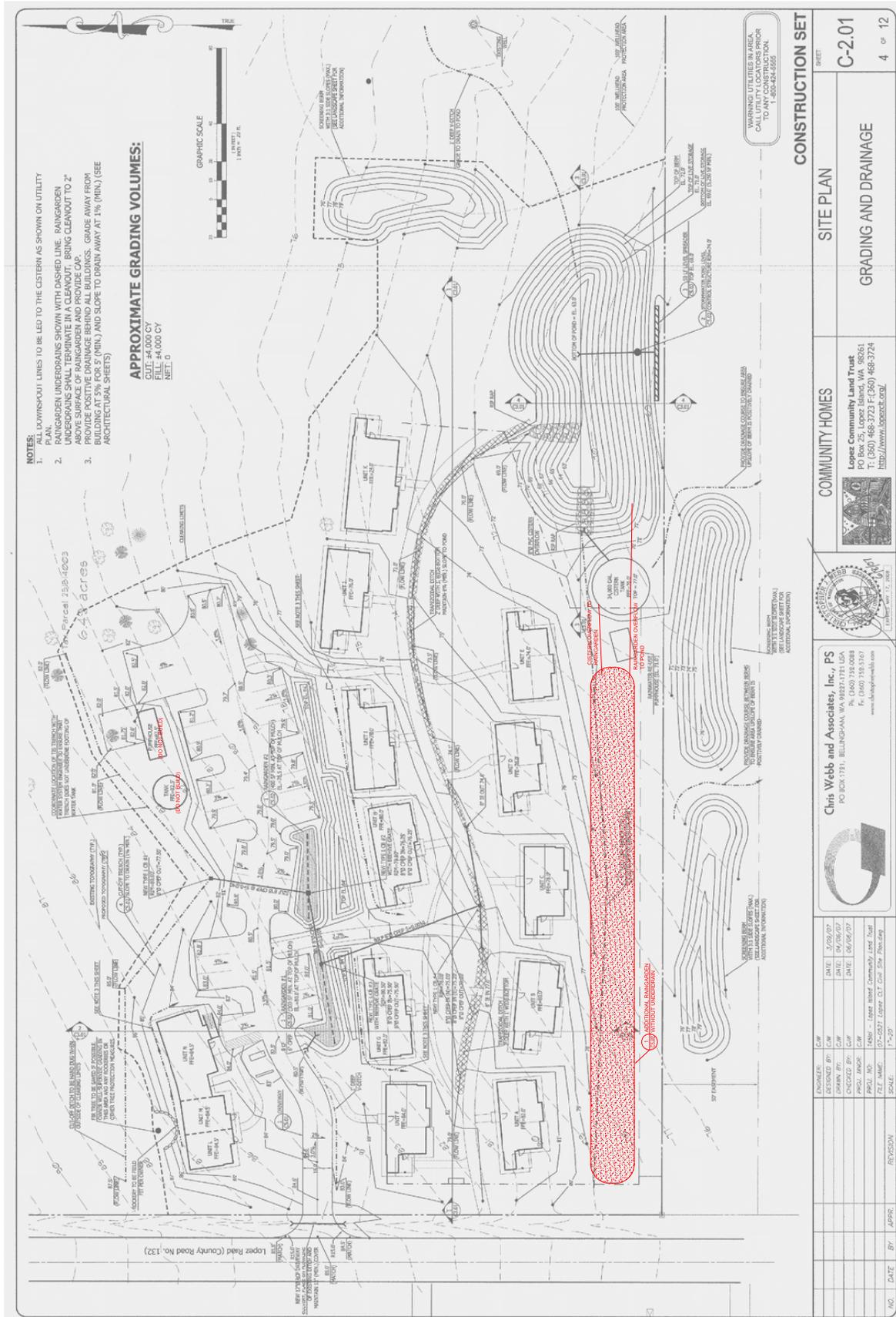
The small footprint homes range from 740 – 890 square feet. The homes are constructed from structural timber framing with strawbale infill. Part of the zero-net energy strategies include high performance fiberglass windows, a 36kW photovoltaic array and wind generator to produce on-site renewable energy, and using a solar hot water pre-heat system. Each house will have energy and water use meters to monitor resource use.

Living Building Challenge Design Changes:

The following changes were made to the Lopez Community Land Trust project to allow it to comply with the Living Building Challenge (LBC) criteria specifically related to water. The LBC requires that 100% of all building water come from captured precipitation and 100% of stormwater and wastewater be managed on site. The following outlines the design response to these criteria by system:

1. Potable Water- Prior to this re-design, this project was designed to meet 100% of its nonpotable water needs from rainwater. The existing design included a 33,000 gallon cistern and a pump house for this non-potable system. To meet its potable and fire needs the project also had a Group A public water system designed. The LBC redesign included the following changes:
 - a) Eliminate the group A water system.
 - b) Convert the non-potable rainwater water system into a potable system. This was accomplished by adding more filtration and disinfection to the system. Calculations were prepared and are included to show how the potable needs can be met with the existing cistern.
2. Sewage- Prior to the redesign the sewage disposal for the project was handled off-site by pumping the sewage to the Fisherman's Bay Sewer District lagoon on the parcel to the south. To manage all of the wastewater disposal needs on-site the following changes were made to the system:

- a) Each unit was outfitted with composting toilets. These toilets are NSF-41 approved and are on the WSDOH approved devices list.
 - b) The sewage force main leaving the site was redirected to an onsite greywater irrigation re-use area. The on-site greywater disposal field was sized per the WSDOH criteria for on-site drip systems.
3. Stormwater- Prior to the re-design the project complied with the 2005 WSDOE stormwater manual and the pond on-site was sized per the WWHM continuous flow model. Appropriate flow control credits were applied in the design to account for the use of raingardens and the 100% annual re-use of the roofwater water in the cistern. While the site was currently in compliance with the latest peak flow and duration standard of the WSDOE the parking lot was converted to pervious concrete and an additional raingarden was added to ensure full on-site mitigation.



CASCADE BUILT DUPLEX

Architect: OPA Design
Jurisdiction: Seattle, WA
Zoning: Multifamily
of Units: 2 Attached Units

Project Description:

A LEED for Homes Pilot Project, this project includes 2 units on a small urban 2500-sf site formerly occupied by one single family home. The existing home was maintained and the duplex was built behind. Green features in the original design include use of advanced stick framing and structural insulated roof panels, rainwater detention planters, and pervious parking surfaces. The project completed construction in Spring of 2008.

Living Building Challenge Design Changes:

The following changes were made to the Cascade Built Duplex project to allow it to comply with the Living Building Challenge (LBC) criteria specifically related to water. The LBC requires that 100% of all building water come from captured precipitation and 100% of stormwater and wastewater be managed on site. The following outlines the design response to these criteria by system:

1. Potable water- Prior to this re-design, this project was designed to utilize utility provided potable water from the City of Seattle. The LBC redesign included the following changes:
 - a) Eliminate the connection to the City water system.
 - b) Add a rainwater harvesting system for all potable water needs. This was accomplished by adding two cisterns and a rainwater re-use pump house. Calculations were prepared and are included to show how the potable needs can be met with the proposed cisterns.
2. Sewage – Prior to the redesign the sewage disposal for the project was handled off-site by gravity side sewer to the City of Seattle. To manage all of the wastewater disposal needs on-site the following changes were made to the system:
 - a) Each unit was outfitted with composting toilets. These toilets are NSF-41 approved and are on the WSDOH approved devices list.
 - b) The sewage line from the site was redirected to an on-site greywater irrigation reuse area. The on-site greywater disposal field was sized per the WSDOH criteria for onsite drip systems. In order to fit the required drip-field, the on-site parking had to be eliminated and converted to a landscaped area.
3. Stormwater – Prior to the re-design the project included the use of pervious paving materials and a stormwater planter. Once the on-site parking was eliminated the remaining small piece of driveway remained as pervious pavement. To meet the 100% on-site mitigation criteria the previously designed stormwater planter was redesigned as a raingarden that was about twice as big. The remaining yard was maintained as landscaping with compost amended soil. While the specific definition of 100% on-site mitigation is currently being developed, the raingarden was sized based on 40% of the tributary area. This is based on a reduction (based on engineering judgment) from the 60% standard shown by a recent memo by Clear Creek Solutions titled “Modeling Assumptions and Results for the Western Washington Rain Garden Handbook” to mitigate 99.4% of flows on till soils.

PATTON PARK APARTMENTS

Architect: SERA Architects
Jurisdiction: Portland, OR
Zoning: Mixed-Use
of Units: 54 Apartments

Project Description:

The Patton Park project is an affordable and transit oriented development consisting of 54 apartments priced to serve families earning 60 percent or less of the median family income in Portland. The project includes 4,500 square feet of commercial space at street level, with four floors of apartments above. The variety of unit types range from studios to family-sized 3- bedroom apartments. The project is currently under construction planned for completion in the winter of 2008/9.

Soils:

A geotechnical engineering report was unavailable and so the soils on-site were investigated through the NRCS online soil survey for the area. Some of this information is included here for reference. The soil survey reports the soils as "Urban Land Latourell complex". This soil type is further described as being loam/silt loam to about 56" in depth and then becoming a Very gravelly sandy loam. Due to the urban location of the project the NRCS soils information is limited. The existing design includes a pervious asphalt paving area and therefore it is reasonable to assume that the near surface infiltration rate would be 2-4 inches per hour.

Stormwater:

Current Design: A stormwater engineering report was unavailable and so the design intent of the current design was derived from the narrative on the construction plans provided. The parking lot directly infiltrates through the use of pervious asphalt pavement material. The roof water infiltrates into the same rock trench that is integral with the open graded base course that underlies the pervious parking lot.

Proposed Design: The proposed stormwater design does not change from the current design very much. Once change is the conversion of all sidewalks to pervious cement concrete pavement and to add the collection of some roof water to be used as make-up water for the MBR/RO closed loop water re-use system.

Potable Water:

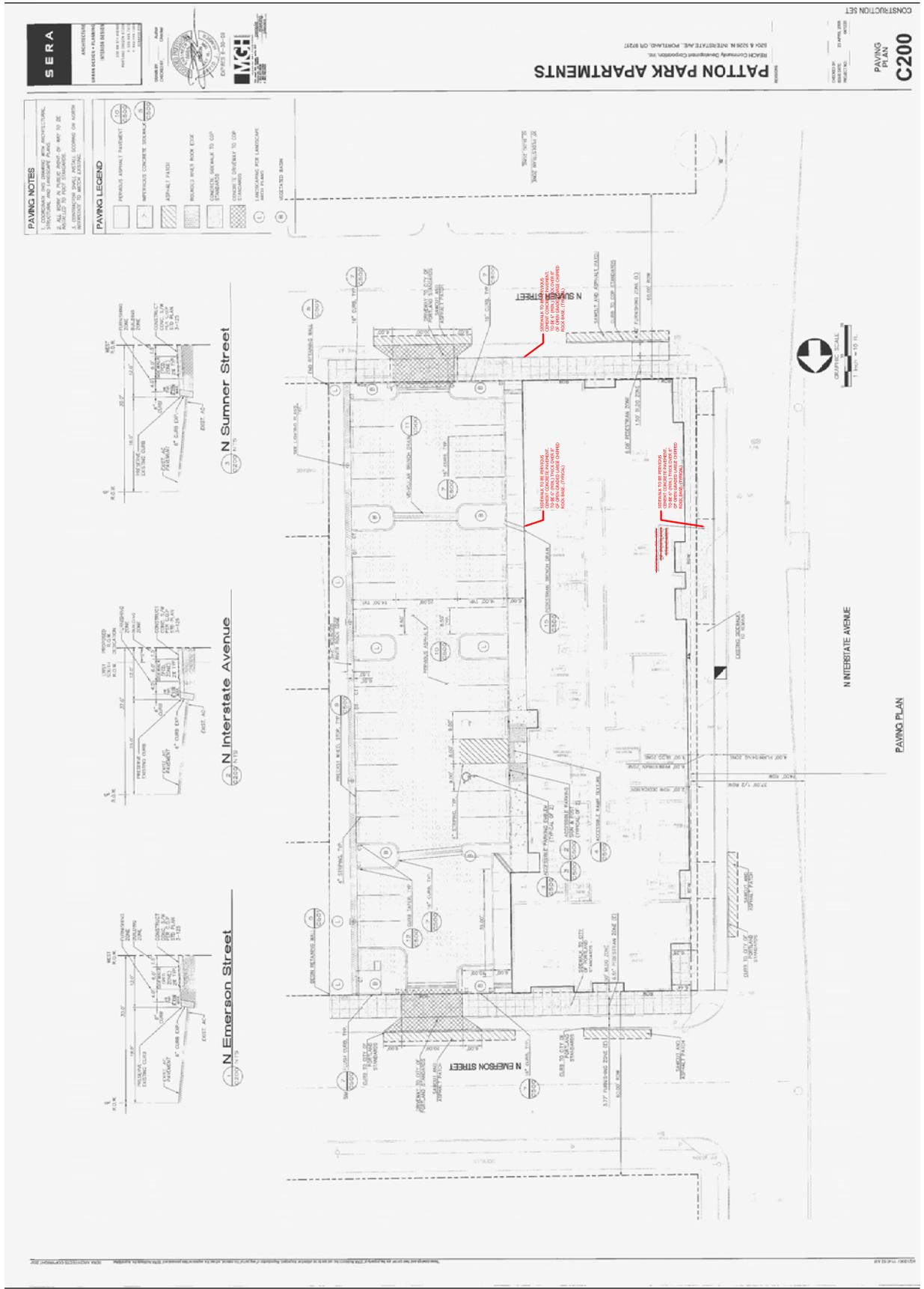
Current Design: The potable water for the site is supplied by the city of Portland water system.

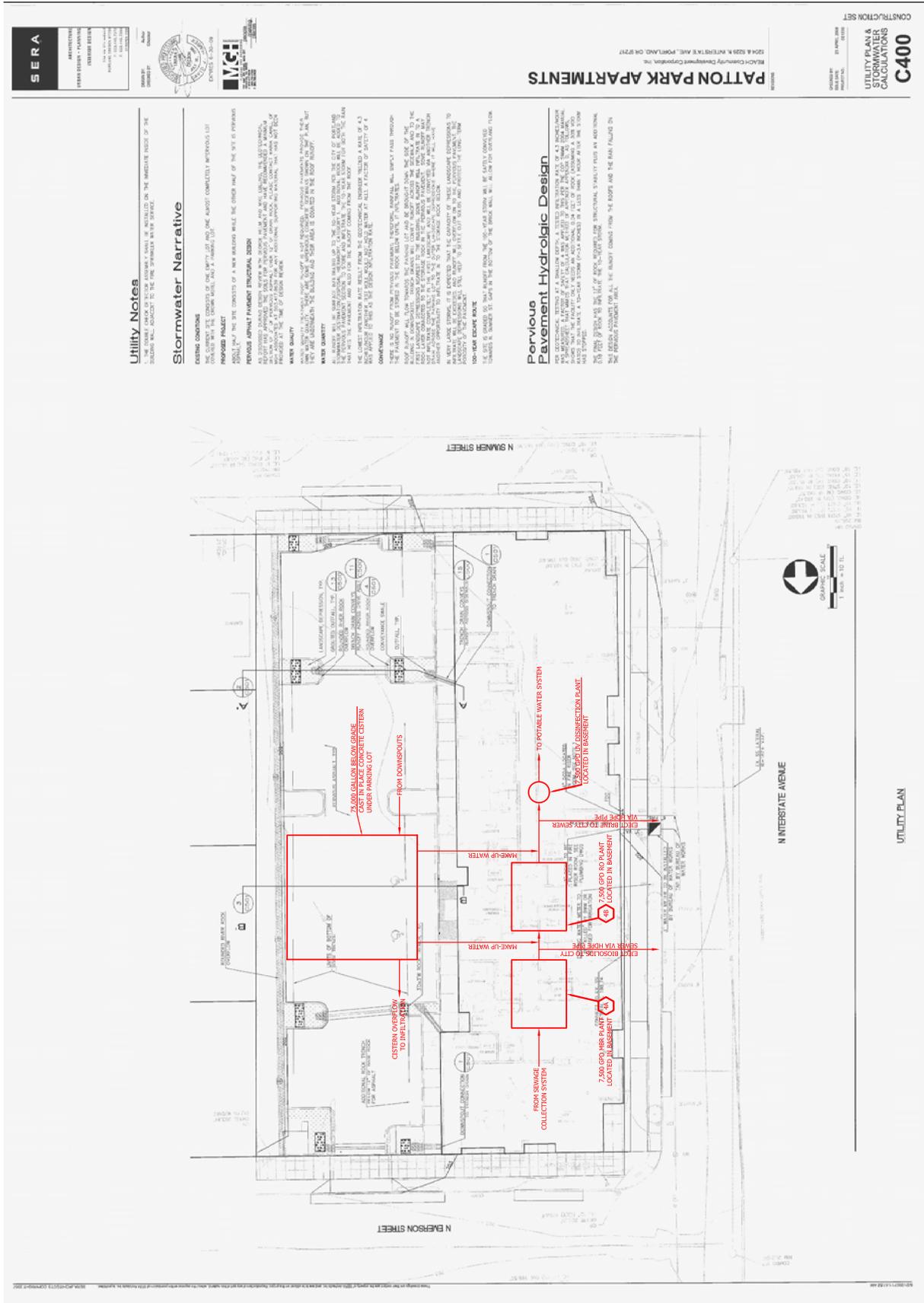
Proposed Design: Due to the density of this project, there is not sufficient collection area to meet the potable water demands of the residents with only collected rainwater. Therefore a complete "toilet to tap" system is proposed. This system is proposed to consist of a Membrane bio reactor (MBR) wastewater treatment system followed by a reverse osmosis (RO) water treatment system with Ultraviolet (UV) disinfection. The MBR plant and the RO plant both will require make-up water to allow for the losses during the treatment process. This make-up water is proposed to be provided by collected rainwater. The flows ejected from MBR and RO plants will require a connection to the city sewer because on-site processing of these effluents is not considered practical on an urban site. A special waiver would be required from the LBC as this element does not strictly comply with the Living Building standard. The sewer connection would be made with heat welded HDPE pipe so as to avoid the use of PVC.

“Waste” Water:

Current Design: The sewage handling for the site is supplied by the city of Portland sewer system.

Proposed Design: See the water section for an explanation of the closed loop “waste” water and water system. The design flow of the MBR system is 55 gpd/person. With 54 apartments and 2.5 people per apartment the design flow for other system would be ~ 7,500 gpd. Assuming a 10% make-up water this would require 750 gallons per day. In order to provide that make-up water, the water from the 11,600sf roof is collected and stored in a 75,000 gallon cistern under the parking lot area. This 10,000cf tank would be cast in place and be about 40'x45'x6' deep.





Utility Notes

1. THE ABOVE CHECK OF EACH APARTMENT SHALL BE INSTALLED ON THE INTERIOR INSIDE OF THE BUILDING WALL, SUBJECT TO THE STORMWATER WATER SERVICE.

Stormwater Narrative

EXISTING CONDITIONS
THE CURRENT SITE CONSISTS OF ONE BUILT-UP AND ONE ALMOST COMPLETELY IMPERVIOUS LOT. THE EXISTING PAVEMENT SHALL BE MAINTAINED.

PROPOSED PROJECT
ABOUT 75% OF THE SITE CONSISTS OF A NEW BUILDING WHILE THE OTHER HALF OF THE SITE IS PAVED.

PERVIOUS PAVEMENT STRUCTURAL DESIGN
PERVIOUS PAVEMENT SHALL BE USED FOR ALL NEW PAVED AREAS. THE PERVIOUS PAVEMENT SHALL BE DESIGNED TO ALLOW FOR THE INFILTRATION OF WATER INTO THE SUBSTRATE BELOW. THE PERVIOUS PAVEMENT SHALL BE DESIGNED TO ALLOW FOR THE INFILTRATION OF WATER INTO THE SUBSTRATE BELOW.

WATER QUALITY
WATER QUALITY SHALL BE MAINTAINED THROUGHOUT THE PROJECT. THE PERVIOUS PAVEMENT SHALL BE DESIGNED TO ALLOW FOR THE INFILTRATION OF WATER INTO THE SUBSTRATE BELOW.

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WATER DISTRIBUTION
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WATER COLLECTION
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WATER TREATMENT
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WATER DISPOSAL
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WATER REUSE
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WATER MONITORING
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WATER RECORDING
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WATER REPLACEMENT
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WATER UPGRADES
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WATER DEMONSTRATION
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WATER EVALUATION
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WATER REVISIONS
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WATER CLOSURE
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WATER RE-ENTRY
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WATER RE-RE-ENTRY
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PATTON PARK APARTMENTS

CONSTRUCTION SET

UTILITY PLAN & STORMWATER CALCULATIONS

C400

DATE: 11/18/08
DRAWN: [Name]
CHECKED: [Name]
SCALE: AS SHOWN

BLANCH & SEHN ARCHITECTS, INC.
1000 N. 10TH AVENUE, SUITE 1000, DENVER, CO 80202

CORVALLIS CO-HOUSING

Architect: Sera Architects
Jurisdiction: Corvallis, OR
Zoning: Multifamily
of Units: 34 Units

Project Description:

The Corvallis Cohousing project is a completed 34- unit housing project including a 3,200 square foot commons building, 8 private garages and a bike barn. Unit types include two-story townhouses and two level stacked flats. The community is fully accessible and was designed in connection with Willamette Neighborhood Housing Services to be affordable for persons with 80% medium family income. 30% of the units were set aside to be sold to families with income restrictions. The project offers an alternative to the traditional subdivision and strives to be as environmentally sustainable as possible, while still providing affordable housing. Emphasis is placed on pedestrian circulation and cycling; not the automobile. Green features include onsite stormwater management through swales and ponds, and separate piping for future graywater reuse. The community established a goal of eventual zero net energy use, reinvesting savings from energy efficiency measures back into PV and solar thermal systems. Starting with 3 solar thermal panels on the common house and by designing the buildings to have a 50% reduction in energy use relative to Oregon Energy code, the proposed reinvestment strategy has been calculated to result in net zero energy in thirty seven years.

Soils:

A geotechnical engineering report was unavailable and so the soils on-site were investigated through the NRCS online soil survey for the area. Some of this information is included here for reference. The soil survey reports the soils as silt loams with hydrological soil group determinations of B and D as shown in the attached soil survey information. The existing design indicates the use of an "infiltration wetlands"/"retention pond" with a design infiltration rate of 0.017 inches per minute (~ 1 inch per hour) approximately in the center of the site where the soils are indicated to be in the "B" hydrologic group. For the purposes of this Living Building Challenge redesign, it is going to be assumed that all areas indicated as hydrological group "B" will assume to infiltrate at ~1 inch per hour and that the entire site is underlain by a restrictive till cap over granular outwash soils. The cap is assumed to be encountered at +/- 4' depth and is approximately 15' thick. This assumption is made to demonstrate a till cap puncture stormwater approach.

Stormwater:

Current Design: A stormwater engineering report was unavailable and so the design intent of the current design was derived from an inspection of the construction plans provided. The site is broken down into 3 basins with the north half of the site draining into two bioswales (one for the NE basin and one for the NW basin). These bioswales are used for stormwater treatment and then the flows are discharged offsite. The flows from the south basin of the site are directed into a bioinfiltration swale/wetland system. This south system is designed to bioinfiltrate the flows directed to it without a formal overflow offsite. Any overflows from this system would weep into the existing oak savannah / wetlands on site that are being preserved.

Proposed Design: The proposed stormwater design is modified in the following ways from the existing design:

1. Eliminate all on-site parking and replace with a) a new transit stop, b) 9 dedicated biodiesel Zip car parking spaces for the residents, c) 6 visitor parking spaces. . The elimination of 45 of the 60 parking means that this community is fully dedicated to being not owning a car and utilizing the shared zip car and transit systems only.
2. Adding increased raingarden bioinfiltration systems for site water management that allows for increased on-site retention. The increased contact time for the stormwater with the native group B soils will allow full infiltration and prevent any off-site flows for compliance with the Living Building standard.
3. Adding compost amended soils. The addition of the compost amended soils in the landscaped areas will increase on-site retention and allow the elimination of any on-site permanent irrigation.
4. Use of only permeable paving materials. The paving required for the zip car parking, transit stop, and the on-site paths/trails will be with pervious cement concrete pavement.
5. Use of Cisterns at every house. Each home will be outfitted with individual rainwater collection systems.
6. Use of till cap puncture system. In order to ensure management of all stormwater onsite, a till cap puncture infiltration approach is proposed for the NE and NW basins. The overflow from the raingarden in these areas will be directed to an infiltration structure that extends below the till cap and into the outwash soils that are assumed to be present at depth.

Potable Water:

Current Design: The potable water for the site is presumed to be supplied by the city of Corvallis water system.

Proposed Design: The potable water demands for each home is to be provided by small selfcontained rainwater re-use systems located at each home. Each home is assumed to have 6,000 gallons of storage in 2 @ 3,000 HDPE cisterns, a ½ hp shallow well jet pump, pressure tanks, 20 micron filtration followed by 1 micron filtration and UV disinfection. The system for the community house will be larger.

“Waste”Water:

Current Design: The sewage handling for the site is supplied by the city of Corvallis sewer system.

Proposed Design: Each home is proposed to be provided with a State approved composting toilet and all greywater flows are directed to a community scale subsurface drip system. The biosolids from the composting toilets is proposed to be composted on-site and used in site landscaping away from any vegetable gardens. The composting toilet selected for all units is the Phoenix system which is PVC free. The greywater system is sized assuming soil type 5 and with at least 12” vertical separation.

MOLNICK (WEST HILL) COTTAGES

Architect: Living Shelter Design

Jurisdiction: King County, WA

Zoning: Single Family Residential

of Units: 11 single family houses using density bonus in cottage code

Project Description:

Existing single family house on a lot zoned for 6 residential units. The Developer used King County's Cottage Housing Density Bonus to subdivide into 11 lots. The super insulated houses feature small footprints, passive solar design, and healthy indoor environments. This project type provides a replicable example of increased density for single family housing in both suburban and urban locations targeted to be affordable to first time home buyers. The project is currently in the final stages of permitting and is targeting Built Green 4-star certification.

Soils:

A geotechnical engineering report was unavailable and so the soils on-site were assumed to be similar to those found at the Cascade Built site. The soils found at the site are "Vashon Till".

Stormwater:

Current Design: The current design for the project included the use of pervious paving materials and a detention vault.

Proposed Design: The proposed design will add enough bioretention that when used downstream of the individual home cistern rainwater systems will meet the 100% on-site mitigation standard as described in the Living Building Challenge. This is based on a reduction (based on engineering judgment) from the 60% standard shown by a recent memo by Clear Creek Solutions titled "Modeling Assumptions and Results for the Western Washington Rain Garden Handbook" to mitigate 99.4% of flows on till soils.

Potable Water:

Current Design: The potable water for the site is presumed to be supplied by the city of Seattle water system.

Proposed Design: The potable water demands for each home is to be provided by small self-contained rainwater re-use systems located at each home. Each home is assumed to have 6,000 gallons of storage in 2 @ 3,000 HDPE cisterns, a ½ hp shallow well jet pump, pressure tanks, 20 micron filtration followed by 1 micron filtration and UV disinfection. The system on the community house will be larger.

"Waste" Water:

Current Design: The sewage handling for the site is supplied by the city of Seattle sewer system.

Proposed Design: Each home is proposed to be provided with a State approved composting toilet and all greywater flows are directed to a community scale subsurface drip system. The biosolids from the composting toilets is proposed to be composted on-site and used in site landscaping away from any vegetable gardens. The composting toilet selected for all units is the Phoenix system which is PVC free.

The greywater system is sized assuming soil type 5 and with at least 12" vertical separation. The system was sized based on assumed design criteria. The amount of parking was reduced to provide sufficient space for the system.

PRINGLE CREEK COMMUNITY

Architect: Opsi Architecture
Jurisdiction: Salem, OR
Zoning: Master Planned Community
of Units: 175 units in Phase 1

Project Description:

Pringle Creek is a 32-acre development designed with the principals of sustainability in mind.

Phase 1 includes 175 market rate housing units currently in construction. When completed, the Pringle Creek Community will feature walkable neighborhoods, a meandering creek and wetlands, a community plaza of preserved and re-purposed historical buildings, community gardens and open green space. Housing types include detached single family, small cottage housing, row houses, live work studio lofts, and attached multifamily units. The project includes restoration of the creek and wetlands (nearly 15% of site) and creation of a bordering riparian zone. Over 1/3 of site will be dedicated to community open space (parks, trail system, gardens) and natural green space (creek, wetlands, existing trees). A “Zero-Impact” stormwater design eliminates impact to the watershed using street and path infiltration verges, rainwater gathering and storage, and improved interflow movement to creek. Some of the single-family homes are planned for “net-zero” energy consumption.

Soils:

A geotechnical engineering report was provided for review. This document is dated June 1, 2005 and was prepared by GRI Geotechnical and Environmental Consultants. The scope of this report is for the northern 32 acres of the Fairview Training center, this is the site for the Pringle Creek Community. The report specifically addressed stormwater infiltration in addition to the earthwork, foundation, roadway, and floor support design data.

The test pit logs included in the report indicate that primarily the near surface soils are a Silt with some sand and trace clay in some of the logs.

Stormwater:

The stormwater management design for this project is detailed in the Storm Drainage Plan and Design Calculations report prepared by W & H Pacific, dated March 27, 2006. This report discusses the infiltration rates of the existing soils as being greater than the design flows to those basins. The report concludes that no detention is required based on the use of these infiltration values.

Current Design: The stormwater engineering report indicates that the project is able to match the existing levels of run-off with a total infiltration approach. This is discussed in the drainage report and is shown on the plans. The current design utilizes a system of pervious asphalt streets, bioretention areas, and open graded pervious gravel alleys and parking areas.

Proposed Design: The proposed stormwater design keeps all of the existing measures in place with the addition of district rainwater collection. The assumption is made that with 100% pervious paving and bioretention woven through the development that the infiltrative capacity of the soil is maximized and the Living Building criteria is met.

Further, the district rainwater systems will deliver much of the rainfall from the roofs to a collection, storage, filtration, and potable water distribution system. To make up for the loss of flows to Pringle Creek, a base flow of MBR treated wastewater effluent will be released as needed via a constructed wetlands.

Potable Water:

Current Design: The potable water for the site is supplied by the city of Salem water system.

Proposed Design: The potable water needs of this project will be met by a series of neighborhood rainwater collection systems. These systems will collect the roof water from the surrounding buildings and store it, treat it, and distribute it back to the buildings for potable uses. The City of Salem receives almost 40" of rain per year on average and based on previous experience at this level of density sufficient quantities of rainwater are available to meet the potable demands of the residents. Additionally, all utility piping on this project will be made with heat welded HDPE pipe so as to avoid the use of any PVC.

The series of Neighborhood storage systems would be connected into a larger network to balance the supply and demand of the various neighborhood systems.

An on-site micro-utility will provide all billing and maintenance for the system and no connection to the City water supply will be needed. Due to the size of the interconnected network of neighborhood cisterns, adequate fire flow can be achieved.

"Waste" Water:

Current Design: The sewage handling for the site is supplied by the City of Salem sewer system.

Proposed Design: The proposed wastewater system for the site includes the use of traditional flush toilets led to a set of gravity sewers as shown in the current plan which lead to an onsite MBR plant. This MBR plant treats the wastewater to a level sufficient for stream augmentation via constructed wetlands and for re-use for non-potable needs such as toilet flushing and irrigation.

A purple pipe network of treated water will be piped through the development pumping treated water back to each lot.

Since the scope of the network of rainwater systems has the potential to affect the base flows in Pringle Creek, the MBR plant will release flows as needed to the creek via a constructed wetlands. These constructed wetlands will serve as a final polishing step ensuring the water quality necessary for stream augmentation. The common areas of the development will also be built with Geoflow subsurface drip irrigation systems to be able to release water from the system and not add to a high flow condition in the creek.

The on-site micro-utility will manage the system to balance the needs of the creek and the levels of water in the system to the highest and best use of water resources available.



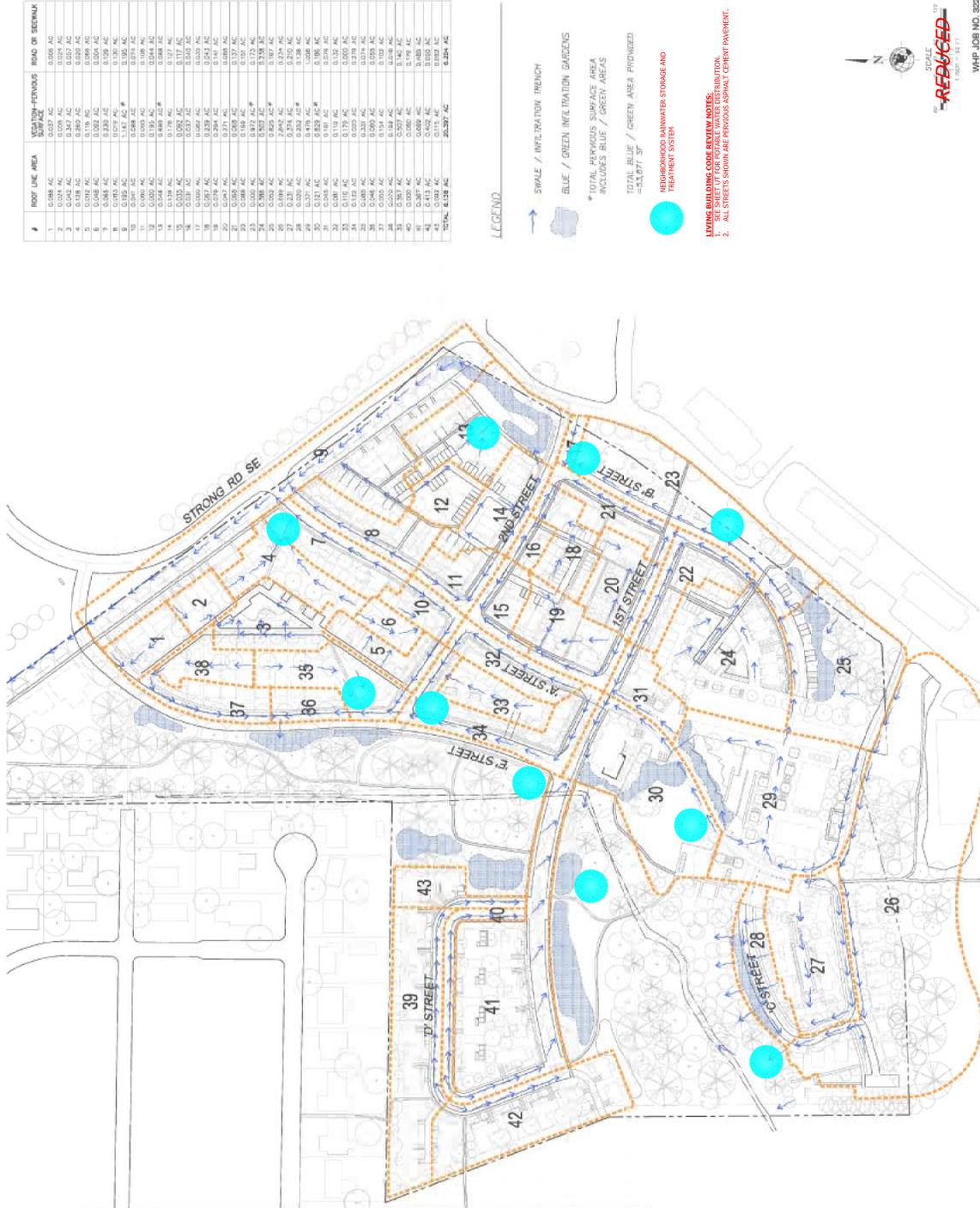
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urban and regional

pringle
creek
community

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SEASIDE, CA 94134
PHONE: 415.775.1200
WWW.OPARCHITECT.COM

PROJECT NO. 08-00-06
DATE: 11/18/08
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CHECKED BY: [Name]
SCALE: AS SHOWN
SHEET NO. SD
TOTAL SHEETS: 4851.01

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APPENDIX D: COMPENDIUM OF SPECIFICATIONS ON LBC OVERLAY DESIGNS

1A: SUN-MAR COMPOSTING TOILET PRODUCT SPECIFICATION



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Capacity

The Excel is the best-selling unit in North America and for good reason. It is a high capacity Bio-drum toilet that is very simple to operate, features well proven technology and is extremely reliable. The Excel was the first ever self-contained composting toilet to be certified by the National Sanitation Foundation (NSF). So, when you purchase an Excel, you are literally purchasing a composting toilet that sets the standard.

The Excel has enough capacity that it can be used just about anywhere; in residences, cottages and even in light commercial applications.

To simulate residential use the Excel was tested by the National Sanitation Foundation (NSF) at maximum capacity for 6 continuous months, during which the Excel produced no odour and produced a clean, safe compost. Only Sun-Mar self-contained units are listed for residential and cottage use by NSF, whose Standard #41 is the toughest composting performance standard in the world.

The 2" vent is attached at the top back of the Excel and can be installed invisibly by running it through the wall and up the outside wall. For comfort the Excel has a sturdy detachable footrest which can be removed to pull out the finishing drawer.

In normal use the Excel can normally evaporate all liquids, however a ½" emergency drain is fitted at the rear and this should be connected if the unit is to be used residentially or heavily, or if prolonged power outages are expected.

MORE INFO



Standard 41
This system is Certified and Listed by NSF.
[Click here for NSF's official Standard 41 listings.](#)

[Customer Referrals](#)
[Click Here](#) for a list of Excel customers and read what they have to say about our products.

[Unit Specifications](#)
Please [click here](#) for Excel specifications, including rough-in dimensions and electricals.

* Pricing is suggested list price only. [Dealers](#) may sell for less.

For Canadian prices visit our [dealer locator](#), or

1B: PHOENIX COMPOSTING TOILET PRODUCT SPECIFICATION

Benefits of the Phoenix

Odorless. There are *no* unpleasant smells in the toilet room, tank area, or around the building. Aerobic decomposition and a positive ventilation system ensure odorless operation. Finished compost is inoffensive.

Waterless. Designed for dry operation. Saves thousands of gallons of water per person.

Rugged. *Lasts a lifetime!* Thick, tough, insulated walls of crosslinked polyethylene. Corrosion resistant fittings.

Capacious. Accommodates families, guests, relatives. Large surge capacity.

Owner-friendly. Easy maintenance is a hallmark of the Phoenix's field proven design. Finished compost is removed just once a year.

Frost-safe. Freezing does not injure the composting process. In cold weather, use can continue at a lower rate. Composting resumes when the system warms up.

Energy efficient. A 12-volt-dc, 5-watt fan is the only electrical load in residential units.

Chemical-free. Requires only an organic bulking agent such as wood shavings. *No chemicals!* Composting uses a wide variety of natural organisms to biochemically decompose wastes.

Clog-proof. Rubber balls, apples, and other items that stop-up conventional flush toilets won't clog the foot-wide toilet chutes and food waste inlet chutes that connect to the Phoenix composting tank.

Pollution-free. Wastes are contained in the Phoenix. A long, uniform, retention time ensures a stable, biologically benign end product, reduced 80-90 percent in volume, that can be transported easily or disposed of on-site.

June, 2003

195 Meadows Road
Whitefish, MT 59937
Voice: 406-862-3854
Fax: 406-862-3855
phoenix@compostingtoilet.com
http://www.compostingtoilet.com



PHOENIX Composting Toilet

Waste + Oxygen + Time + Heat = Compost



Odorless • Waterless
Rugged • Capacious
Owner-Friendly

Residential Models

1B: PHOENIX COMPOSTING TOILET PRODUCT SPECIFICATION (continued)

Residential Phoenixes

Phoenix residential packages contain all of the components necessary for installation except the wood shavings starter bed for the tank, and the 4-inch (100mm) rigid vent pipe. Every package has a Phoenix tank, one toilet with three feet (910mm) of chute, the ventilation system, a manual liquid respray system, a compost bin, rake, and installation and operating instructions.

Capacity. Capacities range from two to eight persons. The temperature of the Phoenix system greatly depends upon the temperature of the compost pile. The rate of composting is significantly influenced by temperature. Warm tanks have a higher capacity than cold tanks.

Our capacity ratings assume a minimum tank room temperature of 65°F (18°C). Below 55°F (13°C), composting is very slow.

The R-199 can be used continuously by two persons. The R-200 accommodates four full-time users.

The R-201 accommodates eight full-time users.

Models R-199 and R-200 can be upgraded by adding a midsection.

Peak use. The Phoenix's large volume accommodates peak use well in excess of its long term rating, an important advantage in seasonal situations such as family reunions. The annual average use should not exceed the rating, but very heavy use over relatively short periods is handled easily.

Graywater Treatment Options

A variety of options exist for treating graywater. Treatment systems that utilize natural biological processes require less energy, and are simpler and more reliable.

Health department approval. Graywater disposal systems usually require local health department approval prior to installation.

Conventional septic system/leach field. Because of graywater's lower flow volume, reduced oxygen demand, and lower suspended solids, the size of the septic tank and field can be reduced significantly. Alternatives to the septic tank such as a roughing filter or forced aeration system, can enhance treatment before infiltration.

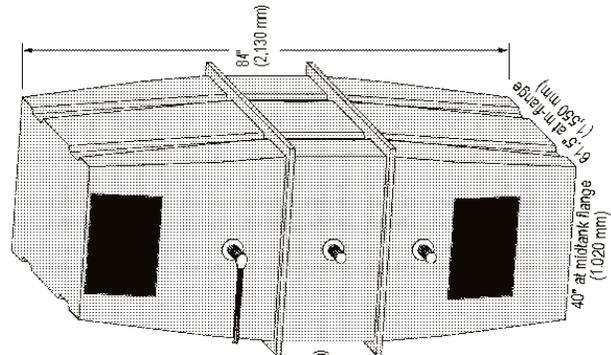
Leach water can be used to irrigate nonfood plants.

Constructed wetland. A diverse collection of aquatic plants is grown in a layer of gravel in a lined shallow trench. The root zone of these plants provides an aerobic environment for bacterial treatment of the flowing graywater. Treated water infiltrates the soil from an unlined portion of the trench. Nutrients can be recovered through biomass removal.

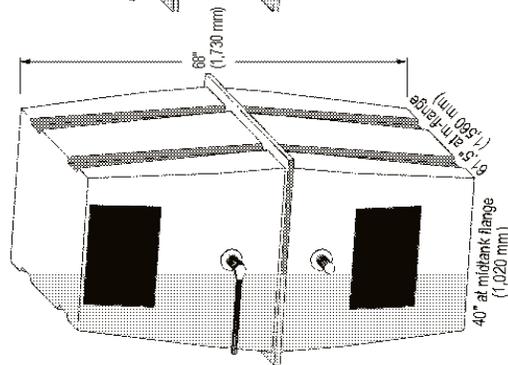
Aerobic infiltration bed. A coarse organic cover isolates the treatment area while allowing air exchange and providing a large surface area for biological activity and freeze protection. Increased longevity and significant nutrient recovery can be effected by alternating between two beds. In cold climates, the treatment can occur within a greenhouse.

Surface irrigation. Graywater can be spray irrigated on non-food plants. Treatment occurs in the biologically rich topsoil layer. Nutrients are recovered in the biomass.

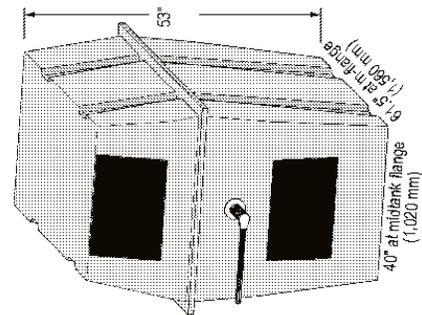
R-201
8-person capacity



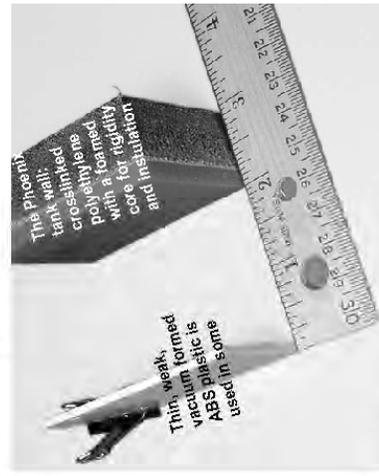
R-200
4-person capacity



R-199
2-person capacity



The Toughest Composting Tank



ACS fabricates the Phoenix from rotationally molded, crosslinked polyethylene, a tough, environmentally benign plastic that is highly resistant to corrosion and does not become brittle at low temperatures. Polyethylene can be recycled easily (many of our buildings use a decking material that contains recycled polyethylene). Fittings, fasteners, and other components are made from stainless steel, fiberglass, and other corrosion resistant materials.

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1B: PHOENIX COMPOSTING TOILET PRODUCT SPECIFICATION (continued)

Installation Considerations

The area in which the Phoenix is located should be at least 43 inches (1,090 mm) wide. Five feet (1,500 mm) of clear space in front of the Phoenix must be provided for maintenance. This area should also be at least 6 inches (150 mm) taller than the tank. The surface supporting the Phoenix should be smooth, flat, level and capable of supporting 4,000 pounds (1,800 kg).

All Phoenix models are 40 inches (1,020 mm) wide and 62 inches (1,575 mm) long. Model 199 is 53 inches (1,350 mm) tall; Model 200, 68 inches (1,730 mm); Model 201, 84 inches (2,130 mm). The unassembled Phoenix fits through an opening 35 inches (890 mm) wide, the opening width of a 36-inch (910 mm) door.

Dry toilets connect to the Phoenix with 12-inch (310mm) diameter chutes that must be vertical (see drawing at left). One Phoenix tank can accommodate two dry toilets on the same floor if they are located back-to-back. The toilets can also be located several stories above the tank. The minimum clearance from the center of the toilet chute to the finished surface of the wall behind the toilet is 9 inches (230mm).

Gravity micro-flush toilets provide an alternative for installations requiring a toilet not directly above the Phoenix. They connect via a 4-inch (100 mm) pipe and require a one-pint water flush. The maximum horizontal offset from the Phoenix

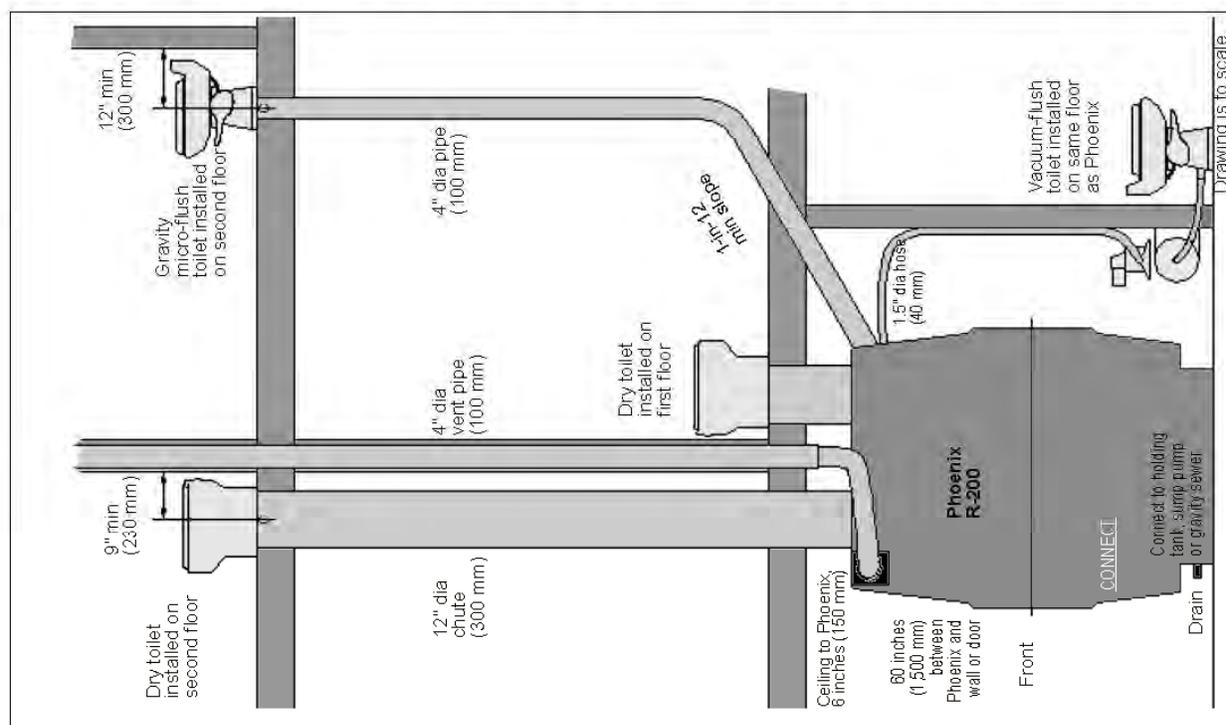
is 10 feet (3,000 mm). The minimum slope is one inch per foot.

Vacuum-flush toilets offer an alternative for installations requiring a toilet on the same floor as the Phoenix (see drawing at left). They connect via a 1.5-inch (38 mm) diameter hose, and require running water and 12 or 24-volt electricity.

Leachate decants through the Phoenix drain which must be connected to a holding tank, sump pump or gravity sewer. Micro and vacuum-flush toilets increase the amount of liquid end product in the Phoenix.

The ventilation fan mounts on either side of the Phoenix. A short length of four-inch flexible hose connects the fan to 4-inch (100 mm) rigid pipe for exiting the roof. Avoid sharp turns and long horizontal runs. The flashing accommodates roof pitches from flat to 12/12. In cold climates, insulate the vent pipe to reduce frost accumulation and condensation. With high snow loads, the vent should exit near the roof ridge.

Electricity is required for the Phoenix's 12-volt-d.c., 5-watt ventilation fan. We provide a 12-volt-d.c. power supply for utility connected homes. An optional uninterruptible supply for areas with frequent electrical outages is available. An energy saving, electronic fan speed controller, available as an option, helps conserve energy in off-grid systems.



Seven Key Questions for Choosing the Right Composting Toilet for You

Composting is a familiar process to many rural and suburban residents. Organic materials, such as leaves, lawn clippings and food waste, are placed in a pile or enclosure. Over time, in the presence of oxygen, heat, and moisture, biochemical processes convert the waste to stabilized compost, which resembles rich, dark, potting soil. Pathogens are nearly eliminated and the volume of the organic material is reduced by 90 percent or more.

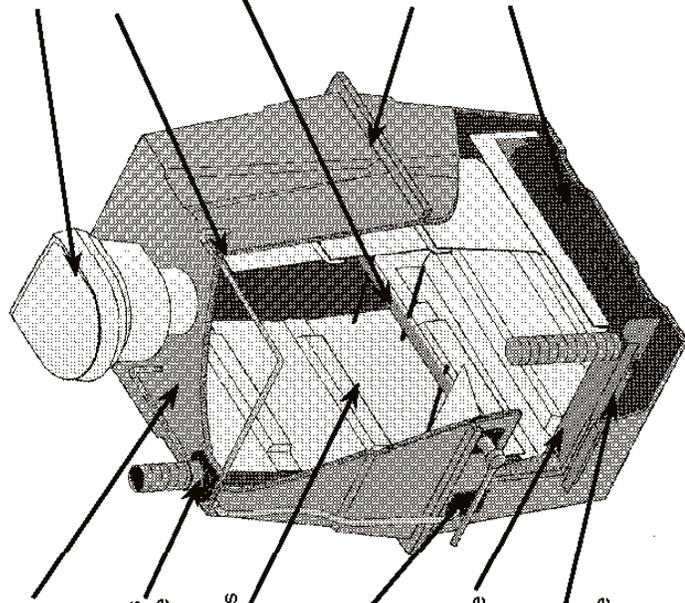
The same biochemical processes are employed by composting toilets to treat human waste. A composting toilet is a system that provides an environment for aerobic (in the presence of oxygen) decomposition. It is a miniature, on-site sewage treatment plant.

Not all composting toilets are created equal. They vary in size, materials, features, effectiveness, maintenance, energy requirements and safety. In choosing a composting system it is useful to consider the following questions:-

1. What are the durability, suitability and longevity of the materials used in manufacturing?
2. Does the size and shape of the composting vessel make sense?
3. Does compost removal require a pumper truck or climbing into the tank?
4. Can you remove compost without also removing fresh waste?
5. What are the energy and ventilation requirements?
6. What are the long term operating costs?
7. Would you personally be willing to perform the required maintenance?

The Phoenix Composting Toilet is a large and very rugged composting system that provides for the safe and effective stabilization of human waste on site. The insulated tank, efficient ventilation system and automatic controls assure the lowest possible heat and electrical requirements; most often these requirements can be met with solar energy. The Phoenix's built-in rotating tines and vertical design assure higher quality compost and easier, safer maintenance.

Rugged & Leakproof — Reliable Operation for a Lifetime



Fabricated from rotationally molded solid and foamed crosslinked and linear polyethylene.

A 5-watt, 12-volt d.c. ventilation fan moves oxygen through the compost and odors out the vent pipe.

Continuous air baffles along the tank sides facilitate aeration of the compost pile without interfering with compost movement.

Air enters the Phoenix through a screened inlet. A sealed path for ventilation air, and a large contact area, increase ventilation efficiency and allow supplemental heating.

Finished compost is removed easily through the lower access door from the entire bottom of the Phoenix.

Liquid is separated from the solids by a screened baffle and respayed, or drained, from the Phoenix. The drain connection can be made from either side.

Durable polyethylene and ABS plastic toilets.

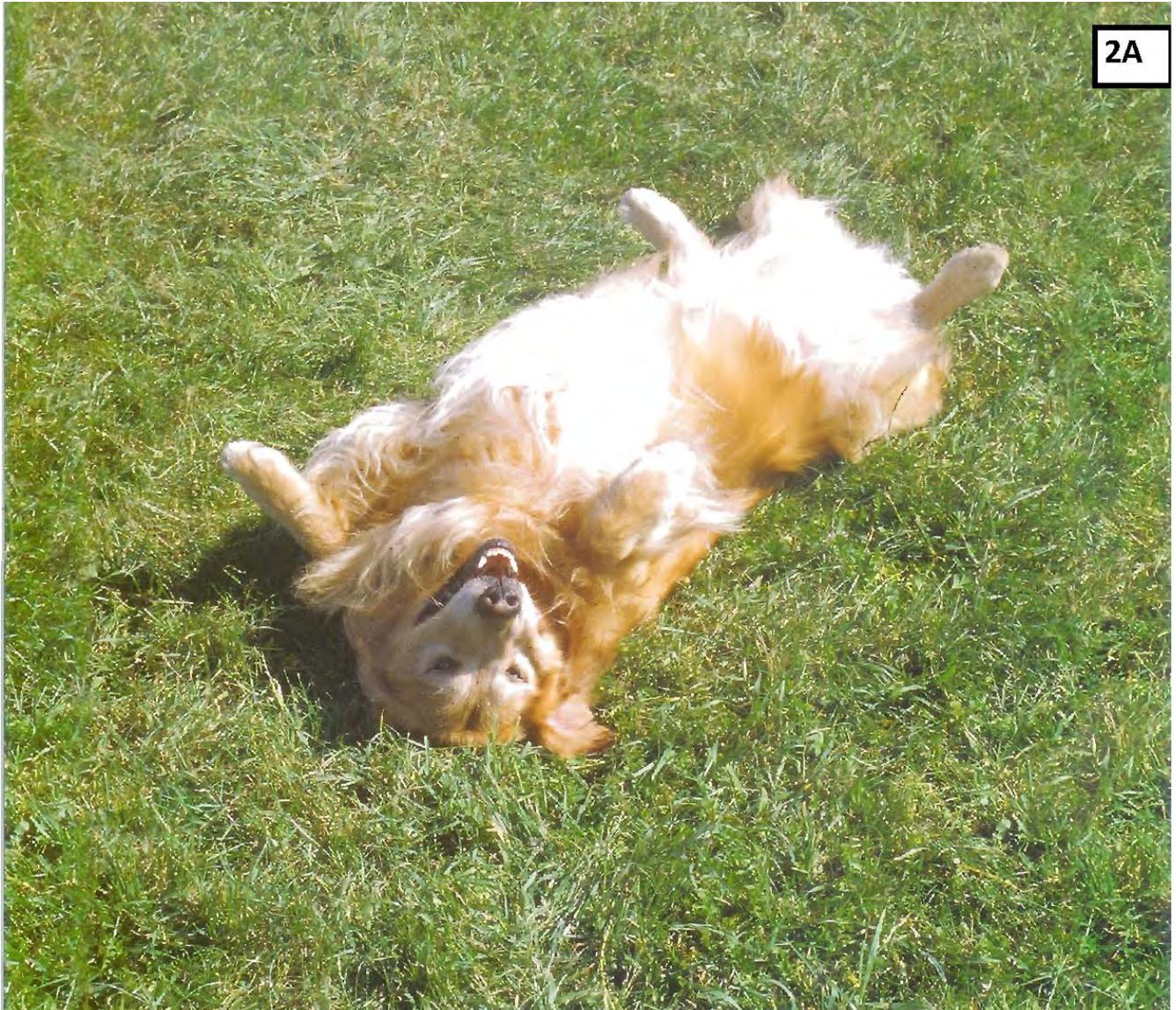
Accumulated liquid and/or fresh water is sprayed on top of the compost pile to maintain moisture and to inoculate the pile with compost-friendly micro-organisms.

Rotating tines control the downward movement of the material in the compost pile. The Phoenix Model 201 has three tine shafts, each above the other. The Model 200 (left) has two shafts (for clarity, only one tine shaft is shown in this illustration); the R-199 Cabin model, one.

A gasket and interlocking flange produce a leakproof joint with only a few bolts and no caulking.

A permanent medium provides secondary liquid treatment beneath the sloped bottom baffle. Air travels over the entire surface of the liquid to increase evaporation and aerobic conditions.

2A: GEOFLOW SUBSURFACE DRIP SYSTEM MANUFACTURERS LITERATURE



2A

**And this is a wastewater dispersal field.
No Worries.**

GEOFLOW
SUBSURFACE DRIP SYSTEMS

2A: GEOFLOW SUBSURFACE DRIP SYSTEM MANUFACTURERS LITERATURE (continued)**Geoflow WASTEFLOW™**

Geoflow's subsurface drip systems solve many of the problems that plague traditional methods of wastewater dispersal. Since the effluent is dispersed underground where it is absorbed in the biologically active soil layer, there is no surface contamination, no ponding, no run-off problems, no bad smells.

Issues such as overspray and aerosol drift are eliminated, dose scheduling is unaffected by land use or weather, and it is a politically and environmentally favorable means of dispersing wastewater.

With subsurface drip, secondary reclaimed wastewater can be used, eliminating the ongoing cost of additional effluent treatment.

Geoflow drip dispersal is recommended for commercial, municipal, industrial, residential and agricultural applications.



Subdivision In Minnesota.

How It Works

The WASTEFLOW dripline has factory-installed emitters evenly spaced along the tubing. The dripline is usually installed six to ten inches below the surface, directly into the biologically active soil horizon where the treated effluent can be absorbed by the plants, animal life, and soil.

Wastewater is pumped to the dripfield on a time-activated dose cycle. The slow, even application of effluent with resting periods is key to the drip system's success.

**Easy To Install —
New or Retrofit**

Geoflow subsurface systems are simple to install. The tubing can be laid on a graded parcel then covered with topsoil or installed using a tubing plow or trencher.

Subsurface drip also solves the problem of small or odd-shaped areas, such as property edges and around buildings and other structures. The flexible tubing can easily be fit to uneven spaces. Since the wetted area is within close proximity of each emitter, run off problems are easily eliminated.



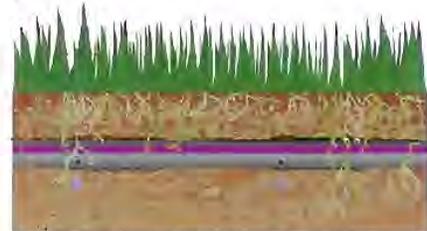
Plow single or multiple driplines at a time.

But What About...?

Clogging — Geoflow drip systems are installed with self cleaning filters to keep large particles from entering the drip field.

WASTEFLOW emitters are also self-cleaning and have been used for over 15 years in actual onsite applications. They are made with large orifices, raised entry ports, and turbulent flow paths to keep smaller particles from collecting in the emitters.

Root intrusion — Each emitter features ROOTGUARD™, patented protection against roots entering the emitters. The non-toxic active ingredient, Treflan™, directs root growth away from the emitters. Treflan is impregnated into the emitters during the molding process.



Rootguard keeps roots from penetrating and clogging the emitters.

Bacterial growth — Geoflow's WASTEFLOW dripline is coated inside with the anti-bacterial, *Ultra-Fresh*™ to inhibit bacterial growth on the walls of the tube and in the emitters. *Ultra-Fresh* has been found to be effective in preventing slime build-up inside the tube, even with effluent that has very high BOD.



Look for the anti-bacterial turquoise lining.

2A: GEOFLOW SUBSURFACE DRIP SYSTEM MANUFACTURERS LITERATURE (continued)

This eliminates the need to scour the dripline with high flush velocities.

There is virtually no discharge into the environment because the active ingredient, TBT-maleate, does not migrate readily through plastic (Note: Ultra-Fresh does not treat the water flowing through the tube.)

Freezing climates — Geoflow systems can be used year round, even in freezing conditions. The polyethylene dripline is flexible enough so as not to crack when it freezes. The dripline self-drains through the emitters every time the system is turned off, and will not hold water. Sound design, including drainback of the system, air vacuum breakers and insulation of the more rigid parts of the system keep the system working even in the coldest climates.

Difficult sites — Geoflow systems can be effective in areas with

- tight soils,
- rocky terrains,
- steep slopes,
- high water tables.

Design guidelines are available directly from Geoflow and at www.geoflow.com.



A steep slope installation in California — 65% slope.

Testimonials

Higgins Corner Retail Development Nevada County, California

"The Geoflow dripline system proved to be successful in four areas: Foremost, there was a tremendous cost saving in installing the Geoflow system. Secondly, the time and effort saved in installing Geoflow as compared to the construction of deep absorption trenches was also a benefit. Thirdly, one and a half acres of land could be used for other monetary-including projects; and fourth, the final disposal site looks like the original untouched property. Neighbors are pleasantly surprised at the final effluent disposal field."

*Mark Kahl, Design Engineer
7H Technical Services Group Inc.*



Higgins Corner, Nevada County, CA.

Ocala Airport Ocala, Florida

"The [44-acre] site has operated successfully at an average of 500,000 gpd over a three-year period. Monitoring data reveals that groundwater quality has not been adversely effected despite high loading rates... The cost to operate and maintain a subsurface reuse system is much less than a conventional irrigation system..."

*Ed T. Earnest, P.E. Utility Engineer,
City of Ocala Engineering Dept.*



Ocala Airport.

Omaha Beach Golf Course Matakana, New Zealand

"As part of the construction of the new 9-holes the developer installed a new subsurface drip irrigation system on some of the new fairways to act as part of the overall community treated effluent disposal system... We are extremely pleased with the system, which gives a very even deep green appearance to the fairways where it was been installed. The fairways that are irrigated with the subsurface drip system are in better condition than those that do not yet have the system."

*Allan Anderson,
Head Greenkeeper*



Omaha Beach Golf Course, N.Z.

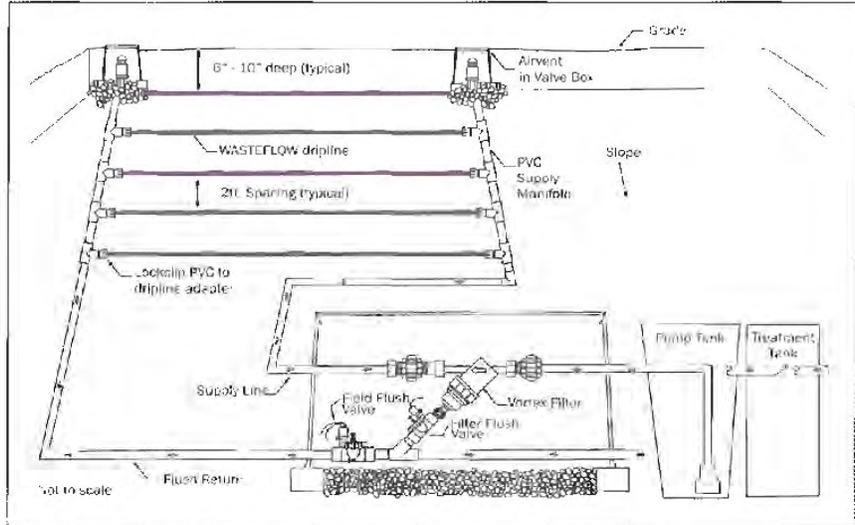
2A: GEOFLOW SUBSURFACE DRIP SYSTEM MANUFACTURERS LITERATURE (continued)

Typical Layout

WASTEFLOW dripline is made of flexible 1/2" polyethylene tubing coated on the inside with an anti-bacterial lining to inhibit bacterial growth. The factory-installed emitters are spaced evenly along the tubing.

The dripline is placed six to ten inches below the surface, directly into the biologically active soil horizon. Effluent is pumped on a time-activated dose cycle through a self-cleaning filter out to the dripfield, providing slow, even application of effluent.

The system returns back to the pump tank or treatment tank in a closed loop, and is kept clean with regular flushing.



Typical disposal field elements and layout

The Drip Emitters

Geoflow offers two different emitters, the Classic and the PC.



WASTEFLOW Classic



WASTEFLOW PC

Each dripper has a filter built in at the entry port to keep particles out.



Turbulent flow path

Effluent travels through a turbulent flow path that helps keep any fine particles from settling inside the dripper.

CUTAWAY OF THE PC EMITTER



Dose mode – When pressurized, the rubber diaphragm flexes across the compensating chamber to regulate flow across 7 to 60 psi.



Flushing mode – As the pump is powered on and off again, the rubber diaphragm relaxes across the exit hole enabling the dripper to self-flush every cycle.

Geoflow Team

The people at Geoflow are the subsurface drip experts. We offer training, answers to your questions, and support every step of the way from concept through design and installation.

Geoflow dripline comes with an unprecedented 10-year limited warranty for root intrusion, workmanship and materials.

GEOFLOW, INC.
506 Tamal Plaza
Corte Madera, CA 94925
www.geoflow.com

Tel: (800) 828-3388
Fax: (415) 927 0120

WASTEFLOW is manufactured under U.S. patents 5,332,160 and 5,116,414, and foreign equivalents. WASTEFLOW and ROOTGUARD are registered trademarks of A.I. Innovations. Treflan is a registered trademark of Dow AgroSciences. Ultra Fresh is a registered trademark of Thomson Research Associates, Inc., Canada.



Look for the purple stripe on the tubing to be sure you are getting Geoflow!

3A1: PREMIER TANKS RAINWATER HARVESTING CISTERN PRODUCT SPECIFICATION

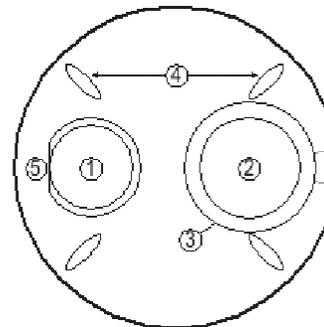
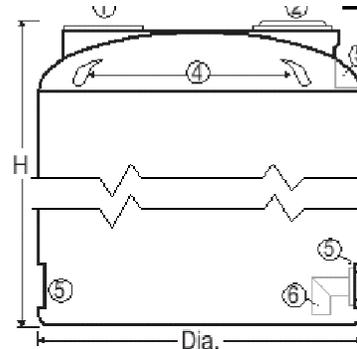
PREMIERTANKS are manufactured to the highest engineering standards, guaranteeing quality and reliability in every product.

- ★ Rugged – one piece – impact-resistant – UV stable.
- ★ CSA and ANSI/NSF 61 certified for drinking water.
- ★ Resistant to most chemicals (consult factory).
- ★ Light green, dark green or black color options.
- ★ 8 year warranty – fully recyclable.



SIZE SELECTION GUIDE

USA		CANADA		Dimensions
Model	US gal.	Model	Imp. gal.	
VU 130	130	VW 110	110	30" Dia. x 53"H
VU 300	300	VW 250	250	47" Dia. x 47"H
VU 480	480	VW 400	400	47" Dia. x 71"H
VU 575	575	VW 480	480	71" Dia. x 44"H
VU 625	625	VW 520	520	47" Dia. x 90"H
VU 795	795	VW 670	670	47" Dia. x 112"H
VU 960	960	VW 800	800	71" Dia. x 67"H
VU 1150	1150	VW 960	960	71" Dia. x 79"H
VU 1440	1440	VW 1200	1200	91" Dia. x 63"H
VU 1535	1535	VW 1280	1280	71" Dia. x 103"H
VU 2000	2000	VW 1660	1660	102" Dia. x 66"H
VU 2340	2340	VW 1950	1950	91" Dia. x 92"H
VU 3000	3000	VW 2500	2500	102" Dia. x 95"H
VU 4000	4000	VW 3330	3330	102" Dia. x 123"H
VU 4999	4999	VW 4160	4160	102" Dia. x 152"H



FEATURES:

1. 17" dia. flat area for fill opening, agitators, instruments.
2. 16" dia. fill opening with self-venting lid.
3. Provision for 21" lid with self-venting lid.
4. Tie-down slots prevent slipping straps.
5. Flat areas provided for additional fittings.
6. 2" Plastic drain fitting with siphon tube.

Note: Additional fittings can be factory or field installed. Details may vary according to tank size.

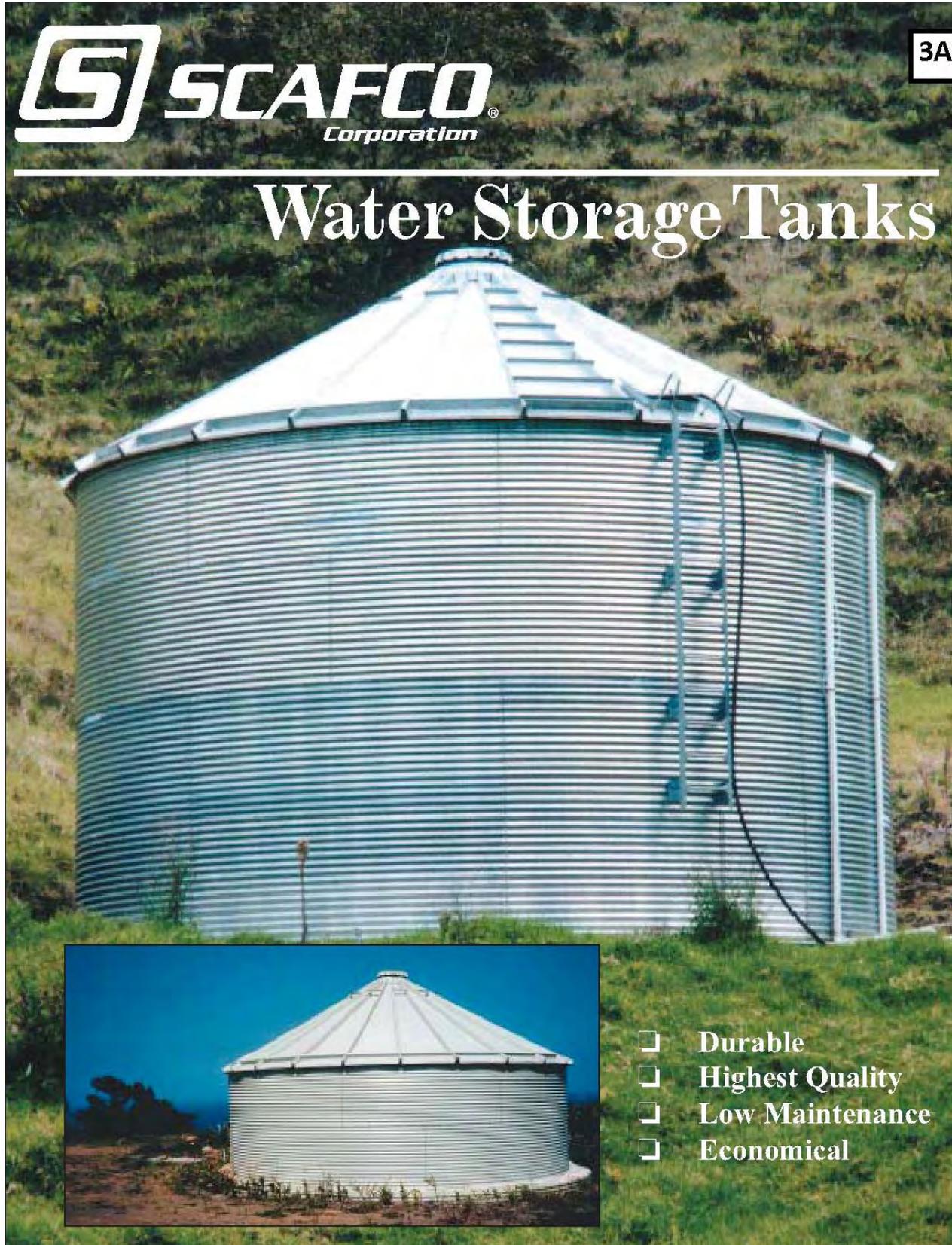
Look for the PREMIER label of quality. PREMIER PLASTICS ... Good Solid Tanks

3A2: SCAFCO WATER STORAGE PRODUCT SPECIFICATION



3A

Water Storage Tanks



- Durable
- Highest Quality
- Low Maintenance
- Economical

3A2: SCAFCO WATER STORAGE PRODUCT SPECIFICATION (continued)

Economical Water Storage • The SCAFCO® Way!
 Corporation

10 WAYS THE SCAFCO WATER TANK BETTER MEETS YOUR NEEDS FOR ECONOMY, LOW MAINTENANCE & LONG LIFE

3/



- 1. Roof Ladder System**
 SCAFCO provides complete tank cover with roof ladder system. The roof ladder includes steel steps bolted to the roof for access to the center hatch cap. Safety steps attach to every other roof panel around the peak, providing sure footing. Optional sidewall ladders available.
- 2. Center Hatch Cap**
 Visible inspection and liner access are possible through SCAFCO's unique center hatch cap. Tanks 6' through 24' in diameter have a handy 24" hatch; those 27' and larger have a 36" hatch.
- 3. Inspection Hatch**
 Installed on every SCAFCO tank (12' & larger) is a man-sized inspection hatch at the eave. Included in one roof panel, this maintenance hatch is factory installed with a latch.
- 4. Great Roof Systems**
 SCAFCO roof panels provide outstanding load carrying characteristics and weatherability. Roof panels together rapidly at the jobsite. Each panel is securely attached to sidewall staves. Optional roof drains to collect rain water are available.
- 5. High-Strength Bolts**
 Every SCAFCO tank is furnished with heat-treated SAE Grade 8.2 (DN 10.9) Bolts. All exposed bolts are high-tensile bolts. The use of zinc-plating to assure durability under harsh weather conditions. Polyethylene washers seal roof and sidewalls against moisture penetration.
- 6. Flexible Liners**
 The liner is suspended inside the tank to form a water-tight membrane. Water never contacts the tank's steel structure.
- 7. Heavy-Duty Anchor System**
 Contoured to match sheet corrugations, sturdy anchor clips secure bottom ring to foundation. Resists horizontal loads. Seismic anchorage available.
- 8. Galvanized Sidewall Staves**
 All steel components are hot-dipped in zinc for high corrosion resistance. SCAFCO's unique 42 2/3" galvanized steel side-wall staves are pre-punched with a single-stroke operation, assuring accurate hole alignment. Sheets are precision roll-formed from high-strength steel. Our extra-stiff 2 2/3" corrugation provides resistance to wind loads. The tank can be field-painted if the owner desires.
- 9. Easy Piping Connections**
 Piping from the foundation base can be joined to the tank by means of a flanged and gasketed joint.
- 10. Rapid Field Assembly**
 Complete assembly instructions are provided; using jacks enables assembly at ground level.

3A2: SCAFCO WATER STORAGE PRODUCT SPECIFICATION (continued)

How Do You Measure Tank Performance?

Consider these performance standards . . .

Corrosion Resistance

Every SCAFCO tank is manufactured from galvanized steel. This hot-dipped zinc coating provides a proven protection against corrosion. The interior is additionally protected by a Flexible liner.

Life Cycle Costs

The Galvanized roof and walls of SCAFCO tanks provide a nearly maintenance-free exterior, virtually eliminating expensive tank repainting costs.

Pre-Engineered Tank System

SCAFCO tanks are available in 11 diameters and 4 wall heights, with capacities to 104,600 gallons. Our experienced engineering staff allows us to respond quickly to your specific tank and site needs.

Local Service and Qualified Installation

SCAFCO tanks are sold and erected by trained builder/dealers using specialized equipment for rapid installation. Our local dealer assure you prompt, quality service.

Wide Selection of Sizes for You!

MODEL NUMBER	DIAMETER		EAVE HEIGHT		OVERALL HEIGHT		CAPACITY	
	FEET	METERS	FEET	METERS	FEET	METERS	GALLON	LITERS
601LSTP	6'	1.83	3' 8"	1.11	5' 2"	1.59	600	2,270
602LSTP	6'	1.83	7' 3"	2.20	8' 9"	2.67	1,400	5,300
603LSTP	6'	1.83	10' 9"	3.28	12' 4"	3.75	2,100	7,950
604LSTP	6'	1.83	14' 4"	4.37	15' 10"	4.84	2,900	10,980
901LSTP	9'	2.74	3' 8"	1.11	6' 1"	1.85	1,500	5,680
902LSTP	9'	2.74	7' 3"	2.20	9' 7"	2.93	3,100	11,740
903LSTP	9'	2.74	10' 9"	3.28	13' 2"	4.02	4,800	18,170
904LSTP	9'	2.74	14' 4"	4.37	16' 9"	5.10	6,500	24,605
1201LSTP	12'	3.66	3' 8"	1.11	7' 3"	2.20	2,600	9,840
1202LSTP	12'	3.66	7' 3"	2.20	10' 9"	3.29	5,600	21,200
1203LSTP	12'	3.66	10' 9"	3.28	14' 4"	4.37	8,600	32,550
1204LSTP	12'	3.66	14' 4"	4.37	17' 11"	5.45	11,600	43,910
1501LSTP	15'	4.57	3' 8"	1.11	8' 1"	2.47	4,100	15,520
1502LSTP	15'	4.57	7' 3"	2.20	11' 8"	3.55	8,800	33,310
1503LSTP	15'	4.57	10' 9"	3.28	15' 2"	4.63	13,500	51,100
1504LSTP	15'	4.57	14' 4"	4.37	18' 9"	5.72	18,100	68,515
1801LSTP	18'	5.49	3' 8"	1.11	8' 11"	2.73	6,000	22,712
1802LSTP	18'	5.49	7' 3"	2.20	12' 6"	3.81	12,700	48,075
1803LSTP	18'	5.49	10' 9"	3.28	16' 1"	4.90	19,400	73,400
1804LSTP	18'	5.49	14' 4"	4.37	19' 7"	5.98	26,100	98,800
2101LSTP	21'	6.40	3' 8"	1.11	9' 10"	2.99	8,200	31,040
2102LSTP	21'	6.40	7' 3"	2.20	13' 4"	4.08	17,300	65,490

MODEL NUMBER	DIAMETER		EAVE HEIGHT		OVERALL HEIGHT		CAPACITY	
	FEET	METERS	FEET	METERS	FEET	METERS	GALLON	LITERS
2103LSTP	21'	6.40	10' 9"	3.28	16' 11"	5.16	26,400	99,930
2104LSTP	21'	6.40	14' 4"	4.37	20' 6"	6.24	35,600	134,760
2401LSTP	24'	7.32	3' 8"	1.11	10' 8"	3.25	10,700	40,500
2402LSTP	24'	7.32	7' 3"	2.20	14' 3"	4.34	22,600	85,550
2403LSTP	24'	7.32	10' 9"	3.28	17' 9"	5.42	34,500	130,600
2404LSTP	24'	7.32	14' 4"	4.37	21' 4"	6.51	46,500	176,020
2701LSTP	27'	8.23	3' 8"	1.11	11' 0"	3.34	13,500	51,100
2702LSTP	27'	8.23	7' 3"	2.20	14' 6"	4.43	28,600	108,260
2703LSTP	27'	8.23	10' 9"	3.28	18' 1"	5.51	43,700	165,420
2704LSTP	27'	8.23	14' 4"	4.37	21' 8"	6.59	58,800	222,580
3001LSTP	30'	9.14	3' 8"	1.11	11' 10"	3.60	16,700	63,220
3002LSTP	30'	9.14	7' 3"	2.20	15' 5"	4.69	35,300	133,625
3003LSTP	30'	9.14	10' 9"	3.28	18' 11"	5.77	54,000	204,410
3004LSTP	30'	9.14	14' 4"	4.37	22' 6"	6.86	72,600	274,820
3301LSTP	33'	10.06	3' 8"	1.11	12' 8"	3.87	20,200	76,465
3302LSTP	33'	10.06	7' 3"	2.20	16' 3"	4.95	42,700	161,640
3303LSTP	33'	10.06	10' 9"	3.28	19' 10"	6.03	65,300	247,190
3304LSTP	33'	10.06	14' 4"	4.37	23' 4"	7.12	87,900	332,740
3601LSTP	36'	10.97	3' 8"	1.11	13' 7"	4.13	24,100	91,230
3602LSTP	36'	10.97	7' 3"	2.20	17' 1"	5.21	50,900	192,675
3603LSTP	36'	10.97	10' 9"	3.28	20' 8"	6.30	77,800	294,500
3604LSTP	36'	10.97	14' 4"	4.37	24' 3"	7.38	104,600	396,950



SCAFCO Grain Systems Company
6200 E. Main Avenue
PO Box 112
Spokane, WA 99211-1215, US

3B1: GOULDS PUMP PRODUCT SPECIFICATION



ITT

Residential Water Systems

Goulds Pumps

JRS5X, JRS5K, JRS5L,
JRD5X, JRD5K, JRD5L
Pump and Tank Packages



TANK FEATURES

- **Deep Drawn Steel Shells:** Provide maximum material strength.
- **Inner Shell:** Prevents diaphragm from over-expanding.
- **Heavy Duty Diaphragm:** Made of finest quality butyl rubber. Separates air and water, maintains air charge.
- **Interior Tank Lining:** Fusion bonded polymeric lining (durable polypropylene liner used on V15P). Both meet FDA requirements.
- **Maximum Working Pressure:** 100 PSI for V45PST and V60PST, 125 PSI for V15P.
- **Temperature Rating:** Maximum 140° F.
- **Appliance Appearance Exterior Finish:** High durability exterior finish of tough, powder coat over a zinc phosphate surface treatment.
- **Heavy Duty Base:** Eliminates corrosion due to condensation and exposure to the elements. Made of high density polypropylene.



Goulds Pumps is a brand of ITT Corporation.

www.goulds.com

Engineered for life

3B1: GOULDS PUMP PRODUCT SPECIFICATION (continued)

ITT

GOULDS PUMPS Residential Water Systems

APPLICATIONS

Home, farm and cottage water systems and booster service.

PUMP SPECIFICATIONS

Pump:

- Pipe connections:
 - 1" NPT pressure
 - 1 1/4" NPT suction
 - 1" NPT discharge.
- Pressure switch:
 - AS4FX preset 30-50 PSI

Motor:

- NEMA service factor.
- 60 Hz.
- 1/2 HP, 115/230 V capacitor start.
- 3500 RPM.
- Built-in overload with automatic reset.
- Stainless steel shaft.

ORDER INFORMATION

Model No.	HP	Replacement Pump Model No.	Tank Model	Drawdown at	
				20/40 PSI	30/50 PSI
JRD5X	1/2	JRD5	V15P	1.7	1.4
JRD5K	1/2	JRD5LT	V45PST	5.1	4.3
JRD5L	1/2	JRD5LT	V60PST	7.3	6.1
JRS5X	1/2	JRS5	V15P	1.7	1.4
JRS5K	1/2	JRS5LT	V45PST	5.1	4.3
JRS5L	1/2	JRS5LT	V60PST	7.3	6.1

PUMP FEATURES

- JRS models have an integral shallow well jet built into the casing, which eliminates the need for a separate shallow well adapter.
- JRD models require a deepwell jet assembly package that must be ordered SEPARATELY.
 - See twin pipe performance rating chart for jet assembly package order number.
- Serviceable:
 - Back pullout design allows disassembly of pump for service without disturbing piping.
 - Two compartment motor for easy access to motor wiring and replaceable components.
 - Corrosion resistant, engineered plastic tubing and fittings are easily removed for cleaning. Premium o-ring design fittings need only be hand tight to seal.
- Powered for Continuous Operation: Pump ratings are within the motor manufacturer's recommended working limits. Can be operated continuously without damage.
- Corrosion Resistant: Electro-coat paint is applied inside and out, then baked on.
- Excellent Air Handling Ability: After initial priming the pump has the ability to re-prime itself even when air gets into the system.
- Drain Plug: For ease of winterizing and maintenance.
- Seal Housing: Engineered composite. Corrosion and abrasion resistant.
- Impeller: F.D.A. compliant, glass filled Noryl®.
- Diffuser (Guidevane): F.D.A. compliant, injection molded, food grade, glass filled Lexan®.

3B1: GOULDS PUMP PRODUCT SPECIFICATION (continued)



ITT

GOULDS PUMPS Residential Water Systems

PERFORMANCE RATINGS

Shallow Well Systems

HP/Order No.	½ HP-JRS5				
Nozzle	AN018				
Venturi	AD3330				
Total Suction Lift (Feet)	Discharge Pressure – PSI				
	20	30	40	50	Max. Shut-off (PSI)
	Gallons Per Minute				
5	14.1	13.3	10.5	5.8	64
10	12.4	12.0	9.2	4.2	59
15	10.5	10.0	8.0	2.4	56
20	8.6	8.5	6.6	1.0	53
25	6.7	6.5	5.0	0.6	51

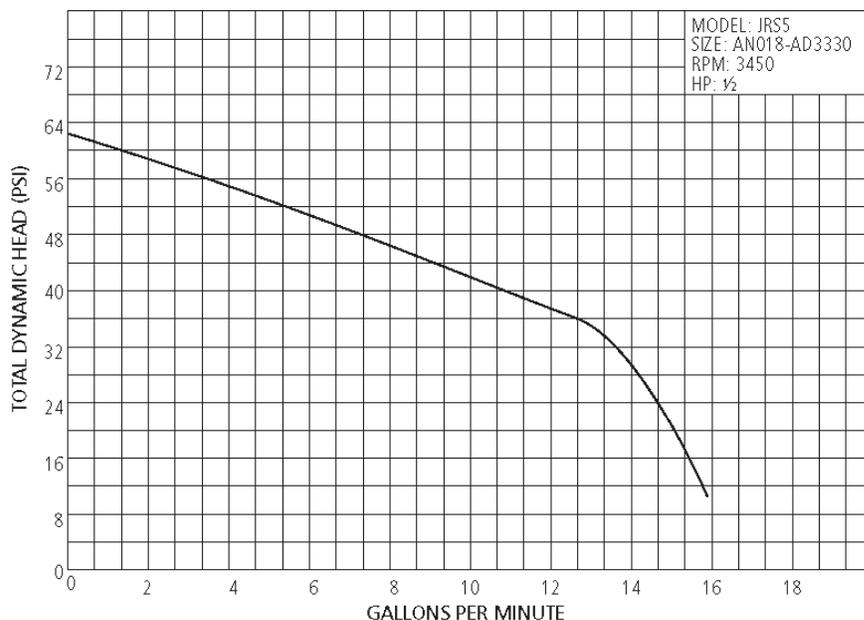
Twin Pipe Systems

HP/Model	½ HP - JRD5					
Jet Assembly Package (2)	FT3-09	FT4-13	FT4-31	FT4-08	FT5-14	
Well Casing Min. I.D. (in.)	3	4		4½		
Pressure	PIPE SIZE (IN.) ¾	1		1½		
Suction	1	1¼		1½		
Jet Body (only)	AT3	AT4		AT5		
Nozzle	AN015	AN017	AN016	AN015	AN018	
Venturi	AD722	AD726	AD723	AD720	AD724	
Control Valve Setting (PSI)	30					
Depth to Jet Assembly (Based on Submergence of 5')	Feet	Gallons Per Minute (GPM) 30-50 PSI Pressure Switch Setting				
	30	6.4	11.7	10.0		
	40	5.7	10.7	8.0		
	50	4.3	9.3	6.8		
	60			6.2	4.7	
	70			5.0	4.2	5.0
	80				3.3	4.3
90				2.8	3.7	

(1) Jet Assembly Package includes: Jet Body, Venturi, Nozzle, Foot Valve

Important Note: An offset of 50 feet will result in a decrease of about 25% from ratings as shown.

JRS5 PERFORMANCE CURVE (At 0' Suction Lift)



3B1: GOULDS PUMP PRODUCT SPECIFICATION (continued)



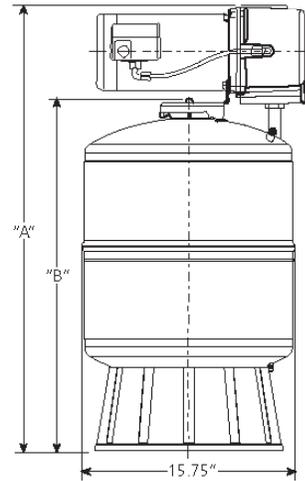
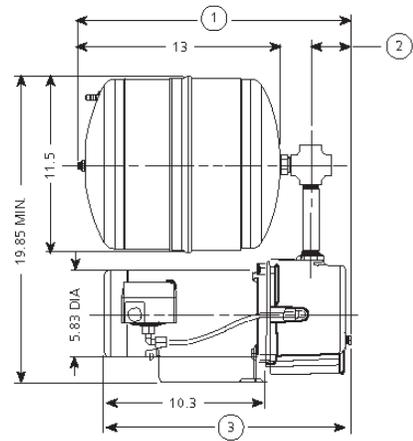
ITT

Residential Water Systems

SYSTEM DIMENSIONS

Model	Tank	Tank Wt. (lb.)	Total Wt. (lb.)	①	②	③
JRDSX	V15P	12	43	17.5	2.5	15.6
JRSSX	V15P	12	43	18.5	3.5	16.7

Model	A (in.)	B (in.)	Tank	Tank Wt. (lb.)	Total Wt. (lb.)
JRDSK	32.5	25.5	V45PST	28	58
JRDSL	40	33	V60PST	40	70
JRSSK	33.0	24.5	V45PST	28	58
JRSSL	40.5	32.0	V60PST	40	70



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SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

BJRPKG December, 2007
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Engineered for life

3C1: PHOTOGRAPH OF RAINWATER CARTRIDGE FILTERS
3F1: PHOTOGRAPH OF UV DISINFECTION



3C2: HAYWARD RAINWATER SAND FILTER PRODUCT SPECIFICATION

PRO™ SERIES PLUS SPHERICAL DESIGN SIDE-MOUNT SAND FILTERS

HAYWARD Pool Products
One source. Every pool.

3C2



Powerful performance. Spherical design.

The pool professional's choice for exceptional filtration in a spherical design. This Pro Series Plus filter incorporates many of the advanced features found in Hayward's Pro Series side-mount filter, delivering high-rate performance for the most demanding installations.

Thanks to its spherical design, the Pro Series Plus evenly distributes the high pressure and stress that are common with solar heating systems, spas, fountains and in-floor cleaning systems. Its impressive underdrain assembly uses 3,800 slots on 10 self-cleaning laterals that ensure totally balanced flow and backwashing. The overall result is a minimal-maintenance filter with greater strength and longer life.



- Pumps
- Filters**
- Heaters
- Heat Pumps
- Cleaners
- Lighting
- Controls
- Electronic Chlorine Generators
- Total System

3C2: HAYWARD RAINWATER SAND FILTER PRODUCT SPECIFICATION (continued)

Optional Valve and Coupling Selections for plumbing ease and versatility.

Manual Air Relief for easy, safe manual release of air from system.

Durable Flanged Inspection/Access Cover provides convenient access to top of filter.

Integral Top Diffuser ensures even distribution of water over the top of the sand media bed. All internal piping is 2" to give smooth, free-flowing performance.

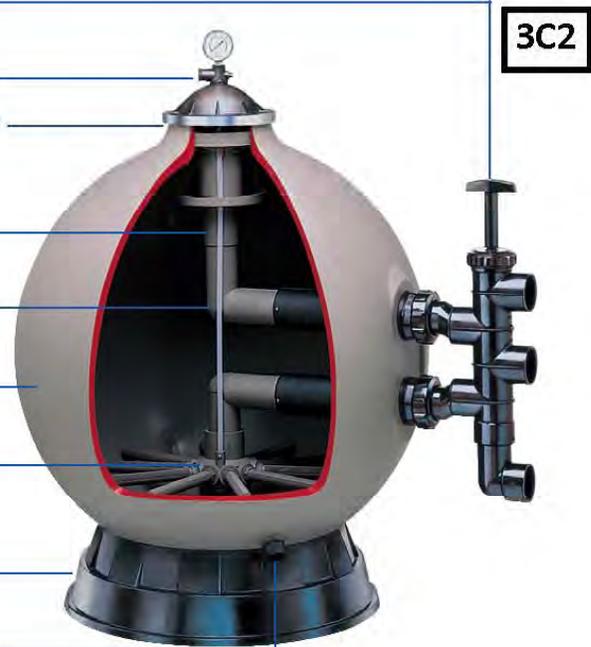
Automatic Air Relief purges any trapped air during operation of the filter system.

Unitized, Corrosion-Proof Spherical Filter Tank is molded of rugged, color-fast polymeric material for maximum strength.

Efficient, Multilateral Underdrain Assembly with 360 slotted, self-cleaning laterals, gives totally balanced flow and backwashing.

Totally Corrosion-Proof Base is rugged and attractively styled to provide strong, stable support.

Integral Molded Drain Plug for easy draining of tank, without the loss of sand.



SPECIFICATIONS — PRO SERIES PLUS SPHERICAL DESIGN SIDE-MOUNT SAND FILTERS	
FILTER TYPE	High-Rate Sand: No. 1/2 Silica Sand (0.45 mm – 0.55 mm)
FILTER TANK	Spherical, Molded Polymeric
UNDERDRAIN	360° Self-Cleaning Slotted Laterals Precision Installed in Ball-Joint Assembly
CONTROL VALVE (sold separately)	2", 7-Position, Vari-Flo™; 2", 2-Position Slide Valve; or 1½" SKT x 2" SLIP Connectors for Multiple (Tandem) Filter Installations
SUPPORT BASE	Injection-Molded ABS
PERFORMANCE RANGE	99 to 130 GPM (375 to 492 LPM)
DIMENSIONS	S311SX – 31" W x 38 ⁵ / ₈ " H (79 cm x 98 cm) S360SX – 36" W x 46" H (91 cm x 117 cm)

Above dimensions are for filter only. Add 14" (36 cm) for multi-port valve, add 7" (8 cm) for slide valve.

PERFORMANCE DATA						
MODEL NUMBER	EFFECTIVE FILTRATION AREA	DESIGN FLOW RATE*	MAXIMUM WORKING PRESSURE	TURNOVER		SAND REQUIRED
				8 hrs.	10 hrs.	
S311SX	4.95 ft. ² 0.46 m ²	99 GPM 375 LPM	50 psi 3.45 bar	47,520 gal. 180 kl	59,400 gal. 225 kl	350 lbs. 159 kg
S360SX	6.50 ft. ² 0.60 m ²	130 GPM 492 LPM	50 psi 3.45 bar	62,400 gal. 236 kl	78,000 gal. 295 kl	700 lbs. 318 kg

*Based upon 20 GPM per ft.² (815 LPM per m²). Maximum allowable NSF rating.

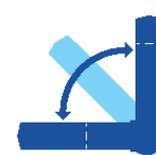


Your Choice of Control Valves

Select from a wide array of valve options for customized control of your filtration system, including Hayward's 2", 2-position slide valve.

Patented Service-Ease Design

with unique folding ball joint design allows lateral assembly to be easily accessed for simple servicing.



4A: MEMBRANE BIOREACTOR SYSTEM



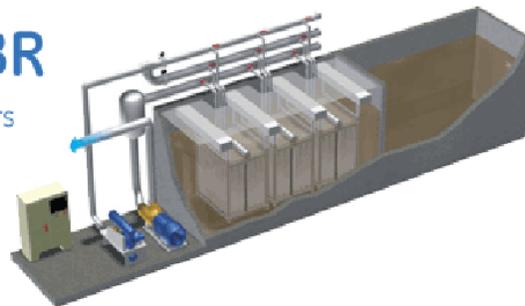
imagination at work

GE Water & Process Technologies

Membrane Bioreactor (MBR)

ZeeWeed* MBR

ZeeWeed membrane bioreactors (MBR) produce effluent for discharge or reuse that far exceeds the world's most stringent regulations.



Efficient, cost-effective wastewater treatment

With membrane bioreactor installations totalling over 450 MGD** of treatment capacity, GE Water & Process Technologies reinforced hollow fiber membranes are the trusted membrane platform. You're investing in peace of mind as well as technology.

ZeeWeed membrane bioreactor systems combine proven [ultrafiltration](#) technology with biological treatment for municipal, commercial and industrial wastewater treatment and water reuse applications. The membrane bioreactor system incorporates reinforced hollow fiber membranes specifically designed to meet the requirements of wastewater treatment. Membrane bioreactor systems replace conventional treatment and combine clarification, aeration and filtration into a simple and cost-effective process that reduces capital and operating costs. The result is consistent, high quality effluent suitable for any discharge or reuse application.

From small and simple membrane bioreactor systems to the world's largest and most dependable, GE has the most system / process engineering and operating experience.

Considering a Membrane Bioreactor Plant?

Learn more about design considerations that will ensure the best value for your dollar, smart features that guarantee trouble-free performance, and operational strategies to handle unexpected situations.

[Membrane Bioreactor Design Considerations »](#)

GE offers real world membrane bioreactor knowledge with industry leading design teams and long-term operating experience which ensures that our customers receive reliable and trouble-free MBR solutions for:

- Plant retrofits
- Cold climate operation
- Bio-phosphorus removal
- Bio-nitrogen removal
- Reverse osmosis pretreatment

4A: MEMBRANE BIOREACTOR SYSTEM (continued)

Direct reuse
 Direct discharge
 Aquifer recharge
 Small, medium and large plants

**peak daily flow rates. This includes membrane bioreactor plants in design, construction or operating as of December 31/04.

Membrane Bioreactor (MBR) Process

The ZeeWeed membrane bioreactor (MBR) process is a GE technology that consists of a suspended growth biological reactor integrated with an ultrafiltration membrane system, using the ZeeWeed hollow fiber membrane. Essentially, the ultrafiltration system replaces the solids separation function of secondary clarifiers and sand filters in a conventional activated sludge system.

ZeeWeed ultrafiltration membranes are immersed in an aeration tank, in direct contact with mixed liquor. Through the use of a permeate pump, a vacuum is applied to a header connected to the membranes. The vacuum draws the treated water through the hollow fiber ultrafiltration membranes. Permeate is then directed to disinfection or discharge facilities. Intermittent airflow is introduced to the bottom of the membrane module, producing turbulence that scours the external surface of the hollow fibers. This scouring action transfers rejected solids away from the membrane surface.

ZeeWeed membrane bioreactor technology effectively overcomes the problems associated with poor settling of sludge in conventional activated sludge processes. ZeeWeed MBR technology permits bioreactor operation with considerably higher mixed liquor solids concentrations than conventional activated sludge systems that are limited by sludge settling. The ZeeWeed MBR process is typically operated at a mixed liquor suspended solids (MLSS) concentration in the range of 8,000 to 10,000 mg/L. Elevated biomass concentrations allow for highly effective removal of both soluble and particulate biodegradable material in the waste stream. The ZeeWeed MBR process combines the unit operations of aeration, secondary clarification and filtration into a single process, producing a high quality effluent, simplifying operation and greatly reducing space requirements.

ZeeWeed Membrane Bioreactor Features and Benefits

- › **Physical ultrafiltration (UF) barrier**
 Produces a high quality effluent suitable for direct reuse
- › **Unmatched fiber ruggedness**
 Ensures a longer membrane life in harsh wastewater operating environments
- › **Hollow fiber geometry**
 Provides a greater filtration surface area which reduces plant footprint and effectively distributes cleaning solutions
- › **Effective backpulse cleaning**
 Maintains long-term, peak system performance and provides a simple, rapid method of recovery in the event of a plant upset
- › **Automated in-situ cleaning**

4A: MEMBRANE BIOREACTOR SYSTEM (continued)

Simplifies system operation and maintenance, while reducing operating costs

> **"Self-healing" fibers**

No catastrophic membrane failures means that your plant keeps working

> **Compact design**

Smaller plant footprint reduces capital costs

> **Proven system performance**

Successful track record of operation in hundreds of municipal and industrial applications provides you with peace of mind

ZeeWeed Membrane Bioreactor Treatment Results

BOD	< 2 mg/L
TSS	< 0.5 mg/L
NH3-N	< 0.5 mg/L
TN	< 3 mg/L**
TP	< 0.05 mg/L**
Turbidity	< 0.2 NTU
Fecal Coliform	< 10 CFU/100 mL
Transmissivity	> 75%

** with appropriate biological design and/or chemical addition

Reinforced Membranes for Membrane Bioreactor Applications

Reinforced membranes™ are preferred for membrane bioreactor (MBR) applications because it's never a perfect world.

The reinforced hollow fiber membrane design philosophy benefits users today and in the future. You may never need to use the built-in safety features such as the ability to effectively backpulse, but if you do, you'll be glad the security is there.

- > Unmatched ruggedness results in a longer membrane life and lower plant life cycle costs
- > "Self-healing" fibers mean no catastrophic membrane failures and no plant shutdowns
- > Effective back-pulse cleaning ensures long-term, peak system performance and a simple method to recover the membrane permeability in the event of a plant upset
- > Compact design means smaller plants and reduced capital and operating costs.

The rugged membranes have a proven track record for operating in all types of demanding environments, including municipal/commercial/industrial wastewater and landfill leachate applications.

* Trademarked in one or more countries

4B: REVERSE OSMOSIS SYSTEM

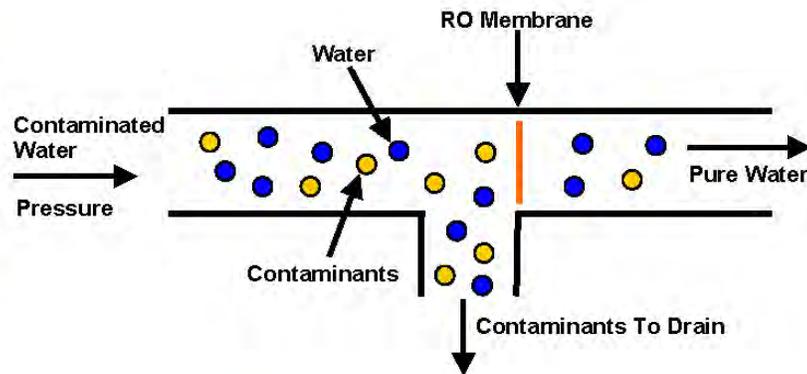


HF Pure Water

203 West Artesia Blvd. Compton, CA 90220-5550 Phone: 310-605-0755 Fax: 310-608-1556

Reverse osmosis is...

The separation of suspended and dissolved impurities, including ions, from a solution through the application of pressure on a special semi-permeable membrane element. The removal of ionic, organic and suspended / dissolved impurities is accomplished during the RO process. Unlike a filter, which separates by conventional filtration, the RO membrane element separates using a process called cross-flow filtration. Feed water is separated into two streams - permeate and concentrate - and collected from both sides of the membrane element.



For more information call 800-421-5000
www.HFPureWater.com

4B: REVERSE OSMOSIS SYSTEM (continued)



SMALL CAPACITY HF2 SERIES SPECIFICATIONS

MODEL:	HF-1.2	HF-1.8
Recovery Range	33-50%	33-50%
Permeate Rate (gpm)	1.2	1.8
Concentrate Rate (gpm)	1.2-0.8	1.8-1.2
PUMP AND MOTOR		
Pump Motor (HP)	0.75	0.75
MEMBRANE ELEMENTS		
Number of elements	2	3
Array	1-1	1-1-1
PIPING		
Inlet (inch)	0.38	0.38
Permeate (inch)	0.38	0.38
Concentrate (inch)	0.38	0.38
OVERALL DIMENSIONS		
Height Approx. (inch)	51	51
Width Approx. (inch)	18	18
Depth Approx. (inch)	15	15
SHIPPING WEIGHT		
LBS. Approx.	75	85



MEDIUM CAPACITY HF4 SERIES SPECIFICATIONS

MODEL:	HF4-2	HF4-3	HF4-5	HF4-6	HF4-8	HF4-10
Recovery Range	50-75%	50-75%	50-75%	50-75%	50-75%	50-75%
Permeate Rate (gpm)	1.5	3	4.5	6	7.5	9
Concentrate Rate (gpm)	1.5-5	3-1	4.5-1.5	6-2	7.5-2.5	9-3
PUMP AND MOTOR						
RO Motor (HP)	3	3	3	3	5	5
MEMBRANE ELEMENTS						
Number of elements	1	2	3	4	5	6
Array	1	1-1	1-1-1	1-1-1-1	2-1-1-1	2-2-1-1
PIPING						
Inlet (inch)	0.75	0.75	0.75	0.75	0.75	0.75
Permeate (inch)	0.5	0.5	0.5	0.75	0.75	0.75
Concentrate (inch)	0.5	0.5	0.5	0.75	0.75	0.75
OVERALL DIMENSIONS						
Approx. Height (inch)	50	50	55	55	60	60
Approx. Width (inch)	30	30	30	30	30	30
Approx. Depth (inch)	20	20	20	26	26	26
SHIPPING WEIGHT						
Approx. LBS. .	170	185	215	235	325	345



*For more information call 800-421-5000
www.HFPureWater.com*

4B: REVERSE OSMOSIS SYSTEM (continued)



LARGE CAPACITY HF4H SERIES SPECIFICATIONS

MODEL:	HF4H-12	HF4H-15	HF4H-20	HF4H-27	HF4H-31
Recovery Range	66-75%	66-75%	66-75%	66-75%	66-75%
Permeate Rate (gpm)	11.2	15	18.8	26.2	30
Concentrate Rate (gpm)	3.4	5	6.3	8.8	10.0
PUMP AND MOTOR					
RO Motor (HP)	7.5	7.5	10	15	15
CIP Motor (HP)	2	2	2	5	5
MEMBRANE ELEMENTS					
Number of elements	9	12	15	21	24
Array	2-1	2-2	3-2	4-3	5-3
Number of Pre-filters	2	2	2	2	2
PIPING					
Inlet (inch)	1.5	1.5	1.5	1.5	1.5
Permeate (inch)	1	1	1	1	1
Concentrate (inch)	1	1	1	1	1
OVERALL DIMENSIONS					
Approx. Height (inch)	61	61	61	61	61
Approx. Width (inch)	77	77	77	77	77
Approx. Depth (inch)	34	34	34	34	34
SHIPPING WEIGHT					
Approx. Low Energy (LBS.)	700	1300	1500	1700	2000
Approx. DLX (LBS.)	1200	1800	2000	2200	2500



Safe Drinking Water



Product Ingredient Water

For more information call 800-421-5000
www.HFPureWater.com

4B: REVERSE OSMOSIS SYSTEM (continued)



The inherent advantages of RO technology can be summed up as follows:

1. RO units produce water similar in quality to demineralized or distilled water.
2. Low operating costs as well as the ability to remove organic contaminants and 95-99% of inorganic salts make RO an attractive and ideal water purification technology for most industrial applications.

The tradition of research and technological innovations at HF provides important advantages to our customers and this is underscored by the constant effort in presenting new models, solutions and plant design ideas.

Three classes of units are available as follows:

HF2 Series Reverse Osmosis Units

The HF2 is available in configurations ranging from 375 to 2,535 gpd. Standard Features include 5-micron pre-filter, automatic inlet shut-off valve, remote machine on/off capability, operating pressure gauge, flow control center including concentrate and recycle valves. Deluxe Features in addition to the standard include low inlet pressure switch, conductivity meter, stainless steel pump, and permeate and concentrate flow meters.



HF4 Series Reverse Osmosis Units

The HF4 are available in configurations ranging from 2,200 to 43,200 gpd. Standard features include one-micron ROsave.Z™s prefilter, automatic inlet shut-off valve, permeate and concentrate flow meters, remote machine on/off capability, thermal motor protection, pre-filter, post-filter, primary & final pressure gauges, and flow control center including concentrate/ recycle valves. Deluxe Features in addition to the standard include auto flush system, low inlet pressure switch, digital conductivity meter with programmable relay, and alarms: low inlet pressure, motor starter overload.



HF4H Series Reverse Osmosis Units

The HF4 are available in configurations ranging from 2,200 to 43,200 gpd. Standard features include 5-micron pre-filter and housing, 20 inch, motor thermal protection, pre/post-filter and primary/final pressure gauges, alarms: low inlet pressure, high amp draw, high permeate conductivity, and remote machine on/off capability. Deluxe features in addition to the standard include casters, upgraded PLC control package, digital pH probe system, alarms: high-low pH, and chemical dosing system.



*For more information call 800-421-5000
www.HFPureWater.com*

4B: REVERSE OSMOSIS SYSTEM (continued)



Pre-Filter

RO pretreatment is critical to extracting the longest life out of the RO membrane elements by removing RO membrane-plugging contaminants from source water. Effective pretreatment minimizes wear-and-tear on your RO elements by reducing the Silt Density Index (SDI) to recommended levels.

Self Contained

Our state-of-the-art Reverse Osmosis systems are compact and self contained, thus saving our customers valuable space as well as enabling freer access to the unit during installation, service or maintenance.



(PLC) Real-time Monitoring Control Panel

Designed around the Allen-Bradley SLC 503 series system, with integrated touch screen, control and real time monitoring, system navigation is a breeze and all programming changes and process parameters remotely.

APPLICATION	HF2	HF4	HF4H
Boiler feed water	X		X
Boiler Water		X	
Car wash	X	X	X
Food ingredient water		X	
Greenhouse watering	X	X	X
Grocery stores	X	X	X
Ion exchange pre-treatment	X	X	X
Metal plating	X	X	X
Process ingredient water	X	X	X
R & D lab use	X		
Restaurant	X	X	X
Rinse water		X	
Safe Drinking Water	X	X	X
Spot free rinse	X		
Whole home RO	X	X	X

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