

The First Optimum Performance Home®

engineered slab part XVII



The First Optimum Performance Home® At The Sea Ranch

Architectural Illustration By Ronald Devesa

Gary Reber

synopsis

- Extensive and complex underslab infrastructure continues to be the focus of construction on the site prior to the pouring of the suspended concrete slab.
- The project's concrete mixes use Portland Cement, Kryton's KIM admixture, Euclid Eucon A+ admixture, and 40 percent fly ash.
- The first stage Amvic ICF construction is the underground wine cellar and uses Carlisle BARRICOAT-R waterproof coating.
- Prior to the granular mixture fill, the placement of the DELTA-MS UNDERSLAB membrane, the under-slab R-Control Perform Guard EPS, and the Uponor AQUAPEX-encased suspended slab concrete pour, all the underground infrastructure for the home will have been installed.
- The radiant floor portions of the 5-inch thick suspended concrete slab and under-slab insulation are encased at the perimeters with the EnergyEdge® 8-inch Frame Building Rail.
- Both the hot and cold water corrugated pre-sleeved Uponor AQUAPEX tubing is further insulated with Armacell AP/Armaflex tube insulation.

Introduction

This is the seventeenth article in the series documenting the design and construction of the first Optimum Performance Home®. The home is now under construction, after more than five years of design and plan development work. Construction financing is being provided by San Francisco-based New Resource Bank, a community bank chartered to fund "green" projects.

The project has been selected by the U.S. Green Building Council (USGBC) for inclusion in the national Leadership In Energy & Environmental Design (LEED®) for Homes pilot program, the nation's most challenging green build certification initiative, and the goal is Platinum certification.

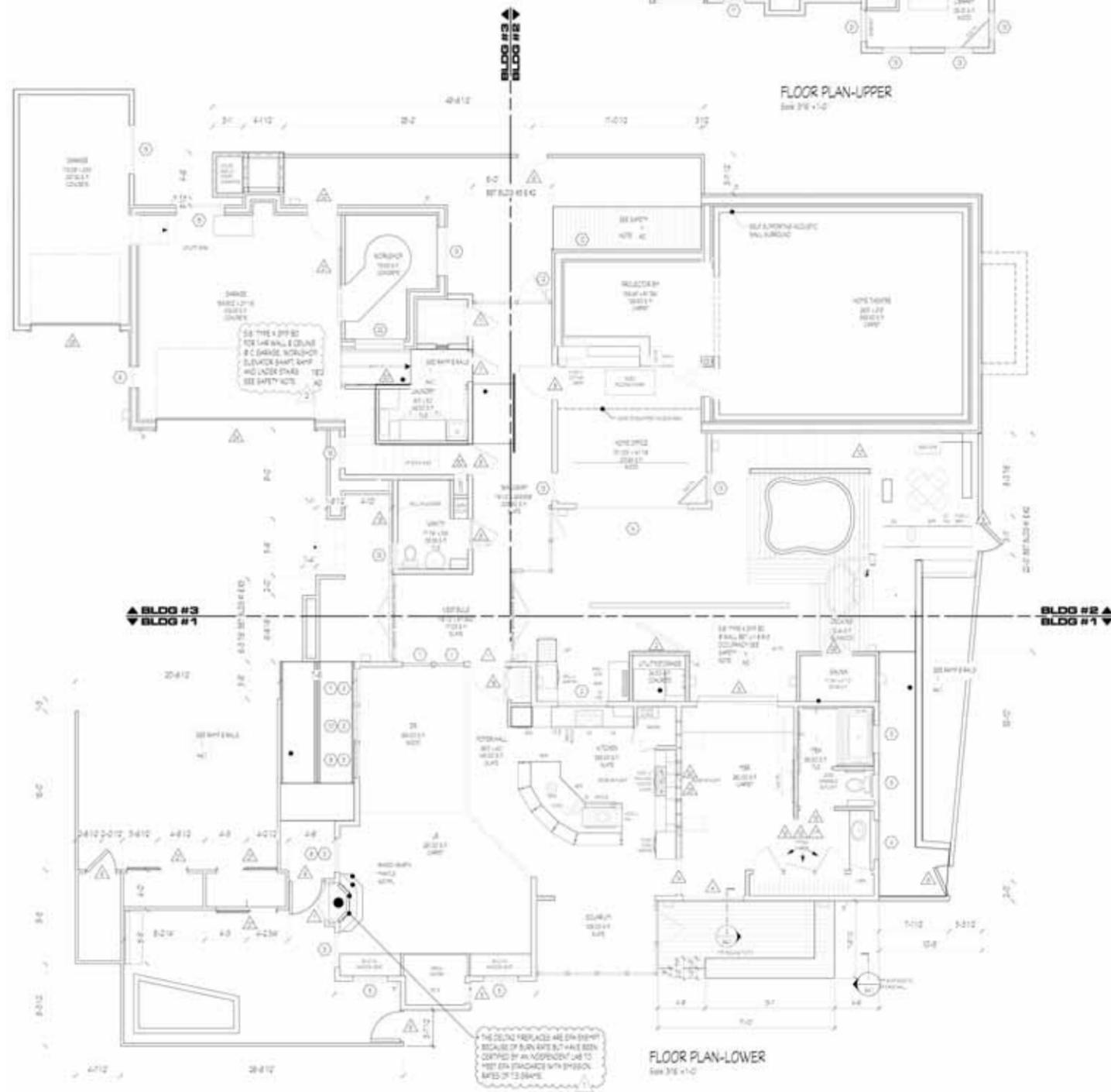
The home is being built at The Sea Ranch, located in Sonoma County, along the Northern California coastline of the Pacific Ocean, approximately 110 miles north of San Francisco.

To document the day-to-day construction of the home, an iBeam Systems time-lapse construction camera is up and running. Visit www.ultimatehomedesign.com/oph.php and then click on the "Optimum Performance Home Build Cam" button. Photos are captured and automatically uploaded to iBeam's secure server every 15 minutes from 6:00 a.m. to 6:00 p.m. each day. The images can easily be e-mailed or printed to document job site conditions. To view time-lapse archive images, enter the user name ophsearch and the password ophsearch.

Using iBeam's technology and an "always on" GetWireless AirLink Raven X EVDO V4221-VA and AirLink Dual-Band



FLOOR PLAN-UPPER
See 316 + 1-2



FLOOR PLAN-LOWER
See 316 + 1-2



The Sea Ranch, Sonoma County, California
Photo Courtesy Rozanne Rapozo
(www.natureasisseeit.com)

EVDO Antenna, our team is able to view a high-resolution photo archive of the entire project daily, including stunning 1920 x 1080p (progressive) high-definition time-lapse movies each month (see a standard-resolution version at www.ultimatehomedesign.com/oph-photos.php).

Upon completion, the entire construction photo archive will be featured as a 1080p high-definition time-lapse movie and will become part of a high-definition television program and educational documentary that Steve Michelson Productions and I are producing.

Ultimate Home Design® Concept

The showcase project is exemplary of the “Ultimate Home Design®” concept, which integrates age-friendly universal design with the best sustainable building practices, while exerting minimal impact on the environment. Universal design is the inclusive, non-discriminatory design of products, buildings, environments, and urban infrastructure; as well as information technologies that are accessible to and useable by (almost) all. With respect to home design, the idea is to design and build homes that have no physical barriers, thus sustaining people of all ages and all capabilities in a functional, comfortable, and aesthetic lifestyle.

A building-science systems approach to home building is the cornerstone of the project, with emphasis on the relationship between the home’s components and the envelope it creates. Also paramount is good stewardship—proper regard and respect for the rights of neighboring homeowners and the surrounding natural setting, and resource efficiency. The goal is to optimize occupant health, comfort, and safety; maximize energy efficiency and structural durability; and minimize environmental impact. In addition, the aim is toward providing a nurturing

home environment to support independent living and sustainable lifestyles.

Part I of this case study series appeared in Issue 1, January/February 2006. The introductory article covered the project scope. Thereafter, each issue has contained a part of the continuing series by working through site planning and preparation; Low-Impact Development (LID); further refinements to the site plan and drainage design; The Sea Ranch Design Committee-approved architectural/structural and grading/drainage submittals with conditions that translated to clarifications on certain building components and material finishes; particular aspects of the home’s mechanical plan; structural aspects of foundations, structural walls incorporating Insulating Concrete Forms (ICFs), and Structural Insulated Panels (SIPs), as well as roofing; the acoustical design of the dedicated Optimum Performance Home Theatre™ and rear-projection room; interior design approaches and materials; kitchen, bath, and home fixtures; universal design architecture; fire-risk mitigation; energy generation; and courtyard experience. “Breaking Ground” was the title of Part XIII, along with “Courtyard Experience.” Part XIV and XV, respectively, covered the initial continuing phases of “Site And Foundation Preparation.” Part XVI further expanded on the “Site and Foundation Preparation.”

The initial site grading, foundation, and mechanical, plumbing, electrical, and low-voltage infrastructure stages have been completed. This complex and leading edge under-slab infrastructure work has been documented in the day-to-day time-lapse photography and archived photos on the *Ultimate Home Design* Web site. Following the installation of the Cosella-Dörken DELTA®-MS UNDERSLAB vapor-retarding membrane and AFM Corporation R-Control® Perform Guard EPS foam slab insulation, the Uponor® AQUAPEX® radiant floor was installed and the engineered suspended concrete slab poured. Presently, work has commenced on the erection of the Amvic® ICF walls.

Completion of the home is anticipated for April 2009. It is our intent to produce a high-definition documentary for

“The goal is to optimize occupant health, comfort, and safety; maximize energy efficiency and structural durability; and minimize environmental impact.”



The elevations of the Optimum Performance Home at The Sea Ranch

educational use by the U.S. Green Building Council, the organization who created the LEED for Homes rating and certification program. Our presentation will reveal the step-by-step process for creating the first Optimum Performance Home—expected to be one of the highest rated, if not the highest, LEED for Homes Platinum residential home in the world! Separately, we have produced an HD promo, which was requested by Planet Green, a network owned by the Discovery Channel. This promo will be promoted to secure national television distribution of a program on the home, which we have titled, the *Ultimate Home Series*. One can view the promo at www.ultimatehomedesign.com/hdvtv.

Construction Scheduling

Below is the breakdown of the initial site preparation, grading process, foundation work, and engineered suspended slab completed or underway. An outline will be provided in Part XVIII for the next stage of construction relating to the above the slab Amvic ICF and ThermaSAVE® SIP walls and roofing, WaterFurnace® geothermal vertical fields, Stormwater Solutions EcoRain™ underground water cistern, and Seepage Control® Environmental Soil Sealant for the pond bottom.

Pre-Construction Start Meetings Site Work

- Clear Lot Vegetation
- Lay Out House Pad
- Install Curtain Drain Around Pad
- Excavate Optimum Performance Home Theatre, Alcove, and Wine Cellar
- Lay Out Footings
- Install Temporary Electrical Power
- Install iBeam Systems Time-Lapse Pro Construction Camera (See Part XIII)
- Install GetWireless and WildBlue Internet Transmission
- Activate Water Service
- Form Underground ICF Home Theatre, Alcove, and Wine Cellar Walls
- Verify Foundations' Site Placement/Inspection
- Rough Excavation Large Pond and Septic Trench to Designated Leech Field
- Install StormTech Infiltration Chambers (See Parts II, III, and IV)

Foundations

- Dig Initial Stage Foundation Footings and

- Install French Drain
 - Pour First Stage Engineered Controlled Density Fill (CDF) Concrete with Portland Cement and Headwaters Resources Fly Ash (See Part VI)
 - Set Forms; Tie Rebar Steel, Hold Downs, and Anchor Bolts
 - Pour Final Stage Foundation Footing Concrete with Portland Cement, Headwaters Resources Fly Ash, Kryton's KIM Admixture, and Euclid Eucon Admixture (See Part VI)
 - Run Spunstrand Acoustically Treated Air-Conditioning Duct for Home Theatre (See Part V)
 - Conduit Trenching for Uponor AQUAPEX Plumbing (See Parts V and X)
 - Run Armacell Insulated Uponor AQUAPEX Hot and Cold Water Tubing
 - Run Plumbing Waste
 - Run Wardflex Flexible Corrugated Stainless Steel Fuel Gas Tubing
 - Run Underground Waterline from Pond to the Boat Garage for Fire Hose Connection (See Part XI)
 - Run Underground Drain from Wine Cellar to StormTech Infiltrator Chambers Located Across the Property Frontage
 - Install Gravel Around Plumbing
 - Run Plumbing Conduit and Supply
 - Run Electrical and Low-Voltage Conduit
 - Lay Out NuTone Central Vacuum System (See Parts IX and X)
 - Run WaterFurnace Geothermal Supply and Return Tubing
 - Finalize Underslab Infrastructure
 - Install EnergyEdge Insulated Form Around Perimeter of Slab
 - Underslab Inspection
 - Place Gravel and Sand Underslab
 - Install Cosella-Dörken DELTA-MS UNDERSLAB
 - Install AMF Corporation R-Control Perform Guard EPS Underslab Insulation
 - Prepare for In-Floor D-Box™ Technologies Custom Motion Platform In Home Theatre (See Part VII)
 - Install Slab Rebar
 - Install Uponor AQUAPEX Radiant Floor Tubing
 - Pour Concrete Slab with Portland Cement, Headwaters Resources Fly Ash, Kryton's KIM Admixture, Euclid Eucon Admixture (See Part VI), and Forta Ferro (See Part XVI)
 - Backfill Courtyard and Spa Area
 - Install Zurn Flo-Thru Trench Drain
 - Pour Concrete Slab with Portland Cement, Headwaters Resources Fly Ash, Kryton's KIM Admixture, Euclid Eucon Admixture (See Part VI), and Forta Ferro (See Part XVI)
 - Install AMF Corporation R-Control Perform Guard EPS Around Perimeter of Slab Under EnergyEdge
 - Waterproof Concrete Stem Walls With Carlisle BARRICOAT-R
 - Backfill Foundation
 - Install Stormwater Solutions EcoRain Underground Water Cistern
 - Install Seepage Control ESS-13
 - Environmental Soil Sealant At Pond Location
 - Construct Amvic ICF Walls
 - Pour Concrete Into Amvic ICFs
 - Construct ThermaSAVE SIP Walls
 - Treat Concrete Slab with Nisus Corporation Bora-Care Termite Barrier Pretreatment
 - Install Roofing Structural Members
 - Install ThermaSAVE SIP Roofing
- Wine Cellar
 - Construct Underground Wine Cellar with Amvic ICFs



**(Top) Armacell
Armaflex Insulation,
(Right) Plumber Jerry
Moyles, Contractor
John Feeney,
(Above) Spunstrand
Saddle Vents**



StormTech® Infiltrator Chambers

- The StormTech SC-310™ chambers are low-profile modular underground stormwater detention structures, approximately 7 feet in length. StormTech chambers are molded from Polypropylene resin, which is inherently resistant to environmental stress cracking and chemicals typically found in stormwater runoff.

- Pour Concrete into Amvic ICFs
- Construct Concrete Roof to Support Earth Garden
- Waterproof Wine Cellar Walls with Carlisle Coatings
- Install Weston Solutions GreenGrid Living Herb Garden

Garages

- Construct West Amvic ICF Garage Wall
- Pour Concrete into Amvic ICFs

Septic System

- Dig Septic Trench, Cut Road, Install Pipes, Backfill Trench, and Repair Road

John Feeney, our on-site supervising contractor and lead carpenter, and his carpenter team consisting of Ian Currie, Gerard Feeney, Aaron Davila Romero, Alain Bernal, and Gabriel Bernal are performing the foundation, Uponor AQUAPEX

radiant floor, and concrete slab work. John's crew works under the direction and with Travis Swithenbank and his specialist crew at QUALCON on the construction of the Amvic ICF walls.

Matthew Jung, owner of 88HVAC, a Geothermal-Radiant-Solar company operating in Marin-San Francisco-Burlingame, California, installed the WaterFurnace geothermal supply and return tubing under the slab.

Sebastopol, California-based Weeks Drilling & Pump Company, under the direction of Chris Thompson, CEO, will drill the five 310-foot-deep geothermal bore holes after the foundation work is completed.

Don Bartlett of Bartlett Mechanical Services will install the WaterFurnace® geothermal and complete the interface with the WaterFurnace system with the Spunstrand underground acoustically damped air-conditioning duct system. Don also oversaw the installation of Uponor AQUAPEX radiant floor tubing. The Spunstrand system was constructed and installed by Jerry Feeney and John Feeney.

Bill Wilson Environmental Planning and Design, LLC is responsible for the on-site water-management systems, including the pond and drains. Aqua Harvest International's Terry McMains, based in Rio Rancho, New Mexico, designed the site application of the EcoRain Stormwater Tank Modules underground water cistern manufactured by Stormwater Solutions, LLC. The cistern will retain roof runoff from Gutter Helmet® guttered interior roof areas. On other eaves, Rainhandler® grids are planned to shatter and re-suspend roof runoff, spraying it to the adjacent mulched landscape areas to facilitate infiltration. Thus, all impervious roof surface areas that produce runoff are mitigated.

The large pond at the eastern rear of the site is intended to both celebrate and accommodate the excess presence of moisture moving across

the site. The pond is designed to act as a hydraulic stabilization feature by storing and managing excess moisture crossing the site, including some of the perched groundwater, and to create habitat value for native and migratory wildlife.

A "beach" with subsurface horizontal geotechnical drains (provided by Smart Drain™) will be installed at the "upper," or southeast corner of the pond, overlain by coarse sand and rock chips, to intercept seepage and runoff from the neighboring property and recharge the pond.

The excavated pond is constructed as a dip in the topography, without any constructed berm or engineered containment. It will be sealed with a vegetable oil polymer (provided by Seepage Control) that is completely non-toxic and used for this purpose, and the pond will not leak.

This Issue

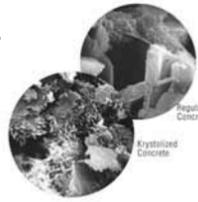
In this issue, the focus continues to be on the various construction elements related to site and foundation preparation.



iBeam Time-Lapse Pro Construction Camera Perspective 2008-09-09

Kryton's KIM® Admixture System

- KIM® admixture renders hardened concrete impermeable to water penetration, reduces drying shrinkage, protects steel reinforcements from corrosion, and improves concrete durability. The advanced integral crystalline chemicals react with water and unhydrated cement particles to form millions of needle-like crystals to permanently block the pathways for water and waterborne contaminants.



Euclid Eucon A+

- Euclid Chemical Company's Eucon A+ Type A admixture serves as a fast-setting, water-reducing, and plasticizing admixture for concrete that does not adversely affect concrete set times.



In previous issues, the site's soil conditions (see Part XIV) were discussed and the remedy. This resulted in Headwaters Resources' Doug Yeggy designing a specially engineered Controlled Density Fill (CDF) concrete mix to fill the voids and provide a strong, stabilized surface upon which to support the foundation footings. Headwaters Resources is the source of the fly ash that we used in the concrete mixes designed for the project. The

Portland Cement Association and the California Portland Cement Company are the sources of the cement used in the project. Delivery of the Portland Cement and fly ash to the concrete production facility was handled by Conti Materials. The local concrete production facility is Bed Rock Products, based in Point Arena (and Gualala), California. Bob Hay's Bed Rock Concrete Pumping is providing the concrete-pumping service for the project.

ect. The mix design for the Amvic ICFs will be used once again for the ICF walls in the next phase of construction.

These mixes use Portland Cement, Kryton's KIM admixture, Euclid Eucon A+ admixture, and 40 percent Headwaters Resources fly ash. The mix design for the standard foundation footings uses 324 pounds of Portland Cement, 216 pounds of fly ash (40 percent), 11 pounds of KIM admixture, and 16 ounces of Eucon A+ admixture per cubic yard. The suspended slab-on-grade mix design uses, per cubic yard, 360 pounds of Portland Cement and 240 pounds of fly ash (40 percent), 11 pounds of KIM admixture, 18 ounces of Eucon A+ admixture, and FORTA® FERRO®. The Amvic ICF concrete mix design will use the mix design that was used for the standard foundation footings (see Part XVI).

For an in-depth presentation on the application of these mixes in the project, see Issue XV.

KIM admixture renders hardened

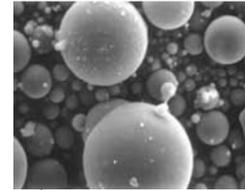
concrete impermeable to water penetration, reduces drying shrinkage, protects steel rebar reinforcements from corrosion, and improves concrete durability. The advanced integral crystalline chemicals in the KIM admixture react with water and unhydrated Portland Cement particles to form millions of needle-like crystals to permanently block the pathways for water and waterborne contaminants.

Euclid Chemical Company's Eucon A+ Type A admixture serves as a fast-setting, water-reducing, and plasticizing admixture for concrete that does not adversely affect concrete set times.

The suspended slab-on-grade mix design incorporates FORTA FERRO, an easy-to-finish, color-blended fiber, made of 100 percent virgin copolymer/propylene consisting of a twisted bundle non-fibrillating monofilament and a fibrillating network fiber, yielding a high-performance concrete reinforcement system. This fiber provides long-term concrete durability and increased impact resistance. FORTA FERRO is used to reduce plastic and hardened concrete shrinkage prior to the initial set, reduce hardened concrete shrinkage cracking, improve impact strength, and enhance concrete toughness and durability. This extra heavy-duty fiber offers maximum long-term durability, structural enhancements, and effective secondary/temperature crack control by incorporating a truly unique synergistic fiber system of long-length design. FORTA FERRO is non-corrosive, non-magnetic, and 100 percent alkali proof. The recommended dosage rate of FORTA FERRO is 3 to 30 pounds per cubic yard of concrete added directly to the concrete-mixing system during, or after, the batching of the other ingredients and mixed at the time and speed recommended by the mixer manufacturer (usually four to five minutes).

These measures were deemed necessary to provide maximum concrete strength for the foundation and engi-

Headwaters Resources



- Fly ash improves the performance of concrete foundations, making them stronger, more durable, and more resistant to chemical attack, while creating significant environmental benefits through stewardship of an abundant industrial resource. Because the tiny fly ash particles fill microscopic spaces in the concrete, and because less water is required, concrete using fly ash is denser and more durable. And concrete containing fly ash becomes even stronger over time compared to concrete made only with cement.



FORTA® FERRO®

- FORTA® FERRO® is a copolymer/propylene fiber that is used to reduce plastic and hardened concrete shrinkage prior to the initial set, reduce hardened concrete shrinkage cracking, improve impact strength, and enhance concrete toughness and durability.



**Above: Uponor AQUAPEX Radiant Tubing, Spunstrand Saddle Vents
Below: Uponor Radiant Send & Return**



neered-suspended slab on grade. The San Andreas Fault is an uncomfortably close neighbor to The Sea Ranch, and the mix design should provide exceptional strength so that the home can survive such a natural disaster and provide safety to the home's inhabitants.

The bulk of the engineered suspended slab on grade has been poured, as well as the wine cellar roof. The slab for the courtyard and master bedroom suite deck



iBeam Time-Lapse Pro Construction Camera Perspective 2008-09-18

Amvic® Insulated Concrete Forms

- The Amvic® ICF 5-in-1 system incorporates structure, insulation, vapor barrier, sound barrier, and studding attachments for drywall and exterior siding in one easy step.



Carlisle® Coatings & Waterproofing

- BARRICOAT-R is a waterproofing and vapor barrier membrane designed for vertical surfaces, above or below ground. MiraDRAIN 6200 is a high-performance, high-strength drainage composite consisting of a three-dimensional, high-impact polystyrene core, and a nonwoven filter fabric.



Clockwise: Infrastructure Overview, Uponor AQUAPEX Radiant Tubing, Wine Cellar, Uponor Radiant Send & Return



remain to be completed in the next phase. The wine cellar roof will feature a Weston Solutions GreenGrid living herb garden planted around a VELUX® Sun Tunnel™ skylight.

The Amvic ICF structural elements of the underground wine cellar have been constructed. With the engineered slab now poured, the next step is to seal and waterproof the stem and foundation walls exposed to the earth. Carlisle® Coatings & Waterproofing BARRICOAT-R will be used for this purpose. BARRICOAT-R is a waterproofing and vapor barrier membrane designed for vertical surfaces, above

or below ground. This roller and/or brush-applied, water-based, asphalt emulsion is modified with a blend of synthetic rubbers and special additives, which cures to form a flexible, monolithic, waterproofing membrane. The membrane prevents lateral water migration. BARRICOAT-R is ideally suited for waterproofing on below-grade foundation walls, and other areas where a seamless elastomeric waterproofing is required.

Drainage plays a critical role in the design and construction of below-grade applications. Without proper drainage, groundwater seepage may cause hydrostatic pressure and leakage, resulting in structural damage. Good drainage is particularly critical to the success of this project, due to the adverse damp conditions contributed by underground springs.

Carlisle's MiraDRAIN's multi-directional flow design allows a continuous path for water discharge, eliminating the potential for hydrostatic pressure buildup. It allows water to pass freely into the drainage core, where it is gravity-fed into the site's drainage collection system.

The exterior earth-encased BARRICOAT-R membrane-protected Amvic ICF wine cellar walls and the ICF walls to be earth-banked will be covered with MiraDRAIN 6200, high-performance, high-strength drainage composite consisting of a three-dimensional, high-impact polystyrene core, and a non-woven filter fabric. MiraDRAIN 6200 has the added benefit of a polymeric sheet adhered to the back of the core, to prevent the drainage core from die-cutting the waterproofing membrane. The filter fabric is bonded to the dimpled polystyrene core to minimize fabric intrusion. The fabric also prevents the passage of soil particles into the core, while allowing water to pass freely.

The exterior concrete roof of the wine cellar will be protected with a

BARRICOAT-R membrane, and MiraDRAIN GR9200 will be applied over the waterproof membrane. This sheeted membrane is designed specifically for green roofs, garden roofs, and large planter applications. Used with the BARRICOAT-R waterproofing, this drainage composite provides adequate water retention for sedums, grasses, and plant life, while providing a channel for excess water to drain.

The slab is 5 inches thick. Under the slab, covering a granular mixture compacted over the soil, Cosella-Dörken's DELTA-MS UNDERSLAB waterproofing and vapor-retarder membrane was installed. This is designed for slabs on or below grade. A 2-inch layer of coarse sand was applied to cover this membrane, upon which a rigid Type IX R-4 (per inch) 2-inch R-Control Perform Guard EPS (expanded polystyrene) insulation from AFM Corporation was installed. R-Control is a proven material with built-in protection against the destructive force of termites.

DELTA-MS UNDERSLAB is a tough, impermeable vapor-retarding membrane that is placed on the earth or granular surface prior to placing the concrete. DELTA-MS UNDERSLAB prevents the early loss of hydrated water, thus producing a concrete that meets design strength and provides more even curing characteristics in concrete. The membrane offers a full-capillary break and vapor retarder that prevents the upward migration of moisture through the capillaries that exist in all concrete. Additionally DELTA-MS UNDERSLAB can act as a barrier to soil gases. This will provide a healthy and dry environment.

A 2-inch-thick R-Control Perform Guard EPS was placed over the DELTA-MS UNDERSLAB to provide superior thermal mass for uniform heat transfer of the WaterFurnace geothermal/heat pump heated water through the Uponor 1/2-inch AQUAPEX in-floor tubing encased in the 5-inch-thick engineered suspended concrete slab.

Cosella-Dörken DELTA-MS UNDERSLAB



- DELTA-MS UNDERSLAB is a tough, impermeable vapor-retarding membrane that is placed on the earth or granular surface prior to placing the concrete slab. The membrane provides a full capillary break and vapor retarder that prevents the upward migration of moisture through the capillaries that exist in all concrete.

R-Control® Perform Guard EPS



- Rigid Type IX R-4 (per inch) 2-inch R-Control® Perform Guard EPS (expanded polystyrene) insulation from AFM Corporation provides superior thermal mass for uniform heat transfer of slab-encased radiant floor systems. Photos courtesy of AFM Corp.



Zurn® Flo-Thru Trench Drain

- The modular Zurn® molded-slop Flo-Thru trench drain is designed for load-bearing strength, hydraulics, chemical resistance, and structural integrity.



Clockwise: Uponor Radiant Send & Return, Spunstrand Saddle Vents, Uponor AQUAPEX Radiant Tubing



Prior to pouring the slab concrete in the courtyard, suspended over the final stage concrete footings, a Zurn® Flo-Thru trench drain will be installed. It will run the full length of the courtyard. The modular Zurn molded-slope drain is designed for load-bearing strength, hydraulics, chemical resistance, and structural integrity.

A significant element in the proper functioning of the dedicated Optimum Performance Home Theatre is the acoustically treated Spunstrand underground air-conditioning duct system that will deliver low-velocity, ultra-quiet airflow circulation in the acoustically treated theatre. The system is specially fabricated with

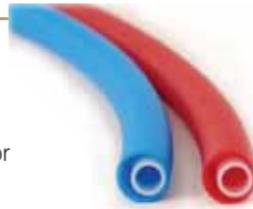
EnergyEdge® Frame Building Rail

- The EnergyEdge® Frame Building Rail (EE8fb) is designed to provide insulation at the radiant floor perimeters of the concrete slab. The PVC channel provides full-rigid insulation coverage from top to bottom of the slab edge to prevent radiant floor heat loss through the edges of the concrete slab.



Uponor® Pre-Sleeved Corrugated AQUAPEX®

- Uponor® 1/2- and 3/4-inch red and blue high-density polyethylene (HDPE) pre-sleeved corrugated AQUAPEX® tubing is designed for durability and provides protection for installation in the soil and allows for easy removal.



Armacell AP/Armaflex® Pipe Insulation

- The expanded closed-cell structure of Armacell AP/Armaflex® pipe insulation makes it an efficient insulation for effectively reducing heat loss on the hot water plumbing and heat gain on the cold water plumbing systems.



NuTone® Central Vacuum System

- A NuTone® Central Vacuum System will be featured in the home to help maintain healthy interior air quality. NuTone's central vacuum power units feature a space-saving, sleek, oval-shaped design; internal sound suppression system; and a status light on the hose handle and power unit, which indicates when the VX™ unit's bag or canister is full and needs emptying.



duckboard and 1-1/2-inch-thick duct liner inserted into the energy-saving R-10 insulated Spunstrand ducts to hush background noise due to ventilation hum, self-generated air noise, and on/off ventilator switching.

The underslab installation of the Spunstrand duct is complete. In the next phase, the exterior components of this system will be completed. (See Part XVI for a description of Spunstrand.)

The radiant floor portions of the 5-inch-thick engineered concrete slab and under-slab insulation is encased at the perimeters with the EnergyEdge® 8-inch Frame Building Rail (EE8fb). The PVC channel provides full-rigid insulation coverage from the top to the bottom of an 8-inch slab edge to prevent radiant floor heat loss through the edges of the concrete slab. Below the EnergyEdge, 7-1/4 x 1-1/2 inch R-Control Perform Guard EPS was installed to satisfy California Title 24 insulation requirements for radiant floor slab edges.

Prior to the granular mixture fill, the placement of the DELTA-MS UNDERSLAB membrane, the underslab R-Control Perform Guard EPS, and the Uponor AQUAPEX-encased suspended slab concrete pour, all the underground infrastructure for the home was installed. This was a time-consuming, labor-intensive job. This work included Uponor 1/2- and 3/4-inch red and blue pre-sleeved corrugated AQUAPEX

tubing with outer Armacell® AP/Armaflex® pipe insulation, the NuTone® VX1000 central vacuum system, and the complex electrical and low-voltage wiring system encased in conduit.

Uponor's red and blue high-density polyethylene (HDPE) corrugated pre-sleeved 1/2- and 3/4-inch AQUAPEX tubing provides protection for the installation in the soil and allows for easy removal and replacement of the tubing, if required. In addition, the red and blue color-coded sleeves easily identify hot and cold waterlines. AQUAPEX's flexibility and strength at temperatures ranging from below-freezing up to 200 degrees Fahrenheit makes it the ideal piping material for hot and cold water plumbing systems, trouble-free fire-sprinkler systems, and hydronic radiant floor-heating systems. PEX is a cross-linked polyethylene.

Armacell AP/Armaflex® pipe (tube) insulation was wrapped over the Uponor AQUAPEX tubing to provide additional thermal insulation. The expanded closed-cell structure of AP/Armaflex pipe insulation makes it an efficient insulation for effectively reducing heat loss on the hot water plumbing and heat gain on the cold water plumbing systems. It is formaldehyde free, low VOCs, fiber free, dust free, and resists mold and mildew, and is made with Microban® antimicrobial product protection for added defense against mold on the insulation. When buried under the suspended slab, the pipe tubing will be channeled through crushed rock rather than through the soil to enhance long-term durability.

Jerry Moyles and his team at Mendocino Coast Plumbing did the installation of the Uponor plumbing system and the Wardflex® flexible corrugated stainless steel fuel gas tubing, which will supply propane to the KitchenAid® Architect Series® II dual-fuel 36-inch-wide range, the Vulcan-Hart professional 36-inch-wide griddle (Vulcan 36RRG), the Kohler® generator,

Wardflex® Flexible Fuel Gas Tubing

- Wardflex® is the gas piping system for the 21st Century with the highest overall rated flow capacity in the industry. Wardflex is recognized as the "system of choice" by major gas utility companies.



and the Navien® tankless water heater. As well, they are charged with the plumbing for the TrendSetter® solar hot water heating system. This system uses two 6 x 7-foot TS-30 Evacuated Solar Tube Collectors and a 200-gallon TS-200 Solar Thermal Storage Tank manufactured by TrendSetter.

Wardflex corrugated stainless steel tubing (CSST) was selected, as it delivers more advantages over black steel pipe or ordinary CSST systems. Compared to either black steel pipe or other ordinary corrugated stainless steel tubing systems, Wardflex delivers more performance and installation advantages. Using continuous flexible annular corrugated tubing made of 304 stainless steel, Wardflex installs without heavy carrying, threading, extensive measuring, or mess. The tubing is connected using special mechanical fittings. The continuous lengths and amazing flexibility of the fully annealed tubing greatly reduces the number of needed connections (and chances for leaks).

Roger Stevenson and his team at Stevenson Electric are charged with the complete installation of the elaborate and sophisticated electrical and low-voltage electronic systems infrastructure under the home and throughout the interior, including the extensive interfaces, fixtures, controls, and equipment

and appliances powered by electricity. This includes the 240-volt assemblies for the Finnleo® Finnish sauna and the Dimension One® Amoré Bay spa, the three 220-volt electric car recharging stations in the garages, and the 240-volt Equi=Tech® 20WQ wall cabinet-mounted balanced AC power unit in the dedicated Optimum Performance Home Theatre and two 240-volt Model "5Q" balanced AC power units—one in the library/home theatre/surround music room and the other in the living room. Stevenson Electric has completed the elaborate underslab infrastructure. Once the ICF and SIP walls are constructed, the next phase of the infrastructure in the interior of the home will commence.

Michael Galica and his team at Marin Outdoor Living is charged with the installation of the Dimension One Amoré Bay spa. The spa will be installed in the next phase, following completion of the courtyard and spa slab pour.

Engineered Environments™ Randy Sterns, Brian Hodges, and Tim Johnson are consulting on the electronic systems design and installation of the home's low-voltage infrastructure and technologies. The underslab infrastructure conduit portion of their work has been completed. Further work will commence once the home's wall and roof structure is complete.



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Bora-Care®

- Nisus Corporation's Bora-Care® is a primary termite barrier pretreatment that creates a continuous barrier that termites cannot cross, eliminating their food source.



Stevenson Electric also installed the NuTone central vacuum system infrastructure underslab. This will eventually tie into the NuTone 1,040-watt cyclonic central vacuum power unit, which features HEPA-rated filtration, Microban protection, and Teflon antistick technology.

Stevenson Electric is further charged with the installation of the two QuietCool™ whisper-quiet whole-house fans and their companion EnviroCool™ evaporative cooling air system manufactured by Southwest Electric Enterprises, Inc. This work will be completed once the building structure is constructed. Unlike conventional air conditioning, QuietCool ventilates the home while removing germs, odors, and indoor pollution and replacing the air with healthier outside air. These high-volume fans can remove and replace all of the air in the home 15 to 20 times per hour. The EnviroCool system allows your home to stay cool for about one-tenth the cost of traditional air conditioning. By drawing the fresh air in through the EnviroCool high-tech space-age media, the incoming filtered air is cooled by as much as 40 degrees and does so whisper quiet. An evaporative cooling mechanism used with QuietCool fans, EnviroCool can lower the temperature in homes far more efficiently than conventional air conditioners can. EnviroCool is

one of the most cost-effective "green" additions a homeowner can add. One system will filter and cool the air in the main residence, and the other in the second-floor guest quarters and library/home theatre/surround music room.

A 3-inch filtered underground waterline will be installed prior to the final backfill around the perimeter of the engineered slab. This is to serve as a surplus supply of water available from the pond. A standard 2-1/2-inch value red-painted standpipe hydrant with a male National Hose fire-thread fitting will be located at the driveway entrance at the front of the property, to which a fire hose can be connected.

Following the curing of the concrete slab and the construction of the ICF and SIP walls, Nisus Corporation's Bora-Care® will be applied directly to the finished surface slab as a primary termite barrier pretreatment. Bora-Care creates a continuous barrier that termites cannot cross, eliminating their food source.

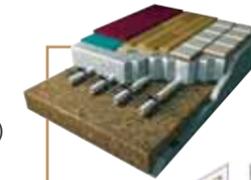
The next installment in this series of case-study articles will continue to cover the actual work being done to accomplish the tasks described, as well as the construction of the above-slab Amvic ICF and ThermaSAVE wall structure. In the meantime,

photos and videos will be posted on the *Ultimate Home Design* Web site (www.ultimatehomedesign.com/oph.php) depicting progress in the construction of the first Optimum Performance Home.

Design Concept

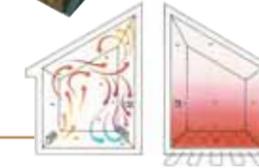
As previously noted in this series, the home design integrates all of the concepts advocated in *Ultimate Home Design*. The goal is to demonstrate how modern building products and methods can make life safer, more comfortable, and more enjoyable. The science of optimum performance homes concerns itself with building structures that use less energy, are quieter and more comfortable, have fewer problems with material degradation, provide clean air and water, and do less damage to the environment. As an integrated and holistic design, the house will serve as a durable residence that allows its occupants to age in place. The exceptionally solid structure should last decades, with minimal maintenance.

The high-performance building systems employed are designed to exceed California building code requirements and resist natural disasters more effectively than a code-minimum house, even with the new California code requirements that require use of non-combustible or fire ignition-resistant building materials. Constructed with stronger building materials and superior techniques, the home will be safer, allowing homeowners greater peace of mind. The Optimum Performance Home qualifies for the Fortified...For Safer Living® program of the Institute for Business & Home Safety (www.ibhs.org/business_protection). This program specifies construction, design, and landscaping guidelines to increase a new home's resistance to natural disaster.



Uponor® Radiant Floors

- Warm water circulates under the floors throughout the Optimum Performance Home using Uponor®'s durable, flexible, and resilient cross-linked polyethylene AQUAPEX tubing, providing a comfortable, even heat without stirring up dust and pollutants.



In addition, the home will meet the guidelines and qualifications for the U.S. Department of Environmental Protection's ENERGY STAR®, the EPA's (Environmental Protection Agency) WaterSense™, and the American Lung Association® Health House® programs. It also will meet the requirements of the National Association of Home Builders' (NAHB) National Green Building Standard, the Sustainable Buildings Industry Council (SBIC) Green Building Guidelines, and the "Green Points" program. Sonoma County and The Sea Ranch Association are now considering

this program for adoption. Furthermore, the home's design was the subject of a case study analysis presentation before the Custom Residential Architects Network (CRAN), Full Spectrum Practice Convention of the American Institute of Architects on October 20, 2007 in Chicago, Illinois.

The home is also a case study of the California Energy Commission in terms of energy-efficiency applications and an advanced water-saving plumbing system.

Finally, the home is a national showcase for the Custom Electronic Design & Installation Association, and is the



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subject of a series of articles on the design and installation of the electronic lifestyle components in the home. These articles are featured in CEDIA's *Electronic Lifestyles*® quarterly magazine.

The Setting

The Sea Ranch is an internationally renowned 5,000-acre environmentally protective residential development situated within a pastoral and forested coastal enclave and nature preserve approximately 110 miles north of San Francisco, California. This stunning development, now celebrating its 43rd anniversary, straddles a 10-mile stretch of Highway 1 along a uniquely beautiful rugged coastline, ending at the northern tip of Sonoma County and the south bank of the Gualala River.

The Sea Ranch is widely regarded as a unique and remarkable residential development. During the 1960s and 1970s, The Sea Ranch was at the forefront of environmentally responsible development. It was conceived and designed by architects and landscape architects who wanted to provide a harmonious mixture of custom homes and pristine natural Northern California landscape in oceanfront, meadow, and forest environments. In fact, The Sea Ranch concept and its architecture are recognized in schools of architecture around the world, and it is frequently used for case studies in environmental and architectural design. The first condominium complex to be built on the southern coastal bluffs of The Sea Ranch is now a registered national architectural site.

Single-family development occupies approximately 2,500 acres without borderline fences or other visible delineation of property lines. The remaining acres are permanent green-scape commons with 45 miles of nature trails for walkers, bicyclists, and equestrians. Each home is custom designed by an architect/architectural designer following site-specific design guidelines and

is situated off a private road network without curbs, sidewalks, or streetlights. The Sea Ranch is a very unique residential development woven into a tapestry of buildings and nature and committed to environmental preservation. The development includes 2,288



Four Perspective Views of the Optimum Performance Home at The Sea Ranch

lots for single-family custom homes, with 523 remaining to be developed (1,741 already developed and 24 under construction).

The Sea Ranch is managed by The Sea Ranch Association, a Common Interest Development (CID) with an elected volunteer Board of Directors, and supported by numerous volunteer committees. All development on The Sea Ranch is subject to design review and the approval of a Board-appointed autonomous Design Committee. The Design Committee is presently comprised of architects and landscape architects, though it does not include anyone with experience in vegetation management or "green" sustainable building design. A legal set of Covenants, Conditions, and Restrictions (CC&Rs) govern the development and are designed to protect The Sea Ranch concept.

The Home

The Sea Ranch Design Committee imposes upon designers architectural building blocks derived from the original rural structures found on the northern California coast. Designers are expected to apply their creativity to render various arrangements and deviations to arrive at a custom solution that specifically responds to the site. Successful proposals submitted to the Design Committee address the issues of passive solar positioning, wind, glazing (window) layout, privacy between neighbors, vegetation protection, view preservation, topography and grade changes, roof slopes, appropriate exterior materials and finishes, and other exterior design considerations—all within the building and site design.

A focus of the Optimum Performance Home's design is to stand as a showcase for the "green" movement and demonstrate means of reducing a home's impact on the planet through the use of Low-Impact Development and environmentally responsible and sustainable building

materials. It is hoped that the home will become a case study for a "Green Points Program" suited to the scale of The Sea Ranch.

The home's 3,272-square-foot living space (4,441-square-foot total building "footprint," including garages, covered walkways, courtyard, and decks) is arranged in a three-building compound using a well-sealed, well-insulated, super-tight building envelope that reduces temperature fluctuations and enhances overall energy efficiency. This arrangement provides for an alcove courtyard protected from the prevailing north-west wind. The home is designed with differing spatial experiences throughout to encourage exploration. The home will display innovative interior design and be furnished in a contemporary Frank Lloyd Wright style appropriate to its dimensions. The home design connects the indoors and the outdoors with covered walkways, a courtyard, decks, and a garden to expand livable space, without requiring heating or air conditioning. The home is designed in accordance with biophilic design principles with abundant and excellent use of natural light and natural indigenous landscaping planned. (For an in-depth analysis of the biophilic attributes of the home, please read "Biophilic Design," "Biophilic Design Attributes," and "The Interior Design Process, Part I: Synthesizing Sustainability, Universal

Design, And Technology" authored by Julie Stewart-Pollack in Issue 3 (May/June 2006), Issue 4 (July/August 2006), and Issue 10 (July/August 2007), respectively.)

The main-floor living area is designed to accommodate the capabilities of all occupants without any challenging physical barriers, even for the elderly and disabled. The home design features a ground-level open plan for the living room, dining room, master bedroom suite, and spacious kitchen with solarium, exhibition cooktops, and home-management system.

The second building in the compound is designed to accommodate a large state-of-the-art Optimum Performance Home Theatre with integrated rear-screen projection room and a home office.

The third building will include a two-car and boat garage, workshop, main-level guest bathroom, and laundry room. The second level of this building will have two guest bedrooms, a bathroom, and a dedicated library/home theatre/surround music room distinguished by a high-tower feature. To insure universal access to this floor, the design provides for an Otis® Gen2 residential elevator.

The entrance and walkways that connect the three buildings and the solarium will be enclosed with insulated- and solar-gain-reduced-tempered glass. There will be a seating area at the vestibule entrance to the home. The main entrance vestibule will serve as an oversized mudroom. The driveway, area around the garage, guest parking, and entrance to the home—as well as all paths—are designed in accordance with The Sea Ranch guidelines governing exterior hard-surfaced paths. All such surfaces are pervious to virtually eliminate



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water runoff. The surface will be packed with decorative crushed rock to enhance the natural appearance of the home's setting. There also will be a dedicated equipment room off the courtyard, which accommodates the Uponor and WaterFurnace radiant-heating apparatus, TrendSetter solar hot water storage tanks, Navien's 98 percent condensing on-demand propane-fired tankless water heater, and other equipment. The backup Kohler® generator is housed within a separate weather-resistant tower located off the north wall of the two-car garage and guest bedroom, within the fenced dog run. The upper level of this tower is designed to optimize the northwest wind performance of the double-stacked PacWind® Seahawk® vertical-axis wind turbines disguised within. A Enviro Energies generator will capture the wind power and distribute it to the GridPoint Connect intelligent energy-management system (see Part XII, Issue 12, November/December 2007).

Along with the PacWind Seahawk/Enviro Energies system, a large high-performance premium photovoltaic Day4 Energy 48MC module 8.7-kW solar PV system will be installed on the south-facing roof of the dedicated Optimum Performance Home Theatre (see Part XII, Issue 12, November/December 2007). The Enviro Energies and Day4 Energy systems will be managed by a dual GridPoint Connect intelligent energy-management system, providing hub connection to the Pacific Gas & Electric power grid and battery backup power.

The home site is nestled on an almost-acre parcel at the edge of a forested area of the southern section overlooking the Pacific Ocean, offering distant water views. The orientation of the home on the site is designed to take advantage of natural lighting and passive solar heating and cooling. Good site and land planning will result in minimal land disturbance and preservation of natural features and environments.

Landscaping will consist of The Sea

Ranch-approved indigenous vegetation with low water requirements and unique water conservation features, including two ponds and a stream supported by rainwater catchment and captured runoff. Site grading has been specifically planned to enhance the project's placement in the watershed, and the design incorporates the principles of Low-Impact Development to minimize runoff from impervious surfaces and mimic the natural hydrology in overall effect. The resultant water harvesting will then minimize the use of irrigation, and the increased infiltration and retention will passively support the native landscape. Additionally, a gray water system will be used for undersurface plant irrigation.

Next

With site preparation and foundation construction now complete, this continuing series of articles will focus on the design elements as they pertain to

each stage of construction as the project progresses, and will include coverage of the technologies and building systems and the materials used and applied to construct the first Optimum Performance Home. **UHD**

The Author

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Product And Contact Information

- AFM Corporation, R-Control, 211 River Ridge Circle, Suite 102A, Burnsville, Minnesota 55337, 952 474 0809, www.r-control.com
- Amvic, Inc., 501 McNicoll Avenue, Toronto, Ontario, Canada M2H 2E2, 416 410 5674, www.amvicsystem.com
- Aqua Harvest International, 3628 Greystone Ridge Court, Rio Rancho, New Mexico 87124, 505 975 5008, www.aquaharvestonline.com
- Armacell LLC, 7600 Oakwood Street Extension, Mebane, North Carolina 27302, 800 866 5638, www.armacell.com
- Bartlett Mechanical Services, 6755 Oak Street, Anderson, California 96007, 408 313 2486, www.bartlettmechanical.com
- Bed Rock Concrete Pumping, P.O. Box 503, Point Arena, California 95468, 707 882 2637
- Bed Rock Products, Inc., 135 Hay Parkway, Point Arena, California 95468, 707 882 2323
- Bill Wilson Environmental Planning & Design, LLC, 71 Del Casa Drive, Mill Valley, California 94941, 415 383 2919, 805 689 7639
- Broan-NuTone, 926 West State Street, Hartford, Wisconsin 53027, 800 548 0790, www.nutone.com
- California Portland Cement Company, 2025 East Financial Way, Glendora, California 91741, 800 272 9119, www.calportland.com
- Carlisle Coatings & Waterproofing, Inc., 900 Hensley Lane, Wylie, Texas 75098, 800 527 7092, www.carlisle-ccw.com
- Conti Materials, P.O. Box 30248, Stockton, California 95213, 209 467 0626, www.contimaterials.com
- Cosella-Dörken Products, Inc., 4655 Delta Way, Beamsville, Ontario, Canada L0R 1B4, 905 563 3255, www.cosella-dorken.com
- Dimension One Spas, 2611 Business Park Drive, Vista, California 92081, 800 345 7727, www.d1spas.com
- EchoStar DISH Network, 9601 South Meridian Boulevard, Englewood, Colorado 80112, 888 825 2557, www.dishnetwork.com
- Energy Edge, 7701 East Kellogg, Suite 722, Wichita, Kansas 67207, 316 618 1983, www.energyedgeform.com
- Engineered Environments, 1250 Marina Village Parkway, Alameda, California 94501, 510 521 7500, www.engineeredenvironments.com

- Equi=Tech Corporation, 18258 Redwood Highway, Selma, Oregon 97538, 877 378 4832, www.equitech.com
- Euclid Chemical Company, 19218 Redwood Road, Cleveland, Ohio 44110, 800 321 7628, www.euclidchemical.com
- Feeney Construction, 14660 McCourtney Road, Grass Valley, California 95945, 530 477 7647, 707 884 9458
- Finnleo Sauna & Steam, 575 East Cokato Street, Cokato, Minnesota 55321, 800 346 6536, www.finnleo.com
- FORTA Corporation, 100 Forta Drive, Grove City, Pennsylvania 16127-6399, 800 245 0306, www.fortacorp.com
- GetWireless LLC, 10901 Red Circle Drive, Suite 325, Minnetonka, Minnesota 55343, 800 990 9025, www.getwirelessllc.com
- Gutter Helmet/Southeastern Metals (SEMCO), 1180 Industry Drive, Jacksonville, Florida 32218, 904 757 4200, www.gutterhelmet.com
- Hacker Industries, Inc., 610 Newport Center Drive, Suite 250, Newport Beach, California 92660, 800 642 3455, www.hackerindustries.com
- Headwaters Resources, 10653 South River Front Parkway, Suite 300, South Jordan, Utah 84095, 888 236 6236, www.flyash.com
- iBeam Systems, Inc., 280 North 8th Street, Suite 30, Boise, Idaho 83702, 800 403 0688, www.ibeamsystems.com
- Kryton Canada Corporation, 8280 Ross Street, Vancouver, B.C., Canada V5X 4C6, 604 324 8280, www.kryton.com
- Marin Outdoor Living, 2100 Redwood Highway, Greenbrae, California 94939, 415 924 8811, www.marinoutdoorliving.com
- Mendocino Coast Plumbing, P.O. Box 41, Manchester, California 95459, 707 882 2628, 707 353 2628.
- Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077, 847 966 6200, www.cement.org
- QUALCON, P.O. Box 566, 333 East Pine Street, Fort Bragg, California 95437, 707 964 5000
- QuietCool, Inc./Southwest Electric Enterprises, Inc., 31235 Loretta Road, Winchester, California 92596, 888 784 3826, www.freshac.com
- Rainhandler/Savetime Corporation, 2710 North Avenue, Bridgeport, Connecticut 06604, 800 942 3004, www.rainhandler.com
- Seepage Control, 7301 West Boston Street, Chandler, Arizona 85226, 800 214 9640, www.seepagecontrol.com

- Smart Drain, Drawer 2219, Columbia, Maryland 21045, 800 638 8582, www.smartdrain.com
- Sonoma County Builders, Inc., 6280 Old Redwood Highway, Santa Rosa, California 95403, 707 837 2997 / P.O. Box 244, Point Arena, California 95468, 707 684 9144
- Spunstrand Incorporated, 620 North Post Street, Post Falls, Idaho 83854, 208 665 7444, www.spunstrand.com
- Steve Michelson Productions, Lobitos Creek Ranch, 2800 Lobitos Creek Road, Half Moon Bay, California 94019-2547, 650 726 2460, www.lobitoscreekranch.com
- Stevenson Electric, 1340 Highway 4, P.O. Box 2642, Arnold, California 95223, 209 768 2100
- StormTech, 20 Beaver Road, Suite 104, Wethersfield, Connecticut 06109, 888 892 2694, www.stormtech.com
- Stormwater Solutions, LLC, 3940 Laurel Canyon Boulevard, Suite 856, Studio City, California 91604, 866 786 7690, www.stormh2osolutions.com
- ThermaSAVE/IHSN, Inc, 4002 Helton Drive, Florence, Alabama 35630, 256 766 3378, www.thermapanel.net
- Uponor North America, 5925 148th Street West, Apple Valley, Minnesota 55254, 800 321 4739, www.uponor-usa.com
- VELUX America, Inc., 104 Ben Cassey Drive, Forth Mill, South Carolina 29708, 888 838 3589, www.VELUX.com
- Vulcan-Hart Company, P.O. Box 696, Louisville, Kentucky 40201, 800 814 2029, www.vulcanhart.com
- Wardflex, 2085 West Avenue 140th, San Leandro, California 94577, 415 971 1531
- WaterFurnace International, Inc., 9000 Conservation Way, Fort Wayne, Indiana 46809, 800 222 5667, www.waterfurnace.com, www.stormh2osolutions.com
- Weeks Drilling & Pump Company, 6100 Highway 12, Sebastopol, California 95472, 707 823 3184, www.weeksdrilling.com
- WildBlue Communications, Inc., Greenwood Corporate Plaza, Building 1, 5970 Greenwood Plaza Boulevard., Suite 300, Greenwood Village, Colorado 80111, 866 945 3258, www.wildblue.com
- Wonderwater, P.O. Box 1510, Mt. Shasta, California 96067, 530 926 5050, 530 925 2586, www.wonderwater.net
- Zurn Flo-Thru Operation, 116 Molly Rex Lane, Mooresville, North Carolina 28117, 704 799 7087, www.zurn.com



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