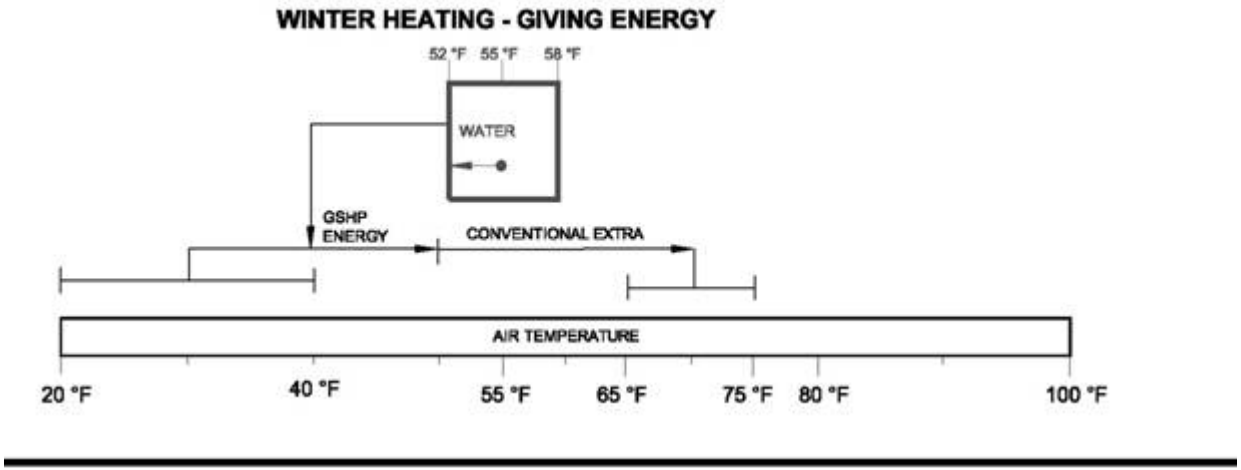
Paul D. Stull III, P.E.
Paul.Stull@amec.com
Tyler Clary, PE
Tyler.Clary@ci.vancouver.wa.us
City of Vancouver
Vancouver, WA
360.487.7169

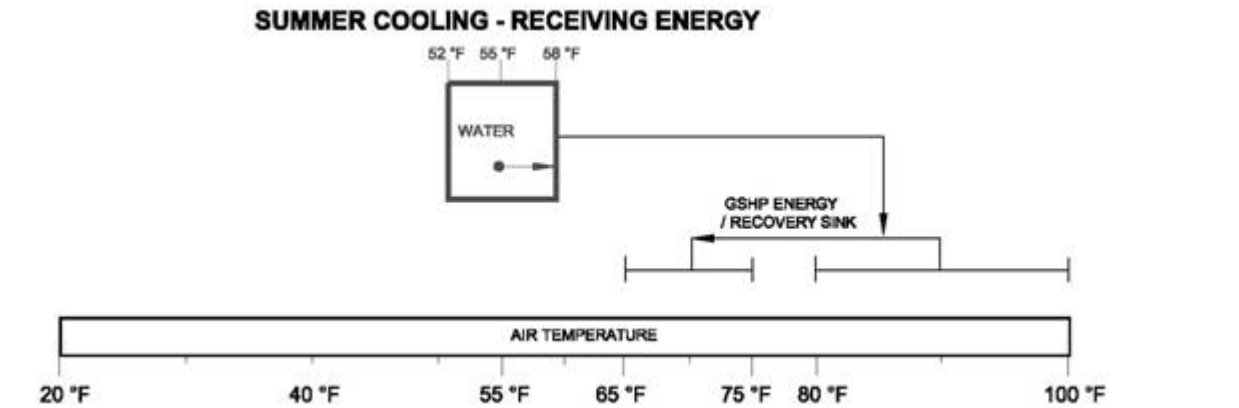
Ground Source Heat Pump System Design and Permitting

AWWA Pacific Northwest Section Conference, May 6- 8, 2009 Salem, Oregon

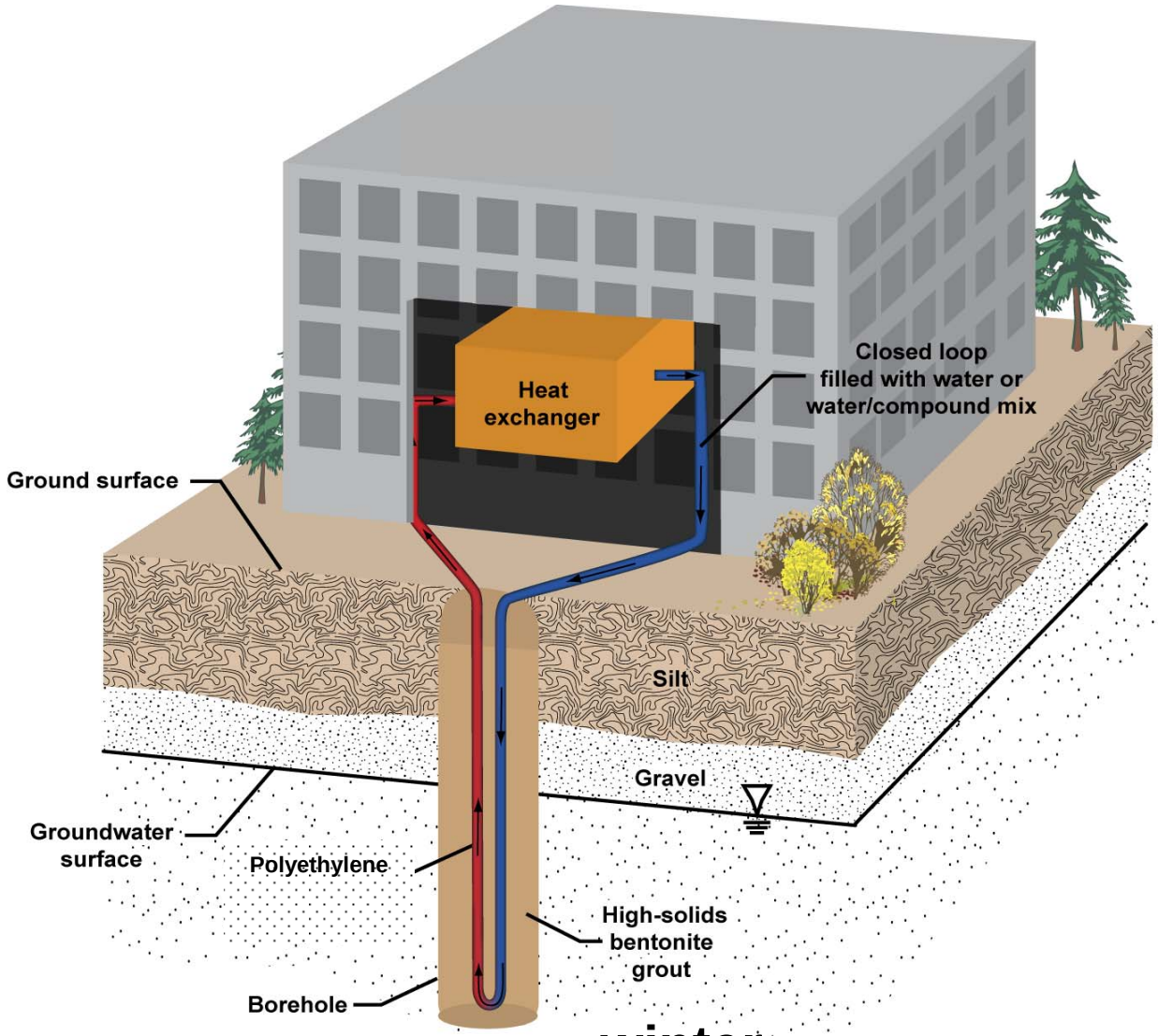
What is a Ground Source Heat Pump?

A ground source heat pump (GSHP) uses the ground and/or groundwater as a source of heat in the winter to heat and a “heat sink” in the summer to cool a building or structure.

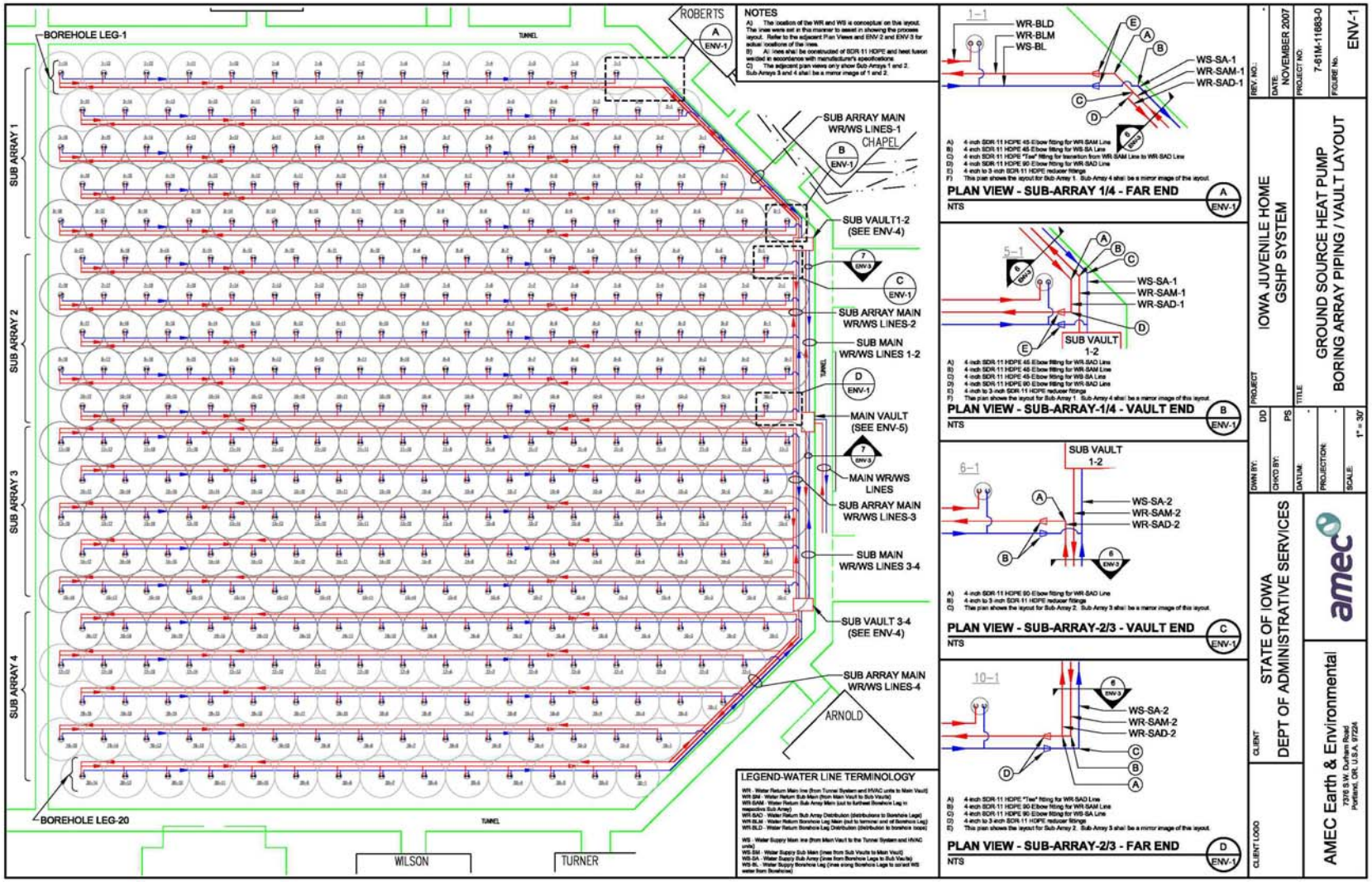




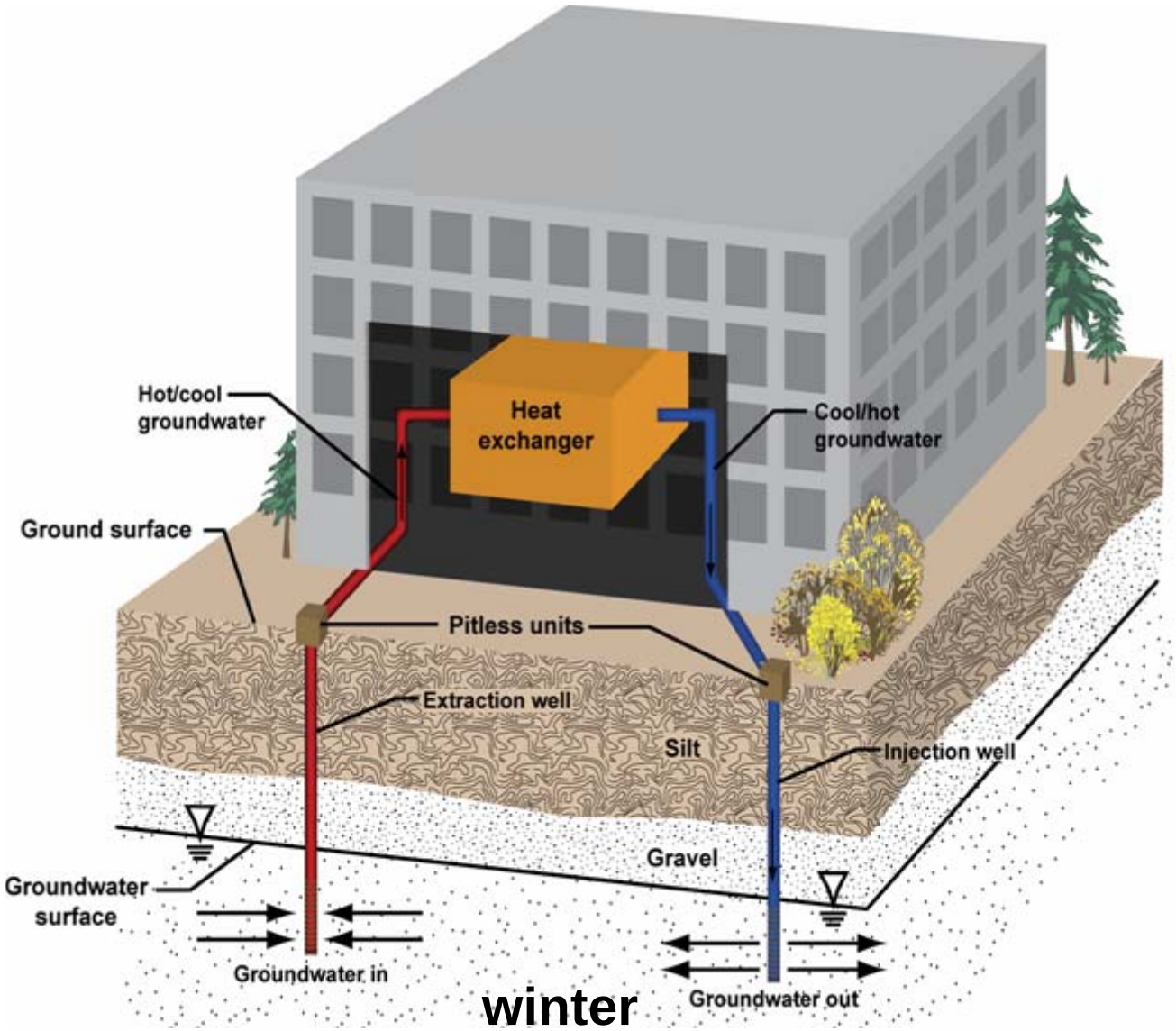
Closed Loop GSHP



Closed Loop GSHP



Open Loop GSHP



GSHP Design Considerations

Closed Loop:

- Lithology
- Space requirement (building footprint vs. site footprint)
- Upfront capital cost
- Permits?

Open Loop:

- Water availability/production
- Water rights
- Depth to groundwater
- Groundwater quality
- Space requirement
- Maintenance costs
- Permits

Other:

- Thermal demands
- Mechanical System Selected (single or multiple systems for exterior piping network)
- Payback period
- Domestic hot water?

Permits

Closed Loop

- Borehole Installation Permit
- Underground Injection Control (UIC) Permit
- Construction Permits

Open Loop

- Water Right Permit
- Underground Injection Control Permit
- Waste Discharge Permit
- Well Construction Permits
- Sewer discharge permit for pumping test

Equipment Considerations

Closed Loop

- Borehole Array
- Pumps/Variable Frequency Drives (VFDs)/Sensors
- Vaults
- Piping Valves
- Control Panel

Open Loop

- Extraction/Injection Wells
- Pumps/VFDs/Sensors
- Piping and Valving
- Control Panel
- Injection Flow Control Equipment
- Pitless Units/Wellhouses
- Desuperheater

GSHP Phased Approach

Phase*
Preliminary Feasibility Study
System Permitting
Bid Specifications and Preliminary System Design
Install Wells (1 Observation; 1 Test) with Aquifer Testing**
Final System Design
Full GSHP system buildout
Building Commissioning

*Does not include building interior (HVAC) system design or implementation

**Assumes open loop system; closed loop involves test borehole installation and thermal conductivity testing

Costs vary depending on project size and location

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GSHP System (Open Loop)

120,000 square foot building

System requirement of 1,250 gpm (maximum output)

Two extraction wells

- 12-inch diameter
- Stainless steel screen
- 130 feet total depth, screened from 80 to 130 feet in a cobble-size, well-rounded gravel
- One pitless unit per well (sanitary seal)

One injection well

- 12-inch diameter
- Stainless steel screen
- 130 feet total depth, screened from 80 to 130 feet in a cobble-size, well-rounded gravel
- One pitless unit (sanitary seal)

**This project won a Grand Award for Building and Technology Systems in the Engineering Excellence 2009 Awards, hosted annually by the American Council of Engineering. Companies of Oregon.*

ACEC
American Council of Engineering Companies

Columbian Permitting (Washington State Department of Ecology)

Water Right Permit

- Time frame to process a water right is approximately 6 - 8 years without expedited permitting
- Expedited permitting process is approximately 1 year
- Use Washington Department of Ecology's Cost Reimbursement Authority

UIC Permit

- The Columbian GSHP is Class V use
- The injection well and GSHP system met the "non-endangerment requirement" of the UIC program
- A UIC permit was not required, but Ecology did require registration
- Injection well was "rule authorized"
- A waste discharge permit was not required

Columbian Permitting (cont.)

Well Construction Permit

- Well driller obtained permits

Sewer Discharge Permit

- Pumping Test was conducted at 1,250 gpm (design rate of GSHP system)
- Sewer discharge permit obtained from City of Vancouver
- City limited pumping test to 8 hours duration and off peak hours

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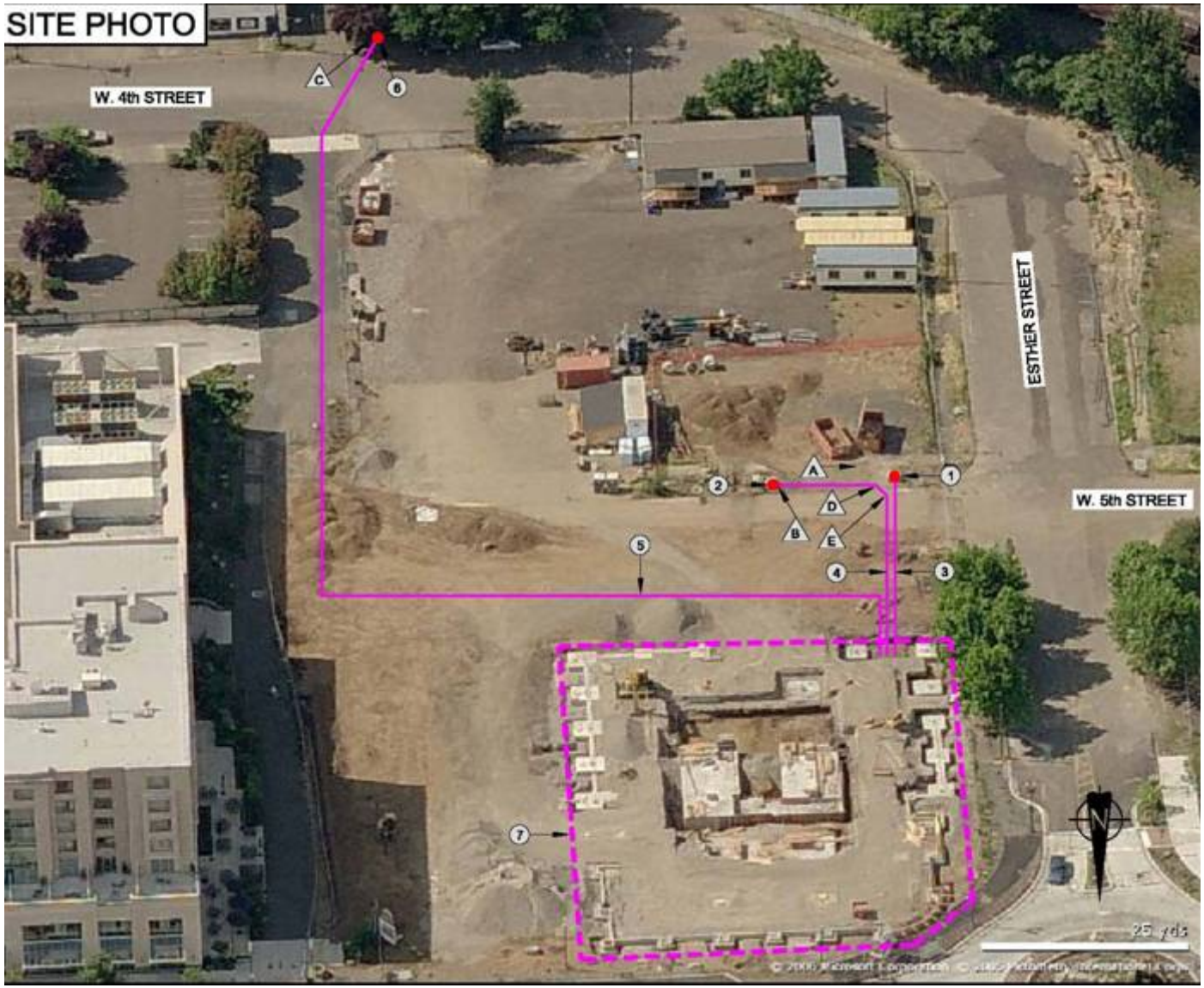

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The Columbian GSHP Energy and Cost Savings

- Projected 36% annual energy savings over the same building built to non-ASHRAE standards
- 460,000 kWh/year (approximate) of electricity
- 4,600 therms/year (approximate) of natural gas
- Reduce CO_2 emissions by over 150,000 lbs per year
- Reduce other pollutant by-products of fossil fuel based electricity production
- Equivalent to planting 225 trees per year
- 227,000 gallons of water saved per year
- Use of “green energy”
- Actual energy savings 51% (post installation)
- $80,000 per year energy savings

Other Information Sources

- International Ground Source Heat Pump Association (IGSHPA)
  http://www.igshpa.okstate.edu/
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
  http://www.ashrae.org/
- National Ground Water Association (NGWA)
  http://www.ngwa.org/

GSHP in Vancouver

- Vancouver water dept. heard of Columbian system after installed
- New type of installation
- Standard double check installed
- What are the State and City backflow requirements?

City of VANCOUVER WASHINGTON

State Requirements

- WAC 173-160, WAC 246-290 and OAR 333-061-0070
- Must develop backflow program that meets or exceeds WAC or OAR requirements
- WAC and OAR state that RPBA or Air Gap required only if site has alternate source cross-connected with the potable water supply

City of VANCOUVER WASHINGTON

PNWS-AWWA Cross Connection Control Manual

- RPBA or Air Gap required on site with “unapproved” auxiliary water supply regardless of if there is an interconnection

City of VANCOUVER WASHINGTON

City of Vancouver Requirements

- Goal was any site with alternative water source needs RPBA or Air Gap regardless of if cross-connection exists with City water.
- Conflicting website, water standards, and code

City of VANCOUVER WASHINGTON

Vancouver Improvements

- Vancouver updating code to require RPBA or Air Gap at any site with an alternate source
- Updating Development Review Procedures to ensure sites with alternate water sources install devices

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Paul D. Stull III, P.E.

Paul.Stull@amec.com

AMEC Earth & Environmental, Inc.

Portland, Oregon

503.639.3400

Tyler Clary, PE

Tyler.Clary@ci.vancouver.wa.us

City of Vancouver

Vancouver, Washington

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