Westwood Public Schools

Hanlon Elementary School Building Project

Sustainability Subcommittee

08.18.2020

WESTWOOD

DORE WHITTIER

Agenda

- Decision Points Overview
- Geothermal Test Well update
- Overview: Life Cycle Cost Analysis (LCCA)
- Rainwater Cistern - Irrigation
- Recommendation to SBC

Decision Points - Overview

1. **Priority: 20% above new energy code to achieve 2% points from MSBA**
2. **Heating/Cooling System options:**
    - **Baseline: Natural Gas**
    - **Tier 1: Water Source Heat Pump with supplemental electric boiler**
    - **Tier 2: Ground Source Heat Pump (Geothermal) :**
    - **Tier 3: Ground Source Heat Pump (Geothermal):**
      with supplemental electric boiler, less wells
3. **100% A/C vs. partial A/C and dehumidification ventilation**
4. **Rainwater Cistern-Irrigation**

Geothermal Test Well – Update

Test Well Program and Geologic Conditions:

- Test Well completed with no issues, faster than expected (600’ in one day)
- Vibration levels measured were low
- Granite encountered 10’ below grade
- Water yield: approx. 5-10 GPM

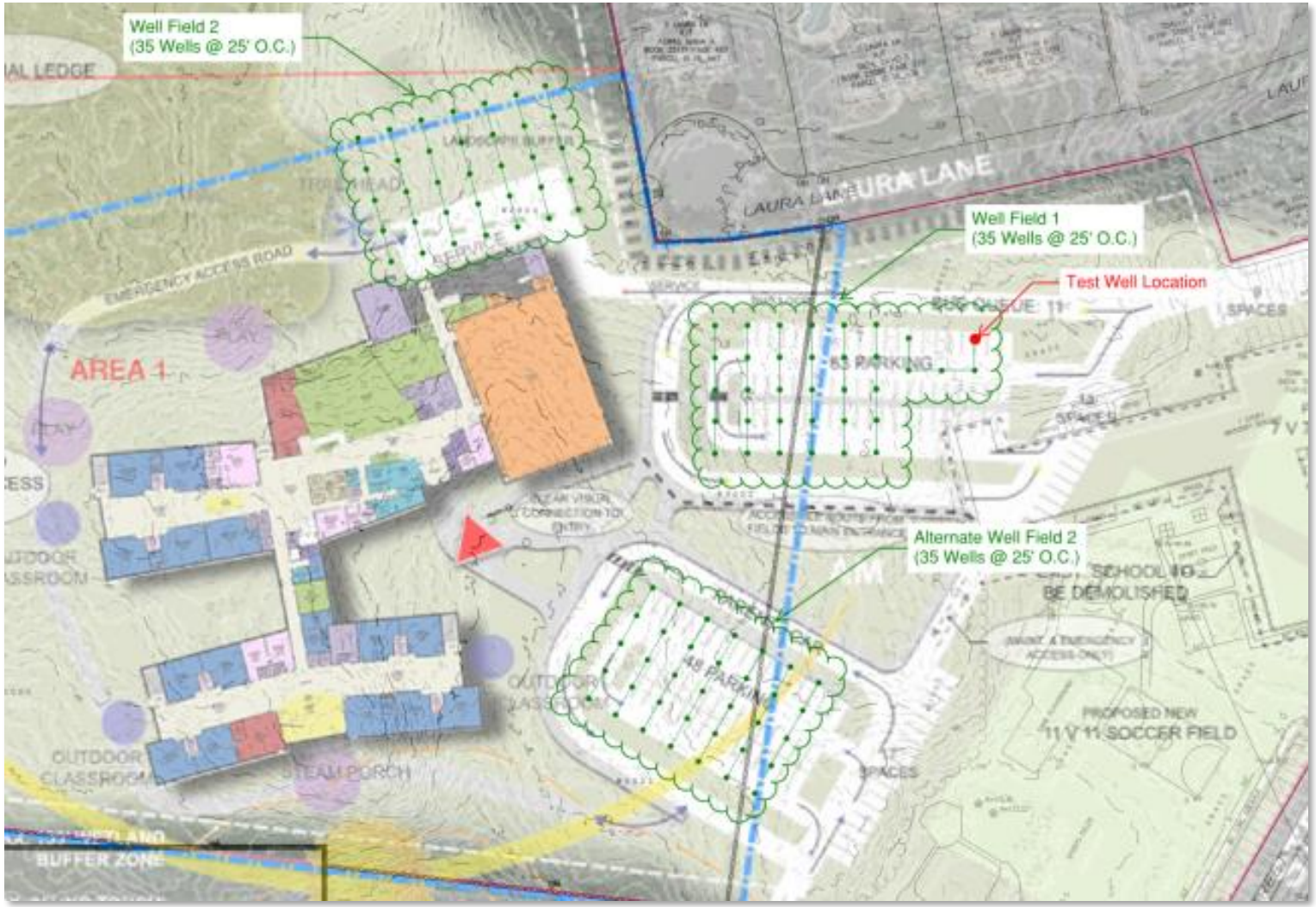
Implications for Design:

- Rock has higher conductivity than soil: Granite = good
- Once thermo-conductivity test is complete (next week), well will be covered

Geothermal Test Well – Possible Locations

Implications for Design:

- Approximately 70 wells are anticipated at 25’ apart.
- 3-4 months for drilling (with two drill rigs)
- Can be done at beginning, during or end of construction (non-critical path item)



Life Cycle Cost Analysis – Summary

EUI

Baseline	System	Gross Capital Investment*	Annual Elec. Cons. (kWh)	Annual Gas Cons. (MBTU)	Annual Electric Cost	Annual Gas Cost	Combined Utility Cost	Annual Utility $/s.f.	Annual kBTU/s.f. (EUI)	Annual Maint. Cost	20 Year Exterior Equipment Replacement Cost	Combined Annual Expense	Combined Expense Savings**	Total Life-Cycle Savings***	Discounted Payback (Years)****
Code Baseline Natural Gas	1. Hot water coil heating/chilled water coil cooling VAV AHU system with energy recovery and terminal VAV boxes with hot water reheat coils 2. Code-efficient gas-fired non-condensing boiler plant 3. High-efficiency (code) water-cooled chiller plant with cooling tower	$7,065,144	542,150	1,784.8	$108,430	$22,489	$130,919	$1.16	32.1	$132,704	$1,469,500	$263,623	-	-	-

Option	System	Gross Capital Investment*	Annual Elec. Cons. (kWh)	Annual Gas Cons. (MBTU)	Annual Electric Cost	Annual Gas Cost	Combined Utility Cost	Annual Utility $/s.f.	Annual kBTU/s.f. (EUI)	Annual Maint. Cost	20 Year Exterior Equipment Replacement Cost	Combined Annual Expense	Combined Expense Savings**	Total Life-Cycle Savings***	Discounted Payback (Years)****
Base Design Natural Gas	1. Dehumidification displacement ventilation diffusers with radiant heating panels 2. Gas-fired heating/dx cooling VAV ventilating units with energy recovery with terminal VAV boxes with CO2 controls 3. High efficiency gas-fired condensing boiler plant	$6,026,583	511,760	1,561.7	$102,353	$19,678	$122,031	$1.08	29.2	$130,279	$919,850	$252,310	$11,313	$1,856,606	Instant ******
Tier 1 WSHP Elct Blr	1. Dehumidification displacement ventilation diffusers with radiant heating panels 2. Hot water coil heating/chilled water cooling VAV ventilating units with energy recovery with terminal VAV boxes with CO2 controls 3. High efficiency water-cooled chiller plant with dry cooler 4. Supplemental electric boiler plant	$7,666,934	887,380	0.0	$175,476	$0	$175,476	$1.55	26.8	$122,079	$330,000	$297,555	-$33,932	-$685,229	Not Reached *****
Tier 2 GSHP	1. Dehumidification displacement diffusers with radiant heating panels 2. Hot water coil heating/chilled water cooling VAV ventilating units with energy recovery with terminal VAV boxes with CO2 controls 3. Geothermal wells with high-efficiency water-to-water source heat pump chillers	$10,917,434	667,000	0.0	$133,400	$0	$133,400	$1.18	20.1	$121,079	$0	$254,479	$9,144	-$2,307,572	Not Reached *****
Tier 3 GSHP Elct Blr	1. Dehumidification displacement diffusers with radiant heating panels 2. Hot water coil heating/chilled water cooling VAV ventilating units with energy recovery with terminal VAV boxes with CO2 controls 3. Geothermal wells with high-efficiency water-to-water source heat pump chillers 4. Supplemental electric boiler plant	$10,459,048	754,620	0.0	$150,923	$0	$150,923	$1.33	22.8	$122,079	$0	$273,002	-$9,379	-$2,396,360	Not Reached *****

21.6% energy savings above Code Baseline

Other Considerations

- The use of full AC will adjust the total numbers proportionately: The 20% above energy code will still be achieved

- **EUI Impact of using 100% AC vs. partial AC is negligible**: Thornton Tomasetti estimates 0.35 to .50 EUI increase and $1,625 to $2,000 annual energy cost

- Tier 1 (water source heat pump): Biggest concern is noise impact and additional cost to mitigate

Tier 1 vs. Tier 2 – Heating/Cooling Systems

Tier 1: Municipal Water Source Heat Pump System

Pros

- Aligns with Westwood Resiliency and Sustainability Comprehensive Draft Plan
- Lower upfront cost

Cons

- Less energy efficient than Tier 2 system resulting in:
  - May require increased electrical service capacity
  - More solar energy required for NZE
  - Increased generator size required
- Need supplemental electric boiler due to heat rejection
- More mechanical equipment visible exterior than Tier 2
- **Higher HVAC sound levels at building exterior vs. Tier 2**
- More maintenance -moving parts, vs. Tier 2

Tier 2: Geothermal Source Heat Pump System

Pros

- Aligns with Westwood Resiliency and Sustainability Comprehensive Draft Plan
- More energy efficient than Tier 1 system resulting in:
  - Likely decrease in electrical service capacity vs Tier 1
  - Less solar energy required for NZE
  - Smaller generator size required
- Less mechanical equipment visible at building exterior
- Lower HVAC sound levels at building exterior vs. Tier 1
- Less annual maintenance: fewer moving parts vs. Tier 1

Cons

- Higher upfront cost

Fossil Fuel Free vs. Natural Gas - Discussion

Sustainability and Resiliency

vs.

Cost

Rainwater Cistern – Irrigation: $140k

- Utilizing native plants and water efficient irrigation methods can minimize the need for excessive water
- Harvesting rain water: effective and educational for a small area
- The heaviest rain events: spring
  vs.
  Most need for irrigation is during July/August. The tank can never be large enough to meet the peak demands
- Supplemental water necessary to meet the irrigation needs
- Cistern/tank water needs treatment to potable water standards. Increased annual operating and maintenance costs
- Will not achieve payback
- Potential for increased cost due to possible ledge

40,000 gallon tank

10’-12’ below grade

Annual water savings: 595,000 gallons

15% of water demand met

Decision Points - Overview

1. **Priority: 20% above new energy code to achieve 2% points from MSBA.... $83.3 M**
2. **Heating/Cooling System options:**

Baseline: Natural Gas	Included
Tier 1: Water Source Heat Pump with supplemental electric boiler:	Add $1.1M
Tier 2: Ground Source Heat Pump (Geothermal) :	Add $3.5 M
Tier 3: Ground Source Heat Pump (Geothermal): with supplemental electric boiler, less wells	Add $3.5 M

3. **100% A/C vs. partial A/C and dehumidification ventilation:..... $ 1.3 M**

4. Rainwater Cistern-Irrigation: ..... $ 0.2 M

Possible max: $88.3 M Total


Questions?