

# **Weld County Justice Center**

## ***Mechanical Systems Analysis — Full Comparison & Recommendation***

DATE

April 22, 2026

*Weld County Judicial Center*

# Mechanical Systems Analysis

*Comparison & Recommendation*

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## Executive Summary

**Recommendation:** Option 1 – water-cooled chillers with condensing gas-fired boilers, 4-pipe. Option 1 has the lowest operating cost of any option (~\$235K Year 1) and is essentially tied with Option 3 for the lowest 30-year LCC (~\$34.0M, within modeling precision). The first-cost premium vs. Option 2 is recovered in ~13 years through operating savings. Because cost favors Options 1 and 3 nearly equally, the decision rests on non-cost factors: acoustic performance against the courtroom NC 25-30 target, equipment service life relative to the 30-year analysis horizon, alignment with Colorado’s electrification trajectory, and fit with the County’s in-house operations capability (Javier’s team specializes in 4-pipe systems).

**Pricing context:** First-cost figures in this document use averaged HVAC \$/SF from two mechanical trade partners (RK Mechanical and Design Mechanical).

**Fallback:** Option 2 (air-cooled, 4-pipe) if project cannot accommodate Option 1's indoor chillers and cooling tower yard. Preserves hydronic 4-pipe distribution and acoustic profile is acceptable with proper enclosure.

**Not recommended:** Option 4 (gas RTUs + electric reheat). Despite the lowest first cost, it has the highest 30-year LCC, cannot meet courtroom acoustic targets, requires full RTU replacement over 30 years, and has the worst alignment with Colorado's electrification trajectory.

## Project Sizing Assumptions

All cost, efficiency, and lifecycle figures in this document are based on the following project-specific assumptions.

Parameter	Value
<b>Total building area</b>	~280,000 SF (courthouse core & shell, excludes parking garage)
<b>Cooling load</b>	~700 tons (400 SF/ton institutional/courthouse rule of thumb)
<b>Supply airflow</b>	~308,000 CFM (1.1 CFM/SF cooling, office/institutional)
<b>Heating airflow</b>	~308,000 CFM (1.1 CFM/SF)
<b>Outside air</b>	20-30% of supply (code minimum plus courthouse best practice)
<b>Altitude correction</b>	5,000 ft – air density 0.063 lb/ft <sup>3</sup> vs. 0.075 at sea level
<b>CFM equation at altitude</b>	CFM = Qs / (0.89 × ΔT) vs. 1.08 at sea level – means ~21% more airflow for same load
<b>Climate zone</b>	ASHRAE 5B (cold, semi-arid) – Weld County
<b>Equivalent full-load hours</b>	2,500 hr/yr (institutional, 5B)

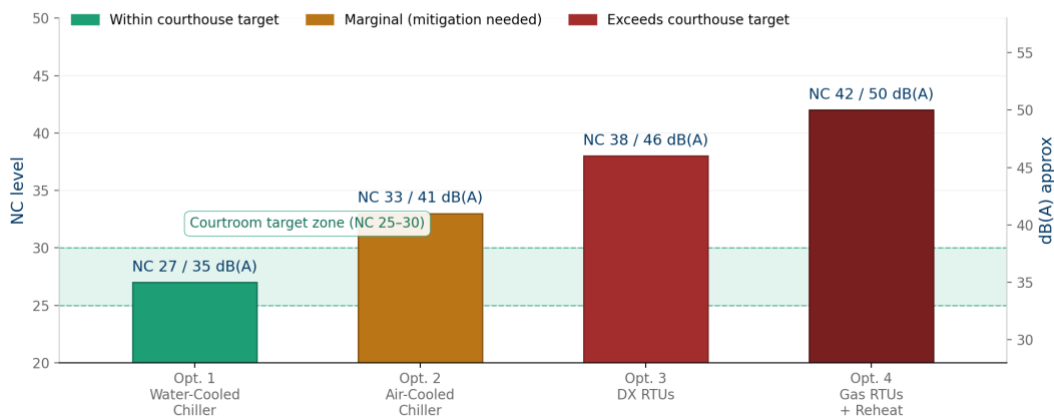
# Industry Context

## Courthouse acoustic targets

Courtrooms require background noise levels in the NC 25-30 range so unamplified speech is intelligible. Federal standards require “confidential” acoustic isolation in judges' offices and courtrooms, and >70 dB isolation in jury deliberation suites. Roof-mounted compressors transmit structure-borne noise into the building – a 2010 Mississippi case ended in a mistrial because the jury could not hear testimony – which is why hydronic distribution with isolated central plant equipment is the consistent design-guide preference.

NC (Noise Criteria) is a single-number rating used for HVAC background noise. NC 25-30 is approximately 33-38 dB(A) – quieter than a typical refrigerator, similar to a quiet library. The chart below shows expected noise levels for each option against the courtroom target zone.

**Courthouse noise levels by HVAC option**  
Background noise at typical courtroom occupant location, 625-ton plant, 250,000 SF building



Every 10 dB increase is perceived as roughly twice as loud, so Option 4 sounds about three times louder than Option 1 inside a courtroom. Options 1 and 2 (chillers with hydronic distribution) keep compressor noise outside the building or in isolated mechanical rooms; Options 3 and 4 (RTUs) transmit compressor noise through the roof structure into occupied spaces.

## Equipment-side dB(A) vs. occupant-side NC

Manufacturer cut sheets list noise as dB(A) at 5 feet from the equipment – typically 40-50 dB higher than what occupants hear inside the building, because distance, walls, and ceiling structure attenuate sound. The chart above uses NC ratings inside the courtroom, which is what the U.S. Courts Design Guide specifies.

System	Equipment dB(A) @ 5 ft	Why occupant noise differs
<b>Water-cooled chiller (Opt 1)</b>	75-85 dB(A)	In mechanical room or remote tower yard
<b>Air-cooled chiller (Opt 2)</b>	85-95 dB(A)	Outdoors in CMU enclosure, 50-100 ft from building
<b>Packaged DX RTU (Opt 3)</b>	78-88 dB(A)	Directly on roof above courtrooms
<b>Gas RTU (Opt 4)</b>	80-92 dB(A)	Same rooftop location plus burner noise

The air-cooled chiller has the loudest equipment dB(A) but produces lower courtroom noise than DX RTUs, because location and attenuation matter more than the raw equipment number.

## Code trajectory – Colorado electrification

Colorado has the most aggressive building electrification trajectory in the Mountain West. Denver's performance-based Energize Denver ordinance sets declining EUI caps through 2030; Colorado municipalities (including Greeley and Weld County) are tracking the same trajectory through adoption of the 2024 IECC and amendments.

- **RTU systems may struggle to meet EUI targets at future benchmarking thresholds.**
- **Gas-fired heating will face increasing scrutiny and possible phase-down.**
- **Water-cooled chillers provide the cleanest pathway to all-electric operation.**
- **Condensing gas boilers remain code-compliant today but should be specified with a future conversion path.**

## Lifespan, efficiency, and operating cost benchmarks

- **Lifespan:** Water-cooled chillers 20-30+ yrs (service life median 23 yr); air-cooled 15-20 yrs; RTUs 15-20 yrs.
- **Efficiency:** Water-cooled chiller ~0.85 kW/ton; air-cooled chiller ~1.5 kW/ton; DX RTU ~1.7 kW/ton.
- **Operating cost:** Water-cooled plants use 16-35% less electricity than air-cooled, but water/wastewater charges add cost in semi-arid climates – site-specific utility rates determine the net.

## Water consumption in a semi-arid climate

Water usage is a known concern: Greeley sits in a water-stressed region, drought planning is an ongoing City priority, and a public courthouse is visible. Option 1's cooling tower will use approximately 4 million gallons per year at full operation – a real and meaningful draw.

## How Option 1 compares to typical building water use

Building Water Use	Estimated Annual Volume	Notes
Cooling tower (Option 1)	~4M gal	Evaporation + 25% blowdown at 700 tons, 2,500 hr/yr operation
Domestic water (sinks, toilets)	~2.8-4M gal	280K SF courthouse, ~700-900 daily occupants
Landscape irrigation (typical)	~1.5-2.5M gal	Depends on landscape design and irrigation strategy

## Reducing Option 1's water footprint

Several design measures can substantially reduce or offset cooling tower water use. These are not mutually exclusive; combining them compounds the savings:

- **Hybrid wet-dry cooling tower.** Operates dry most of the year, only switching to wet during peak conditions. Cuts water use ~20% (saves ~800K gal/yr). \$50-\$100K first-cost premium. Recommended as the primary water-conservation measure for Option 1.
- **Higher cycles of concentration.** Standard towers operate at ~3-4 cycles before blowdown. With proper water treatment, 6-8 cycles is achievable, cutting blowdown water by 30-50% (saves ~300-600K gal/yr). Cost: minor controls upgrade.
- **Air-side economizer integration.** Use outside air for cooling when temperatures allow, reducing chiller and tower runtime. Greeley's climate (cold, dry winters and shoulder seasons) is well-suited;

can cut tower operating hours by 20-30%. This is already expected to be part of the base design, regardless of system selection.

- **Capture cooling tower blowdown for irrigation.** Tower blowdown is high in dissolved solids but usable for landscape irrigation with proper treatment. Could offset 100% of irrigation demand on the courthouse site (~1.5-2.5M gal/yr offset).

With a hybrid tower plus higher cycles of concentration plus economizer integration, Option 1’s effective water use can drop from ~4M gal/yr to ~2.4-2.6M gal/yr – a 35-40% reduction. Adding blowdown reuse can push net municipal water use lower still.

## Drought and water shortage resilience

Colorado municipalities operate under tiered drought response plans. Greeley's plan moves through four stages from voluntary conservation (Stage 1) to essential-use-only with possible commercial curtailment (Stage 4). Two protections favor the County under any of these scenarios:

- **Cooling towers are typically classified as essential equipment, not discretionary outdoor use.** Drought restrictions target irrigation, fountains, pools, and car washes first. Indoor cooling for occupied institutional buildings is rarely curtailed because shutting it down means shutting down the building.
- **A judicial center is essential public infrastructure.** Courthouses host constitutionally required functions and cannot be shut down for water restrictions the way commercial uses can. This is similar to how hospitals are protected during droughts.

Even so, mandatory percentage reductions can apply to all commercial users during severe drought. The water-conservation measures recommended for Option 1 also serve as drought-resilience capacity – the courthouse can absorb major restrictions without operational impact.

Greeley Drought Stage	Typical Reduction Target	Option 1 Capacity to Comply	Operational Impact
<b>Stage 1 – Advisory</b>	0-10%	Easily met with hybrid tower alone	None
<b>Stage 2 – Mandatory</b>	10-15%	Easily met with hybrid + higher cycles	None
<b>Stage 3 – Severe</b>	15-25%	Met with full conservation package (45% headroom)	None
<b>Stage 4 – Critical</b>	25-50%	Met with full package + drought-mode operation	Minimal – may slightly raise indoor temperature setpoints

## If water usage is a hard constraint

If the County determines that any cooling tower water use is unacceptable – regardless of mitigation – Option 2 (air-cooled, 4-pipe) eliminates tower water use entirely. The trade-offs are real and worth naming:

- **Energy:** Option 2 uses ~75% more electricity than Option 1 (~700K kWh/yr more). At Colorado's grid mix, that is real carbon impact.
- **Lifecycle cost:** ~\$800K higher 30-yr LCC vs. Option 1 at current rates.
- **Equipment life:** Air-cooled chiller has shorter life (15-20 yrs vs. 23-30+) and requires one mid-life replacement on a courthouse roof.
- **Acoustic:** Manageable with CMU enclosure but adds first-cost not in current quote (~\$40-\$80K).

This is a values trade-off the County should make explicitly: water savings vs. energy use, equipment life, and acoustic complexity. Both are defensible positions; the analysis is meant to support the County's decision rather than make it.

## Equipment Lifecycle

The Weld County Judicial Center is a building designed for long-term use (50-75+ years). The HVAC system selected today will need to either operate that long or be replaced mid-life – and the replacement cost, disruption, and procurement effort are real factors in the decision, particularly for an occupied courthouse.

### Service Life by System Type

Equipment	Typical Service Life	Industry Median	End-of-Life Driver
<b>Water-cooled centrifugal chiller</b>	23-30+ yrs	23 yrs	Compressor wear, refrigerant phaseout
<b>Air-cooled chiller (outdoor)</b>	15-20 yrs	18 yrs	Thermal cycling, weather exposure
<b>Cooling tower</b>	20-25 yrs	22 yrs	Fill degradation, corrosion
<b>Condensing gas boiler</b>	20-25 yrs	22 yrs	Heat exchanger fatigue
<b>Packaged DX rooftop unit</b>	15-20 yrs	17 yrs	Compressor failure, cabinet corrosion
<b>Gas/electric rooftop unit</b>	12-18 yrs	15 yrs	Combustion components, heat exchanger
<b>Pumps (base-mounted)</b>	20-25 yrs	22 yrs	Seal/bearing wear (rebuildable)
<b>Air handling units (custom)</b>	25-30 yrs	27 yrs	Cabinet corrosion, controls upgrade
<b>Hydronic piping</b>	40-50+ yrs	45 yrs	Corrosion at fittings
<b>Building controls / BAS</b>	12-15 yrs	13 yrs	Software obsolescence

### Mid-Life Replacement Disruption

**Why this matters more than the LCC math suggests:** An occupied ~280,000 SF courthouse cannot easily shut down for HVAC replacement. Mid-life replacement events for Options 2-4 carry hidden costs that a pure NPV calculation does not fully capture:

- **Temporary cooling rental:** \$80-\$150K for a multi-week project at this building scale.
- **Operational impact:** Courtrooms cannot be reliably scheduled around HVAC outages – schedule conflicts, security re-coordination, and access management for crane/rigging work all add cost and friction.
- **Refrigerant compliance:** EPA refrigerant phaseouts (R-410A in 2025, low-GWP transitions ongoing) mean equipment approaching end-of-life may face restricted refrigerant availability.
- **Removal cost premium:** Crane/rigging, demolition, electrical and piping recoordination, and roof penetration work add 25-40% to the equipment-only number.
- **Bottom line:** Option 1 is the only option with a realistic chance of avoiding any major mid-life replacement event over the 30-year analysis period.

## Cost Analysis

This section uses fully-loaded mechanical pricing from two contractors, averaged for the 30-year LCC analysis.

### Contractor Pricing Average

Option	Average \$/SF	Total @ 280K SF
Opt 1 Water-Cooled	\$101.00	\$28,280,000
Opt 2 Air-Cooled	\$97.75	\$27,370,000
Opt 3 DX RTUs + Boilers	\$91.62	\$25,653,000
Opt 4 Gas RTUs + Reheat	\$83.00	\$23,240,000

### Modeling Assumptions for 30-Year LCC

Parameter	Value
Reference plant size	~700 tons (~280,000 SF at 400 SF/ton)
Analysis period	30 years
Discount rate	4% real (typical municipal cost of capital)
Equivalent full-load hours	2,500 hr/yr (institutional, Climate Zone 5B)
Electric rate	\$0.11/kWh (Xcel commercial CO typical, 2026)
Electric escalation	2.5%/yr
Water + sewer rate	\$10.84/1,000 gal combined (Greeley 2026)
Water rate escalation	4%/yr (Greeley 2022 bond plan)
Maintenance/chemicals escalation	2.5%/yr
Cooling tower water use (Opt 1)	~4M gal/yr
First cost basis	Averaged \$/SF from RK and Design Mechanical
Maintenance budget	WC chiller \$25/ton-yr; AC chiller \$15; RTU \$18; Gas RTU \$12
Chemical treatment	~\$4.67/ton-yr per water loop: Opt 1 = \$14 (3 loops), Opt 2 = \$9.33 (2 loops), Opt 3 = \$4.67 (1 loop) <i>(a loop = one water circuit requiring its own treatment – chilled, heating, or condenser)</i>

## Annual Operating Cost (Year 1)

Cost Category	Opt. 1 WC	Opt. 2 AC	Opt. 3 DX RTUs	Opt. 4 Gas RTUs
Energy (electric)	\$164,000	\$289,000	\$327,000	\$475,000
Water + sewer	\$43,000	–	–	–
Maintenance	\$17,500	\$10,500	\$12,600	\$8,400
Chemical treatment	\$9,800	\$6,500	\$3,300	–
<b>Total Year 1 operating</b>	<b>\$234,500</b>	<b>\$306,000</b>	<b>\$342,900</b>	<b>\$483,400</b>
<b>vs. Opt. 1 (Yr 1)</b>	Baseline	+\$71,500	+\$108,400	+\$249,000

Operating cost figures are tons-driven and remain unchanged across pricing iterations. Option 1 saves ~\$71,500/yr vs. Option 2 in Year 1, growing with electric rate escalation. Over 30 years, Option 1 saves ~\$3.3M in cumulative operating cost vs. Option 2.

## 30-Year Lifecycle Cost Summary

Net present value (NPV) of all costs over 30 years, 4% real discount rate, 700-ton reference plant, averaged contractor pricing for first cost. Options 1 and 3 are essentially tied for lowest LCC; Option 4 is the highest despite the lowest first cost.

Cost Component (NPV)	Opt. 1 WC	Opt. 2 AC	Opt. 3 DX RTUs	Opt. 4 Gas RTUs
First cost (averaged)	\$28,280,000	\$27,370,000	\$25,653,000	\$23,240,000
30-yr energy (NPV)	\$4,000,000	\$7,000,000	\$7,900,000	\$11,500,000
30-yr water/sewer (NPV)	\$1,300,000	\$0	\$0	\$0
30-yr maint + chemicals (NPV)	\$450,000	\$260,000	\$245,000	\$130,000
Replacement (PV at swap yr)	\$0	\$280,000	\$245,000	\$320,000
<b>Total 30-yr LCC (NPV)</b>	<b>\$33,975,000</b>	<b>\$34,890,000</b>	<b>\$34,040,000</b>	<b>\$35,165,000</b>
<b>vs. Opt. 1</b>	Baseline	+\$915,000	+\$65,000	+\$1,190,000
<b>LCC per SF (280K SF)</b>	\$121	\$124	\$121	\$126

**Bottom line on cost:** Option 1 has the lowest operating cost of any option and is essentially tied with Option 3 for lowest 30-year LCC, within modeling precision. Option 4 has the highest LCC despite the lowest first cost – the operating cost penalty and double replacement cycle drive it past the other options on a lifecycle basis. Cost favors Options 1 and 3 nearly equally.

## Simple Payback Analysis

With averaged contractor pricing, the first-cost premium for Option 1 vs. Option 2 is ~\$900K. Year 1 operating savings of ~\$71,500 give a simple payback of ~13 years. Option 1's premium is recovered through operating savings within the first half of the building's life, with continued savings accumulating thereafter.

Comparison	First Cost Premium	Yr 1 Op Savings	Simple Payback	30-yr Op Savings
Opt 1 vs. Opt 2	+\$905,000	\$71,500	<b>13 years</b>	\$3.3M
Opt 1 vs. Opt 3	+\$2,610,000	\$108,400	<b>24 years</b>	\$5.0M
Opt 1 vs. Opt 4	+\$5,040,000	\$249,000	<b>20 years</b>	\$11.8M

Payback periods are longer than rule-of-thumb thresholds for private-sector capital projects (typically 5-10 years), but appropriate for institutional/government buildings with 30-50 year life spans. The County is making a multi-decade infrastructure commitment, and Option 1 still pays back well within that horizon.

## Cost Analysis Caveats

- **Acoustic enclosure for Option 2:** May not be fully captured in either quote; could narrow the Opt 1 vs Opt 2 first-cost gap by \$40-\$80K.
- **Hybrid tower option (Opt 1):** Could reduce water consumption ~20%, improving Option 1's LCC by ~\$240K NPV at this scale.

# Qualitative Scoring Matrix

This matrix applies ME Engineers' scoring framework across 18 criteria in six categories. Color-coded: Best (dark blue), Better (teal), Good (beige). All four options scored on the same criteria. With Options 1 and 3 essentially tied on cost, the qualitative factors below are decisive.

Criteria	Opt. 1 WC	Opt. 2 AC	Opt. 3 RTU	Opt. 4 Gas
<b>CONSTRUCTABILITY &amp; ARCHITECTURAL</b>				
Shaft area required	Good	Good	Good	Good
Mechanical room footprint	Good	Better	Better	Best
Ceiling plenum impact	Good	Good	Good	Good
Structural impact	Better	Good	Good	Good
Equipment screening needs	Better	Good	Good	Good
Building code (refrigerant mgmt)	Best	Best	Best	Best
Energy code alignment (future)	Best	Better	Good	Good
<b>PERFORMANCE</b>				
Indoor air quality	Best	Best	Good	Good
Acoustics (NC 25-30)	Best	Better	Good	Good
Response to load changes	Better	Better	Good	Good
Temperature control precision	Best	Best	Good	Good
<b>MAINTAINABILITY</b>				
Accessibility	Better	Best	Best	Best
Maintenance cost	Good	Better	Best	Best
Equipment lifespan	Best	Better	Good	Good
Future flexibility	Best	Best	Best	Better
<b>ENERGY &amp; SUSTAINABILITY</b>				
EUI performance	Best	Better	Good	Good
Carbon reduction pathway	Better	Better	Good	Good
<b>COST</b>				
First cost	Good	Better	Best	Best
Operating cost	Best	Better	Good	Good
30-yr lifecycle cost	Best	Better	Best	Good
<b>PROJECT FIT</b>				
Ops familiarity	Best	Best	Better	Better
Courthouse design-guide fit	Best	Better	Good	Good

## Score Summary

Score	Opt. 1 WC	Opt. 2 AC	Opt. 3 RTU	Opt. 4 Gas
"Best" scores	13	6	5	4
"Better" scores	5	10	1	3
"Good" scores	3	5	16	16

Option 1 has the most "Best" scores (13), driven by acoustic fit, equipment lifespan, courthouse design-guide alignment, energy code positioning, lifecycle cost, operating cost, and ops familiarity. Option 2 scores well on maintainability and accessibility. Options 3 and 4 score higher on first-cost and mechanical-room footprint, but accumulate more "Good" scores overall, particularly in performance and sustainability categories.

## Additional Considerations

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### Future Electrification Path

The Weld County Judicial Center will be in service through the 2050s. All options should be evaluated against Colorado's electrification trajectory.

- **Option 1 (water-cooled chiller + gas boiler):** Boiler plant is the only fossil element; can be replaced with a heat recovery chillers, air-source heat pumps, or electric boilers at mid-life. Cleanest pathway to all-electric operation.
- **Option 2 (air-cooled chiller + gas boiler):** Same boiler conversion path as Option 1.
- **Option 3 (DX RTUs + gas boilers):** Boiler conversion feasible; RTUs themselves may need to be replaced with heat-pump RTUs at mid-life.
- **Option 4 (gas RTUs + electric reheat):** Requires complete system replacement to electrify. Highest carbon reduction cost of any option.

## Option 1 – Water-Cooled Chillers + Boilers (4-pipe)

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### Pros

- **Best acoustics.** Quietest central plant option; tower can be remote. Aligns with courtroom NC 25-30 targets.
- **Highest efficiency.** ~0.85 kW/ton; 16-35% lower electricity than air-cooled.
- **Lowest operating cost.** ~\$235K Year 1 – lowest of all options.
- **Tied for lowest 30-yr LCC.** ~\$34.0M NPV (essentially tied with Option 3, within modeling precision).
- **Long life.** Service life median 23 yrs; likely zero major replacements over 30 yrs.
- **Courthouse design-guide alignment.** Aligned with U.S. Courts Design Guide and ASHRAE acoustic standards.
- **4-pipe simultaneous heat/cool.** Important for courtrooms, chambers, and offices.
- **Clean electrification path.** Only the boiler is fossil; can be replaced with a heat pump loop at mid-life.

### Cons

- **Highest first cost.** ~\$28.3M (averaged) vs. ~\$27.4M for air-cooled – ~\$900K premium, recovered in ~13 years.
- **Most space.** Boiler vault, chiller room, and cooling tower yard. RJA has flagged exterior fit.
- **Higher maintenance.** \$25/ton/yr plus chemicals. Specialized chiller and boiler upkeep.
- **Water cost in semi-arid climate.** ~4M gal/yr = ~\$45K/yr Year 1 at current Greeley rates.
- **Legionella mitigation.** Drift control and water management plan required.

### Project notes

- **Space:** RJA to confirm chiller room and cooling tower yard fit before lock-in.
- **Ops:** Javier from the Weld County Facility Team specializes in 4-pipe systems – this reduces the maintenance-complexity concern noted above.
- **Hybrid tower:** Wet-dry hybrid can cut water use up to 20%, improving LCC by ~\$215K NPV at this scale.

## Option 2 – Air-Cooled Chillers + Boilers (4-pipe)

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### Pros

- **Lower first cost.** ~\$27.4M (averaged) – ~\$900K less than Option 1.
- **Negligible water use.** Significant in a semi-arid climate.
- **Simpler maintenance.** \$15/ton/yr; no tower chemistry, no Legionella program.
- **Same 4-pipe distribution as Option 1.** Preserves simultaneous heat/cool capability.

### Cons

- **Higher 30-yr LCC.** ~\$34.8M NPV vs. ~\$34.0M for water-cooled – ~\$800K lifecycle penalty driven by energy.
- **Higher acoustic impact.** Loud compressors and fans. Needs CMU enclosure (~\$40-\$80K), possibly not in either contractor's quote.
- **Lower efficiency.** ~1.5 kW/ton; degrades further in hot weather.
- **Mid-life chiller replacement.** 18-yr service life means 1 chiller swap (~\$550K) over 30-year horizon.

## Option 3 – Packaged DX RTUs + Hydronic Heat

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### Pros

- **Lower first cost.** ~\$25.7M (averaged) – ~\$2.6M less than Option 1.
- **Tied for lowest 30-yr LCC.** ~\$34.0M NPV – essentially tied with Option 1 within modeling precision.
- **Simpler shaft distribution.**
- **Standard maintenance workflow.**

### Cons

- **Higher operating cost than Option 1.** ~\$340K Year 1 vs. ~\$235K – ~\$105K/yr penalty that compounds with electric escalation.
- **Roof noise.** Marginal under courtroom acoustic targets – the primary disqualifier for courthouse use.
- **Lower efficiency.** ~1.7 kW/ton.
- **Short lifespan.** 15-20 yrs means 1-2 full RTU replacements over the building's life.
- **Mid-life replacement disruption.** RTU swap on an occupied courthouse roof requires crane access, security coordination, temporary cooling rental.
- **Future energy code risk.** May struggle to meet EUI targets under Colorado's electrification trajectory.

### Comparison vs. Option 1

Option 3's first cost is ~\$2.6M lower than Option 1, and 30-year LCC is essentially tied. With cost roughly equivalent over the lifecycle, the differentiators between Options 1 and 3 are: (1) courtroom acoustic performance – Option 3 is marginal against NC 25-30 targets, which matters given the building's primary function; (2) replacement cycles – Option 3 requires 1-2 RTU replacements over 30 years vs. 0-1 for Option 1; (3) electrification path – Option 1's boiler can be converted at mid-life, while RTUs may require full replacement; (4) temperature control precision – central plant equipment typically delivers tighter control than packaged RTUs in chambers and judicial offices.

## Option 4 – Packaged Gas RTUs + Electric Reheat

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### Pros

- **Lowest first cost.** ~\$23.2M (averaged).
- **Simplest install.**
- **Standard maintenance.**

### Cons

- **Highest 30-yr LCC.** ~\$35.2M NPV – ~\$1.2M worse than Option 1, despite lowest first cost.
- **Worst acoustics.** Cannot meet courtroom NC 25-30 targets.
- **Highest operating cost.** ~\$485K Year 1.
- **~15 yr lifespan.** 2 full replacements over 30 yrs.
- **Imprecise control.** Inconsistent comfort in courtrooms and chambers.
- **Weak sustainability profile.** Requires complete system replacement to electrify.
- **2015 IECC constraint.** Constant-volume RTUs cannot exceed 4.5 tons – likely means dozens of small units.

### Why not recommended

Even with the lowest first cost, Option 4 has the highest lifecycle cost and poses a direct conflict with the acoustic NC 25-30 targets for courtroom spaces.

## Recommendation

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Pursue Option 1 (water-cooled chiller + boiler, 4-pipe) as primary. Cost favors Options 1 and 3 essentially equally on 30-year LCC, so the recommendation rests on non-cost factors where Option 1 has the stronger profile.

### The cost case for Option 1

- **Lowest operating cost.** ~\$235K Year 1 – saves ~\$65K/yr vs. Opt 2, ~\$105K/yr vs. Opt 3, ~\$250K/yr vs. Opt 4. Operating savings compound with electric escalation.
- **Tied for lowest 30-yr LCC.** ~\$34.0M NPV (essentially tied with Opt 3 within modeling precision).
- **First-cost premium pays back in 13 years.** ~\$900K premium vs. Opt 2 recovered through operating savings within the first half of the building's life.
- **Cost rules out Option 4.** Highest LCC (~\$35.2M, ~\$1.2M worse) despite lowest first cost – driven by 2x replacements and highest operating cost.

### The non-cost case for Option 1

- **Acoustics.** Best fit for courtroom NC 25-30 targets – the building's primary function depends on this.
- **Equipment life matches building horizon.** 20-30+ yr service life means likely zero major replacements vs. 1-2 for other options. Avoids mid-life disruption to an occupied courthouse.
- **Future code alignment.** Cleanest pathway to all-electric operation; meets Colorado's electrification trajectory with a single mid-life boiler conversion.
- **Ops.** Javier specializes in 4-pipe – reduces the maintenance-complexity downside.

### Fallback

- **Option 2 (air-cooled, 4-pipe):** If project rules out Option 1. Preserves hydronic 4-pipe distribution and acoustic profile is acceptable with proper CMU enclosure. ~\$800K LCC penalty vs. Option 1.

### Reducing Option 1's water footprint

If the County is concerned about cooling tower water usage, Option 1's water draw can be reduced 35-40% from baseline through a combination of design measures:

- **Specify a hybrid wet-dry cooling tower.** Operates dry most of the year. Cuts water use ~20% (saves ~800K gal/yr). \$50-\$100K first-cost premium. Recommended as the primary water-conservation measure.
- **Run higher cycles of concentration with proper water treatment.** Cuts blowdown water 30-50% (saves ~300-600K gal/yr). Minor controls cost.
- **Air-side economizer integration.** Reduces tower runtime by 20-30% in Greeley's climate.
- **Optional: blowdown reuse for irrigation.** Can offset additional 1-3M gal/yr of municipal water draw if pursued.

These measures bring Option 1's effective water use to ~2.4-2.6M gal/yr – a meaningful reduction. If the County views any cooling tower water use as unacceptable regardless of mitigation, Option 2 (air-cooled, 4-pipe) is the natural fallback – same 4-pipe distribution, eliminates tower water entirely, ~\$800K LCC penalty and ~75% higher electricity use.