WATEREUSE ASSOCIATION

Sustainable Solutions for a Thirsty Planet®

The Water-Energy Nexus in Arizona – Water Reuse at Palo Verde Nuclear Generating Station

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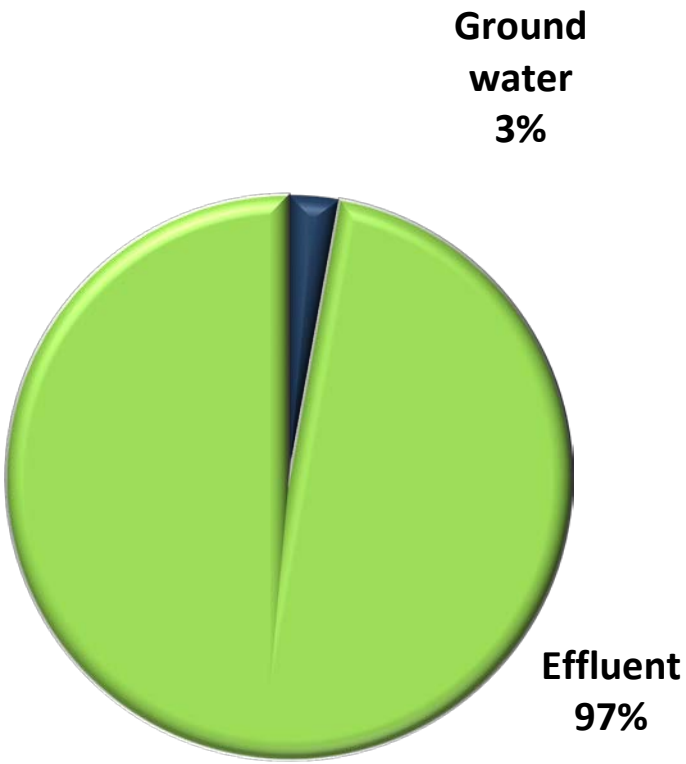
PALO VERDE

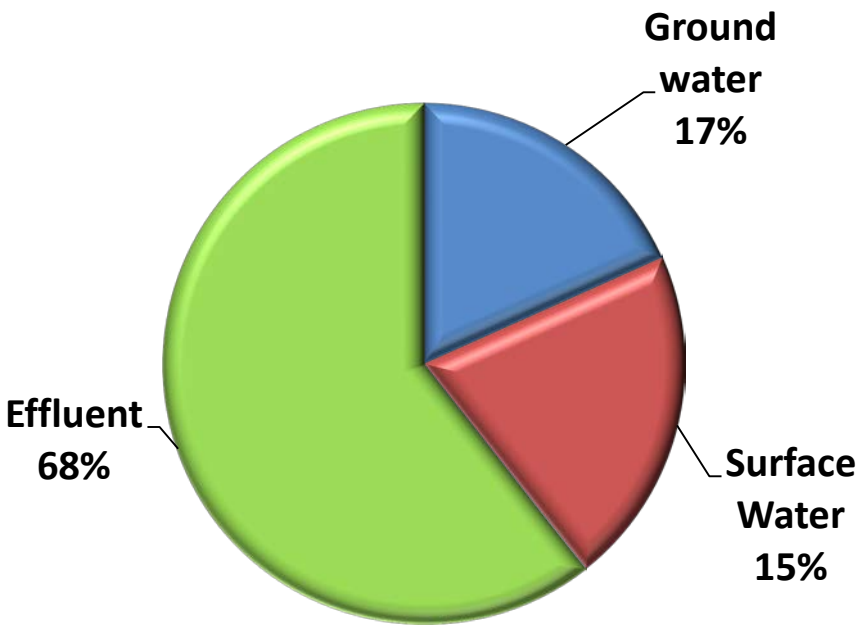
aps

Arizona Public Service Company

- Investor-owned regulated public utility
- 126 years old
- 6500 employees
- Operate power plants with 10,600 MW generating capacity
- 33,000 miles transmission
- 1.3 million customers
- Own/operate 9 power plants
  - 1 nuclear, 2 coal, 6 gas-fired
  - Renewable portfolio – PV solar, solar-thermal, wind

2014 Water Use by Type



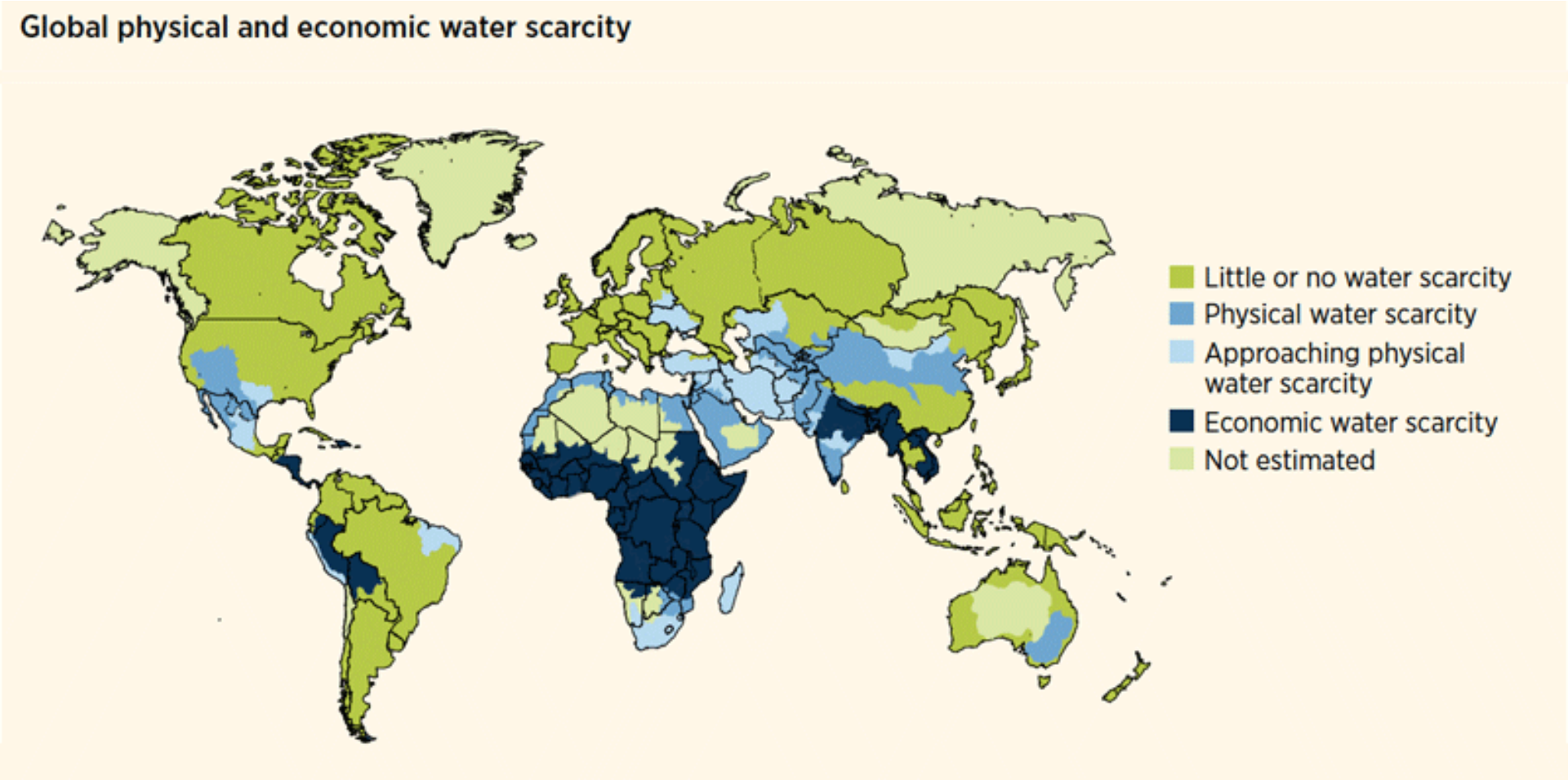


Palo Verde 2014
Water Use = 73,071 AF
MWH = 32,323,543

Total APS 2014
Water Use = 112,080 AF
MWH = 53,474,908

1.6 billion people — a quarter of humanity — live without electricity

www.Globalssues.org

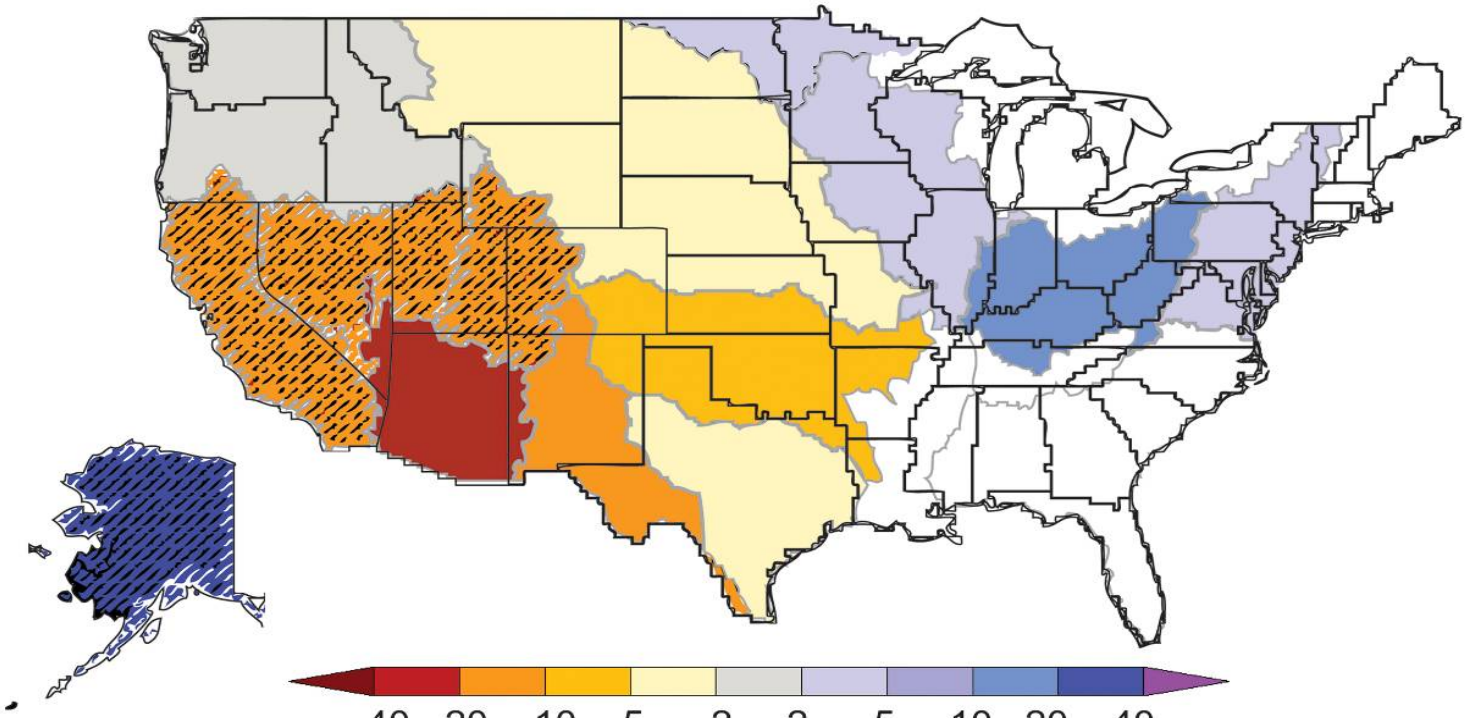


1.1 billion people live without access to freshwater

Regional Water Resources

"...requirements of the CO River Compact may only be met 60–75% of the time by 2025...." (IPCC Technical Report on Water, 2008)

Projected % change in runoff (2041–2060)



Milly *et al.*[151]

As drought grips most of U.S., Arizona endures 12th year

Jul. 19, 2012 10:48 PM
The Arizona Republic and USA Today

Arizona Water-Energy History

- 1970's - Wastewater had a bad image, low value, limited use.
- Developing Arizona needed reliable, inexpensive power and a way to reuse reclaimed water, freeing other higher quality water supplies for growth.
- The electric and water utilities had foresight to understand this need.
- But there was a challenge in building the largest nuclear power plant in the US in the desert - uncertainty in building where no large body of water was available – this had never been done.

Cooling Water Options Were Evaluated

- Groundwater
  - Sustainability
  - Subsidence issues
- Surface Water
  - Limited accessibility
  - Supply fully appropriated
- Effluent
  - Adequate supply
  - Reliable and sustainable
  - Not being utilized in 1973

Photo Source-Land Subsidence near Phoenix AZ , courtesy ADWR

Commitment to Reclaimed Water

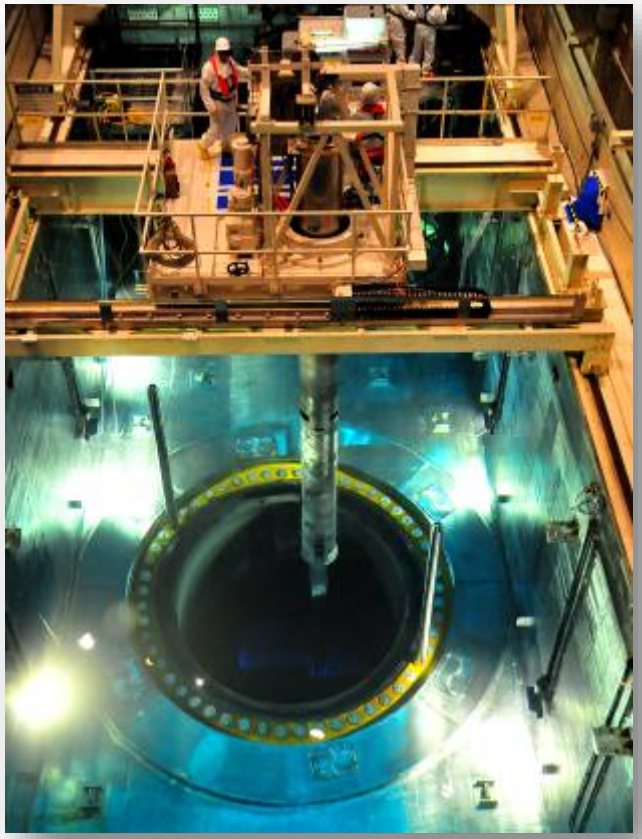
- Palo Verde was the first and remains the only nuclear power facility in the world that uses 100% reclaimed water for cooling
- Unlike other nuclear plants, Palo Verde maintains “Zero Discharge,” meaning no water is discharged to rivers, streams, or oceans
- Palo Verde/SROG is an excellent example of a water-energy partnership

Palo Verde…

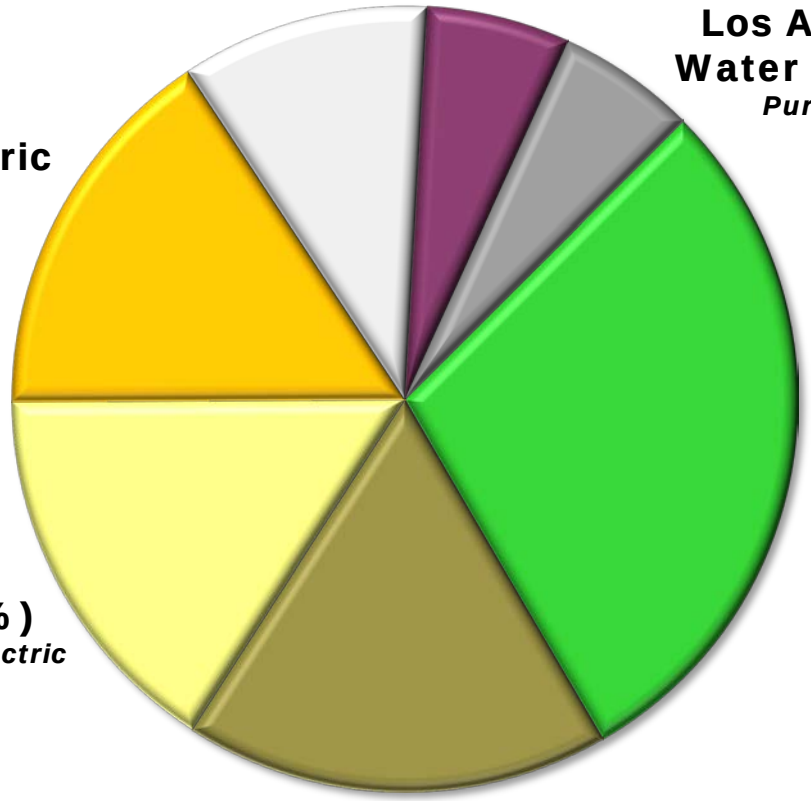
- Concept presented to APS Board of Directors in 1969
- Water sources evaluated and tested – effluent contract with SROG in 1973
- Initial construction permit — May 1976
- Began commercial operation
  - Unit 1: January 1986
  - Unit 2: September 1986
  - Unit 3: January 1988

Palo Verde…

- Largest power generator in the U.S.
- Total output 4,030 net megawatts
  - Meets the electrical needs of approximately 4 million people



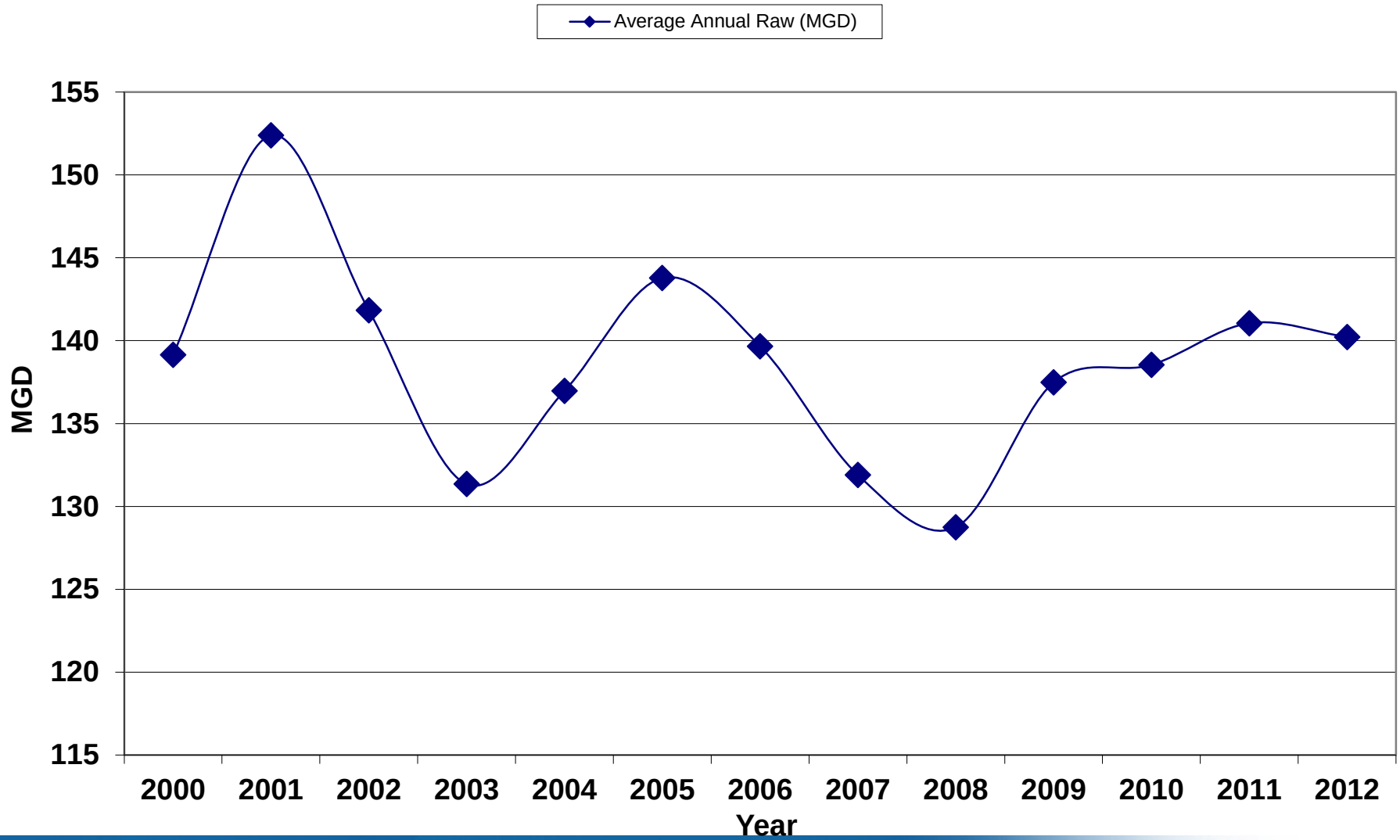
Palo Verde Participants



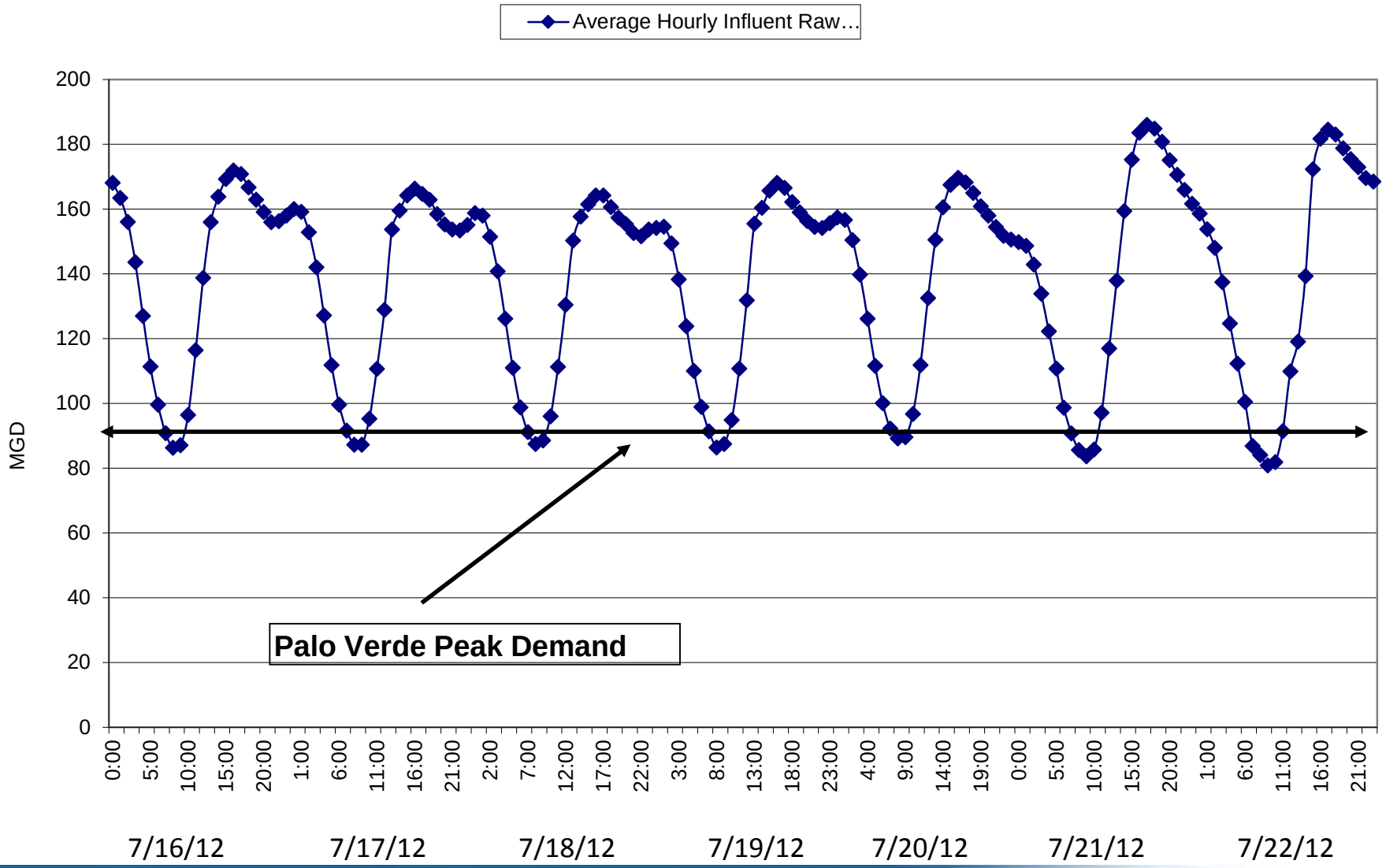
91st Avenue WWTP

- Capacity 229,000 AFY
- Treating 151,000 AFY
- 65,000 – 75,000 AFY to Palo Verde Nuclear Generating Station
  - (Additional 5,000 AFY from Cities of Tolleson and Goodyear)
- 30,000 AFY to Buckeye Irrigation District
- 28,500 AFY to Tres Rios Wet Lands

Average Annual Flow MGD



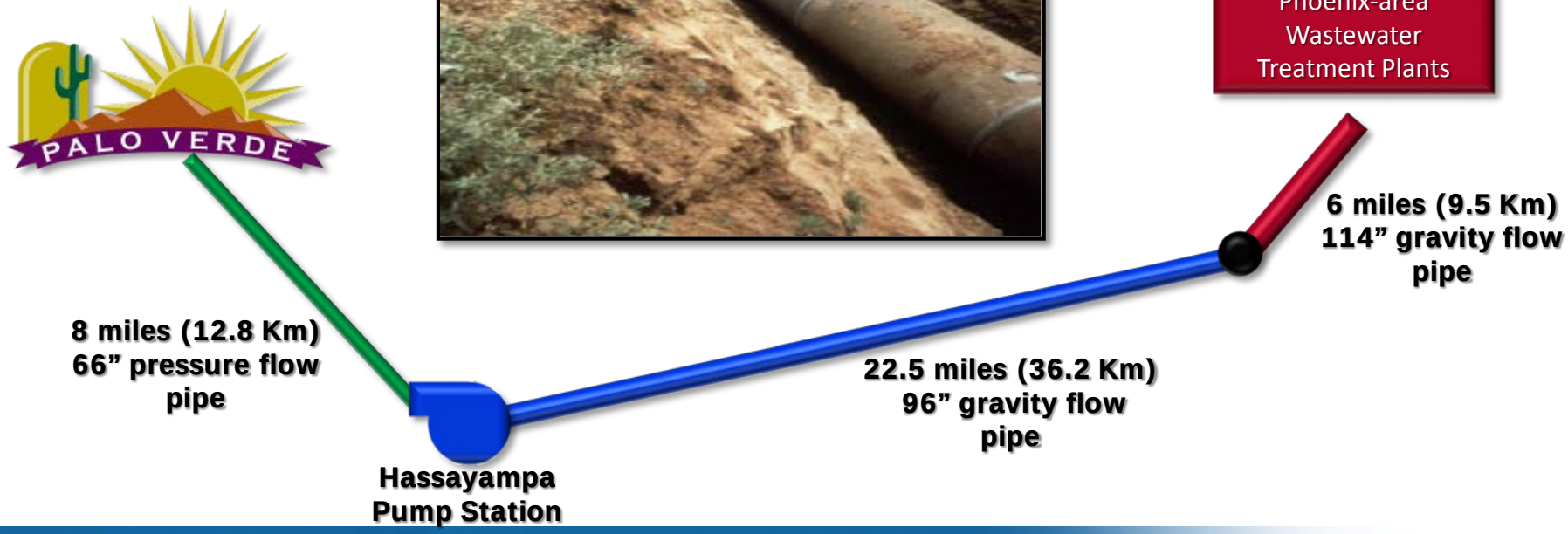
Hourly Flow - MGD



Palo Verde Nuclear Generating Station Water Reclamation Facility

Conveyance System

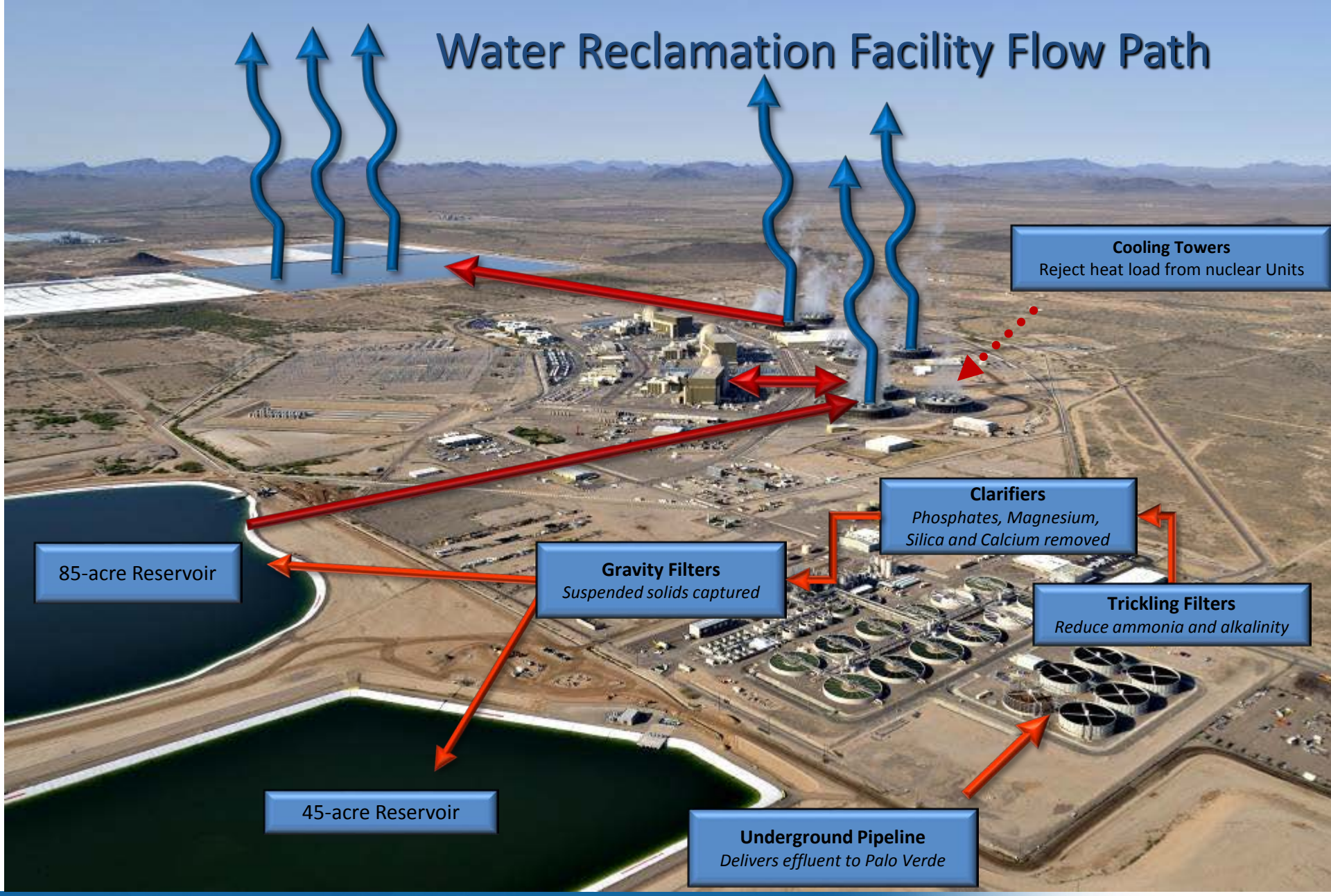
28.5 miles (46 Km) of gravity flow with 100 foot elevation drop,
8 miles (13 Km) pumped flow with 150 foot elevation increase



WRF Treatment Process

The Palo Verde Water Reclamation Facility (WRF) is a 90 MGD tertiary treatment plant that reclaims treated secondary effluent from the local cities.

Water Reclamation Facility Flow Path



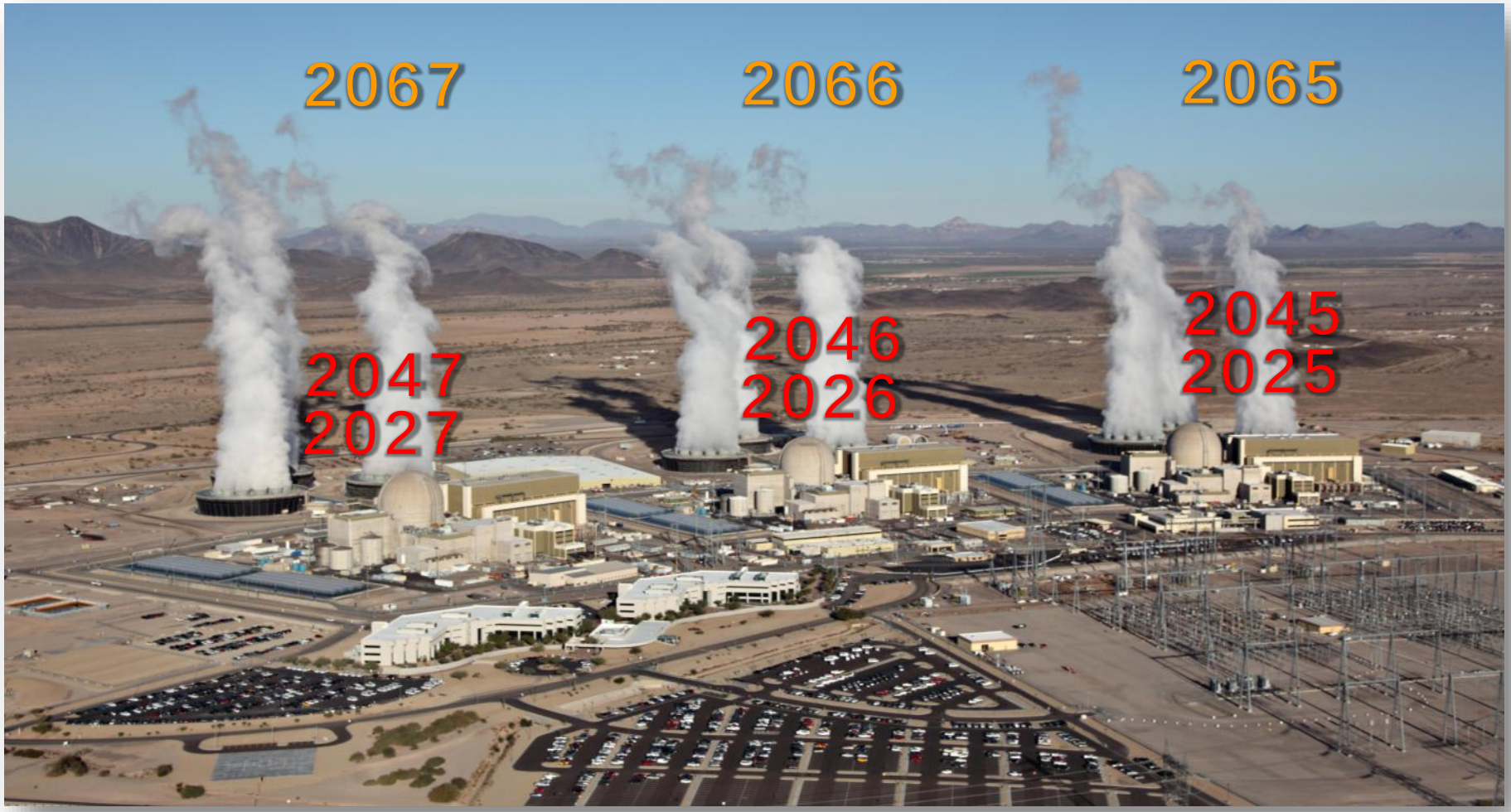
Water Use

- 2014 cooling water Intensity
  - 734 gallons/MWh
- 2014 cooling water use
  - 73,071 acre feet
    - ~23.8 Billion Gallons
- Cooling Water cycles 24
  - 25,000 – 29,000 TDS PPM
    - (air quality standards limit PV to 30,000 ppm TDS)

Water Disposal

- Cooling tower blowdown (annual rate/unit)
  - 352 million gallons
  - 1,082 Acre Feet
- Evaporation rate 60 – 72 inches/yr
  - 3,250 – 3,900 AF/yr
- Note redundancy in impoundments, allows for relining in 20 years

License Renewal



Drivers for New Effluent Contract

- The 1973 effluent contract with the SROG Cities would terminate in 2025 (Unit 1), 2026 (Unit 2), and 2027 (Unit 3)
- In December 2008, APS submitted operating license renewal applications, which was approved and extends the operating life of Palo Verde through 2047
- Securing alternative water supplies would require significant time and funding
- APS was determined to proactively secure a long-term water supply for Palo Verde now rather than wait

Summary of Essential Contract Terms

- Term
  - 2010 through 2050
  - Includes an opportunity to negotiate an extension to the contract for an additional 20 years through 2070
- Quantity: 80,000 acre-feet (AF) per year
  - Reduction of 25,000 AF from quantity of 105,000 AF under 1973 contract
  - Establishes new monthly minimum supply requirements

Looking Forward

- Educate both water and energy consumers of the relationship between water and energy
- Employ more efficient water use strategies such as dry or hybrid cooling towers
- Participate in water and energy efficiency research efforts
- Utilize treated effluent and impaired waters when practical
- Increase renewables portfolio and energy efficiency to reduce overall water intensity

Water & Energy for the Future