SNOW & RAIN: DESIGN DIFFERENCES BETWEEN ON-SITE SYSTEMS IN THE ICY COLD AND WET TROPICS



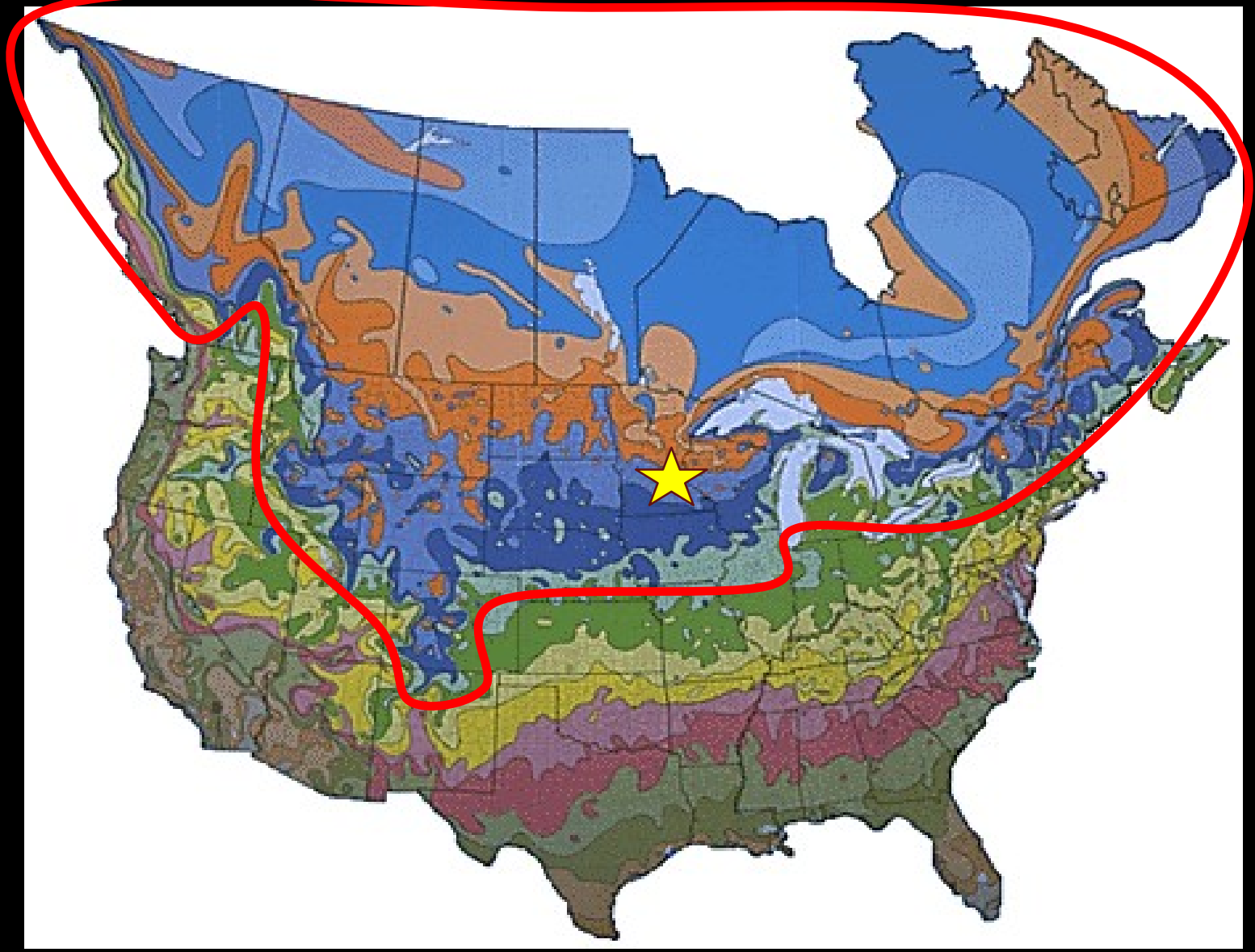
Presented by Ben Kele and Sara Heger

The materials being presented do NOT reflect the opinions of NOWRA

PRESENTATION OVERVIEW

- Climate considerations
- Designing in cold and tropical climates
- Installation considerations
- Managing through the challenges

COLD!

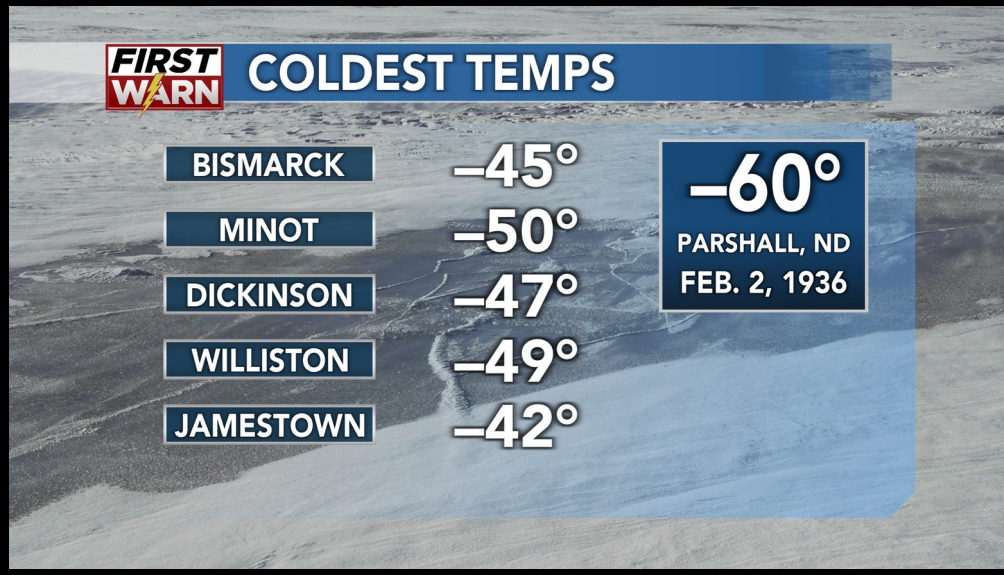


HOW COLD IS IT?

- The 10 coldest towns in America (population 20,000+)

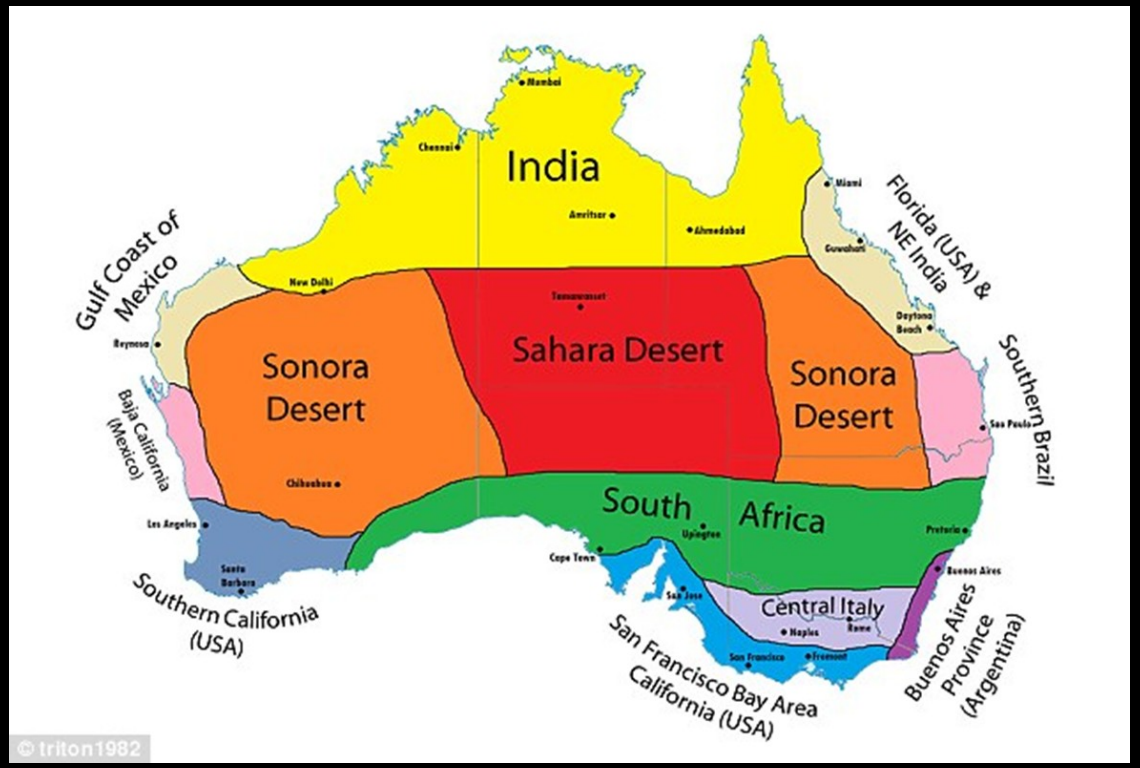
  1. Fairbanks, Alaska
  Population: ~32,500
  Avg Annual Temp: 27.6°F
  Record Low: −66°F
  Winter Reality: Below freezing year-round.

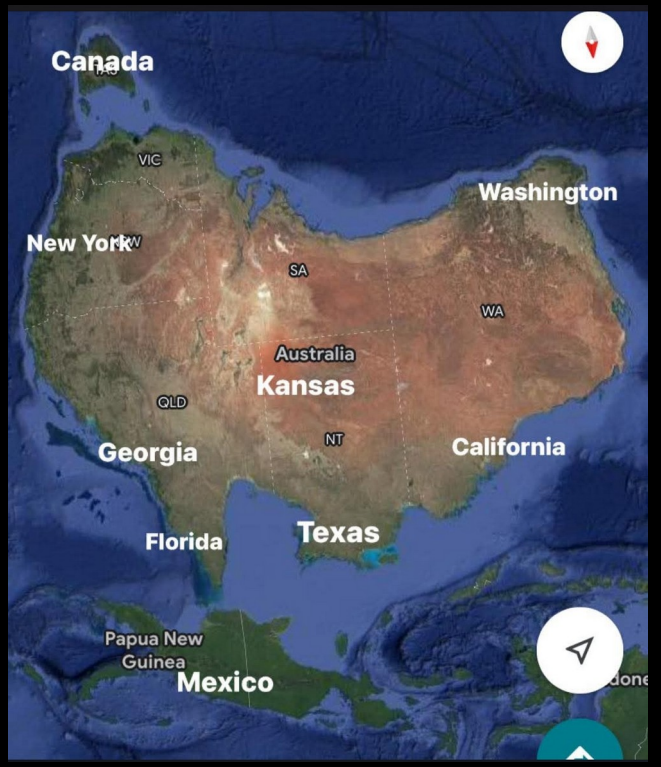
- Inversions trap cold for weeks.
  2. Grand Forks, North Dakota
  Population: ~59,000
  Avg Annual Temp: 39.8°F
  Record Low: −43°F
  Winter Reality: Flat, open terrain = brutal wind chills.



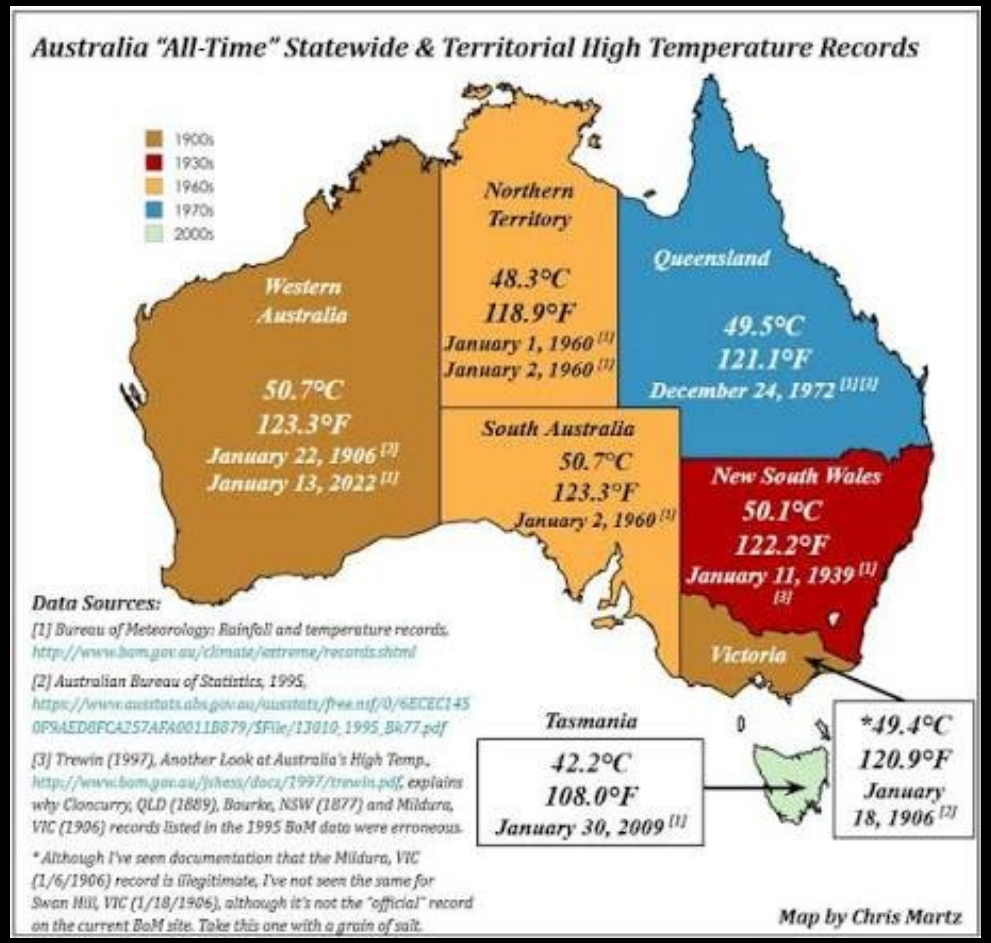
- 3. Butte, MT, Duluth, MN, Marquette, MI, Williston, ND, Bismark, ND, Fargo, ND, St. Cloud, MN, Aberdeen, SD,

TROPICAL


India
Sonora Desert
Sahara Desert
Sonora Desert
South Africa
Central Italy
Gulf Coast of Mexico
Florida (USA) & NE India
Southern Brazil
Baja California (Mexico)
Southern California (USA)
San Francisco Bay Area California (USA)
Buenos Aires Province (Argentina)
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Canada
Washington
New York
Australia
Kansas
Georgia
California
Florida
Texas
Papua New Guinea
Mexico

HOW WARM IS IT?



SNOWFALL COMPARISON

- The Australian Snowfields are slightly smaller than Connecticut
- The area of Australia that yearly receives any snowfall is equal to New Jersey



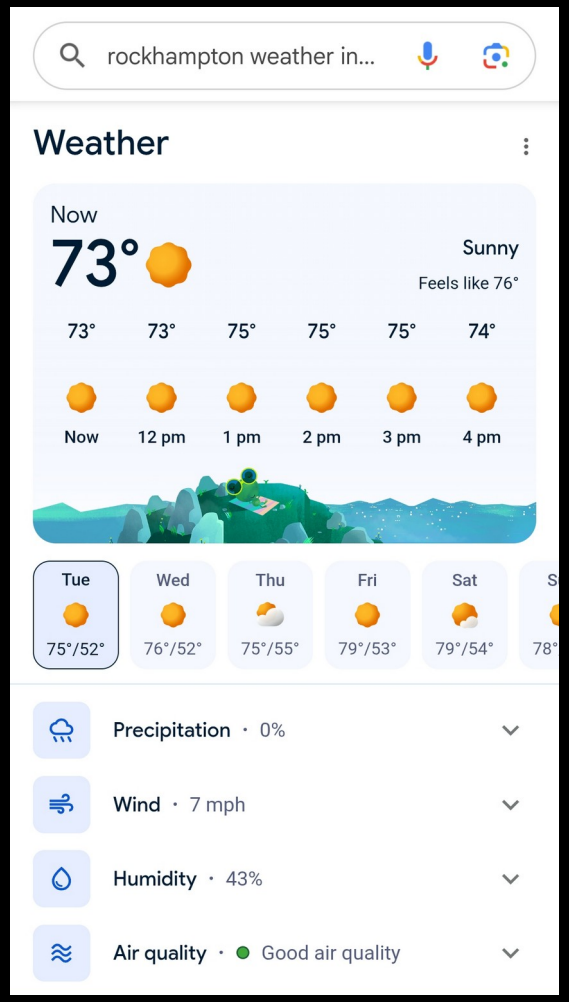


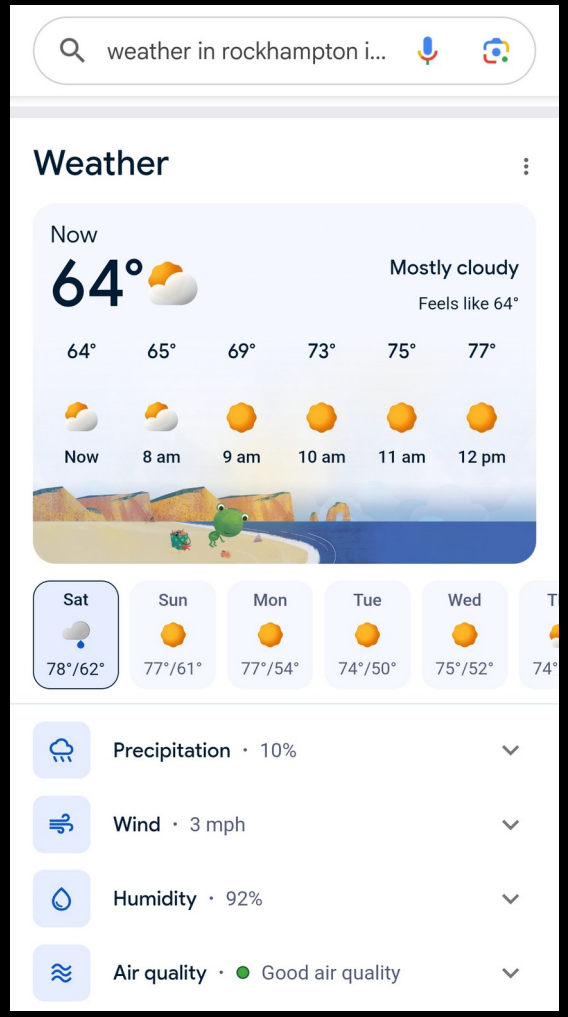
HOW WARM AND WET IS IT?

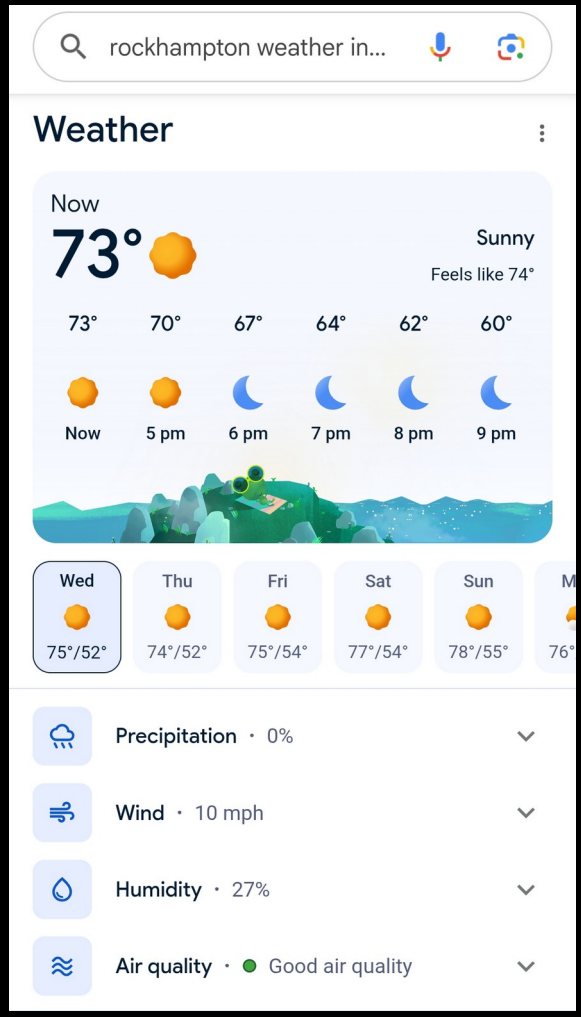
- Winter Clothes are Different
  - Good conditions for evapotranspiration during winter
  - Trees and grass green year round
- Rainfall is different
  - Wet season is the Summer
  - Tropical Storms
  - Long-term overcast conditions are rare
- Humidity is often high enough to stop evapotranspiration
- Water temperature remains high year round
- Good conditions for strong odors



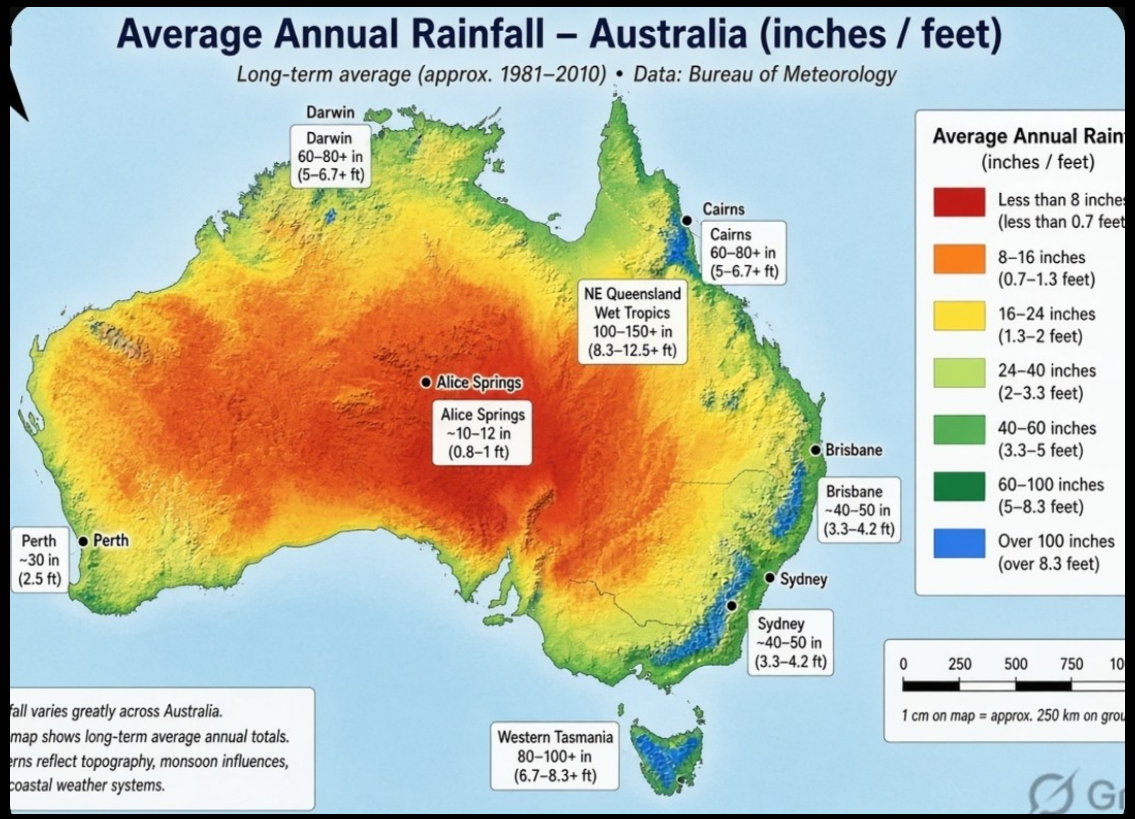
WINTER IN THE TROPICS

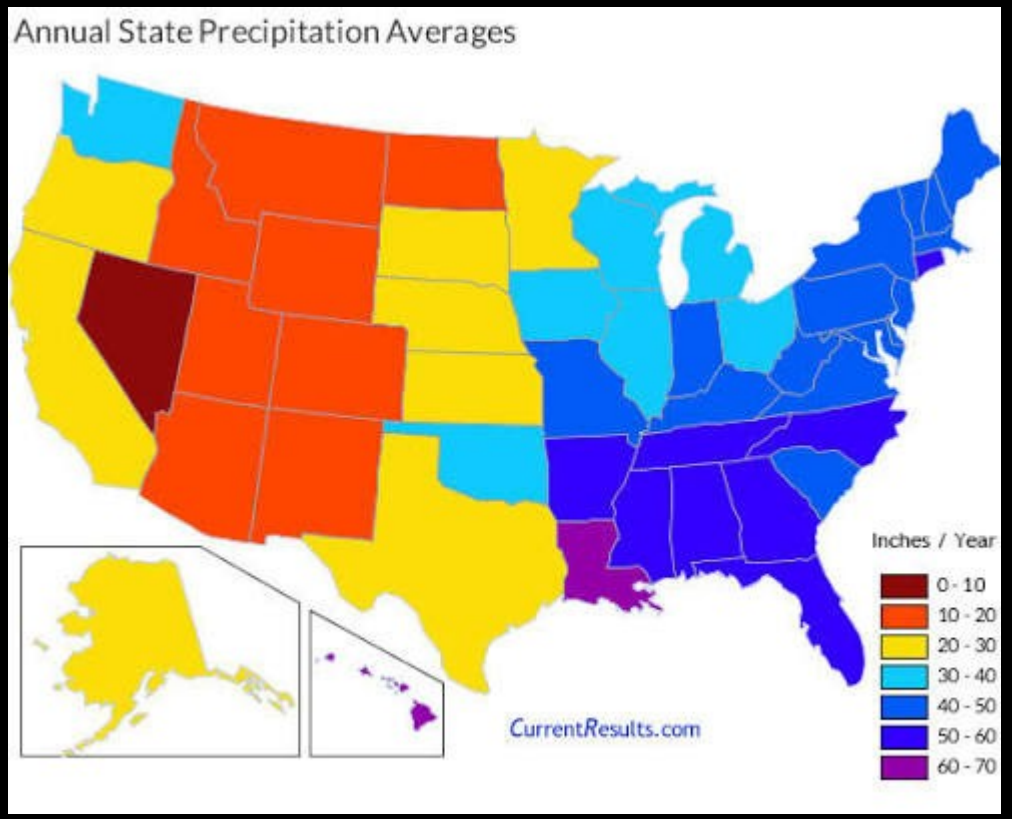






RAINFALL COMPARISON





DESIGN SOLUTIONS

DESIGN SOLUTIONS – COLD – PIPING

- Ensure all pipes are designed to drain
- No check valves
- Low pressure pipe
  - Supply line typically drains back to dosing tank
  - Manifold drains into supply line or laterals
  - Laterals must have some perforations down to drain the laterals

DESIGN SOLUTIONS – COLD – FLOW

- Challenge: Small volumes of wastewater moving slowly
  - Low/no usage
  - Gravity flow
  - High-efficiency furnace condensate
  - Drips/leaks
- Solutions
  - Route condensate out of system
  - Incorporate dosed distribution
  - Utilize time dosing/remote monitoring to detect leaks and drips
  - Insulate components

DESIGN SOLUTIONS – COLD – INSULATION

- Include insulation in design specifications when needed
  - Areas with cold temperatures and little snow accumulation
  - Compacted areas with lower insulating properties
    - Driveways
    - Poured concrete patios/parking areas
  - Access manholes to grade
  - Access boxes to grade

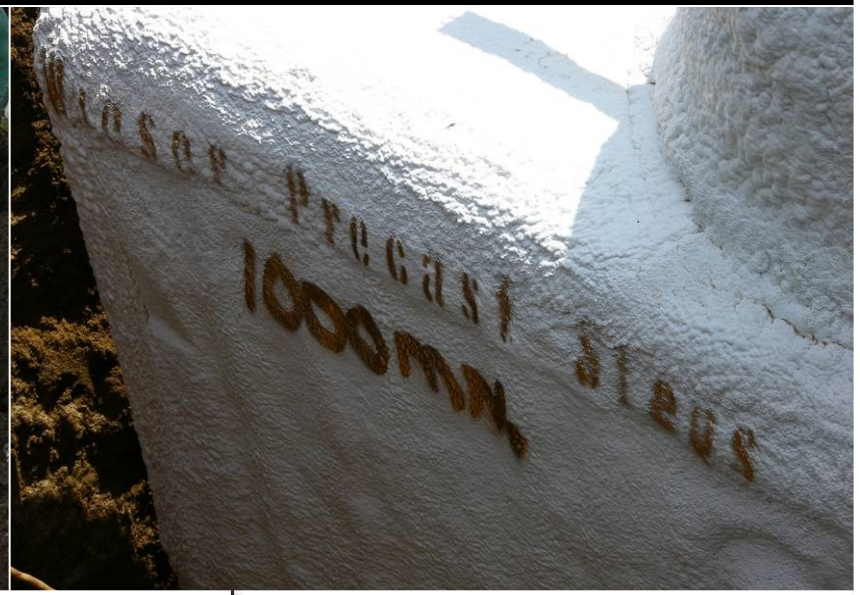
INSULATED PIPE APPLICATIONS





INSULATING TANK OPTIONS











INSULATING MANHOLE LID OPTIONS







DESIGN SOLUTIONS – TROPICAL

- Avoiding rainfall/stormwater infiltration is the main consideration
  - Also need to minimise the release of odors
- Tanks and soil dispersal areas must use techniques that minimise the risk of rainfall getting into the tanks and flooding the soil dispersal area
- Tanks are rarely fully buried
  - Top of the tank exposed
  - Risers not needed
- No risk of water freezing in pipes
  - Less attention to low points (but we should for even distribution)
  - Micro-dosing of pumped systems possible
- Air temperature remains relatively high year round
- Dispersal area and/or soil treatment area cannot be in lowest section of the block in the path of overland flow of stormwater

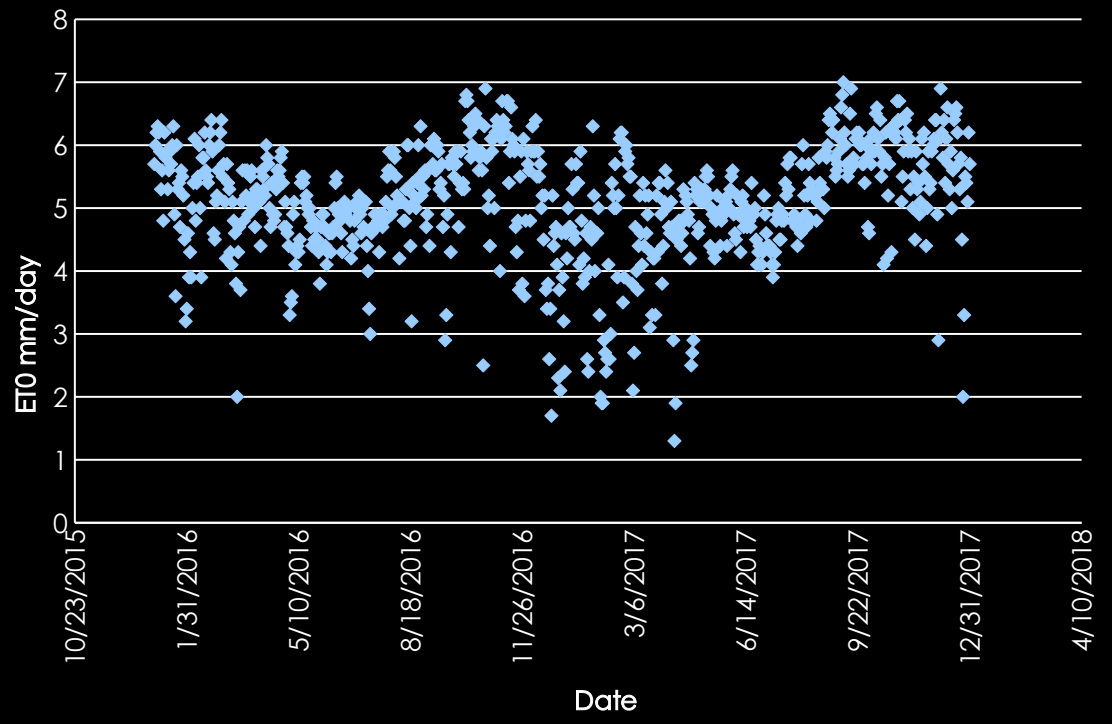


DESIGN SOLUTIONS – TROPICAL

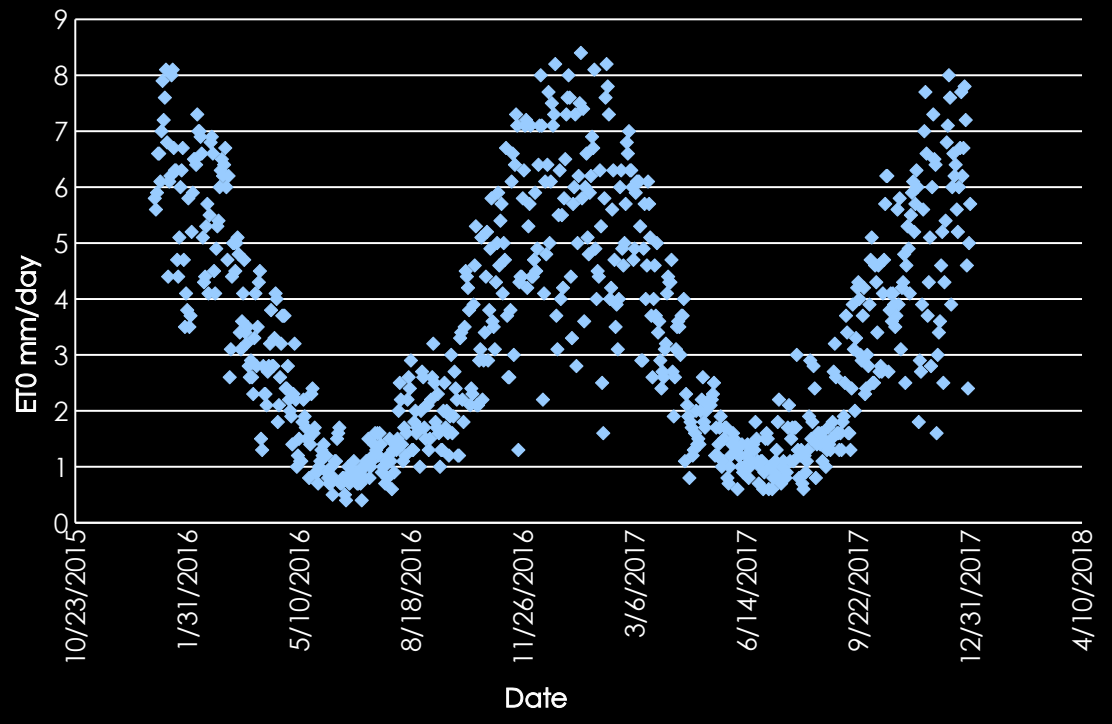
- Using rainfall data on its own will not be a good indicator of the evapotranspiration rate
  - With tropical thunderstorms you can have 10 hours of daylight and then a late afternoon downpour
    - If your system is designed to have a minimal impact from rainfall and overland stormwater flow you can have good evapotranspiration in high rainfall areas
- High Humidity can shut down evapotranspiration
  - Siting the evapotranspiration area in a location where it gets a breeze will lower the risk of this occurring
    - But too much wind will also impede evapotranspiration

EVAPOTRANSPIRATION CONDITIONS

DARWIN



MINTARO



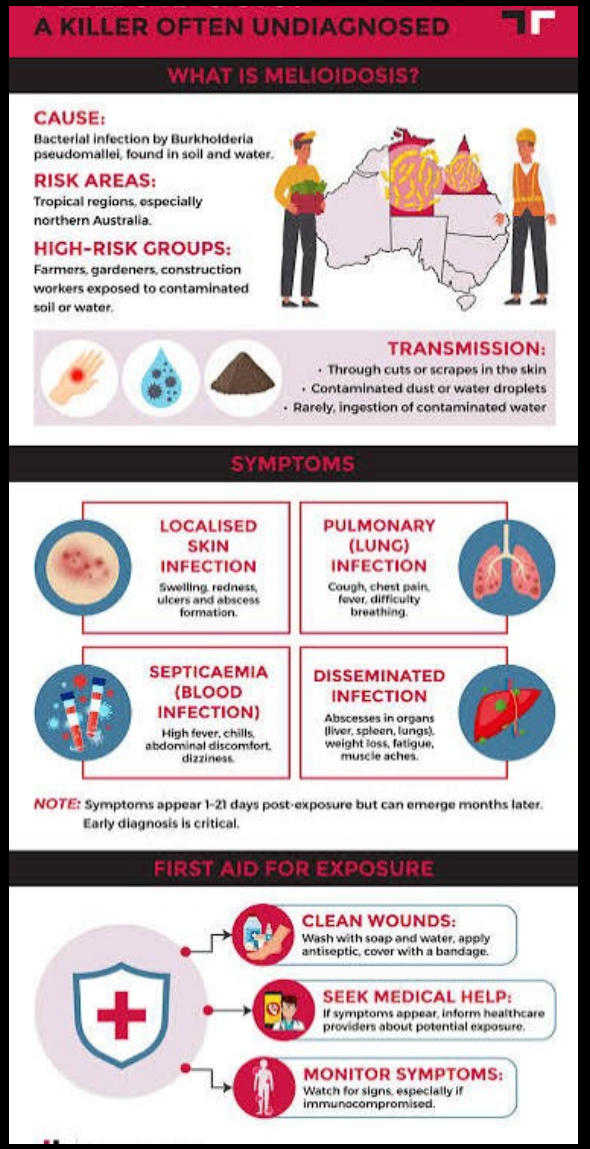
DISINFECTION UNITS



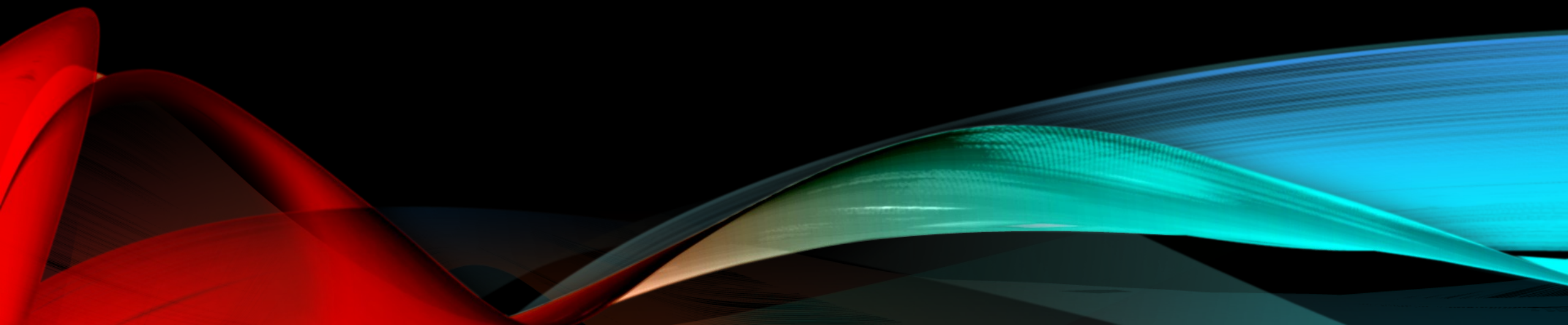
- Many Fecal Bacteria can survive and replicate more easily in tropical climates
- *E.coli* can survive and replicate for weeks in tropical soils
  - Freezing does not kill some fecal bacteria but it stops replication and puts them into a hibernation state
- Odor causing bacteria can be a big issue in tropical climates
- Disinfection units commonly installed

TROPICAL DISEASES

- *Burkholderia pseudomallei*
  - Melioidosis
  - 10% mortality with prompt care
  - 40% mortality with delayed care
  - 90% mortality with serious pre-existing conditions
- Queensland 2025
  - 261 cases
  - 37 deaths
- Associated with flooding
- Loves to live in on-site systems and soil dispersal areas

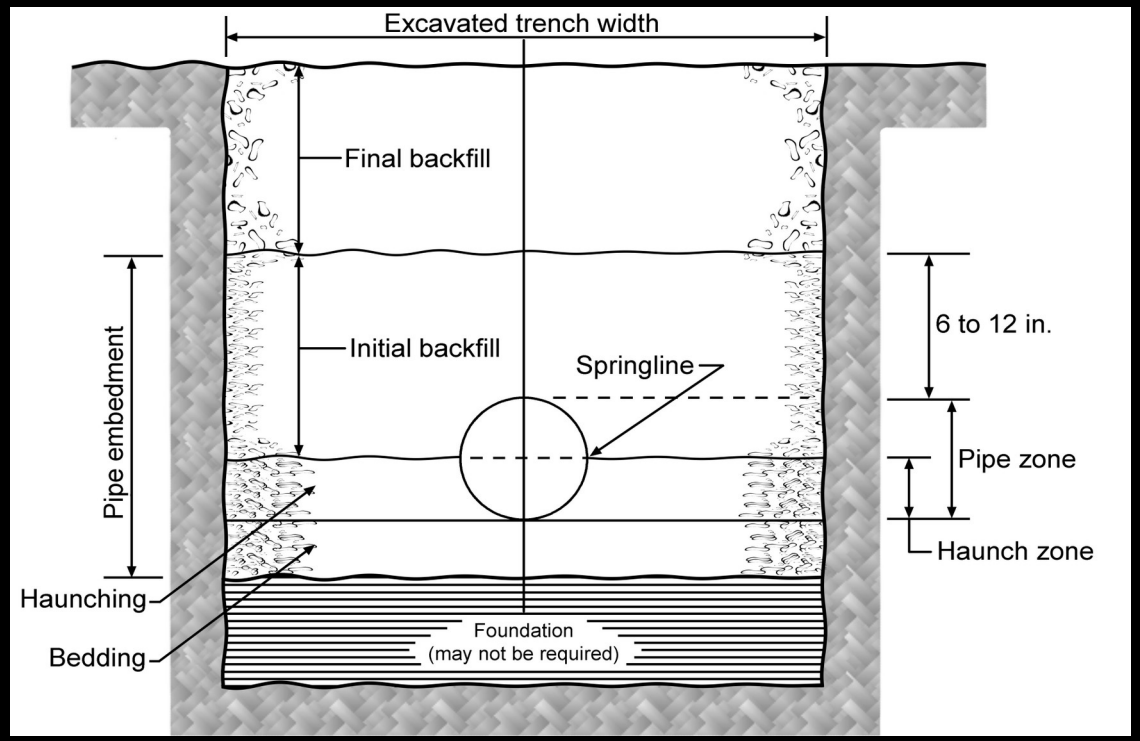


INSTALLATION CONSIDERATIONS



INSTALLATION – COLD - PIPING

- All pipes must be properly bedded
- Material
  - Maximum rock diameter is 2.5 inches
  - Do *not* use organic or frozen soil
  - Free of debris
  - Bed, haunch, and backfill properly for support



PIPE BEDDING & INSULATION





INSTALLATION – COLD - PIPE SLEEVING

- Use in areas where pipe needs additional support
  - Under driveways, roads, structures
  - Wastewater pipe close to water lines or crosses water lines
  - Underlying soil is disturbed



INSTALLATION – COLD - FROZEN SOILS

- Any frost is too much frost for an above-grade system
- For below grade trenches frost could be present, however cannot extend to the depth of the required sidewall or bottom area of the trench/bed
- Snow should be removed with caution





INSTALLATION – COLD - FROZEN SOIL

- No way to test the plastic limit
- Scarification will not work
  - Soil can be frozen solid
  - Large clumps instead of exposing natural soil structure
  - Shattering in dry frozen soils
- If scarified when frozen as the soil thaws it can “seal off” the scratched area
- The large frozen clumps will also hamper constructability

INSTALLATION SOLUTIONS – TROPICAL

- Avoiding the impact of high rainfall
  - Scheduling major works in the dry season (winter)
- Letting heat get away, rather than trying to retain it
  - Average temp range in a septic tank is between 77'F-to-95'F
- OHSA requirements focused on managing the heat
  - Very different to 'don't eat the yellow snow'




OVERSIZE

TANKS ABOVE GROUND





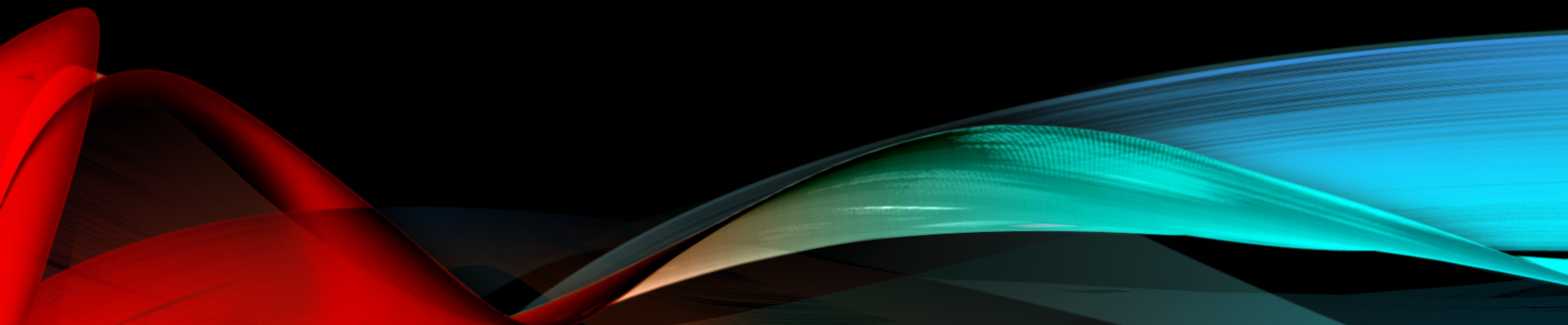
- No need to insulate
- Keeping rainfall/surface stormwater out more important
- Can make plumbing to them harder
- Techniques to stop them floating are important
  - Never leave an empty tank

INSTALLATION SOLUTIONS – TROPICAL





MANAGEMENT THROUGH THE CHALLENGES



MANAGEMENT CHALLENGES – COLD -WHY DO SYSTEMS FREEZE?

- Cold temps, little or now snow cover
- Compacted snow or soil
- Lack of vegetation
- Cold wastewater
- Cold air entering the system

- Freezing of lines
  - Trickle flow
    - Low/no usage
    - Gravity flow
    - High-efficiency furnace condensate
    - Drips/leaks
  - Dips in pipe
- Components holding effluent
  - Distribution boxes
  - Ponded systems
  - Malfuctioning systems

MANAGEMENT CHALLENGES – Cold -

Immediate Tasks when a System Freezes

- Tell homeowner to shut pump off if it has one
- Camera line to see if pipe has fall and where blockage is
- If soil treatment system is not frozen
  - Jet or steam out the building sewer or supply lines



Management challenges – Cold -

Immediate Tasks when a System Freezes

- Add a heater
  - STEP-HEAT - low voltage heating of small or large storage tanks
  - Stock tank heaters
  - Septic heater
- Thaw system –heat blankets
- Use tanks as holding tanks until spring
  - Minimize water use
- Provide recommendations for repairs/replacement in the spring
- Do NOT
  - add antifreeze, salt or an additive
  - pump out sewage onto the ground surface
  - start a fire over the system
  - run water continually to try to unfreeze system.



MANAGEMENT CHALLENGES –COLD –

THERMAL CONDUCTIVITY FOR COVER MATERIALS

- Thermal conductivity is a measure of how much energy/heat is being transferred through an area
- 1 inch of polystyrene as good as:
  - ~12 inches of sandy soil
  - ~43 inches of clay soil

Material	Thermal Conductivity ($MJ/m^2 \cdot d \cdot {}^oC$)
Polystyrene	0.0026
Fluffy snow	0.0056
Loose straw	0.0078
Soil	0.0449
Sand	0.0302
Clay	0.1123

MANAGEMENT CHALLENGES – COLD - HOMEOWNER PREVENTION TECHNIQUES

- Add mulch over areas of concern
- Let lawn get long in fall
- Use water (normally)
- Plan accordingly if going away for extended period
- Fix leaky fixtures
- Don’t compact on system
- Don’t let cold air enter the system
- Report any surfacing of sewage to an onsite professional



MANAGEMENT CHALLENGES – TROPICAL

- Blowers & Pumps often die from running too hot
  - Let heat get away
    - Without causing an odor issue
- Some Regulators, especially for commercial systems require wet weather storage and pump outs if rainfall is extended
- Stopping traffic (foot & vehicle) over the top of wet dispersal fields
- Management of vegetation growing in the dispersal areas



MANAGEMENT CHALLENGES – TROPICAL





UNSURE AREAS OF DIFFERENCE

- Rate of lateral movement of water through the side walls of trenches (soils) between cold and warm climates is often debated
- The viscosity of water increases as its temperature drops. When water is colder, it becomes thicker and experiences greater friction as it flows through the complex pathways of soil pores. The rate of flow drops by about 2% to 3% for every 1°C the soil cools.
- The semi-permeable biomat (merkin) at the bottom of the trench, acts as a thermal insulation and traps heat. The slow flow rate (semi-permeable) of the relatively warm wastewater through the biomat also helps keep the soil warm. So, the combination of the warm wastewater & thermal insulation keeps the soil at the bottom of the trench warmer than the soils on the sides. This may provide a preferential pathway for the water compared to the relatively cold soils on the side walls.
- The microbiological activity of the biomat itself does not seem to make much of a difference temperature wise; only produces around 1°C

CONCLUSION

- Plenty of differences in between on-site systems in the cold and warm climates
- Regulations and accreditation (NSF) processes often don't cover these issues in detail
- Additional research and education in this area would be beneficial

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