

# Rainwater Collection in Cold Environments

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# Rainwater Collection in Cold Environments



Introduction



Concept of Rainwater Harvesting in Cold Environments



RWH Requirements for Cold Environments



Proposal for Net Zero and Conclusion

# Introduction

- Only a few have prepared any guidelines for water collection in cold climates.
- Alaska Building Research group titled *Water Cistern Construction for Small Houses, Series HCM-0155*.
- Natural disasters and water security as well as how to store water in cold climates
- Winter hydrologic conditions—ice, freezing temperatures, snow, and snowmelt—present special considerations for water collection and stormwater runoff.

# Concept of Rainwater Harvesting in Cold Environments

## ■ Cold Weather RW Collection Considerations

- Winter hydrologic conditions—ice, freezing temperatures, snow, and snowmelt—present special considerations for water collection and stormwater runoff. With freshly fallen snow 10 inches of snow will equal approximately 0.7 inches of water or another way to calculate it is 14 inches of freshly fallen snow will equal 1 inch of water. Over time the snow becomes more compacted and by the time the snow begins to melt it will yield more water per inch; closer to 3-4 inches of snow will equal 1 inch of water.

## ■ Basic Components

- Same as any system except need insulation and non freezing components.

# Rainwater Harvesting Requirements for Cold Environments

## ■ Cold Weather RW Collection Considerations

- Tanks: Larger tanks are recommended as a large tank will take longer to freeze than a small one; a round tank is recommended as a round tank will lose heat more slowly than a rectangular one of the same volume; straight sides are recommended as corrugated sides have more surface area; insulation is recommended e.g., spray-on polyurethane foam; tank roofs should be designed to withstand heavier loads such as snow and a steep-angle roof allows the snow to slide off faster; a central tank roof support is recommended for additional strength; tanks should be designed to take into account the rising and falling water surface level and internal fittings—ladders attached to walls—should be avoided.

# Rainwater Harvesting Requirements for Cold Environments

## ■ Cold Weather RW Collection Considerations

- Tank Water: In cold water settling velocities are up to 50 percent slower; higher pollutant levels maybe experienced in the water as the pollutants—such as ash from fireplace use—will likely build up during the cold season and when melt does occur, larger quantities of runoff water may be experienced; during deep-freeze conditions moving water is less likely to freeze than standing water and the water in the tank may need to be constantly cycled to prevent freezing, possibly cycled through a solar hot water system.

# Rainwater Harvesting Requirements for Cold Environments

## ■ Cold Weather RW Collection Considerations

- Pipes: If possible pipes should be buried below the freeze line; pipe distribution points should be located as close to the use as possible and preferably inside a building; using suitable piping materials will reduce the probability of pipes splitting; Medium Density Polyethylene (MDPE) remains ductile even at lower temperatures (health implications of drinking water filtration requirements is unknown and water quality should be evaluated with all piping materials), and the typical warm-weather PVC pipe is more brittle at lower temperatures; if the system is not used during cold periods, the pipes should be drained.

# Rainwater Harvesting Requirements for Cold Environments

## ■ Cold Weather RW Collection Considerations

- Valves: Valves can be protected by being placed in insulated boxes.
- Tank Foundations: Heat loss from the water in the tank to the ground may occur causing the soil below the water to thaw quicker causing structural instability; mounting a tank on an insulated concrete is an option or a gravel base will reduce the heat transfer.
- Pumps: The fact that engine fluids thicken at lower temperatures should be taken into account and appropriate diesels and oils should be used; pumps should be protected in a pump house or insulated box.
- Chlorination: The reaction rate of chlorination is seriously affected at lower temperatures, if this is a technique used for purification, more time may be required for the purification/reaction time. The Alaskan Building Research Series HCM-01557, *Water Cistern Construction for Small Houses*, lists a few very good points to be addressed when using cisterns in cold climates. Those points are as follows:



# Rainwater Harvesting Requirements for Cold Environments

## ■ Cold Weather RW Collections Considerations

- In non-permafrost areas and above-grade cistern may only need side and top insulation as soil heat may be enough to keep the water from freezing.
- If a cistern is placed on solid rock, soil warming of the cistern water is unlikely and the cistern bottom should be insulated.
- Insulation of square/rectangular cisterns should use boards of extruded polystyrene due to their moisture resistant properties. Cylindrical cisterns should be insulated with batt insulation and a Visqueen (polyethylene) outer layer.

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

# Rainwater Harvesting Requirements for Cold Environments

## ■ Cold Weather RW Collection Considerations

- If a cistern is located below-grade it needs to be placed below the freeze depth to avoid frost/freeze problems. If this is an extreme depth, an option would be to insulate the ground above the cistern. The necessary depth of soil cover will relate to the thickness of the insulation.
- All pipes should be insulated and heat tape treaded inside the pipes or wrapped around them. Heat tapes can be placed in loops on the bottom of the cistern as well as around the intake. An automatic thermostat with a temperature sensor placed inside the cistern should be used to turn on and off the heat tapes.
- Summer cisterns should always be emptied, cleaned, and decommissioned (including disconnecting downspouts) for the winter season.

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

# Rainwater Harvesting Requirements for Cold Environments

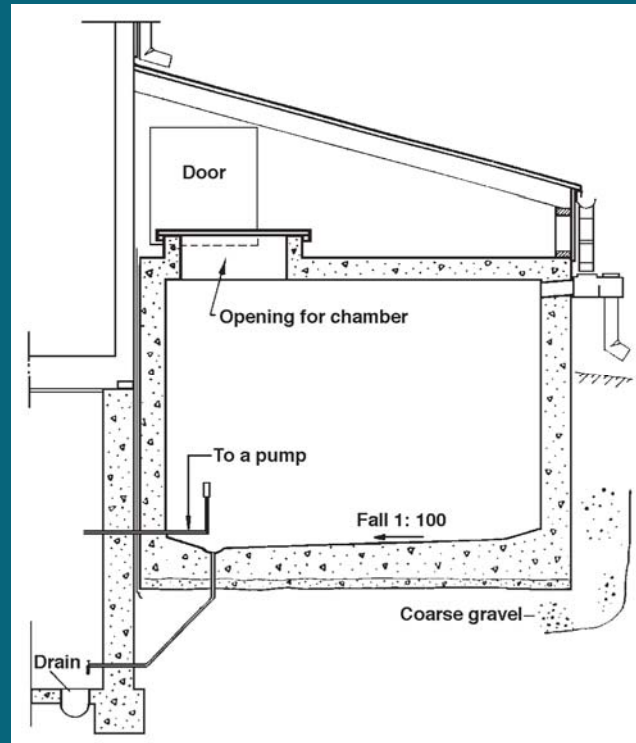
## ■ Cold Weather RW Collection Considerations

- Heat tapes can be used on the downspouts, gutters, and along the roof eaves to avoid frozen systems and allow water collection to be continued during cold times. The storage system can also be disconnected from the collection components during the winter if no collection is needed or desired.
- Cold climates cause more concern for maintenance as the tank, pipes, valves, and other components of a system such as the roof of an above-grade tank need to be inspected more often to evaluate conditions and potential stress points. This list is a beginning and some items may have been overlooked as every site is unique and may have special issues to be evaluated.

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

# Rainwater Harvesting Requirements for Cold Environments

## ■ Details

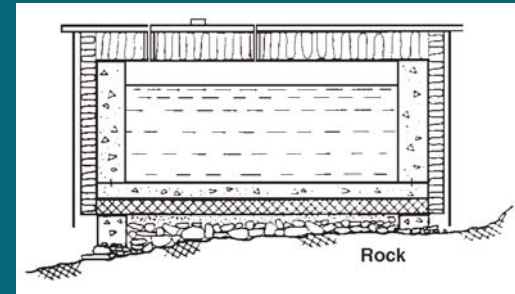
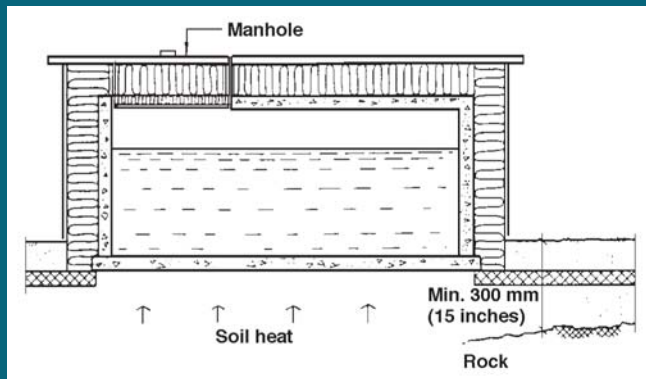


Cistern built partially above ground.

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

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## ■ Details



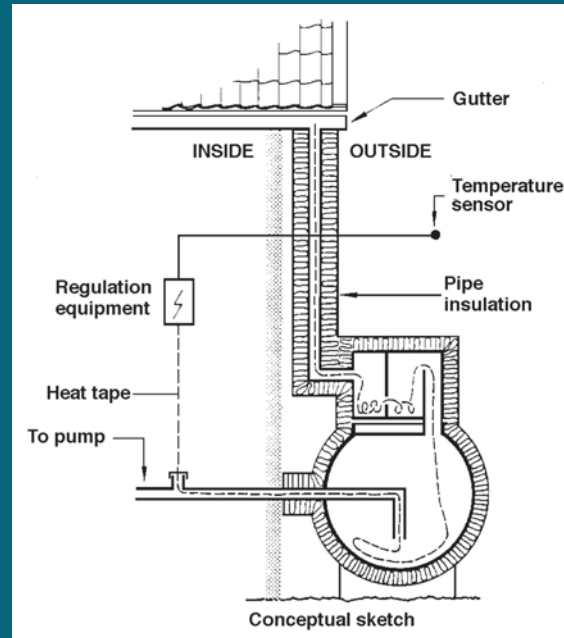
Frost protection of cistern on rock.

Frost protection using the soil geothermal heat (in nonpermafrost areas only).

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

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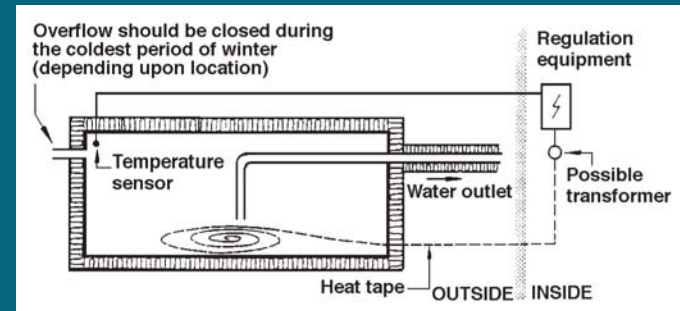
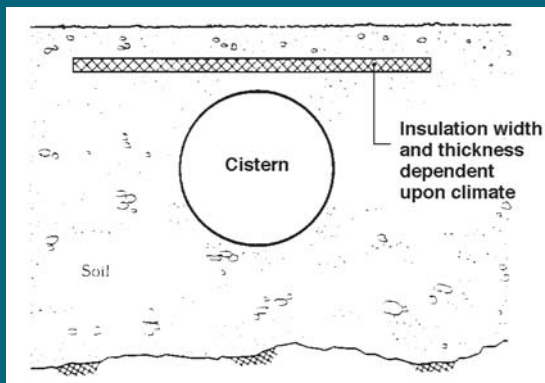


Frost protection can consist of pipe insulation and heat tape within pipes and the cistern.

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

# Rainwater Harvesting Requirements for Cold Environments

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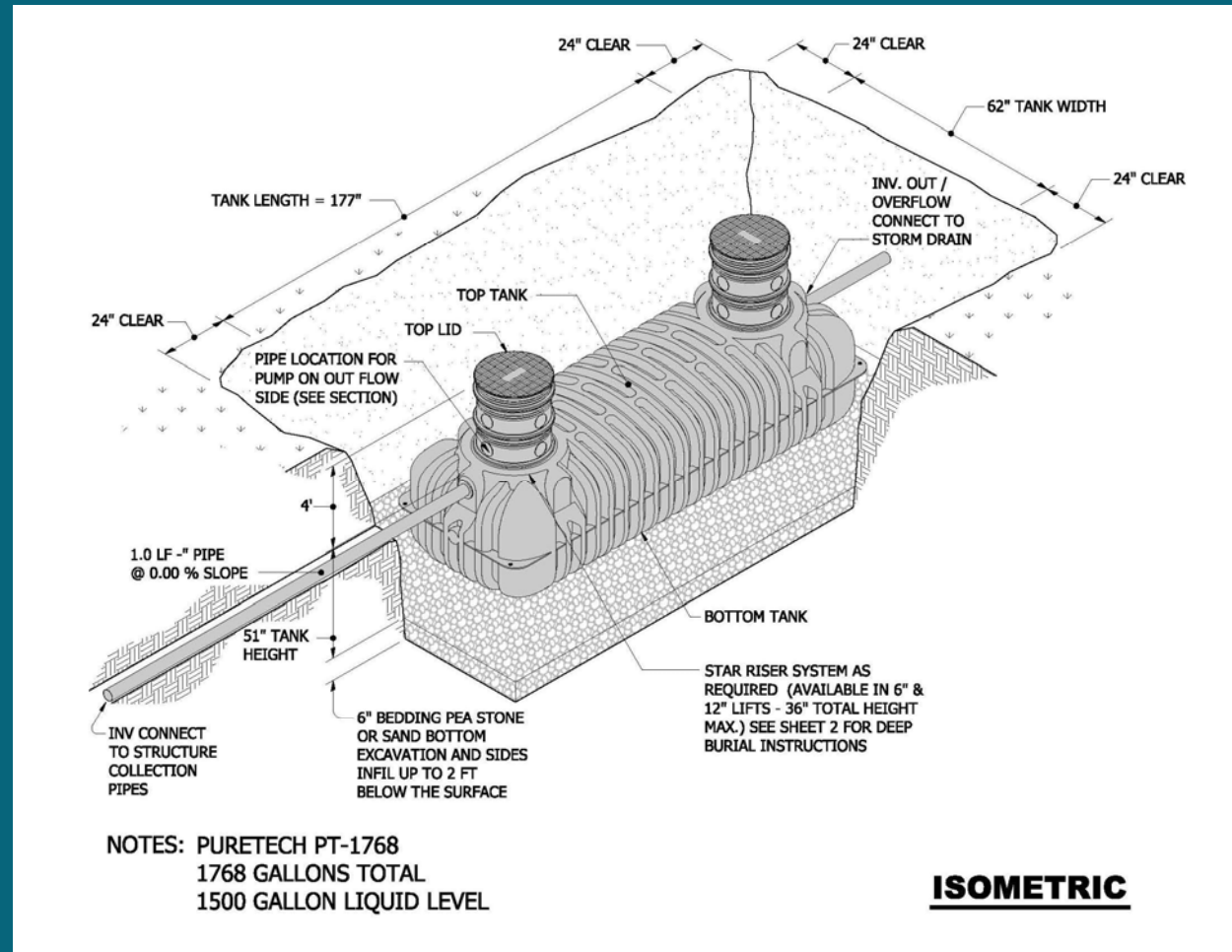
Frost protection of cistern with heat tape, note temperature sensor is placed inside the cistern.

If excavation to frost free depth is extreme, the ground above the cistern can be insulated with blueboard or similar.

(Source: Water Cistern Construction for Small Houses, Alaska Building Research Series HCM-01557)

# Proposal for Net Zero - Tank

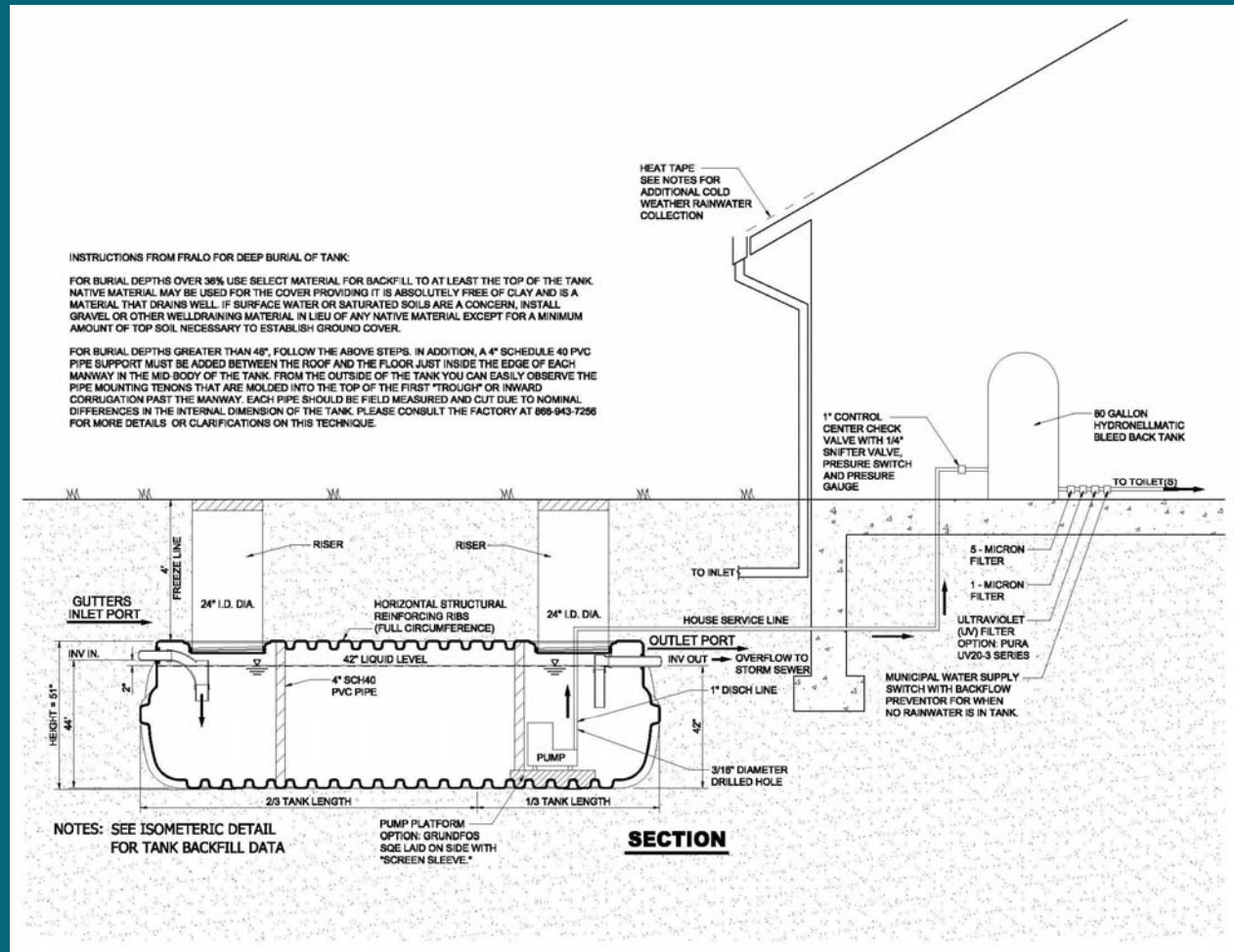
## Detail





# Proposal for Net Zero – Home Connection

## Detail



# Conclusion

- **Follow RW Collection for Cold Environments**
- **Follow Tank Deep Burial Recommendations by Manufacturer**
- **Use Captured Water for Landscape Irrigation or for Toilet Flushing**
- **Use a First-flush Device at the Downspout Connection to the Underground Pipes**
  - Small Basket Filters
- **Potentially Use Leaf Catchers at the Gutter Downspout Connection**
  - Leaf Catcher or Leaf Beater - Australian

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