Our Beloved Fountain: Making Water Features Sustainable

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Society Places a Certain Value on Fountains and Water Features:

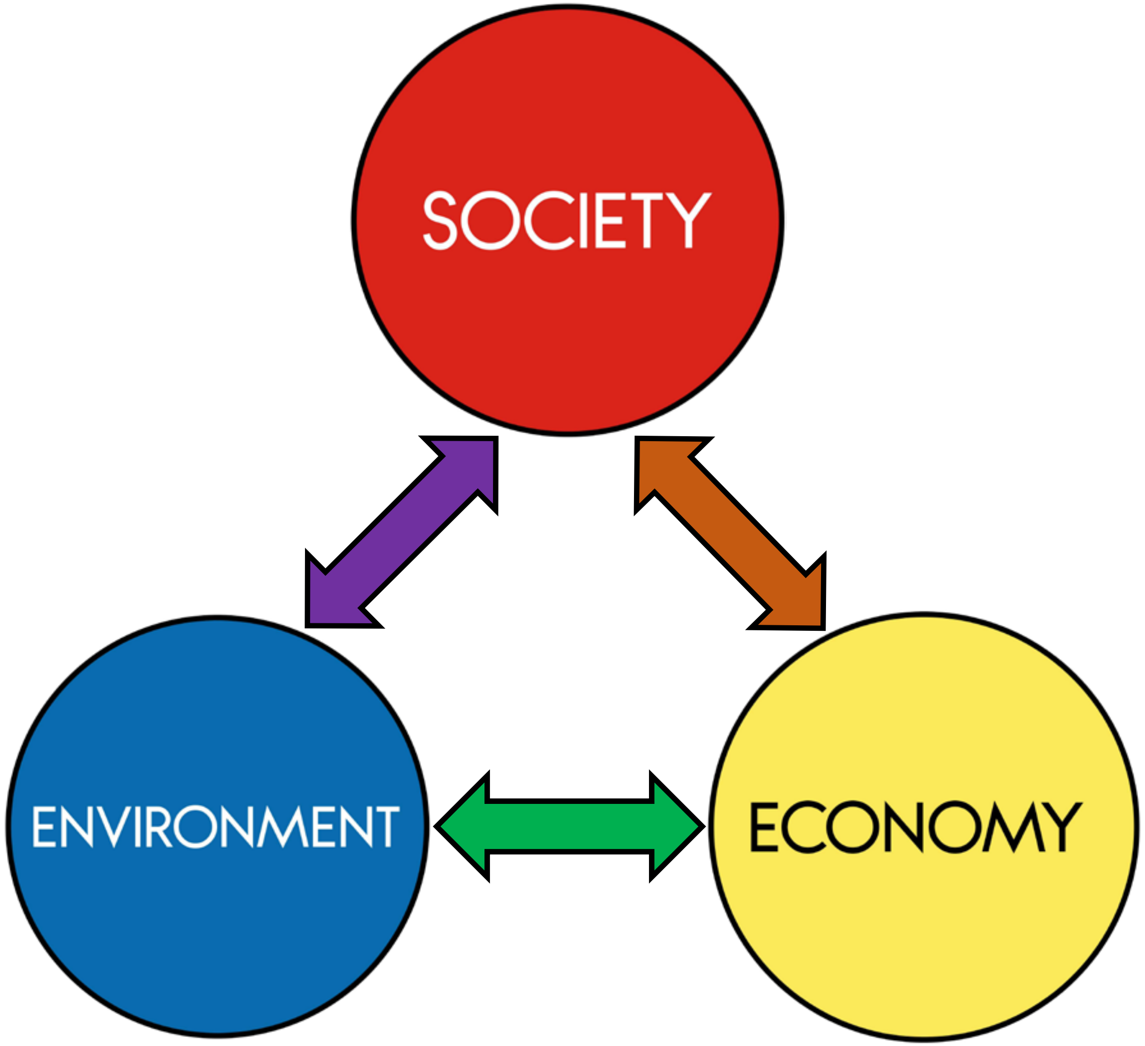
- Attractiveness
- Public Use
- Net Health Effects

All Factors can be both Positive and Negative

Water Features can be Considered "Social Resources"

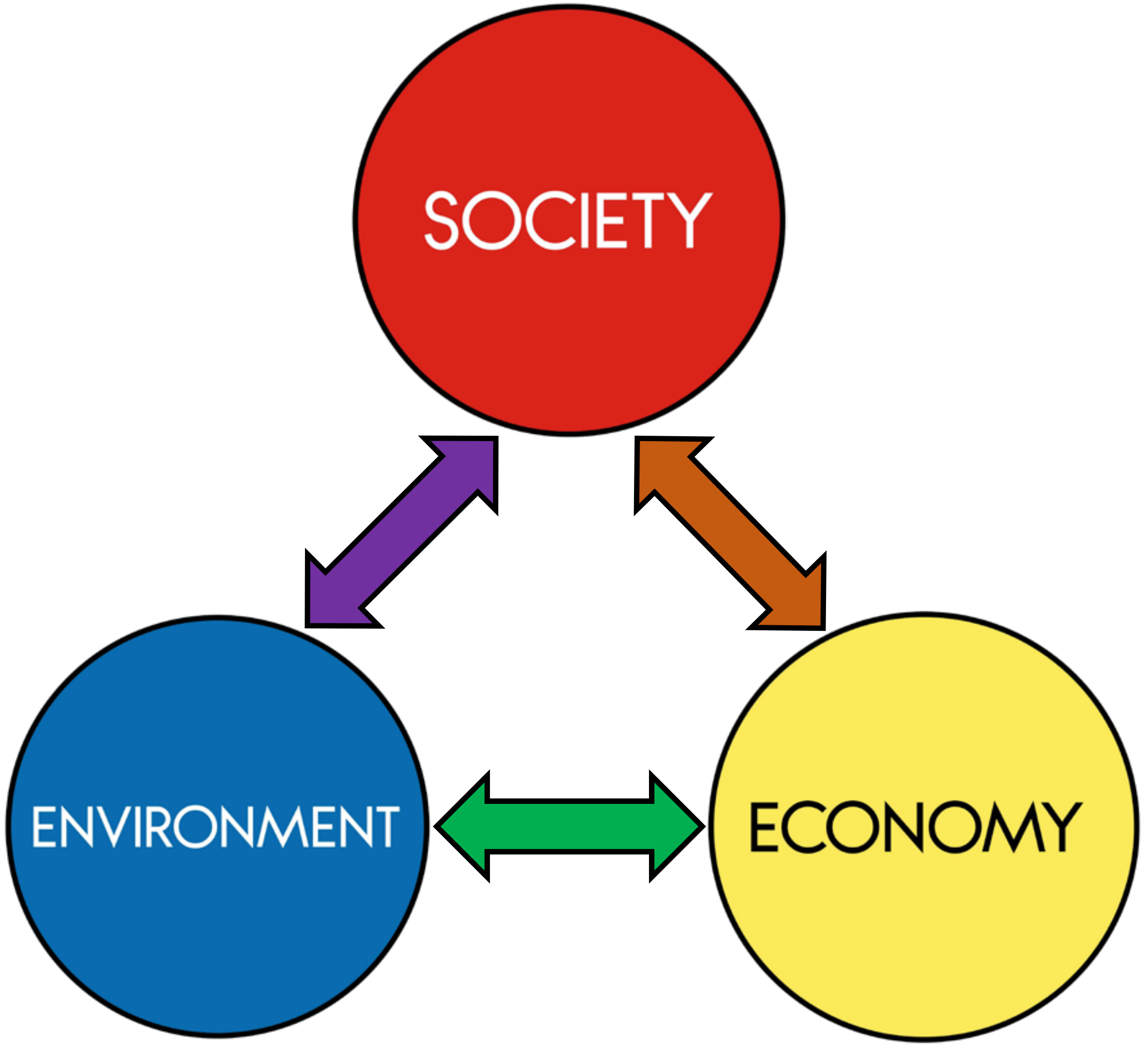
Sustainability

- "Three Dimensions"
- From a Design Perspective, One Cannot Achieve Sustainability without Considering All Three
- To the Layperson: Sustainability is perceived as purely "Green" or Environmental
- To me (as an Engineer) it is an Exercise in Resource Accounting



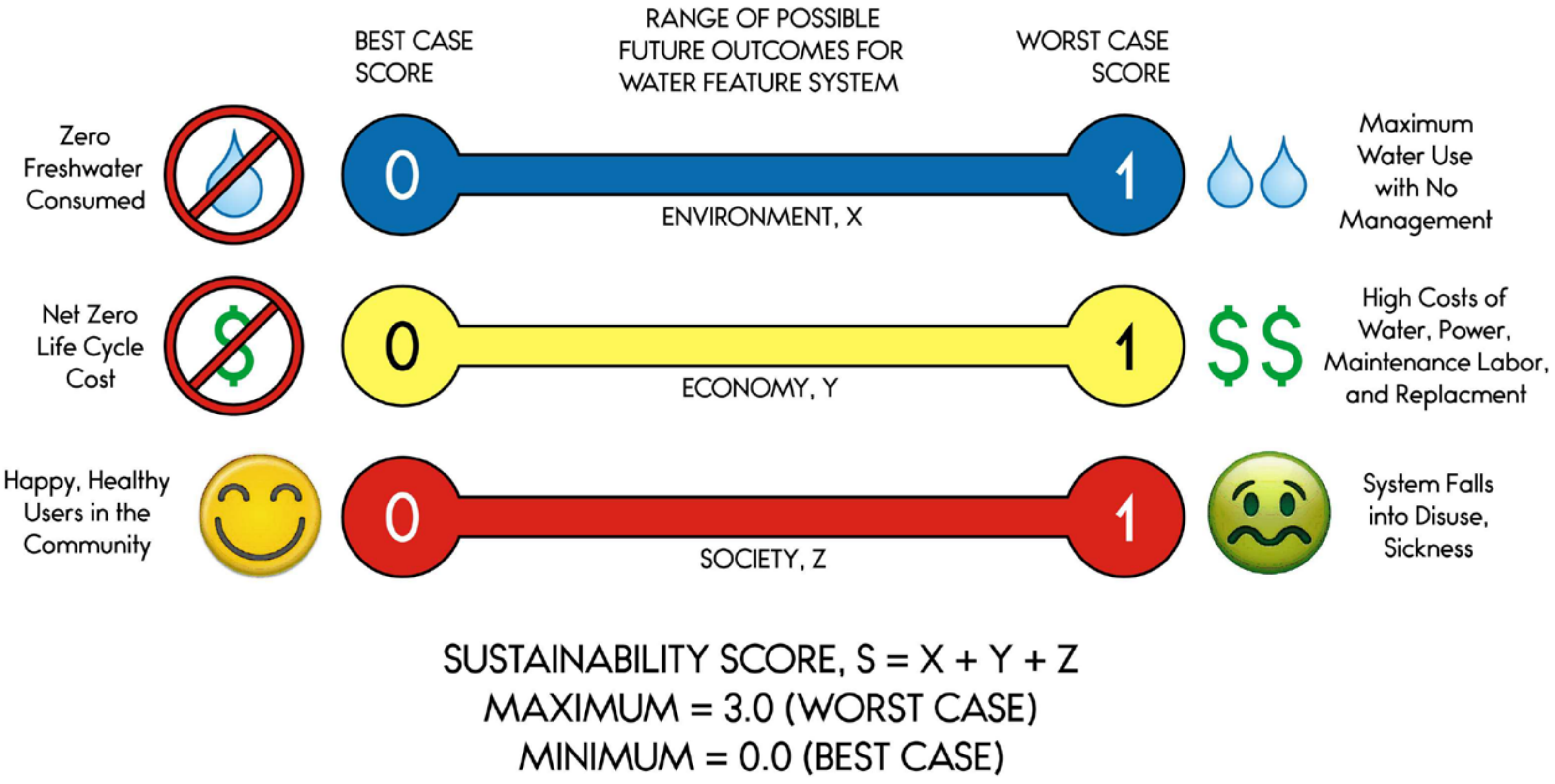
Sustainability

- Sustainability can be achieved by being "Self-Sustaining"
- By Lessening the Dependence on Outside Resources such as:
  - Freshwater Consumed
  - Life Cycle Costs
  - Preservation of Water Features as Intended for Social Use
- A project can survive under a number of outside influences



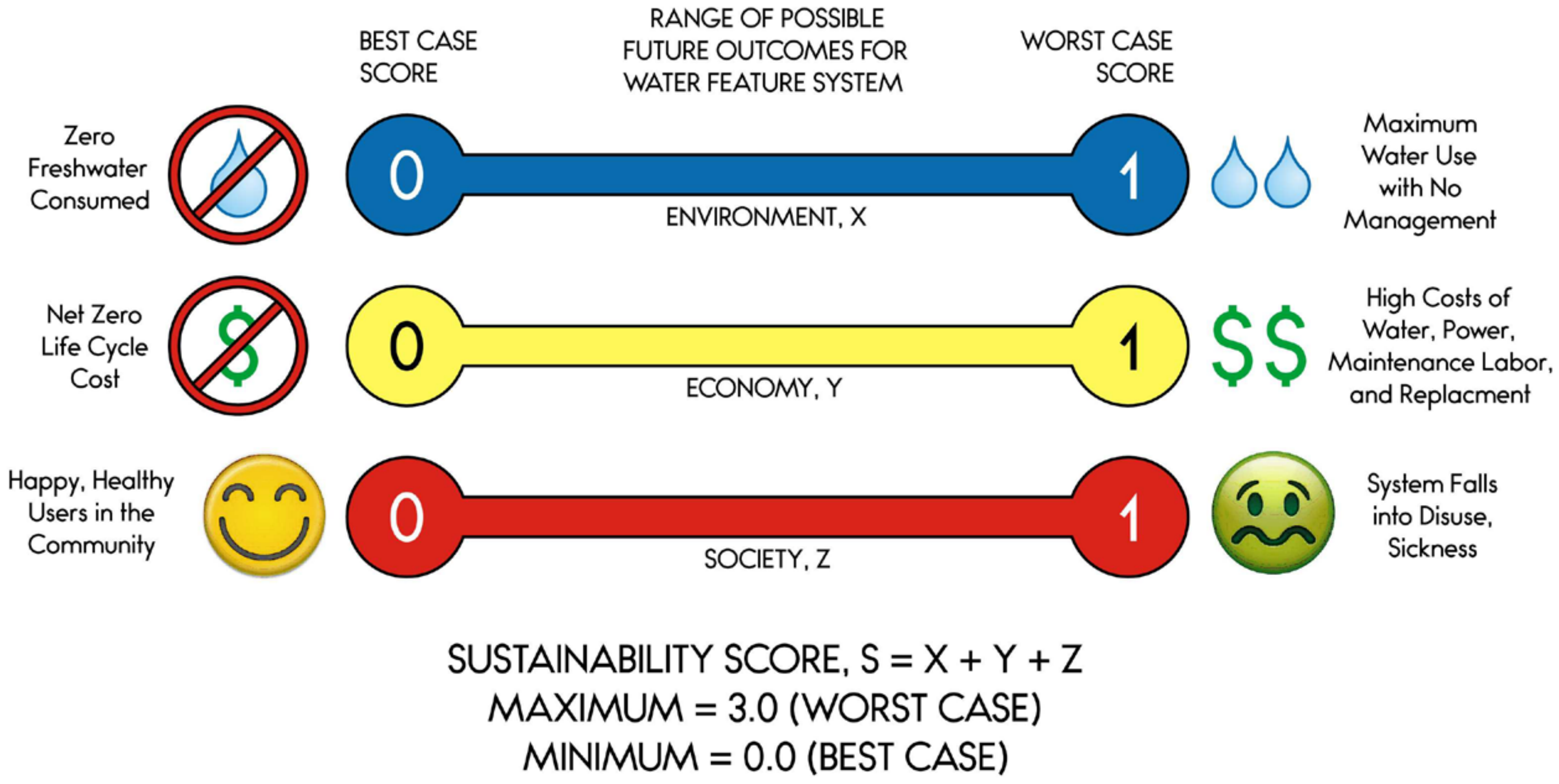
Sustainability

- "Sustainability Score" From 0.0 – 3.0
- Theoretical, but principles can be applied to practice



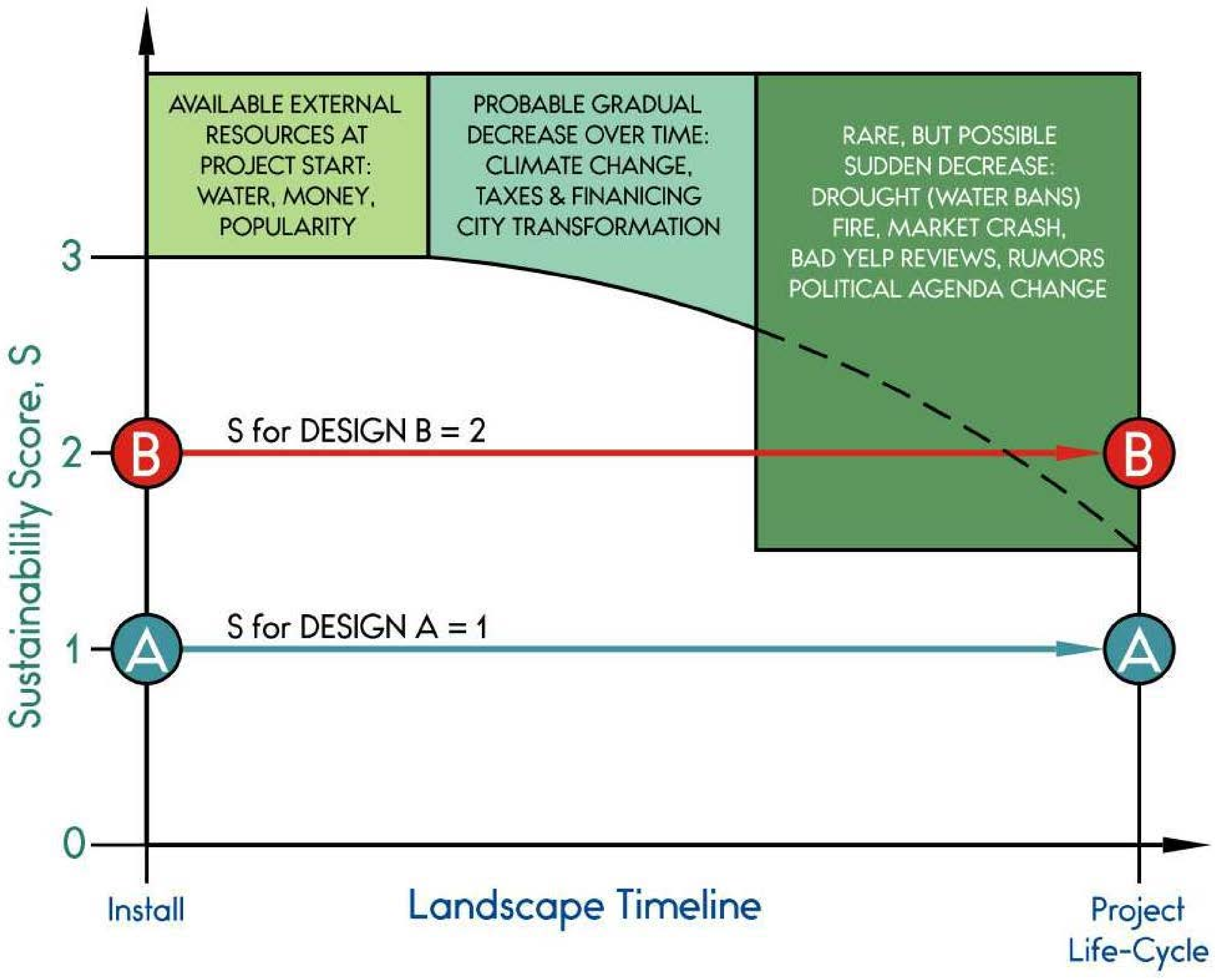
Sustainability

- We all can agree that a Society Score of 0 is a fixed goal
- Therefore, our degree of Sustainability is derived from Water Consumed and System Costs



Sustainability

- "Sustainability Score"
- From 0.0 – 3.0
- Low Score =
  Less Dependent on
  Outside Resources
  Not in our Control
- High Score =
  Very Dependent on
  Outside Resources
  Possibly Unavailable

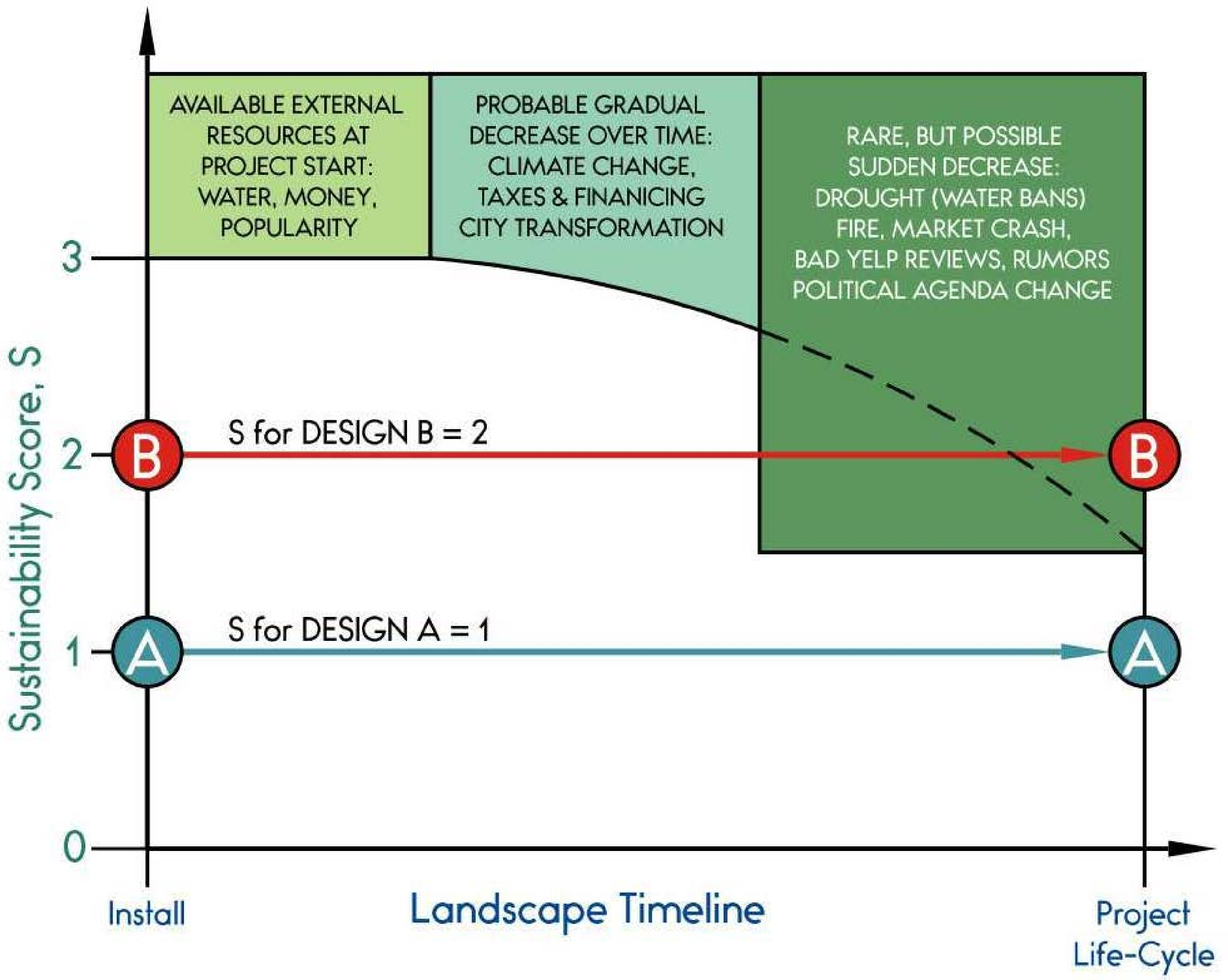


Sustainability

- The Goal:

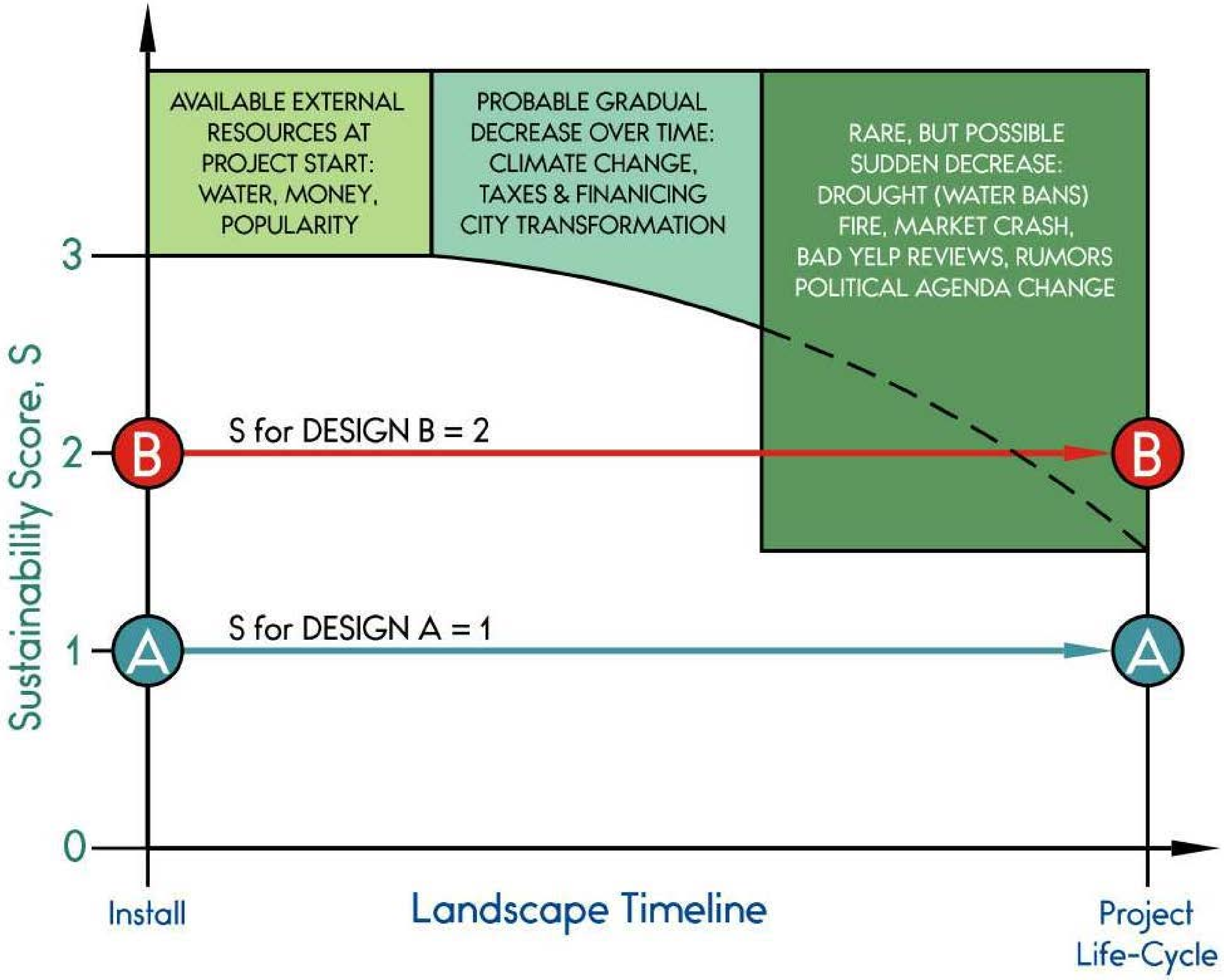
Achieve Autonomy in all of our Landscape Systems so that we are not subject to:

- Water Bans
- High Water / Power Costs
- Effects of Climate Change (Drought, etc.)



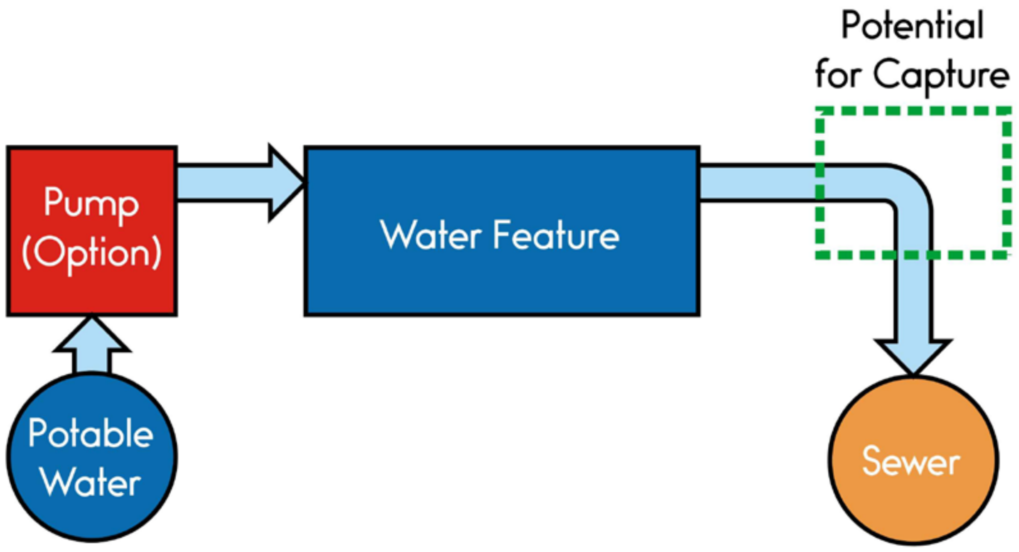
Sustainability

- Design and Install is the Key to Starting Sustainable
- Maintenance is the Key to Staying Sustainable throughout a Project Life-Cycle
- Cursory Review of Water Feature Components



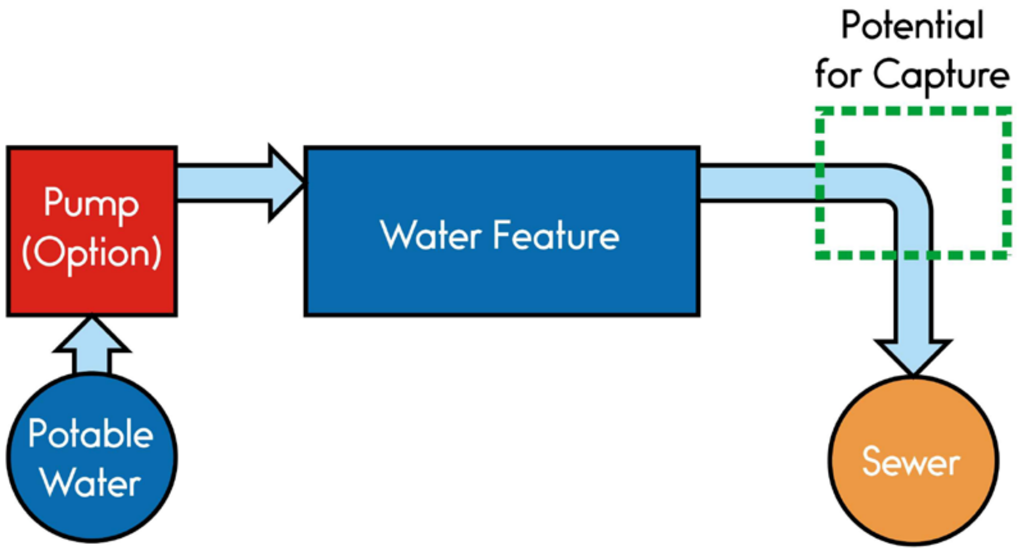
Pass Through Systems

- Pros:
  - Simple Flow Path
    - Water to Sewer
  - Pumps Sometimes Not Needed (using Street Water Pressure)
  - Easier to Maintain
  - Minimizes Spread of Disease (Although not Eliminates)



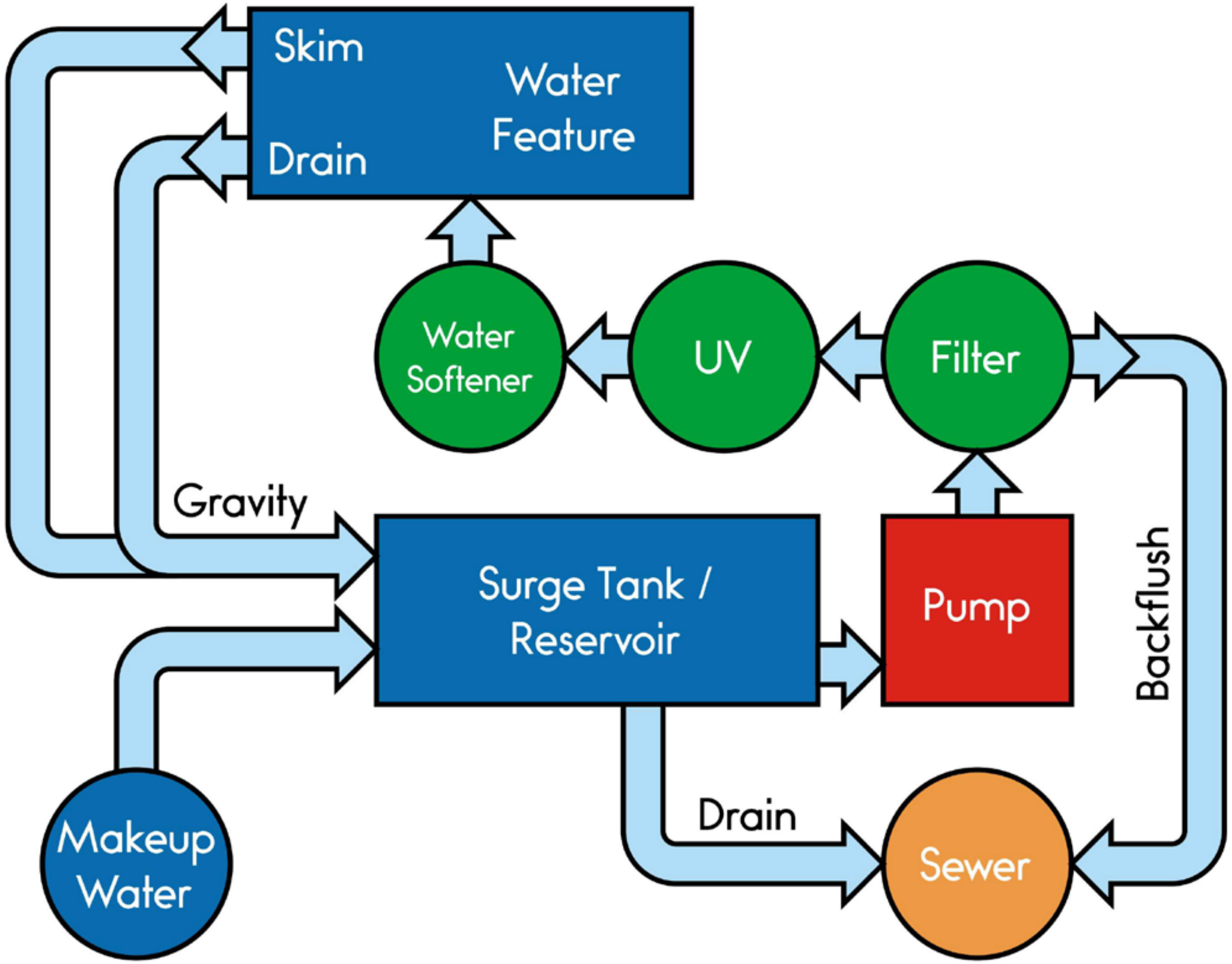
Pass Through Systems

- Cons:
  - Substantial Water Waste and Cost
    - Although there exists a potential to capture and reuse this water
  - Still needs Maintenance for Biofilm, Hard Water, and/or Iron Staining



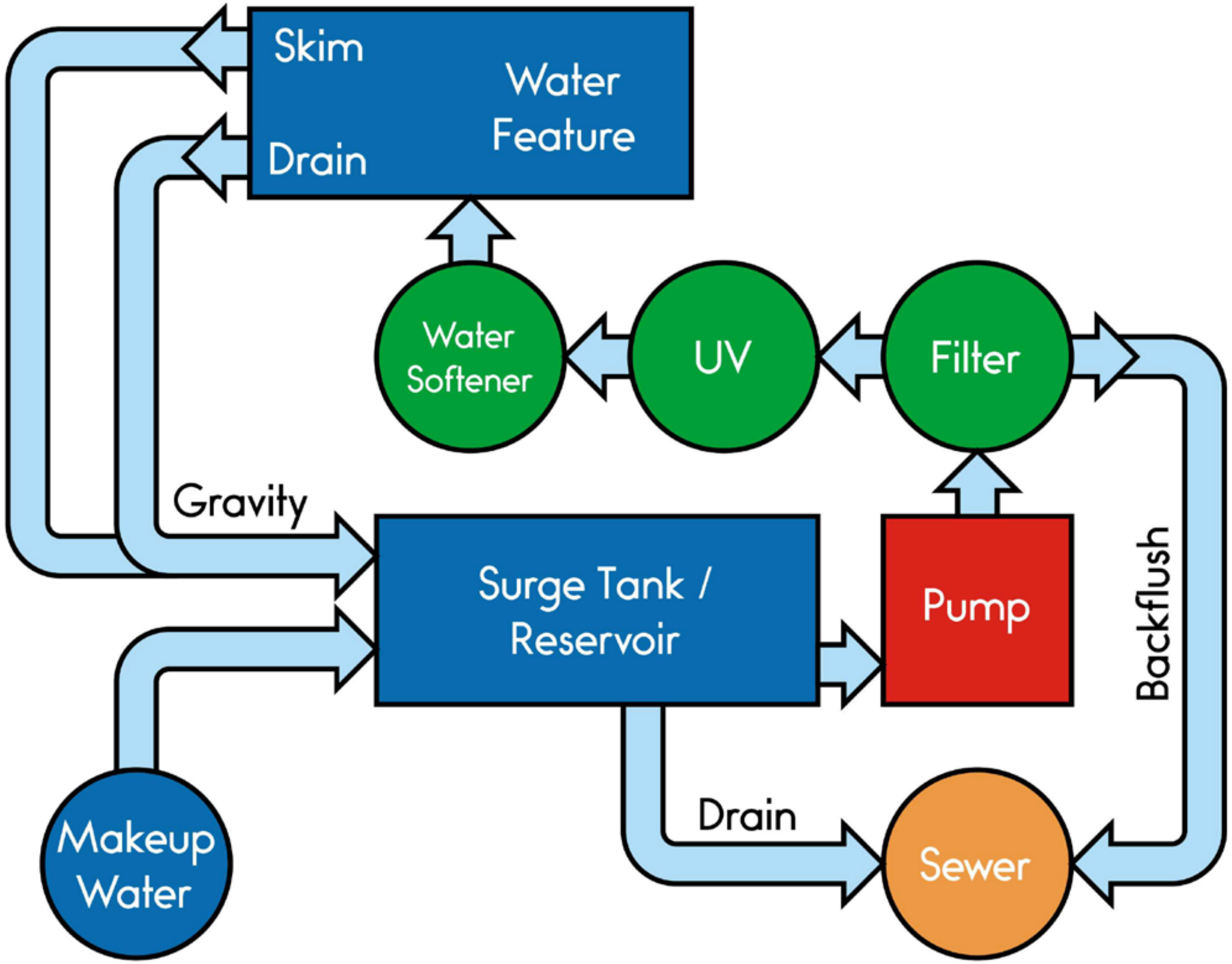
Recirculation Systems

- Pros:
  - Higher Water Savings
    - Although a Makeup Water System is Still Needed
  - More Opportunity for Water Treatment and Automation
  - More Ornate, Dramatic, Visually and Aurally Pleasing Systems



Recirculation Systems

- Cons:
  - High Initial Installation Costs
  - More Maintenance Tasks and Costs
  - More Opportunity for Disease Transmission without proper Maintenance



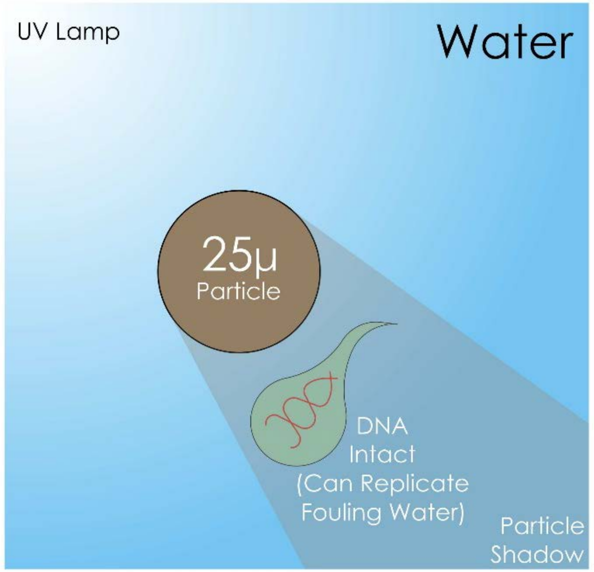
Go over some of these mechanical items

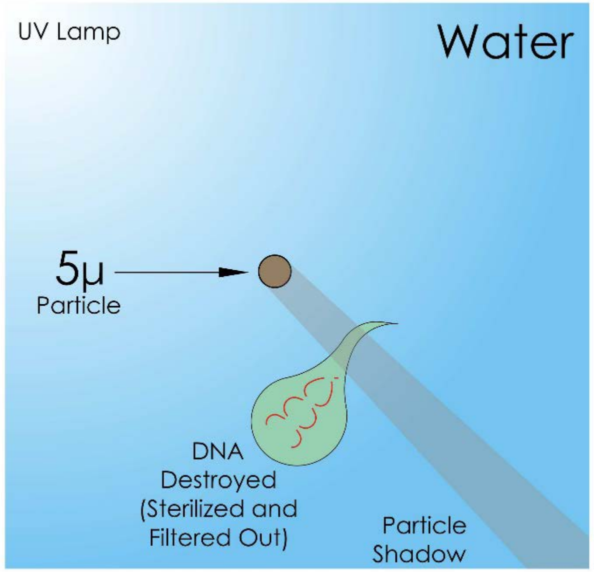
Mechanical Filtration

- Cartridges, Discs, and Screens Capture Particulate in Water Supply
- Sand, Gravel, Glass Beads and Other Media such as Minerals and Activated Carbon can remove some Dissolved Chemistry
- Automatic Backflushing helps Maintenance and Clean Up

Ultraviolet (UV) Disinfection & Sterilization

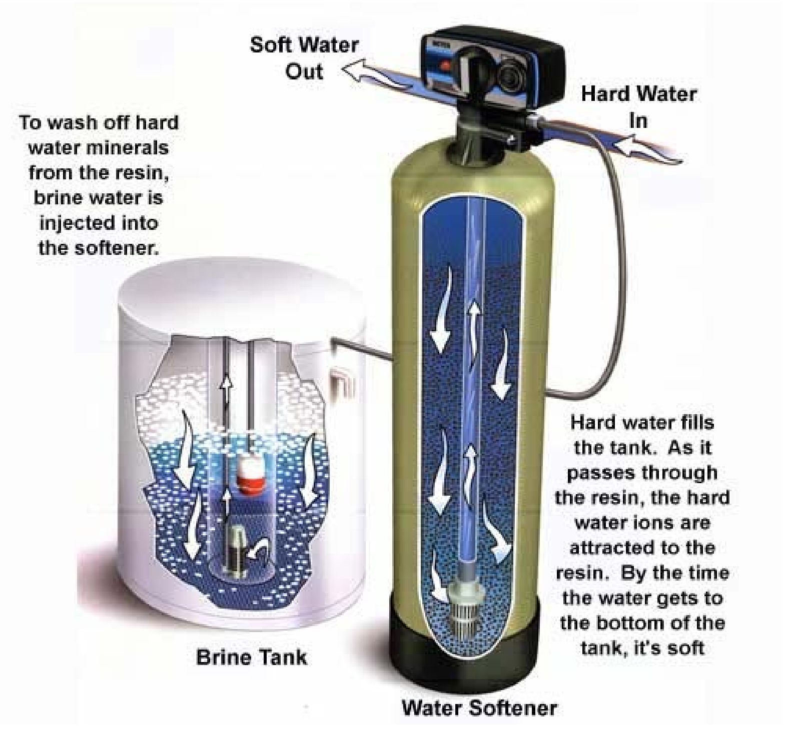
- Uses Long UV Bulbs to Pass Water Across
- UV Light Destroys DNA of Organisms to Prevent Replication—Fouling System
- Filtration First down to 5 – 10 microns to Prevent Particle Shadows

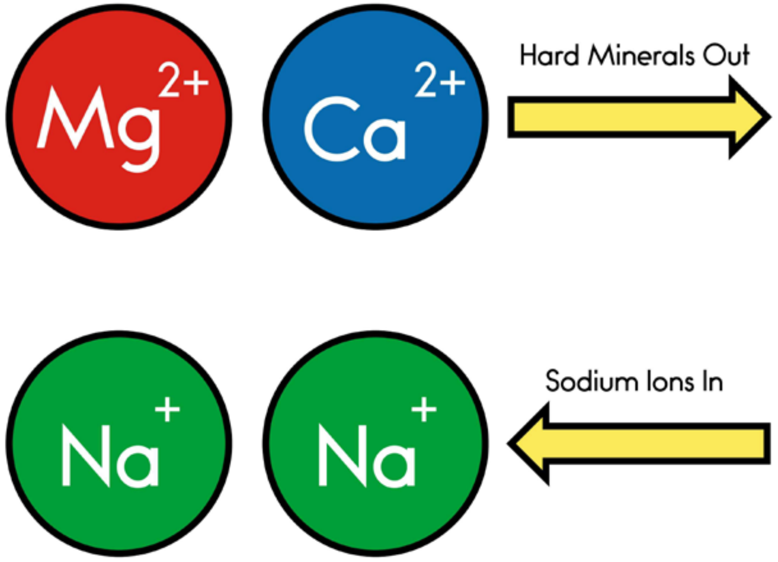




Water Softening

- Chemical Treatment or Addition to Prevent Hard Water and Lime Scale
- Typically Works with Ion Exchange or Adding Lime
- Extends Plumbing and Equipment 25 – 50% Longer with Hard Water Supplies



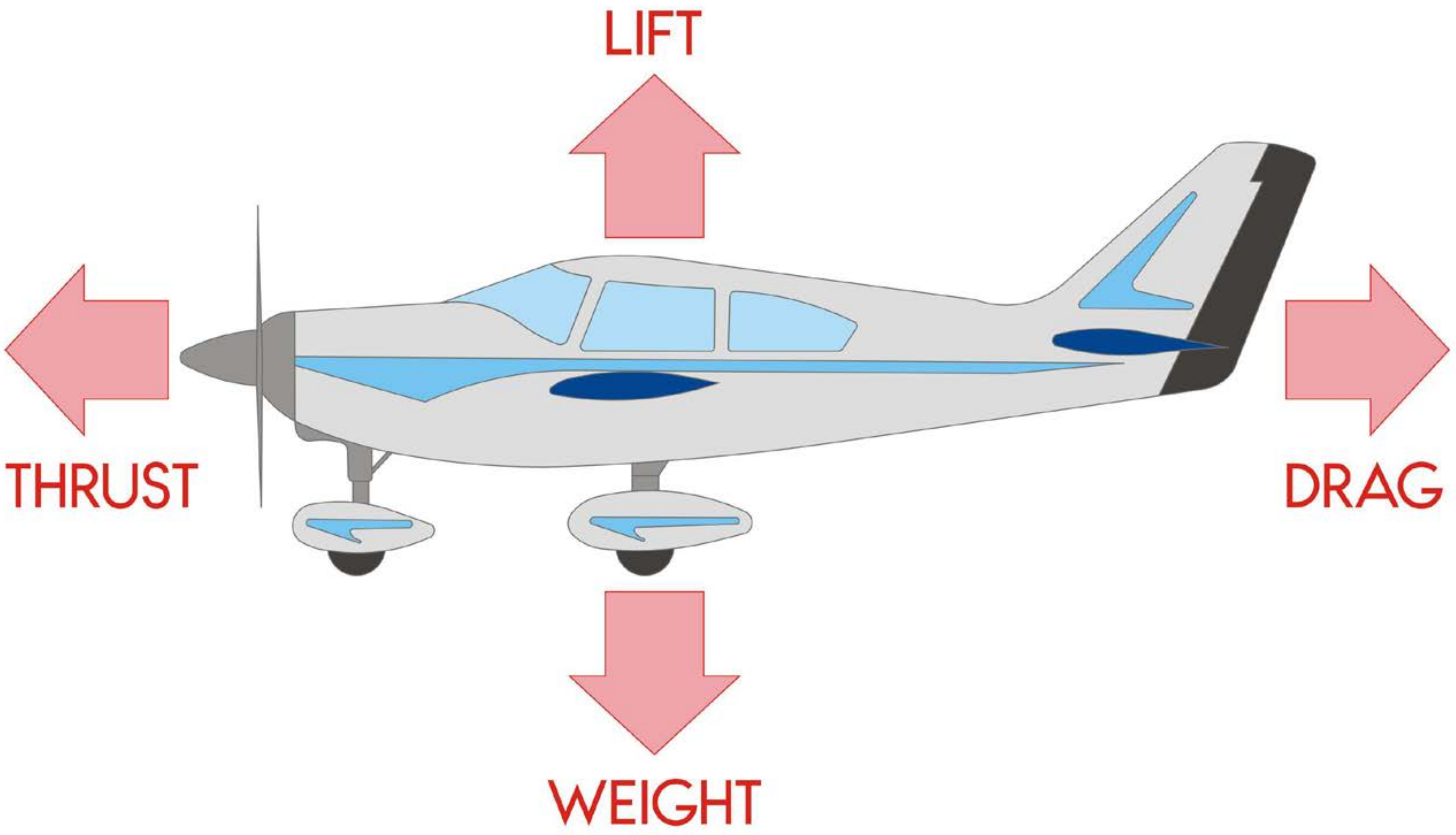


Advanced Chemical

- Typically Found with Swimming Pools and Recirculating Water Parks
- Can Add Automation to Chemical Addition, Filtration, and Refill Valves
- Takes Training and Dedicated Staff to Maintain and Monitor

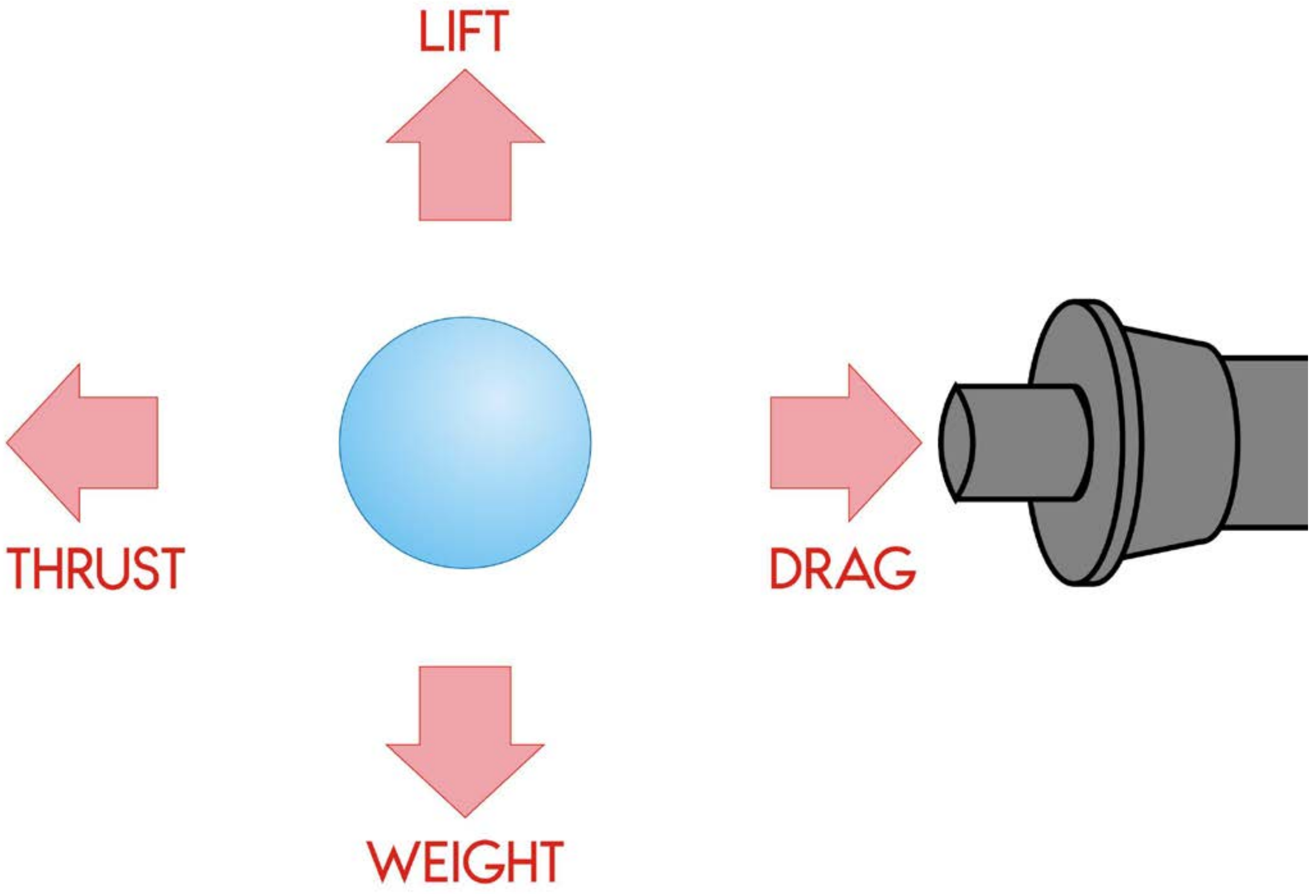
Pumped Flow (Nozzles)

- Designing for the Correct Pressure Ensures Nozzle Sprays Hit Their Intended Targets



Pumped Flow (Nozzles)

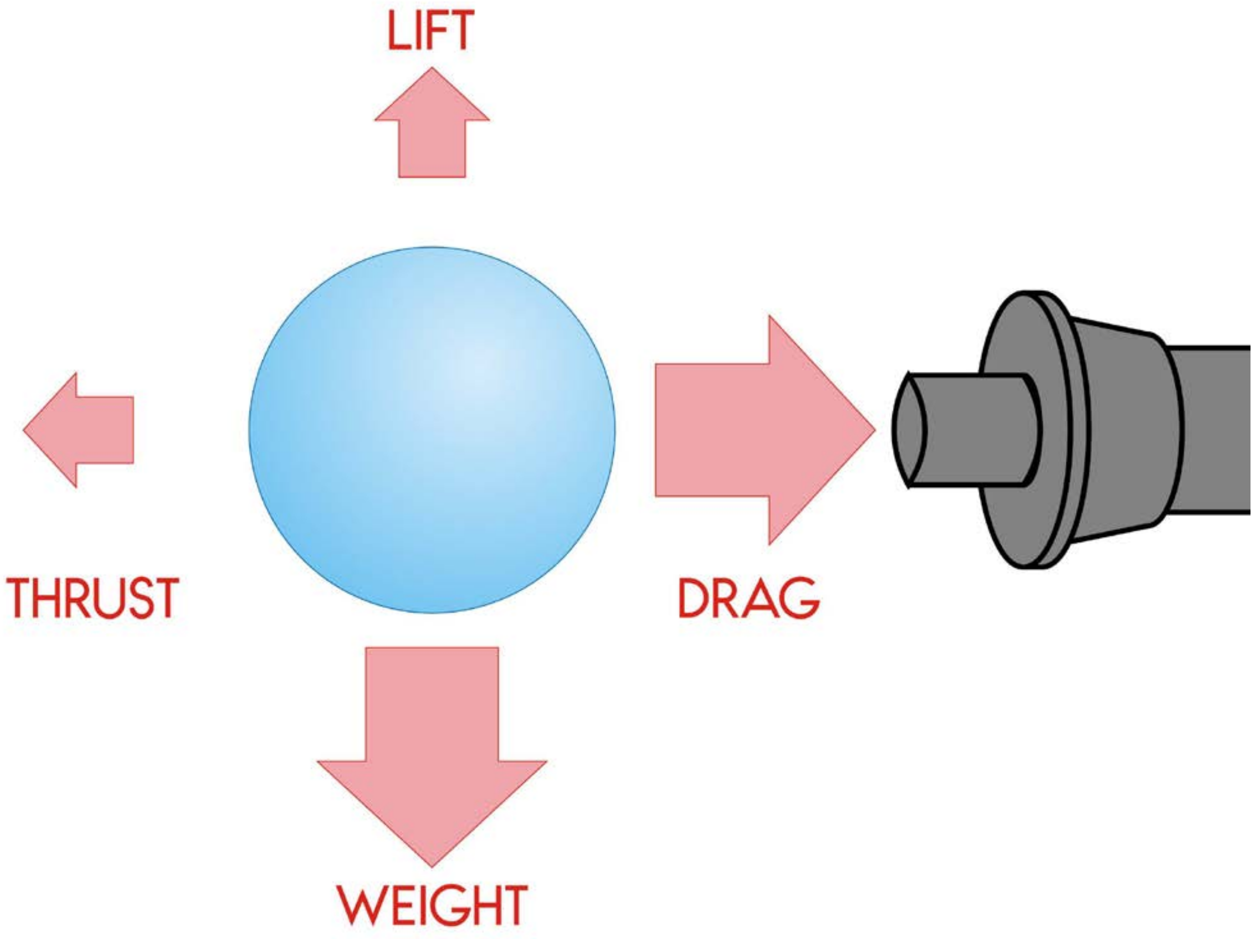
- Designing for the Correct Pressure Ensures Nozzle Sprays Hit Their Intended Targets
- Balanced Pressure



Pumped Flow (Nozzles)

- Designing for the Correct Pressure Ensures Nozzle Sprays Hit Their Intended Targets

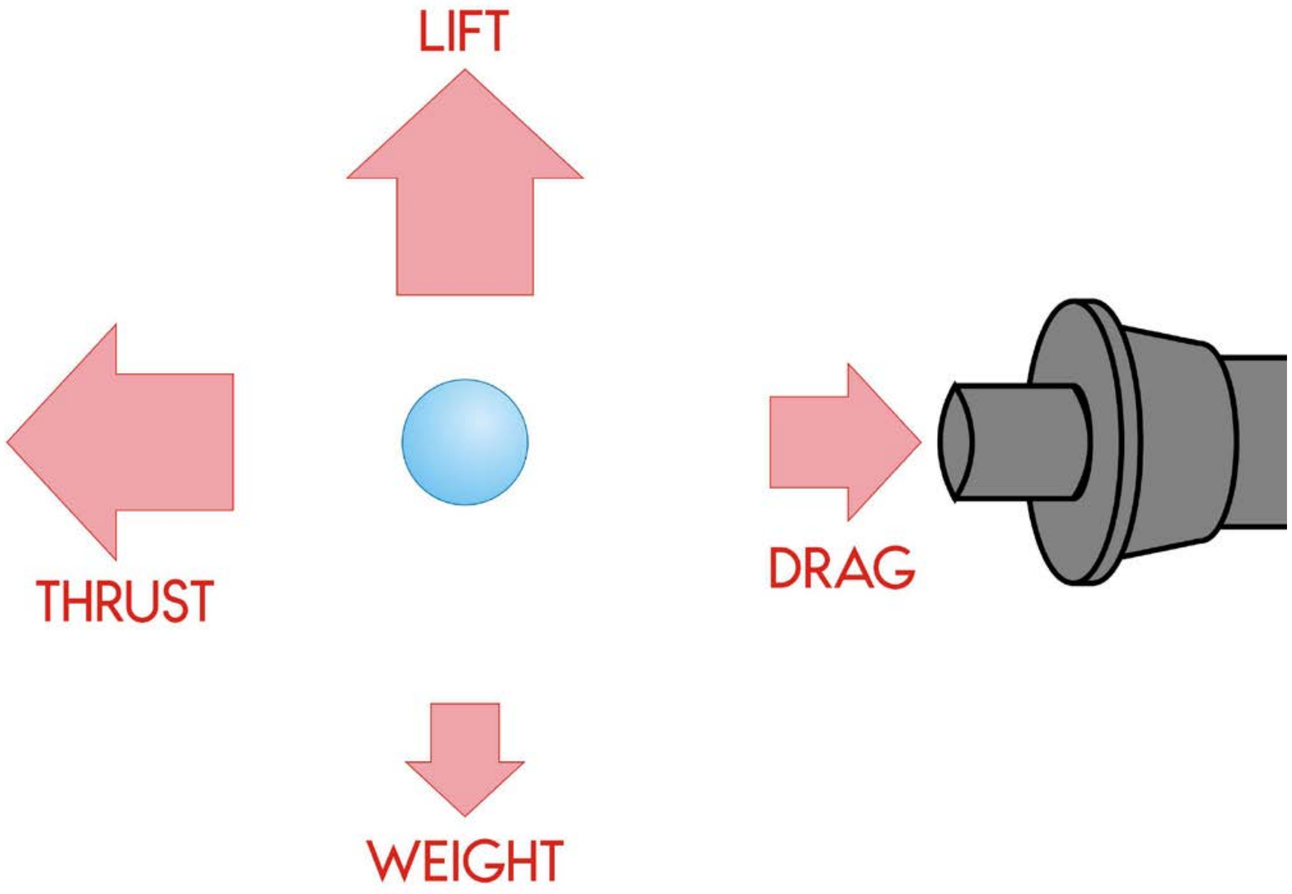
- Low Pressure
  Too Heavy



Pumped Flow (Nozzles)

- Designing for the Correct Pressure Ensures Nozzle Sprays Hit Their Intended Targets

- High Pressure
  Too Small,
  Atomized
  (Ingestible)

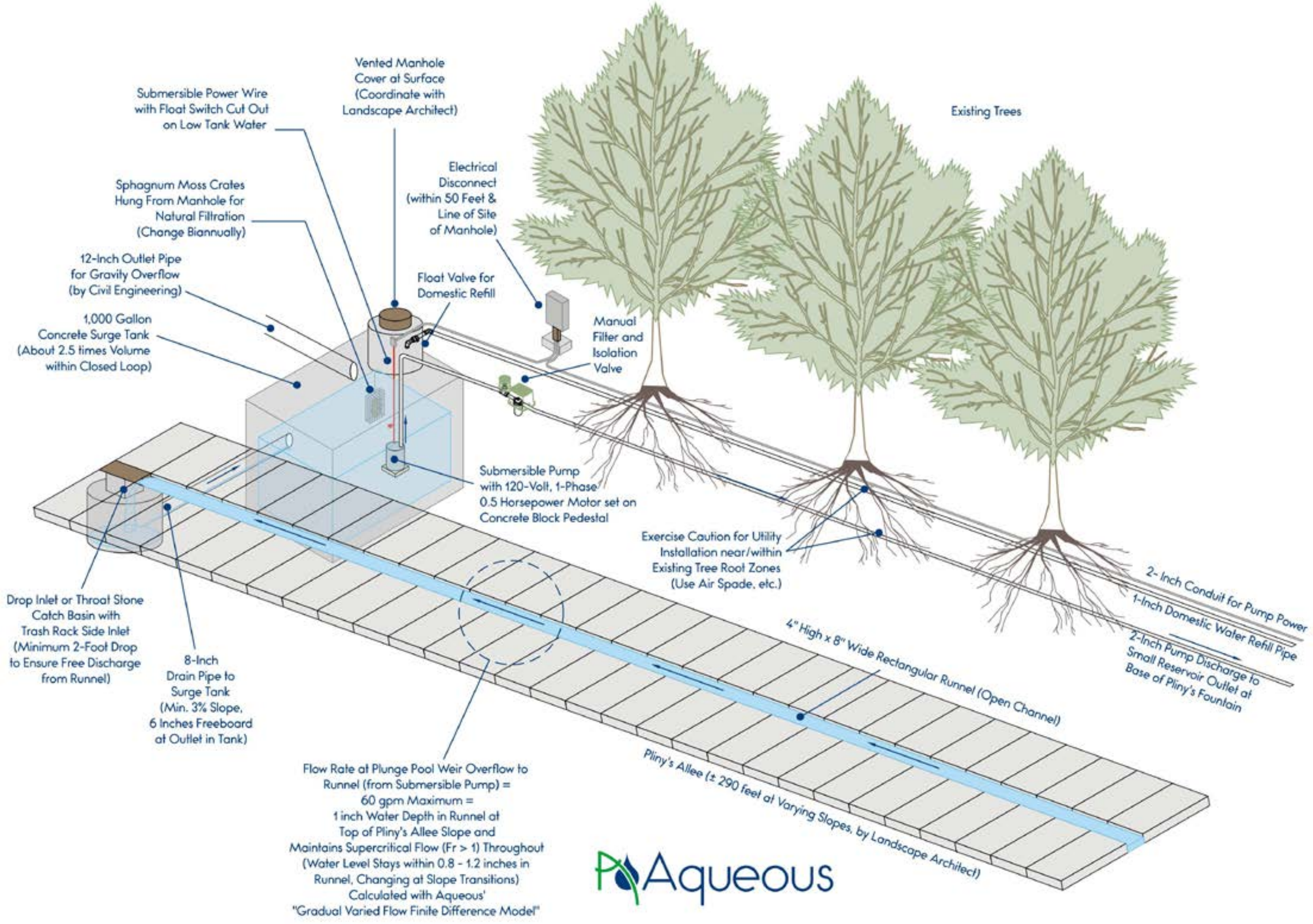


Open Channel (Gravity) Flow

$$\frac{dy}{dx} = \frac{S_0 - n^2Q^2/\left(\alpha^2A^2R_h^{1.33}\right)}{1 - Q^2b_0/(gA^3)}$$

- Understanding Hydraulics and Open Channel Flow is Critical to Keep Water within the Closed Loop

- Computational Fluid Dynamics (CFD) or other Computer Modeling (Finite Difference) used to Estimate Flows, Water Depths, etc.



Water Sustainability & Controls

- Automatic Climate Sensing:
  - Wind Sensing
    - Shutoff in High Winds
  - Rain Sensing
    - Shutoff in Rain
  - Temperature Sensing
    - Shutoff during Low Temperatures

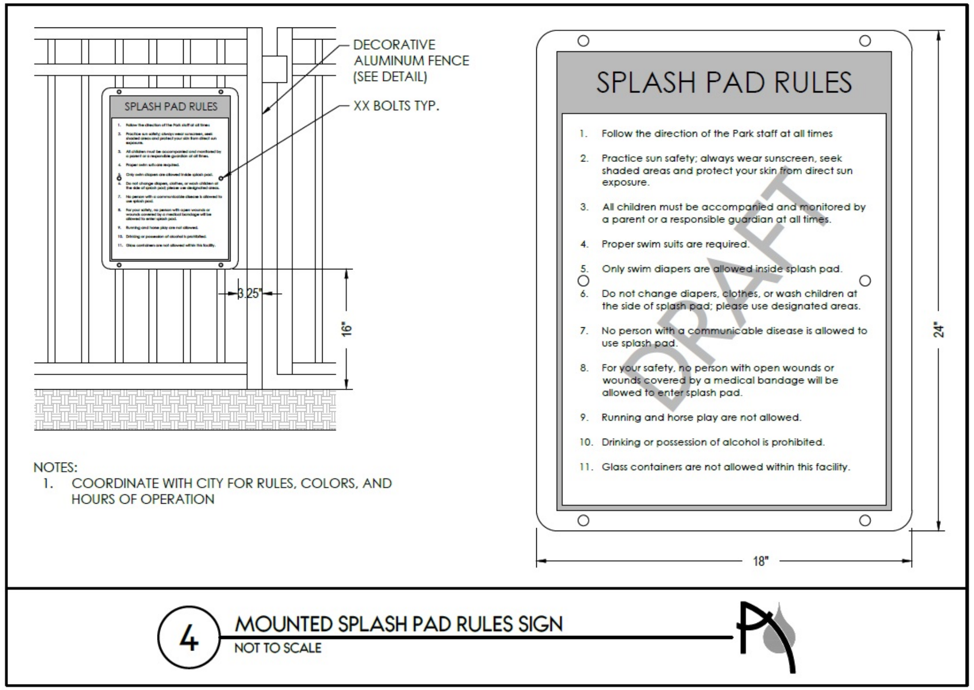
Water Sustainability & Controls

- Motion Sensing
  - System Automated to only Turn On when People Nearby

- Activation Bollards
  - People Have to Turn On System To Use

Signage

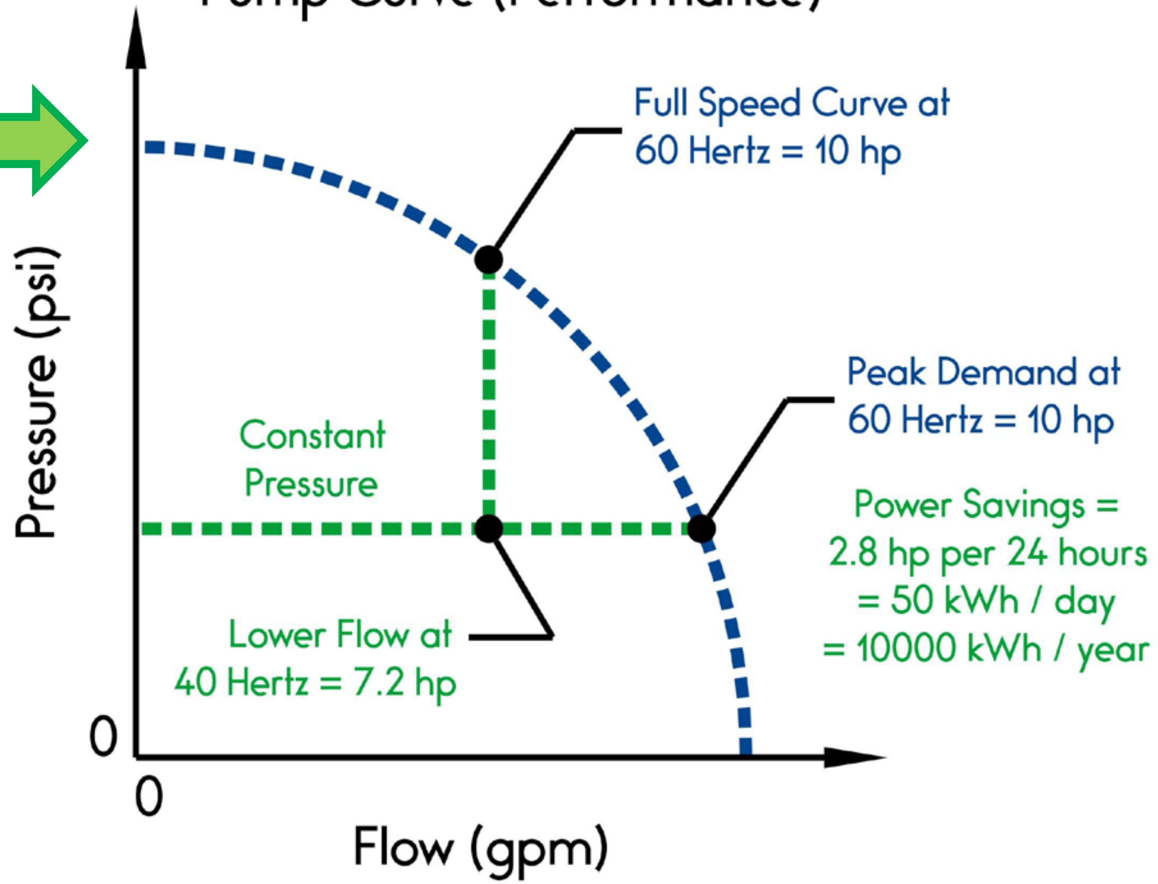
- Let Public Know Where or Not Drink Water, Swim, or Wade
- Further Emphasis to Society to Stay Safe and Do Not Do Anything Imprudent



Electrical Sustainability

- Motion Sensing/Activation
- Variable Frequency Drives (VFD) on Pump Systems
- LED vs. Incandescent
- Solar-Powered Lighting
- Dimmable vs. Non-Dimmable Lights
- +/- 50% Savings in Electric Power Consumption

Frequency (Hertz) ~ Power Consumption
Pump Curve (Performance)



Maintenance Plan

1. First Year Guarantee by Contractor

    a. Provide Training to Owner
    b. Provide O&M Manual
    c. Provide Basic Troubleshooting
    d. Provide First Winterization and Spring Startup
    e. Provide a List of Qualified Service Technicians
    f. Set up Internet Access, Text Notification, Web/Mobile App

Maintenance Plan

2. Filter Cleaning

a. Ensure System is Shut Down
b. Ensure Pressure is Relieved in System Prior to Opening Valves and Filter
c. For Manual Filters, Check at least Once per Week
d. For Automatic Filters, Check via Remote Access and Check Weekly to Ensure Proper Operation

Maintenance Plan

3. UV System

a. Replace Bulbs Annually at Winterization (whether or not expired)
b. Observe system during routine daily/weekly maintenance
c. Where possible, provide automation with a central controller

Maintenance Plan

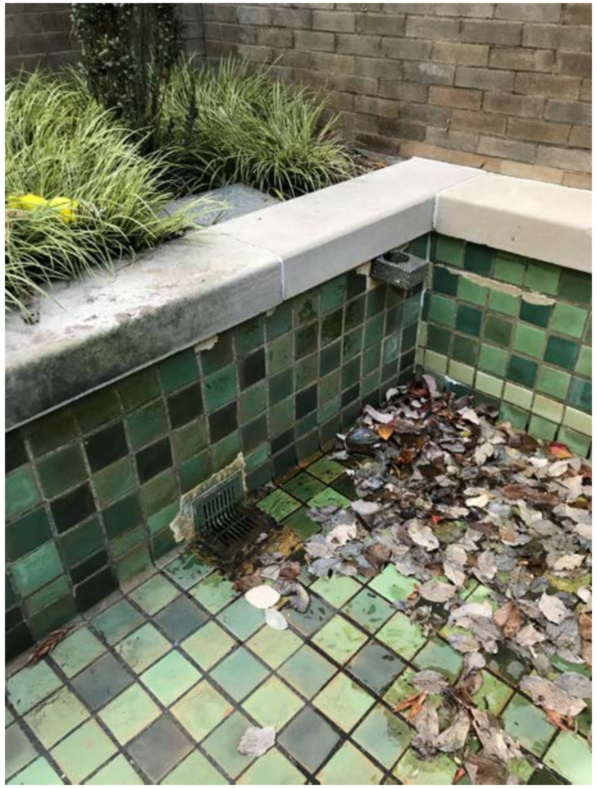
4. Softening

a. Provide routine checks of water upstream and downstream using test strips or solutions for hardness
b. Ensure brine tanks and chemical feeds are full to be able to rinse off hard water minerals from resin

Maintenance Plan

5. Washing of Surfaces

a. Biofilm, Pollen, Dust, Mold, Mildew, and Debris can accumulate on Damp/Submerged Surfaces
b. Systems need to be shut down periodically, drained and scrubbed or power washed with a safe detergent or soap and rinsed with clean water



Maintenance Plan

6. Hard Water Scale

   a. Exercise Valves! Opening and closing valves periodically with hard water will extend life of system and components
   b. Check nozzles and pipe for mineral deposits.
   c. Use Wire Brushes and Organic Lime Scale Remover where Possible

Maintenance Plan

7. Reservoir Cleaning

a. With Reservoirs and Surge Tanks that capture outside drainage, sediment can build up and clog pumps over time

b. Proper maintenance of tanks includes annual vacuuming or power washing sediment to sewer system

Maintenance Plan

Summary of Maintenance

- Helps to Maintain the Intended Use, Look, Design of the Water Feature over its Life Cycle
- Helps to Prevent the Effects of Sudden Drops in Resource Availability like Water Rate Hikes, Down Time, and Major Repairs
- The Level of Maintenance that an Owner is willing to assume has to be discussed during and incorporated into the design
- Design and Maintenance Planning are Key Components in Value Engineering

Maintenance Plan

Annual Maintenance Cost Estimates (Rules of Thumb)

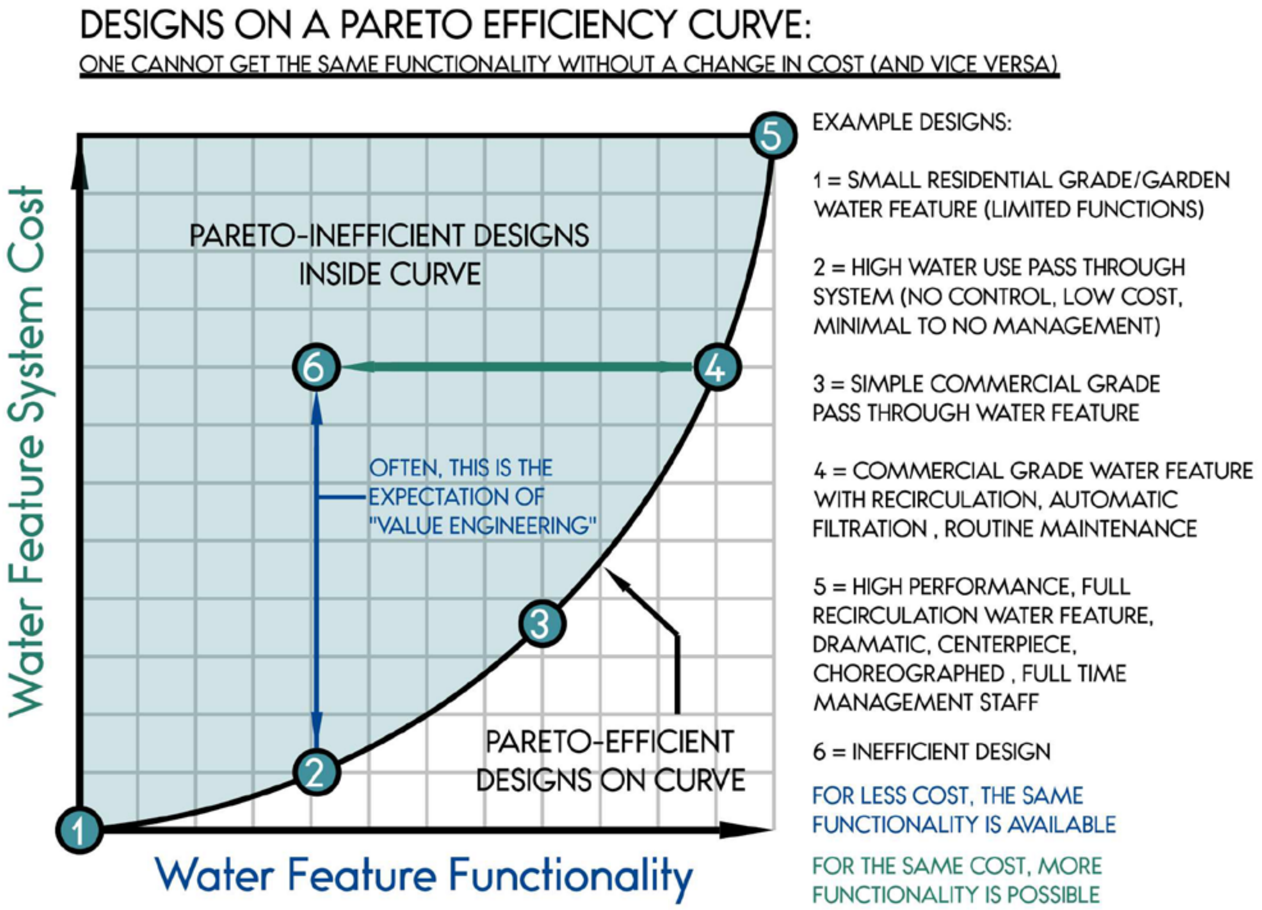
- Pass Through Systems
  - ¼ - ½ hour per day for every day open
  - Splash Pad Open 90 days per year
  - Plan for 45 hours of maintenance/checking per year
  - $2,000 - $2,500 per year

- Recirculation Systems
  - 1 - 2 hour per day for every day open, plus 1 service call
  - Fountain Open 120 days per year
  - Plan for 180 – 240 hours of maintenance per year
  - $10,000 for labor + $2,000 for service calls

Value Engineering

We Have to Understand our Clients' Needs and Wants in the Long-Term

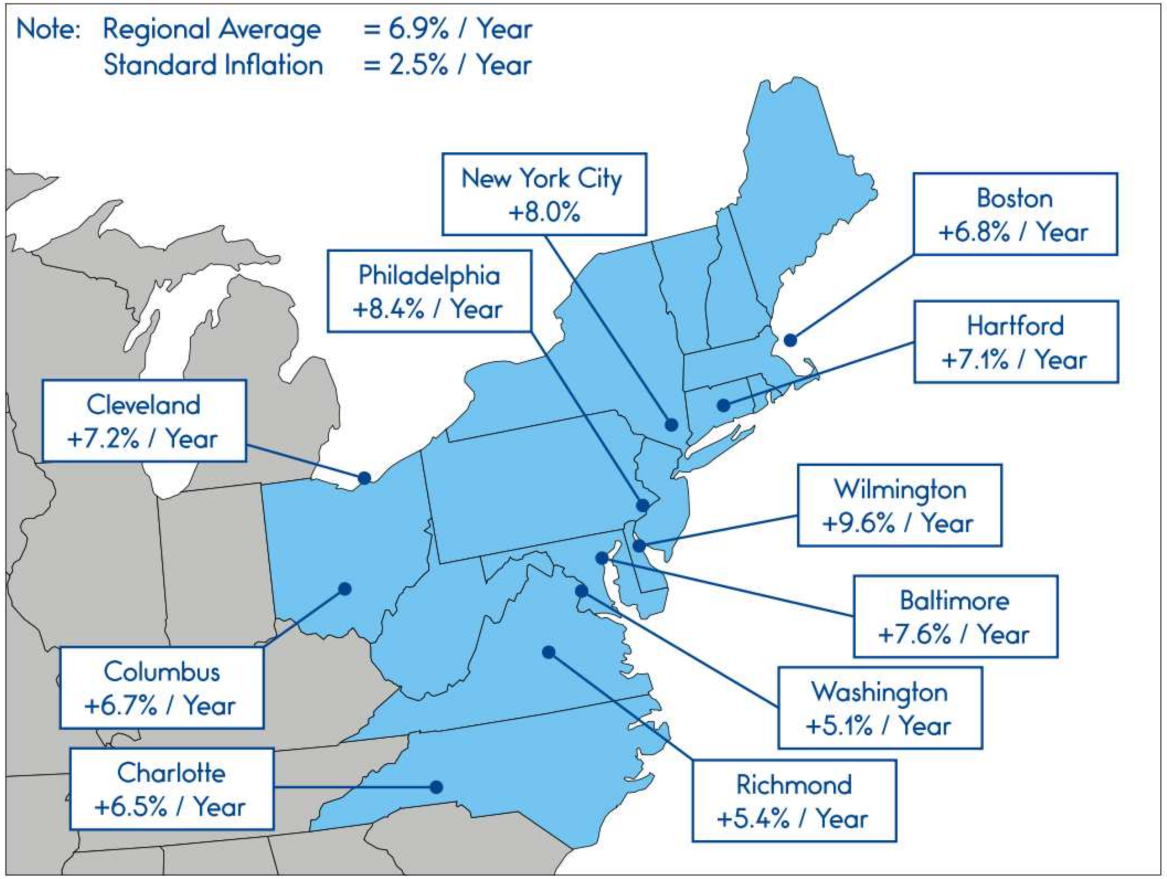
- Value Engineering is not "Free Cost Cutting"
- Real Value Engineering is TRADEOFFS through Pareto Efficient Design
- Understanding Current and Future Costs Critical to Value Engineering and Sustainability



Estimating Costs

Requires a Basic Understanding of Current and Future Water and Labor Costs

- Domestic Water Increases about 7% annually to pay for infrastructure, workers, etc.
- Laborers have had modest Cost of Living raises (about 2% annually) but other costs such as Health Care increase faster than 2%



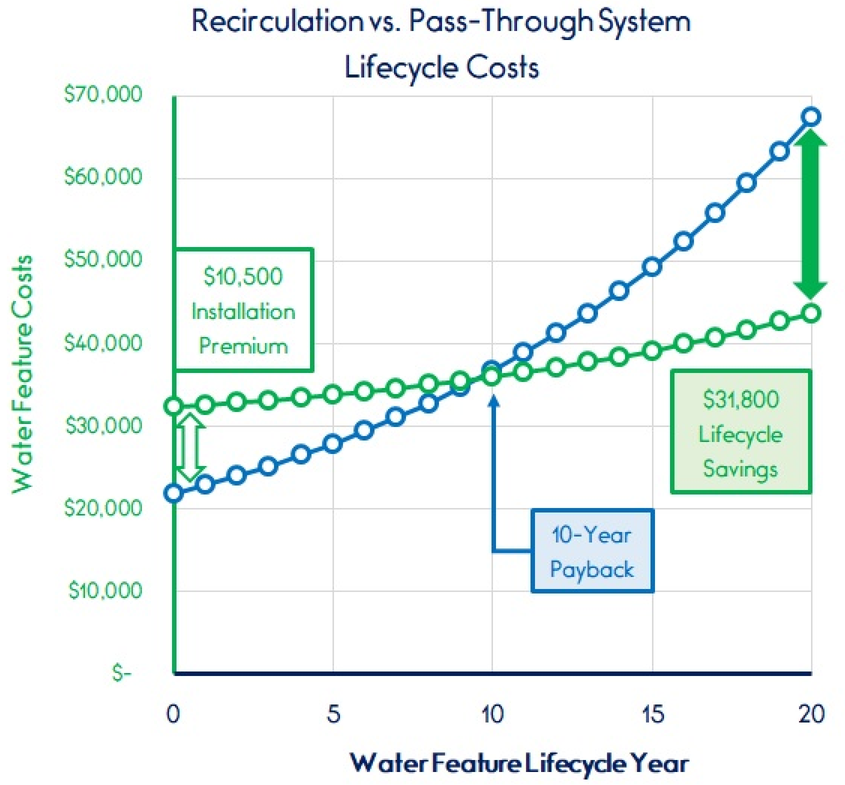
Estimating Costs

Discerning Value

- Cash Flow Diagrams and/or Life Cycle Cost Spreadsheets
- Payback Analysis Critical
  - Sometimes Paybacks are too long to justify expensive installs

Estimated Premium for Recirculation System Installation Costs over Pass Through System	$10,500
Average Municipal Water Annual Rates Increases for Water Feature (Water + Sewer Costs)	7.50%

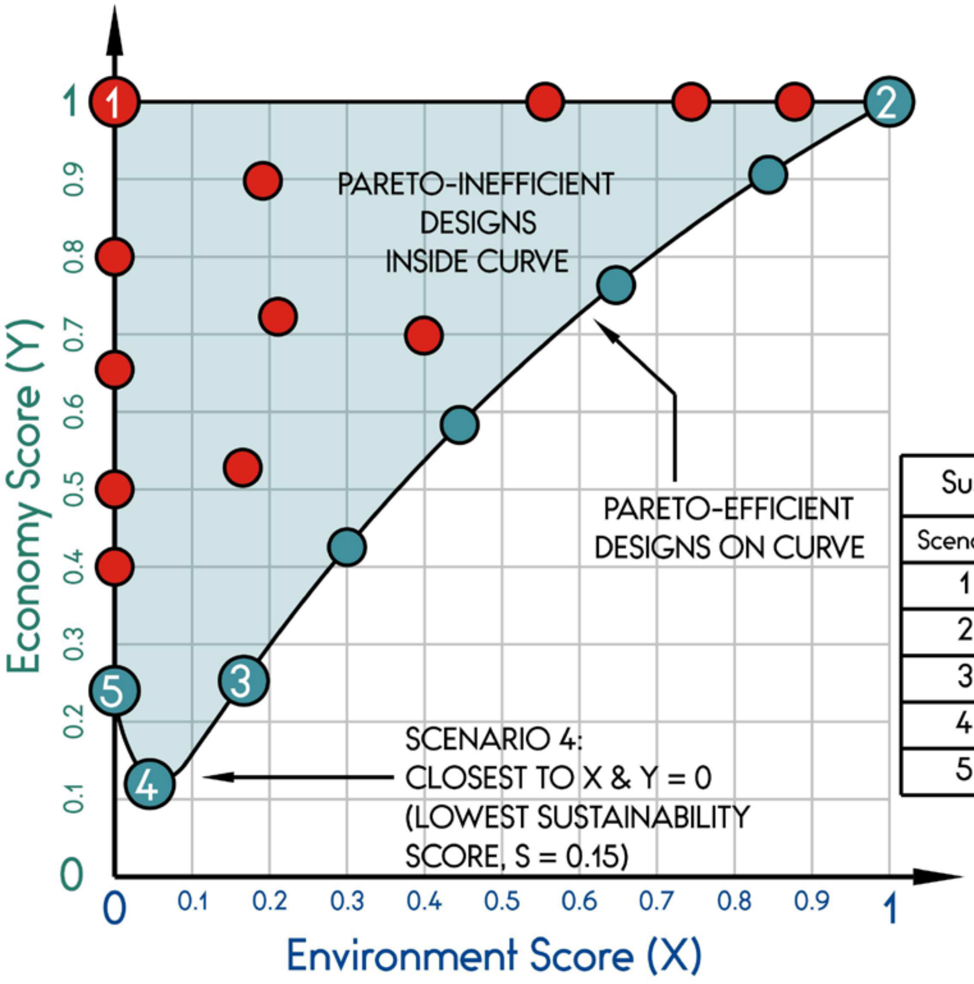
Water Cost per 100 cubic feet	Payback Costs (Years)	20-Year Lifecycle Savings
$ 5	20	$ 10,600
$ 6	18	$ 12,700
$ 7	16	$ 14,900
$ 8	15	$ 17,000
$ 9	14	$ 19,100
$ 10	13	$ 21,200
$ 15	10	$ 31,800
$ 20	8	$ 42,400
$ 25	7	$ 53,100
$ 30	6	$ 63,700



Estimating Sustainability

Under the Context of the “Sustainability Score”:

- Different Designs can be weighed based on not only cost (Economy), but also water consumption (Environment)
- By definition, a “sustainable” design is one that weighs Economy, Environment, and Society Equally (Pick lowest total score)



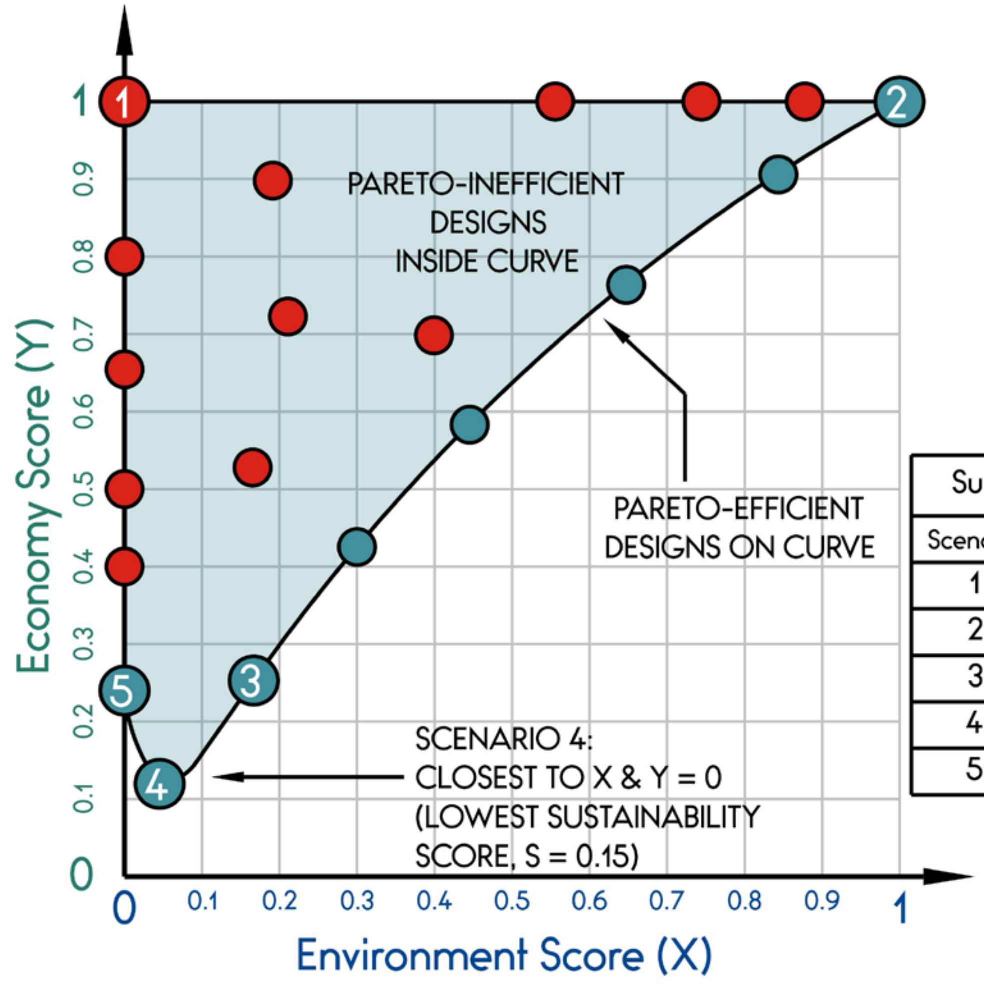
Sustainability Score Summary

Scenario	X +	Y +	Z =	S
1	0.00	1.00	1.00	2.00
2	1.00	1.00	0.00	2.00
3	0.18	0.26	0.00	0.44
4	0.03	0.12	0.00	0.15
5	0.00	0.24	0.00	0.24

Estimating Sustainability

Under the Context of the "Sustainability Score":

- Going over these combinations of systems is critical for performing a "True Value Engineering" analysis
- It also clearly defines a strategy and goal to move forward in design and maintenance



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Conclusions

- In the context of Sustainability, there are generally three agreed-upon dimensions
  - Economy, Environment, and Society
- Ideally, we consider all dimensions equally; however, the Society piece (minimize disease transmission and safety) is non-negotiable.
- But, there are always opportunities to be more sustainable and frugal with our Economic and Environmental Resources
- Sustainable Design entails Long-Term Design with clear objectives in the Planning and Value Engineering processes

Thank You!

- I appreciate your time and interest in this topic
- I will be happy to answer any questions