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Associated Supply Company, Inc. Filtration Systems and Design Considerations



Why does Filtration Matter?

- Public health & safety
- User comfort and experience
- Regulatory compliance
- Energy and operational costs
- Prevent the spread of recreational water illnesses



Are all Public Pools the Same?

- Bather loads
- Water temperature
- Age usage
- Operational considerations
- Different swim uses – rehab, recreation, competition, instruction



Classifying Pools (ISPSC)

Classifications

- A: Accredited comp. pool
- B: Public pool
- C: Semi-public pool
- D: Activity Pool
 - Wave, activity, plunge, lazy river, vortex, feature
- E: Therapy pool
- F: Wading pool

Types

- Type 0: Non-diving
- Type 1-5: Residential pools suitable for diving and type specific diving equipment
- Type 6-9: Public or semi-public pools suitable for type specific diving equipment



Class A: Fargo Island Park Competition Pool (2025)





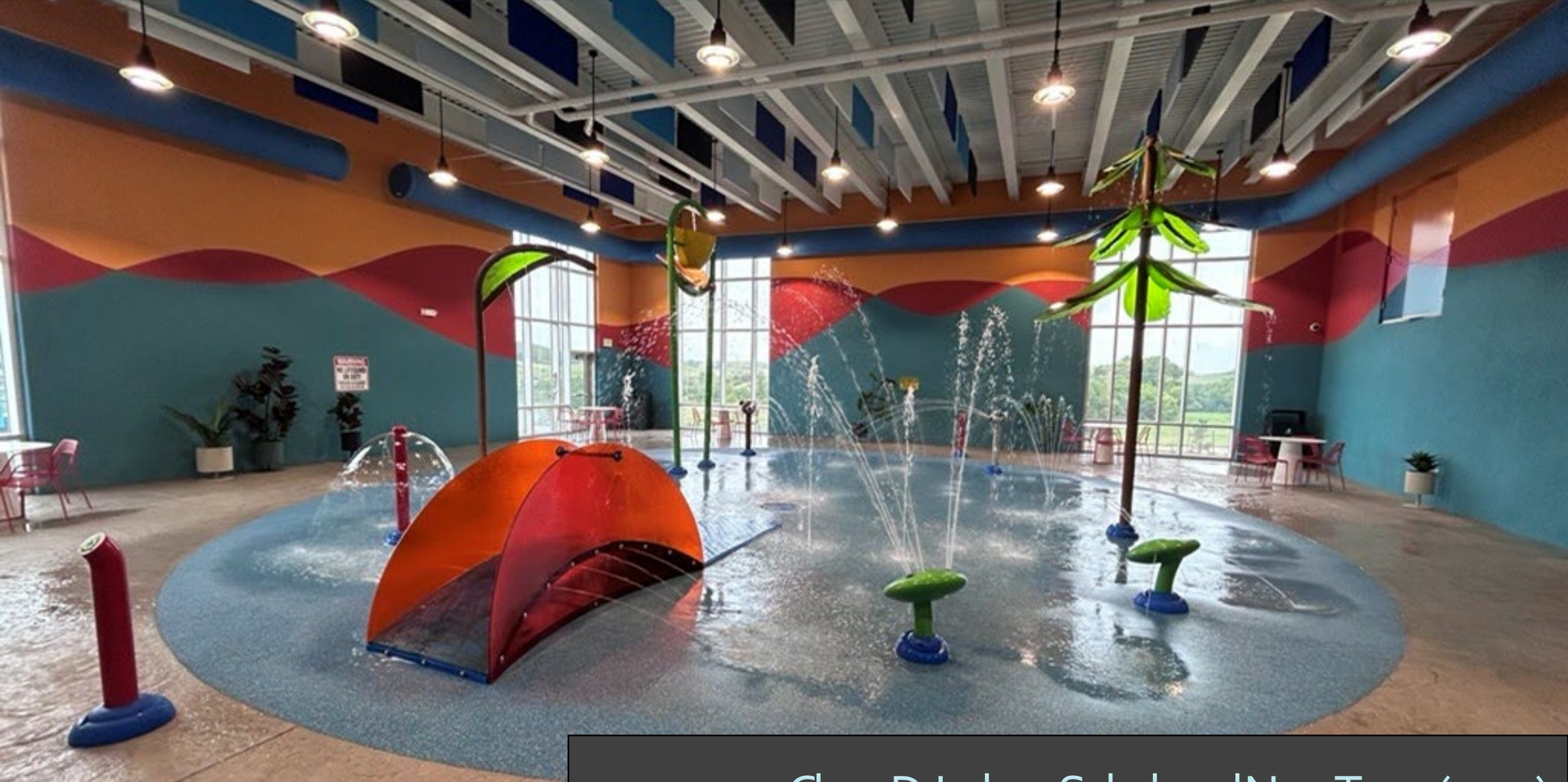
Class B: Williston WaterWorld (2025)

Class C: Ranch at the Wilds (2022)



Class D: Williston WaterWorld (2025)





Class D: Indoor Splashpad New Town(2024)

Class E: Anne Carlsen Therapy Pool (2024)



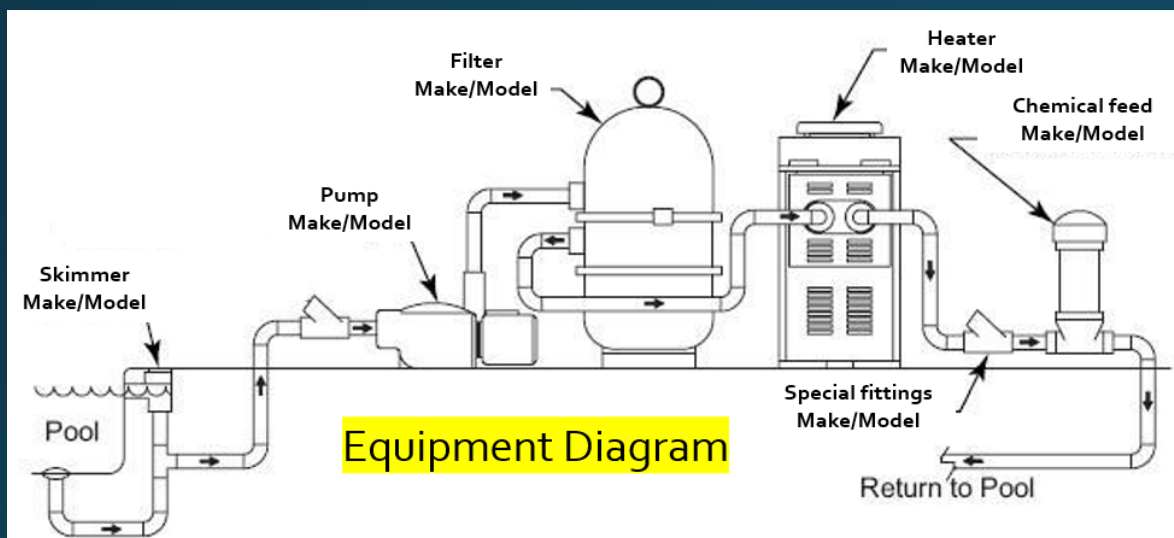


Class F: Lakota Wading (2023)

Filtration Systems



Basic Pool Recirculation System



- Suction plumbing
 - VGB Main drains & suction outlets
 - Skimmers
 - Gutters
- Recirculation pump
- Filter
- UV
- Heater/chiller
- Chemical feed system
- Return plumbing

Why is Filtration Critical?

- Remove suspended solids
- Reduce turbidity
- Support effective disinfection
- Prevent pathogen transmission
- Reduces chlorine demand
- Protects other equipment



Acceptable Filter Types

- High-rate sand filters
- Regenerative media filters
- Diatomaceous Earth (DE) filters
- Cartridge filters
- Any other NSF50 listing



Filter Media Rate (FMR)

FMR is the speed at which fluid passes through a filter. It's measured in gallons per minute per square foot (GPM/FT²)

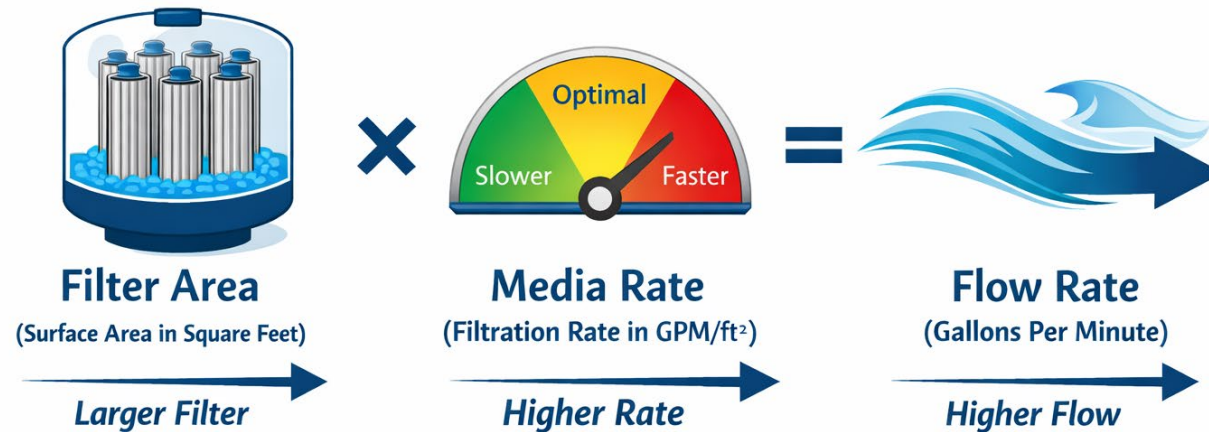
Filter Type	Filter Media Rate	Typical Size	Flowrate
High-rate sand, zeolite, glass	15 gpm/ft ²	5-50+ ft ²	75-750+ GPM
Regenerative media filter	0.5-1.4 gpm/ft ²	500-1,625 ft ²	250-2,275 GPM
Diatomaceous Earth	2.0 gpm/ft ²	50-500+ ft ²	100 – 1,000+ GPM
Cartridge	0.375 gpm/ft ²	200-1,000 ft ²	75-375 GPM



Filter Relationships

- Filter Area (ft²)
- Flowrate (GPM)
- Filter Media Rate (GPM/ft²)

$$\text{Filter Area} \times \text{Media Rate} = \text{Flow Rate}$$





Exceeding the Filter Media Rate

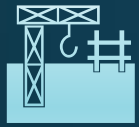
- Sand filters
 - Dirt material driven further into the sand bed
 - Channeling can bypass the filtration process
- Cartridge filters
 - Debris driven into the filter element
 - Filter elements tears
- Regenerative media filters
 - Filter elements tears
- D.E. filters
 - D.E., minerals, and oils will be forced into the grid cloth
 - Shortened grid life due to tears

Flowrate & Turnover Rate

- Turnover rate
 - The time it takes to recirculate the entire pool
 - Measured in units of time
- Flowrate
 - The rate water is flowing through the recirculation system
 - Measured in gallons per minute
 - Flowrate = Pool Volume ÷ 60 ÷ Turnover Rate

The diagram illustrates the formula for calculating Flowrate. It starts with a blue rectangular pool icon labeled "Gallons". This is followed by a division symbol (÷), then a circular arrow icon labeled "Flow Rate", another division symbol (÷), the number "60", an equals sign (=), and finally the letters "TR" labeled "Turnover Rate".

$$\text{Gallons} \div \text{Flow Rate} \div 60 = \text{TR}$$



Turnover Rate

Turnover is the amount of time required for the entire volume of water in the swimming pool to pass through the recirculation system once.

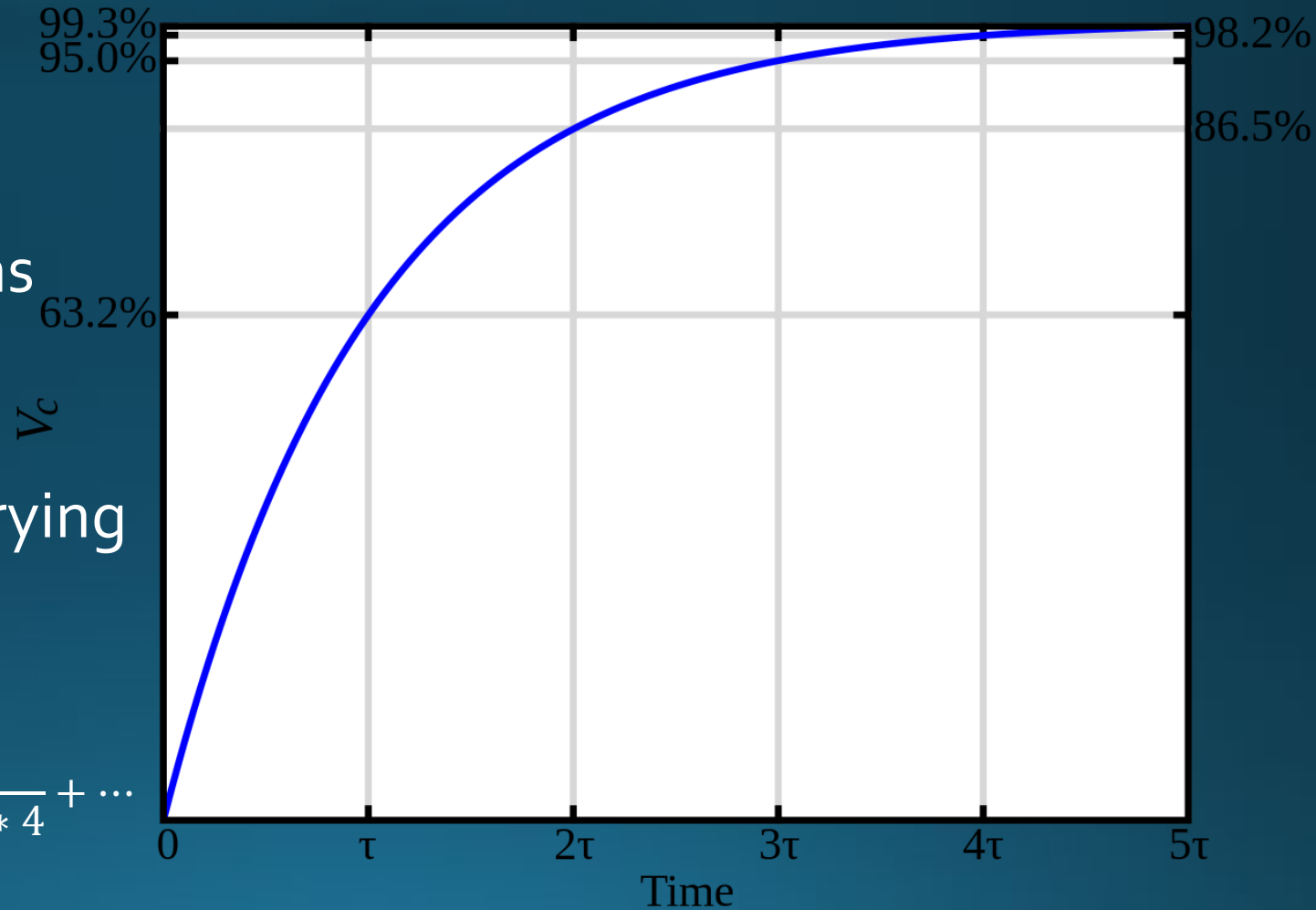
Class of Pool	Turnover	Notes
A, B, C	6 hours	Competition, public, and semi-public
D	2 hours	All special use pools 2 feet or deeper
Wading pools (D)	1 hours	All wading pools less than 2 feet
Spas	30 min	Hot bodies of water



Where does 6 hours come from?

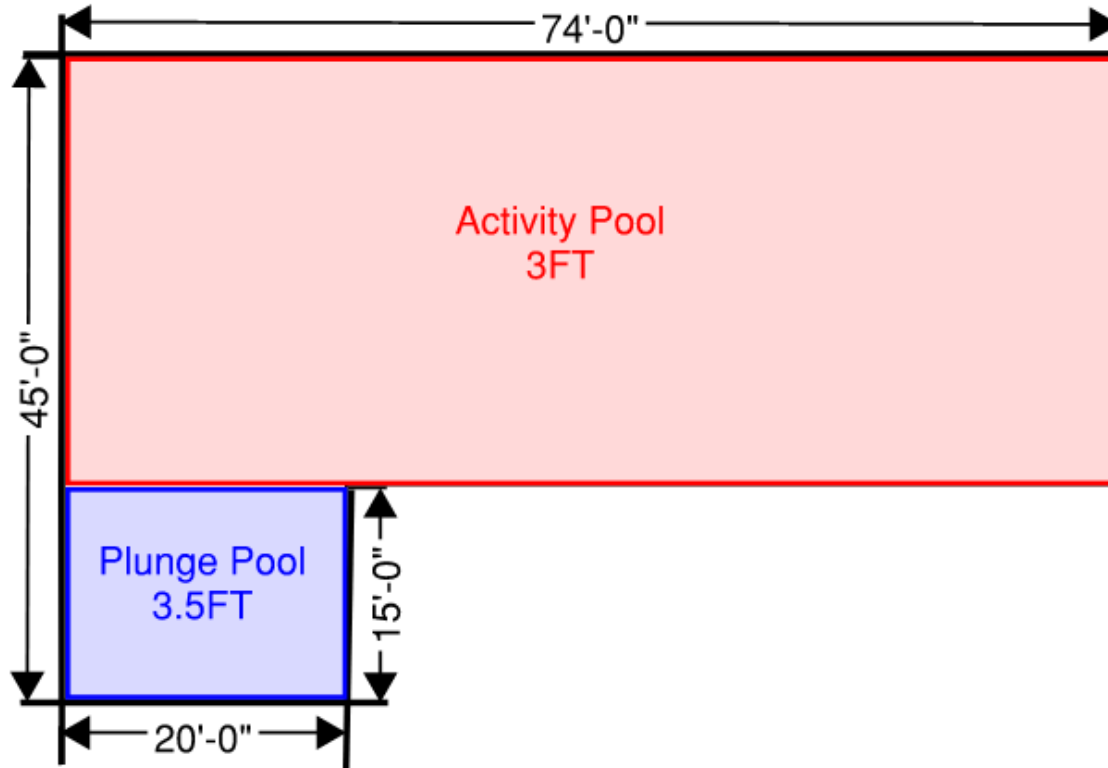
- Heating and Cooling
 $1 - \frac{1}{e} = 0.932$
- RC Circuit Capacitor Charging
 $1 - \frac{1}{e} = 0.865$
- First-Order Chemical reactions
 $1 - \frac{1}{e} = 0.865$
- Infection spread
 $1 - \frac{1}{e} = 0.95$
- Soil absorption
 $1 - \frac{1}{e} = 0.95$
- Biological growth toward carrying capacity
 $1 - \frac{1}{e} = 0.982$
- Pool turnover
 $1 - \frac{1}{e} = 0.993$

$$e = \sum_{n=1}^{\infty} \frac{1}{n!} = 1 + \frac{1}{1} + \frac{1}{1*2} + \frac{1}{1*2*3} + \frac{1}{1*2*3*4} + \dots$$





Sizing a Filter Example

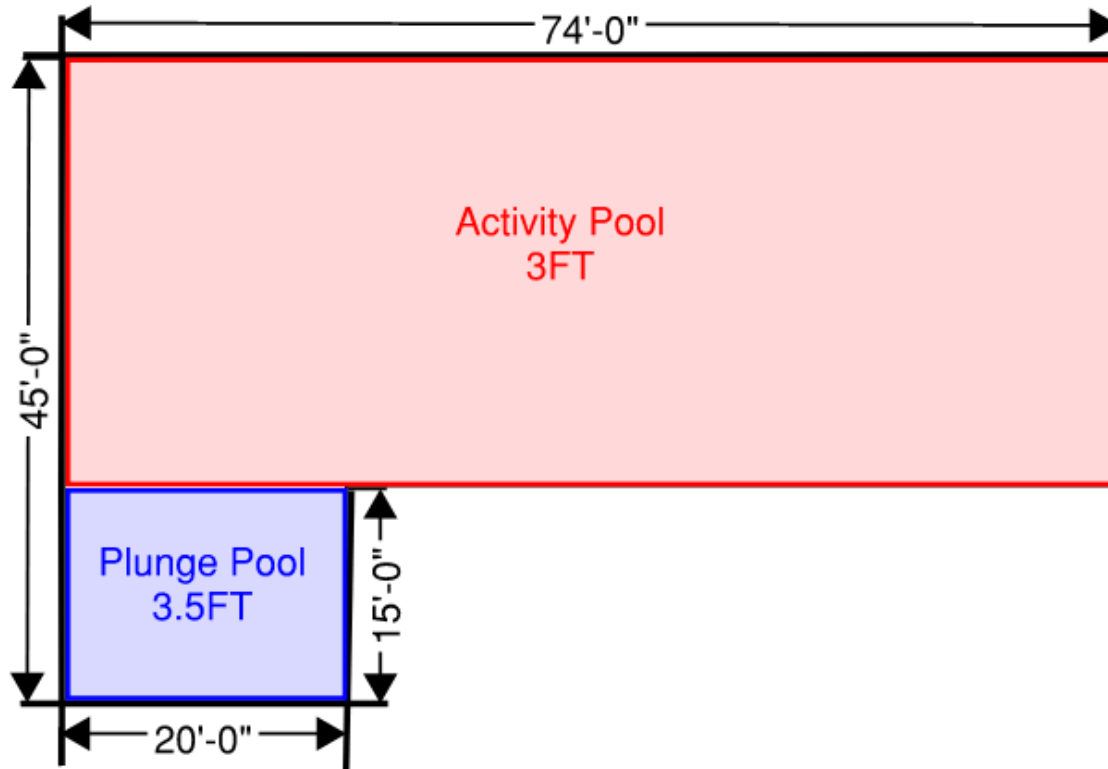


Step 1: Determine the correct turnover

- Identify what class of pool it is based on local code
 - MAHC Plunge Pool 1 hr
 - MAHC Activity Pool 2 hr



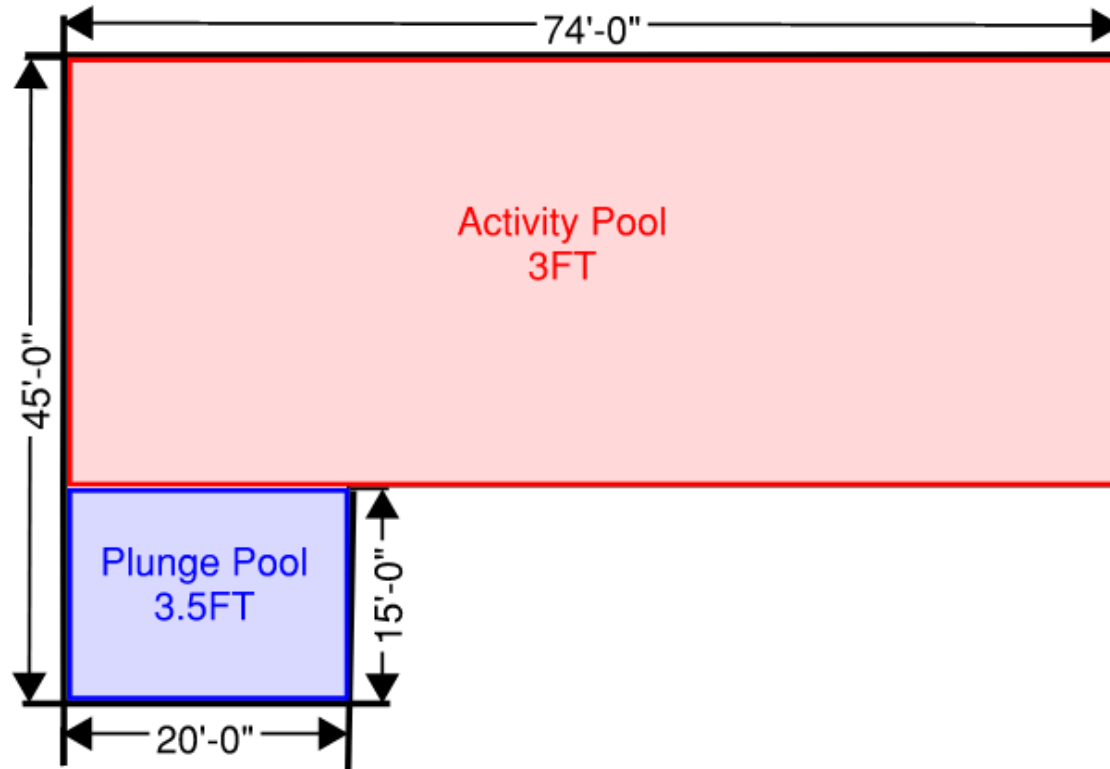
Sizing a Filter Example



Step 2: Determine the flowrate

- Determine volume of each type of pool
 - **Activity Area: 49,817 GAL**
 - **Plunge Area: 7,854 Gal**
- Required turnovers
 - **Activity (>2FT depth) 2hrs**
 - **Plunge 1 hr**
- Determine flowrates
 - **Activity 416 GPM**
 - **Plunge 131 GPM**
- Calculate the total flowrate for the pool
 - Total 547 GPM
- Determine total volume
 - Volume: 57,671 GAL

Sizing a Filter Example



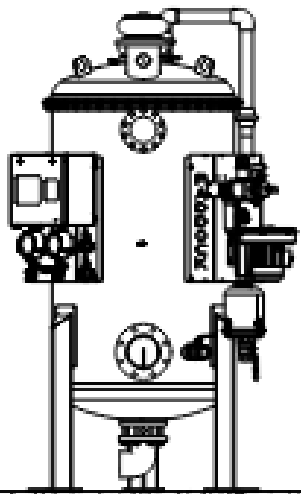
Step 3: Size the filter using the FMR

- Sand filter @ 15 GPM/ft²
 - 37 SF Filter Area
- Regen filter @ 0.5 GPM/ft²
 - 1,094 SF Filter Area
- DE filter @ 2 GPM/ft²
 - 274 SF Filter Area
- Cartridge filter @ 0.375 GPM/ft²
 - 1,459 SF Filter Area

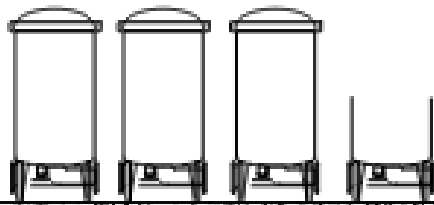


Filter Media Comparison

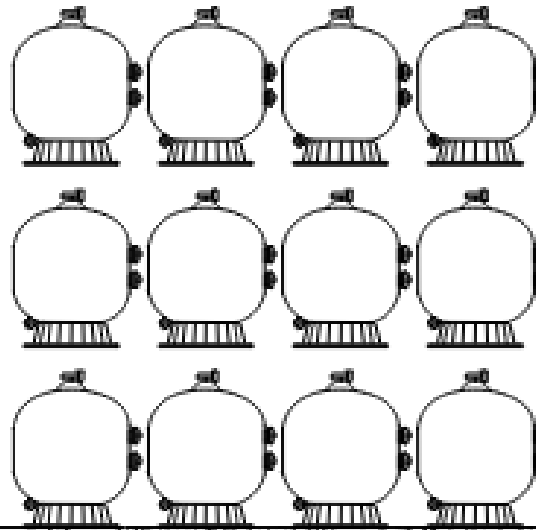
REGENERATIVE MEDIA FILTER
FILTER AREA: 1,141 SF
FILTER MEDIA RATE: 1.0 GPM/SF
FLOWRATE: 1,150 GPM



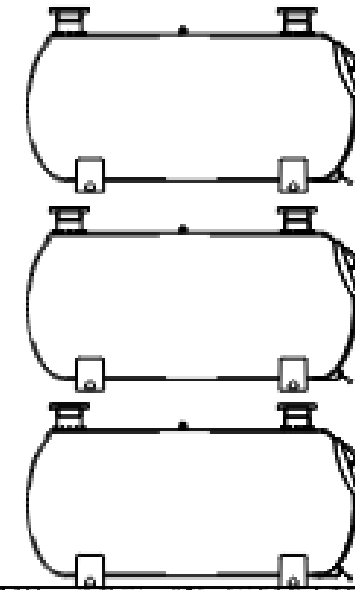
CARTRIDGE FILTER
FILTER AREA: 1,200 SF (4,200 TOTAL)
FILTER MEDIA RATE: 0.3 GPM/SF
FLOWRATE: 1,260 GPM



COMMON SAND FILTER
FILTER AREA: 7.05 SF (84.6 SF TOTAL)
FILTER MEDIA RATE: 15.0 GPM/SF
FLOWRATE: 1,269 GPM



HORIZONTAL SAND FILTER
FILTER AREA: 27 SF (81 SF TOTAL)
FILTER MEDIA RATE: 15.0 GPM/SF
FLOWRATE: 1,215 GPM



Class A: Fargo Island Park

816,051 Gallons

2,720 GPM (6hr)

493 Bathers

12,323 SF

20 SF per Bather

1,655 Gallons per Bather



Class B: Williston WaterWorld

125,496 Gallons

525GPM (~4hr)

207 Bathers

4,128 SF

15-20 SF per Bather

606 Gallons per Bather



Class C: The Ranch At the Wilds

25,731 Gallons

90GPM (4.75hr)

46 Bathers

920 SF

15-20 SF per Bather

559 Gallons per Bather



Class D: Williston WaterWorld

91,687 Gallons

800 GPM (~2hr)

233 Bathers

4,653 SF

15-20 SF per Bather

394 Gallons per Bather



Class D: New Town Splashpad

2,000 Gallon Tank

106 GPM (19MIN)

96 Bathers

1,195 SF

12.5 SF per Bather*

21 Gallons per Bather



*12.5 SF was determined as the area of a 4' diameter circle.

Class E: Anne Carlsen Therapy Pool

54,675 Gallons

450 GPM (~2hr)

76 Bathers

1,522 SF

20 SF per Bather

720 Gallons per Bather



Class F: Lakota Wading Pool

3,825 Gallons

64 GPM (1hr)

35 Bathers

520 SF

15 SF per Bather

109 Gallons per Bather



Spas: Lifetime Fitness (Wheat Ridge, CO)

1,470 Gallons

86 GPM (17 MIN)

9 Bathers

96 SF

10 SF per Bather

163 Gallons per Bather



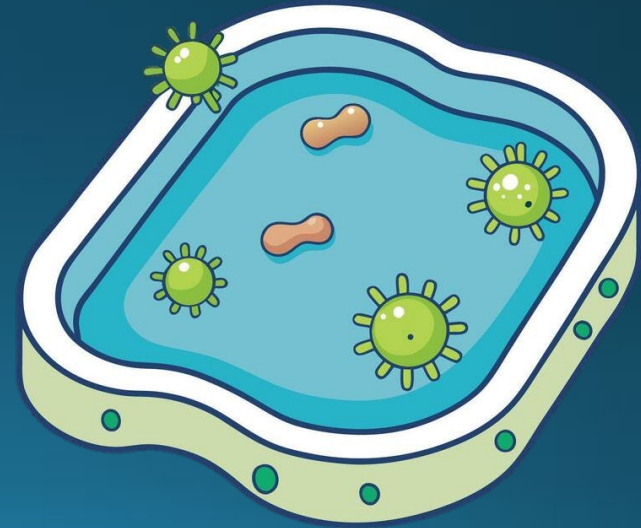
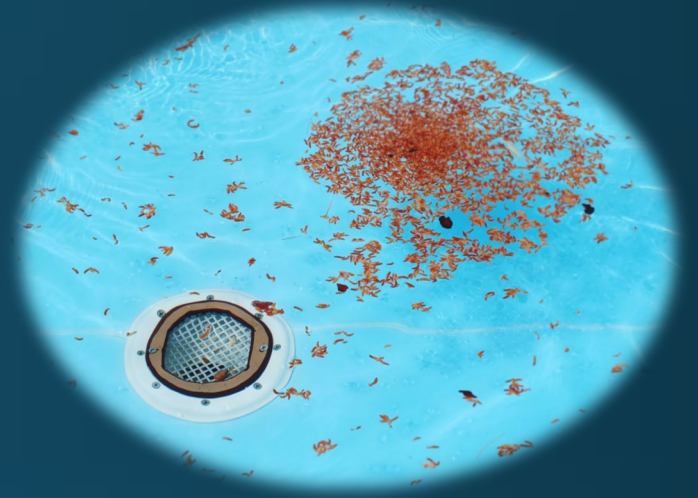


Bather Load Recap

Class of pool	Turnover (MIN)	Volume (GAL)	Gallons per Bather
A: Comp	300	816,051	1,655
B: Public	239	125,496	606
C: Semi-public	285	25,731	559
D: Activity	114	91,687	351
E: Therapy	118	54,675	720
F: Wading	122	3,825	109
D: Splashpad	19	2,000	21
Hot spa	17	1,476	163

Public Pool Contaminants

- Physical contaminations
 - Hair (skimmers)
 - Dirt (strainer)
 - Skin cells (filter)
- Biological
 - Bacteria (Legionella Pneumophila, Shigella, E. Coli o157:H7)
 - Viruses (Adenoviruses, Noroviruses)
 - Protozoa (Crypto, Giardia)
- Chemical
 - Body oils
 - Cosmetics/Lotions/Sunscreens
 - Disinfection By-Products





Response to Contaminants



- Physical contaminations
 - Routinely clean pool floor
 - Empty strainers daily
 - Backwash frequently
- Biological
 - Minimum 1 ppm FC
- Chemical
 - Breakpoint Chlorination
 - Dilution



Questions?

Associated Supply Company, Inc.



MAHC–Turnover Rates

Table 4.7.1.10: Aquatic Venue Maximum Allowable Turnover Times

Type of Pools	Turnover Maximum
Activity Pools	2 hours or less
Diving Pools	8 hours or less
Interactive Water Play*	0.5 hours or less
Lazy River	2 hours or less
Plunge Pools	1 hour or less
Runout Slide	1 hour or less
Wading Pools*	1 hour or less
Wave Pools	2 hours or less
All Other Pools	6 hours or less
Surf Pools	Submit engineering justification from equipment manufacturer

*Shall have secondary treatment

Aquatic Venue Maximum Allowable Turnover Times for Spa, Therapy*, & Exercise Pools

Temperatures	Load	Turnover Maximum
≤ 72°–93°F (22°–34°C)	> 2,500 gals/person (9.46 m ³)	4 hours or less
≤ 72°–93°F (22°–34°C)	> 450 gals/person (1.7 m ³)	2 hours or less
≤ 72°–93°F (22°–34°C)	≤ 450 gals/person (1.7 m ³)	1 hour or less
≥ 93°–104°F (34°–40°C)	All	0.5 hours or less

*Shall have secondary treatment



MAHC—Capacity

4.1.2.3.5.3 Calculating Theoretical Peak Occupancy The THEORETICAL PEAK OCCUPANCY shall be calculated by dividing the surface area in square feet of the AQUATIC VENUE by the density factor (D) that fits the specific AQUATIC VENUE being considered.

THEORETICAL PEAK OCCUPANCY = AQUATIC VENUE Surface Area / D

The density factors (D) are Water/BATHER-related:

- 1) FLAT WATER density factor = 20 ft² (1.9 m²) per BATHER.
- 2) AGITATED WATER density factor = 15 ft² (1.4 m²) per BATHER.
- 3) HOT WATER density factor = 10 ft² (0.9 m²) per BATHER.
- 4) WATERSLIDE LANDING POOL density factor = manufacturer-established capacity at any given time.
- 5) INTERACTIVE WATER PLAY water density factor = 10 ft² (0.9 m²) per BATHER on surface.

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- 6) SURF POOL density factor = manufacturer-established capacity at any given time.

Non-water/PATRON-related:

- 7) DECK density factor = 50 ft² (4.6 m²) per BATHER.
- 8) STADIUM SEATING density factor = 6.6 ft² (0.6 m²) per BATHER.
- 9) Diving Boards and Tall Platforms density factor = 300 ft² (27.9 m²) per BATHER

- Bather Load *4.1.2.3.5.3 Calculating Theoretical Peak Occupancy*



MAHC - Floor Slope

Under 5 ft

Over 5 ft

4.5.2 Bottom Slope

4.5.2.1^A Under Five Feet In water depths under 5 feet (1.5 m), the slope of the floor of all POOLS shall not exceed 1 foot (30.5 cm) vertical drop for every 12 feet (3.7 m) horizontal.

4.5.2.2 Five Feet or Over In water depths 5 feet (1.5 m) and greater, the slope of the floors of all POOLS shall not exceed 1 foot (30.5 cm) vertical to 3 feet (0.9 m) horizontal.

Exception: POOLS designed and used for competitive diving shall be designed to meet the STANDARDS of the sanctioning organization (such as NFHS, NCAA, USA Diving, or World Aquatics).

4.5.9 Zero Depth (Sloped) Entries

4.5.9.1 Slip Resistant Where ZERO DEPTH ENTRIES are provided, they shall be constructed with SLIP- RESISTANT materials.

4.5.9.2 Maximum Floor Slope ZERO DEPTH ENTRIES shall have a maximum floor slope of 1:12, consistent with the requirements of MAHC 4.5.2.1.

4.5.9.2.1 Slope Changes Changes in floor slope shall be permitted.

4.5.9.3 Trench Drains Trench drains shall be used along ZERO DEPTH ENTRIES at the waterline to facilitate surface skimming.

4.5.9.3.1 Flat or Follow Slope The trenches may be flat or follow the slope of the ZERO DEPTH ENTRY.

4.5.9.3.2 Handholds Any handholds that present a trip hazard shall not be continuous along the ZERO DEPTH ENTRY.

4.5.9.4 Rope and Float Line Where the bottom of a POOL slopes from a ZERO DEPTH ENTRY to water depths greater than 3 feet (0.9 m) and includes an area for young non-swimmers to wade and play, a ROPE AND FLOAT LINE shall be installed at the 3 feet (0.9 m) depth to provide a visual and physical separation between the area for toddlers and young non-swimmers and the deeper areas of the POOL.

4.5.9.4.1 Exceptions An exception shall be made for WAVE POOLS, SURF POOLS, and WATERSLIDE LANDING POOLS.

Slope 4.5.2 Bottom Slope



MAHC - Deck Requirements

- Clearance of 4' around perimeter
- Horizontal joints no larger than 3/16 inches
- Vertical gaps of no larger than 1/4 inches
- Access hatches must be lockable
- Deck material must be suitable for pool environment, non-toxic, and substantially impervious

Table 4.8.1.3 Minimum Slopes for Drainage

Surface	Minimum Slope
Smooth finishes; such as tile, hand-finished concrete & lightly- broomed concrete	1/8 inch per foot (3.2 mm/30.5 cm)
Moderately textured finishes; such as exposed aggregate or medium-broomed concrete	1/4 inch per foot (6.4 mm/30.5 cm)
Heavily textured finishes; such as brick (where permitted)	3/8 inch per foot (9.5 mm/30.5 cm)

Slope 4.8.1.3.1 Deck Slope



MAHC - Deck Requirements

Minimum Slopes for Deck Drainage



Slope 4.8.1.3.1 Deck Slope

ADA Requirements

- *Title II of the Americans with Disabilities Act (ADA) - U.S. Department of Justice*
- Accessible Means of Entry
 - Pools 300 linear feet or larger need 2 mean
 - Pools less than 300 linear feet need 1
- 1 Mean of Entry must be Sloped Entry or Pool Lift
- Second Mean of Entry may be
 - Pool lift, sloped entry, transfer wall, transfer system, accessible pool stairs
- Must be an accessible route from entrance to swimming pool

Barrier Requirements

- *Safety Barrier Guidelines for Residential Pools - U.S. Consumer Product Safety Commission*
 - 1. 48" Minimum Height
 - 2. Gate is self latching and self closing – must be able to lock
 - 3. 4" maximum gap for solid substrate, 2" maximum gap soft substrate
 - 4. Cannot pass a 4" disk through
 - 5. Gates must open outward from pool
 - 6. Barriers must not be easily climbable

These guidelines are intended to keep young children out of the pool area.

Barrier Requirements

Swimming Pool Barrier Requirements

① Barrier Height at Least 48 Inches

② Gate is Self-closing and Self-latching



③ Maximum Four-inch Gap at Bottom

④ Cannot Pass a 4" Disk Through Vertical Slots

⑤ Gate Opens Outward from Pool

⑥ Cannot be Easily Climable

Water Quality & Health

