# Future Proofing Pool Water Circulation for Safe Bathing - Science into Practice

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# Future Proofing Pool Water Circulation for Safe Bathing – Scope of Talk

**Bather Safety – what do we need?**

Physical safety – space and water clarity

Microbiological safety – pathogens inc. crypto

**Water Circulation – main impacts on water quality**

Removal of dirt and Crypto by filtration

Control of microbes by disinfectant

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# Future Proofing Pool Water Circulation for Safe Bathing – Scope of Talk

**Current guidelines**

Based on experience over many years

Can limit opportunities to do things better

**Comparison of  UK and German guidelines**

PWTAG Swimming Pool Water/COP

German DIN Standard

**Future proofed guidelines**

Based on scientific insights tested in practice

Potential role of automated monitoring of key parameters

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# The Big Question…

Do Commercial Pools in England really need to be spending >£100 million pa circulating water?

Research with Loughborough University + Swim England database

Based on assuming compliance with PWTAG and DIN standards

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# Cost of Pool Water Treatment (Circulation) – the National Picture (Commercial Pools)

Could reduce this by at least 50% if adopt the following:

✓ Slow pumps down when pool closed

✓ Slow pumps down during periods of low bathing load

✓ Improve efficiency of pumps

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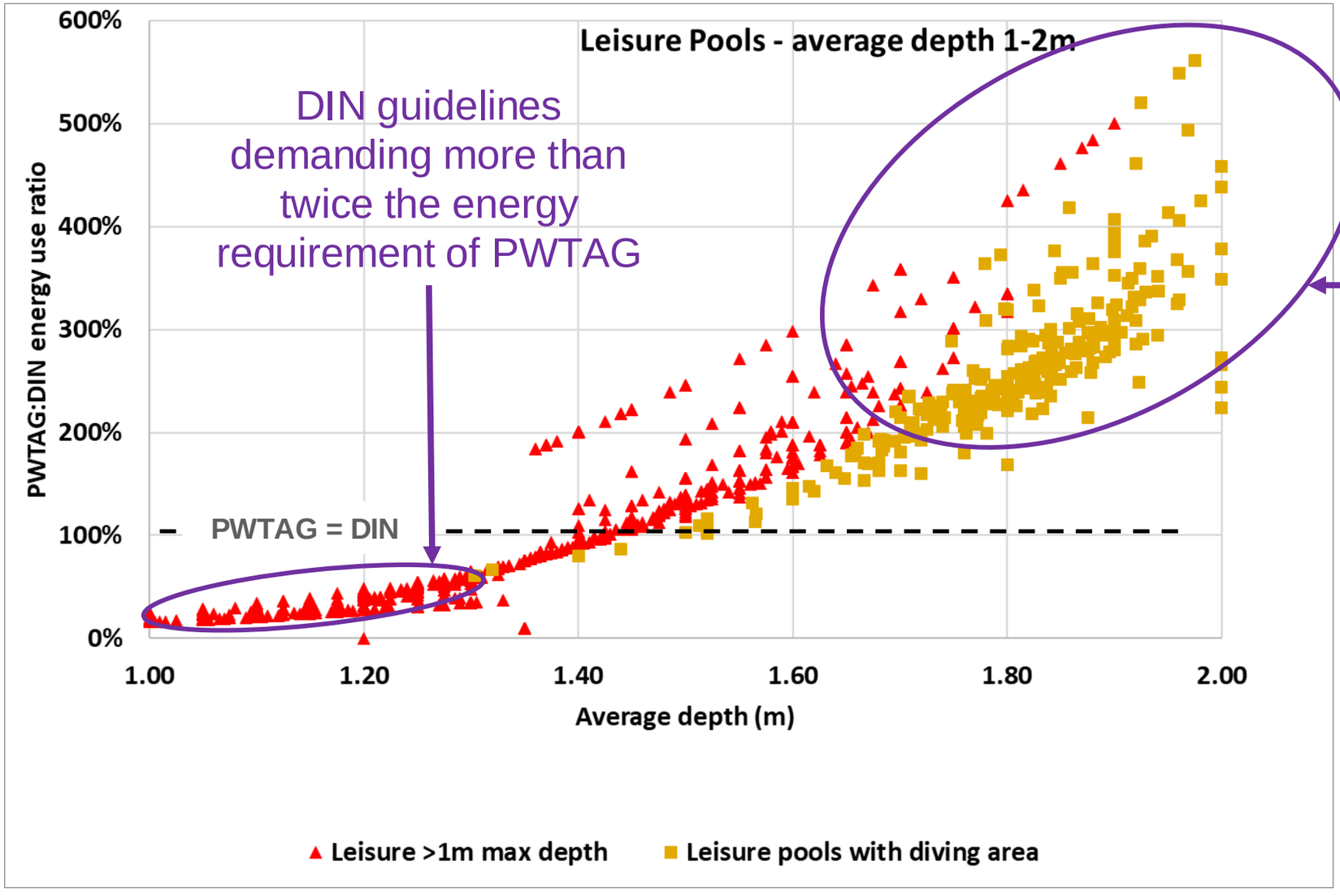
# How much energy do we need to circulate water?

## Comparison of PWTAG and DIN circulation guidelines for Leisure Pools**




DIN guidelines demanding more than twice the energy requirement of PWTAG

PWTAG guidelines demanding more than twice the energy requirement of DIN

PWTAG and DIN circulation guidelines VERY different in terms of energy implications.

- Yet both claim to provide excellent water quality.
- What can we learn from this?

**Research by Loughborough University with Pool Sentry using Sport England database

# Safety of Bathers in the Pool is Priority

**Maximum Instantaneous Bathing Load**

Adequate space in pool for each bather

Area of pool per bather ($m^2$/bather)

**Maximum Daily Bathing Load**

Contaminants in water managed by pool plant

Removal of dirt and crypto by filtration ($m^3$/bather)

Control of microbes by disinfectant

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# Example of potential savings in water circulation costs at a Leisure Centre

## Before Smart Pump Control

202,907 kWh pa

£0.21 per kWh

= £42,600 pa

## After Smart Pump Control (projected)

81,813 kWh pa

£0.21 per kWh

= £17,200 pa

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# Example of potential savings in water circulation costs at a Leisure Centre

## Before Smart Pump Control (as built)

VSDs “Set and Forget”

| | |
|---|---|
| Pool open | 40 Hz |
| Pool closed | 35 Hz |

## After Smart Pump Control (projected)

VSDs “Manage with Knowledge”

| | |
|---|---|
| Pool open | 30 - 40 Hz |
| Pool closed | 25 - 35 Hz |

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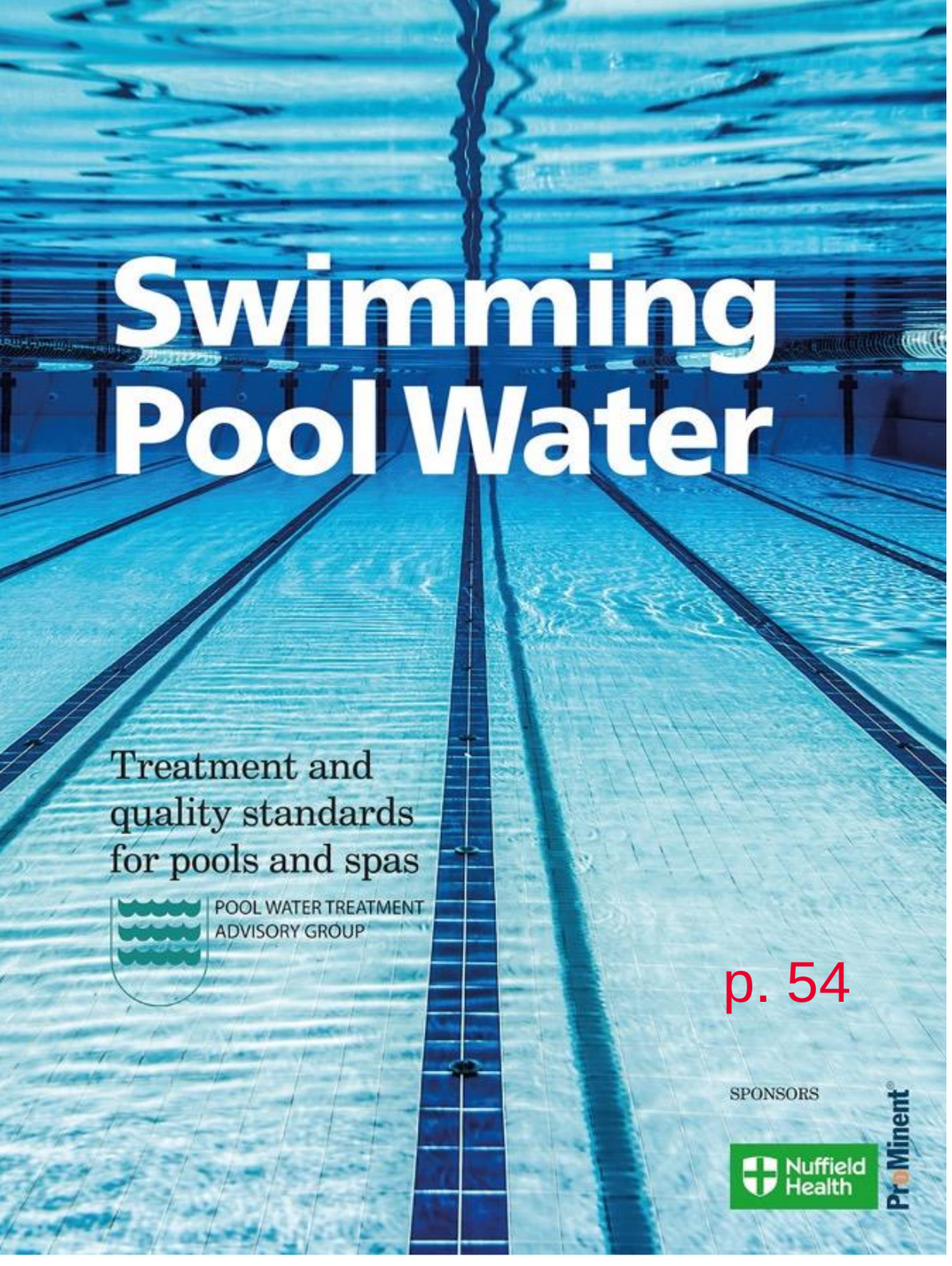


***"a VSD can set the flow accurately and efficiently. To reduce the circulation rate from its peak level to a lower one during quieter periods"***

**But how to do this?**

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# The Science: Peer-Reviewed Papers

water

MDPI

*Article*

## Revisiting the Gage–Bidwell Law of Dilution in Relation to the Effectiveness of Swimming Pool Filtration and the Risk to Swimming Pool Users from *Cryptosporidium*

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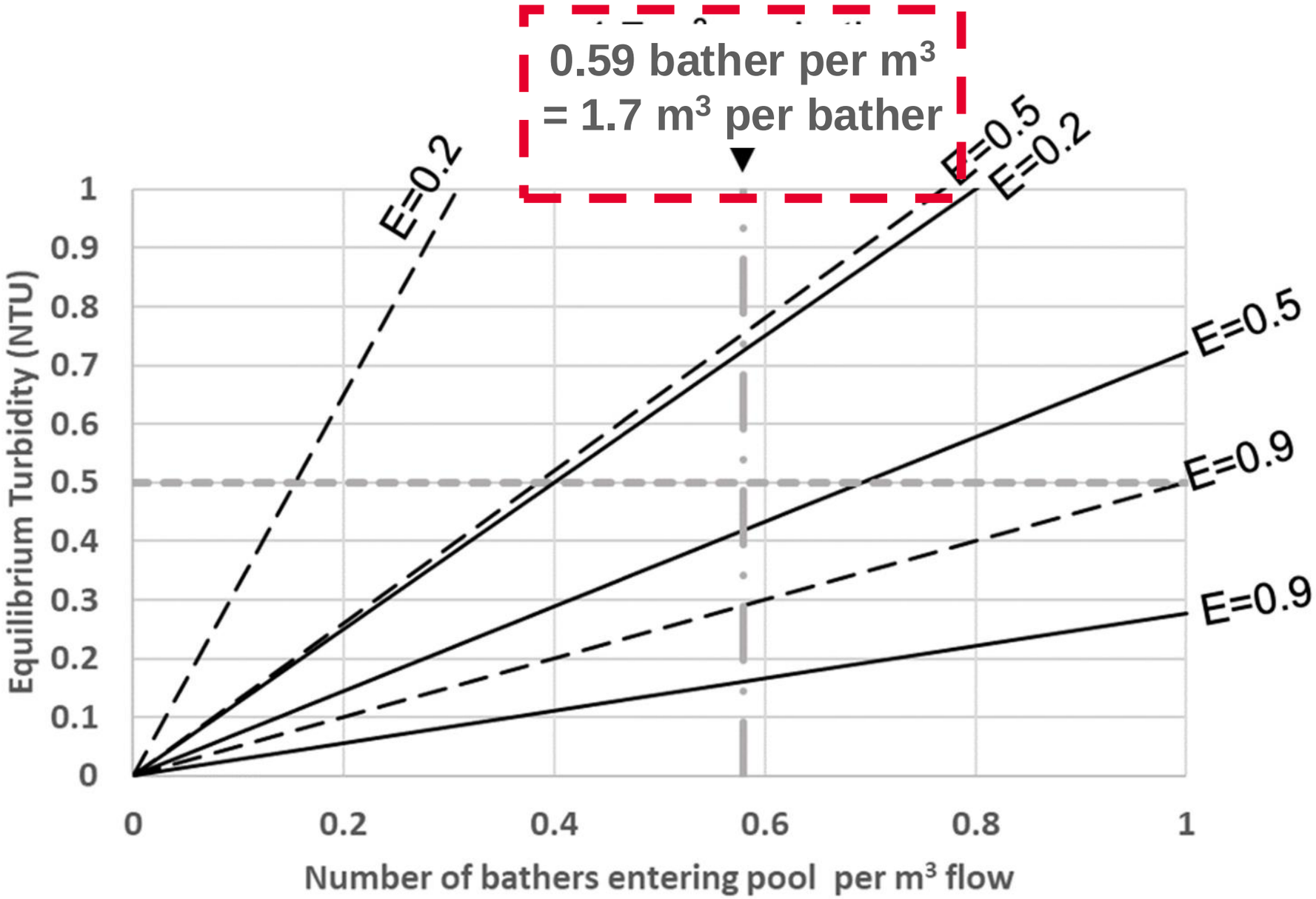
From the Paper – 1.7 $m^3$ water treated per bather ensures PWTAG compliant turbidity if pool operating at max bathing load 24h a day with filters only 50% efficient (E=0.5) and dirty bathers

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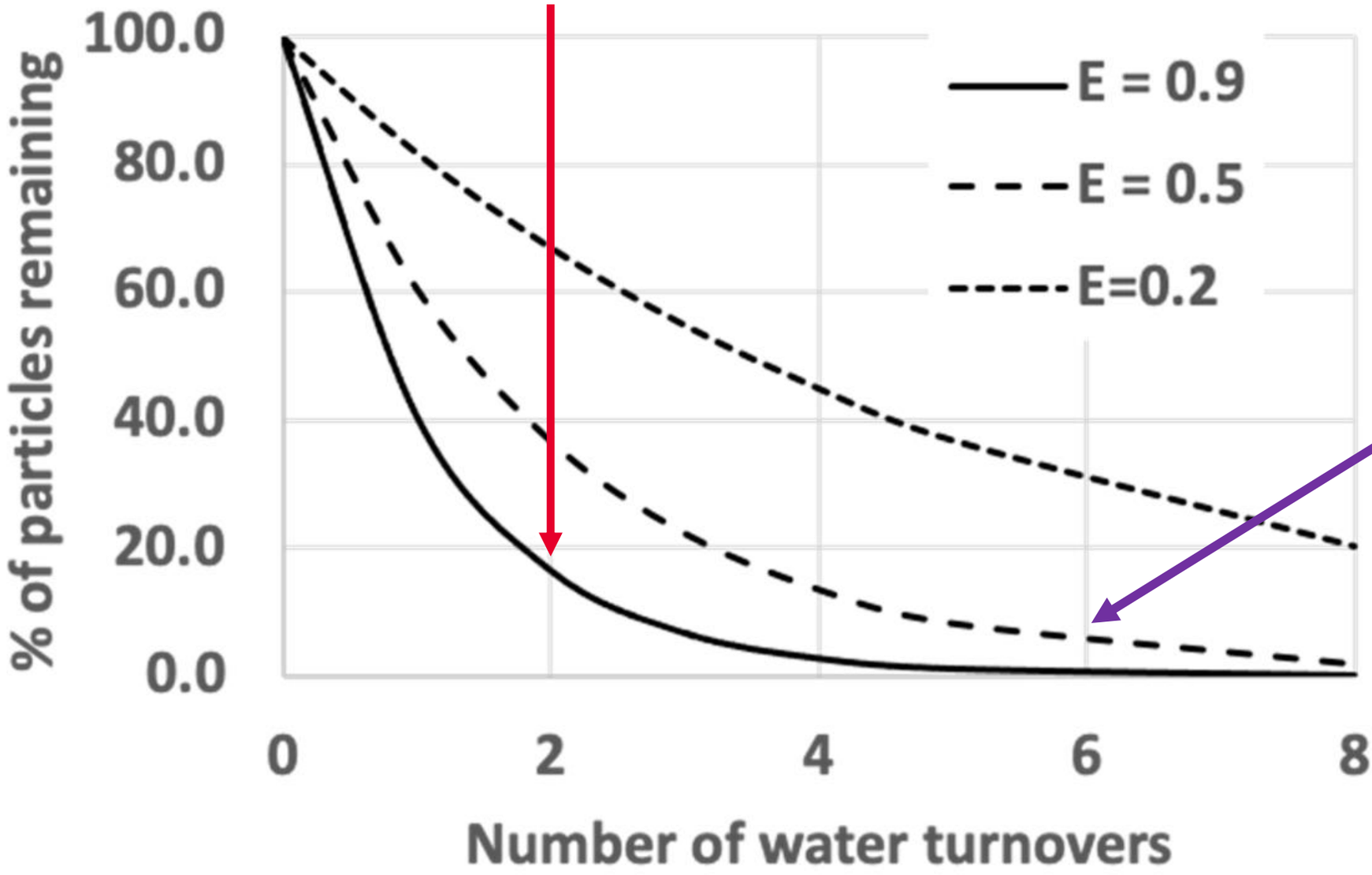
# From the Paper – implications of filter efficiency for particle removal (including Crypto)

## 80 % particles removed after 2 turnovers




**Are 6 turnovers enough with poorly efficient filters?**
**How do you know?**

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# What the Science is Saying

When a pool is closed at the end of a swim session

80% of particles remaining in the pool water at closing are removed by filtration within 2 turnovers. Most (typically >> 80%) will have been removed while pool is open.

→Opportunities for energy saving during closed period

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# What the Science is Saying

If you treat 1.7 $m^3$ water per bather, then should be able to keep water <0.5 NTU even with:

- dirty bathers
- filtration efficiency as low as 50%
- sustained maximum instantaneous bathing load 24 h/day

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# What Do The Guidelines Say?

- PWTAG Swimming Pool Water (UK)
- DIN Standard (Germany)

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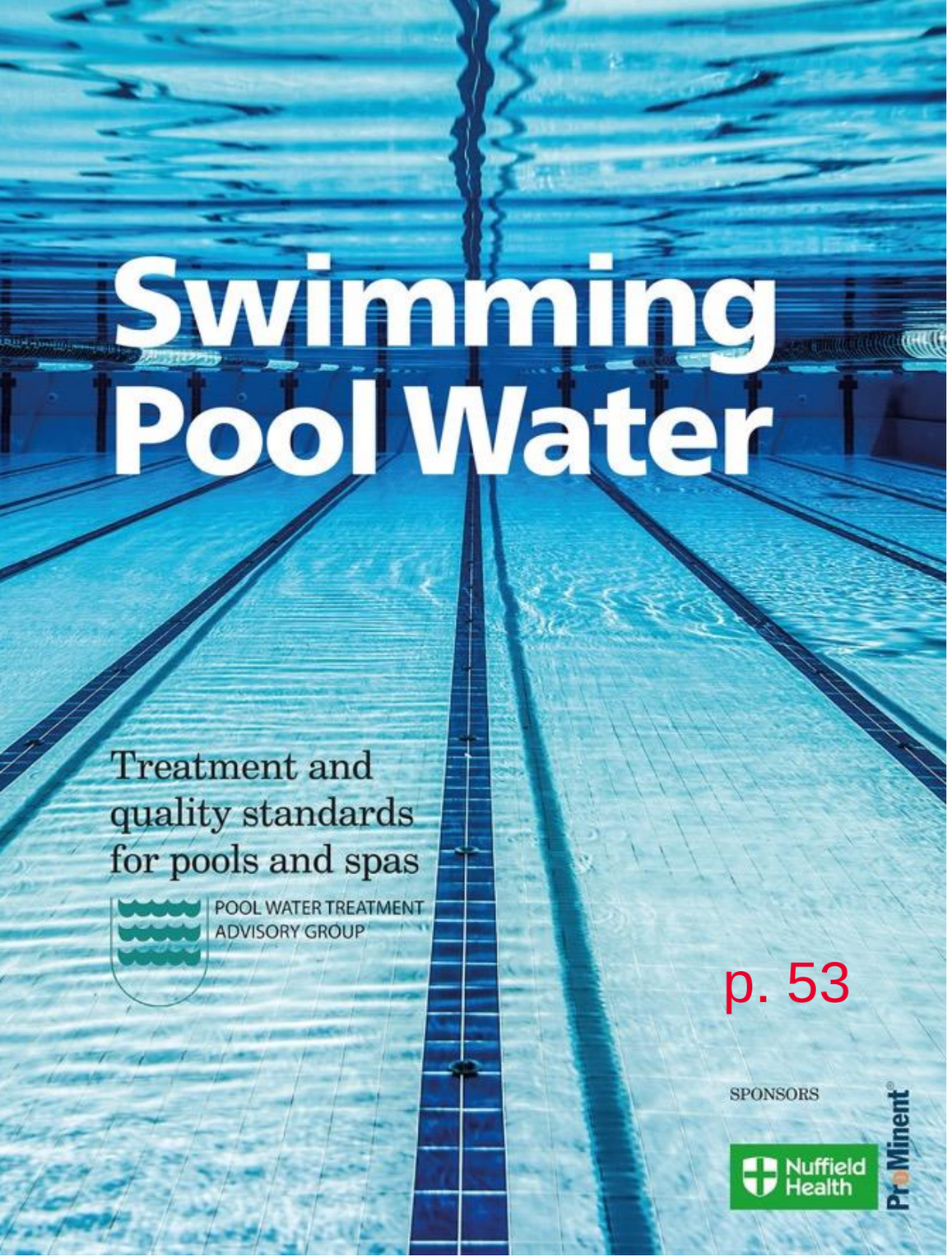


**Circulation Rate ($m^3/h$) calculated from:**

**1.7 $m^3$ x Instantaneous Bathing Load**

***"it has been arrived at from good practice over the years."***

**1 h bathing session?**

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November 2012

# DIN 19643-2

DIN

ICS 13.060.30

Supersedes
DIN 19643-2:1997-04 and
DIN 19643-5:2000-09

## Treatment of water of swimming pools and baths –
## Part 2: Combinations of process with fixed bed filters and precoat filters,
## English translation of DIN 19643-2:2012-11

**Circulation Rate ($m^3/h$)**
**calculated from:**

**2.0 $m^3$ x Instantaneous Bathing Load**

**1 h bathing session**

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# Maximum Bathing Load per Hour

**PWTAG**

**Maximum bathing load per hour**

= Circulation rate ($m^3$/h)/1.7 $m^3$ water treated per bather

**DIN 19643**

**Maximum bathing load per hour**

= Circulation rate ($m^3$/h)/2.0 $m^3$ water treated per bather

**All assuming 1h average swim duration**

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# Safety of Bathers in the Pool is Priority

**Adequate space in pool for each bather**

→ ? Area of pool per bather

**Contaminants in water managed by pool plant**

Removal of dirt and crypto by filtration

Control of microbes by disinfectant

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# Maximum Instantaneous Bathing Load

**PWTAG***

Shallow water (<1 m) 1 bather per 2.2 m²
Standing water depth (1-1.5 m) 1 bather per 2.7m²
Deep water (>1.5 m)1 bather per 4 m².

**DIN 19643**

Shallow water (<1.35 m) 1 bather per 2.7 m²
Deep water (>1.35 m) 1 bather per 4.5 m².

*HSG179 refers to BS EN 15288 for what is termed the “occupancy ratio” of 1 bather per 3 $m^2$. However, this was removed from the 2018 revised version of BS EN 15288

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# Safety of Bathers in the Pool is Priority

**Adequate space in pool for each bather**

✓ Area of pool per bather

**Contaminants in water managed by pool plant**

? Removal of dirt and crypto by filtration

Control of microbes by disinfectant

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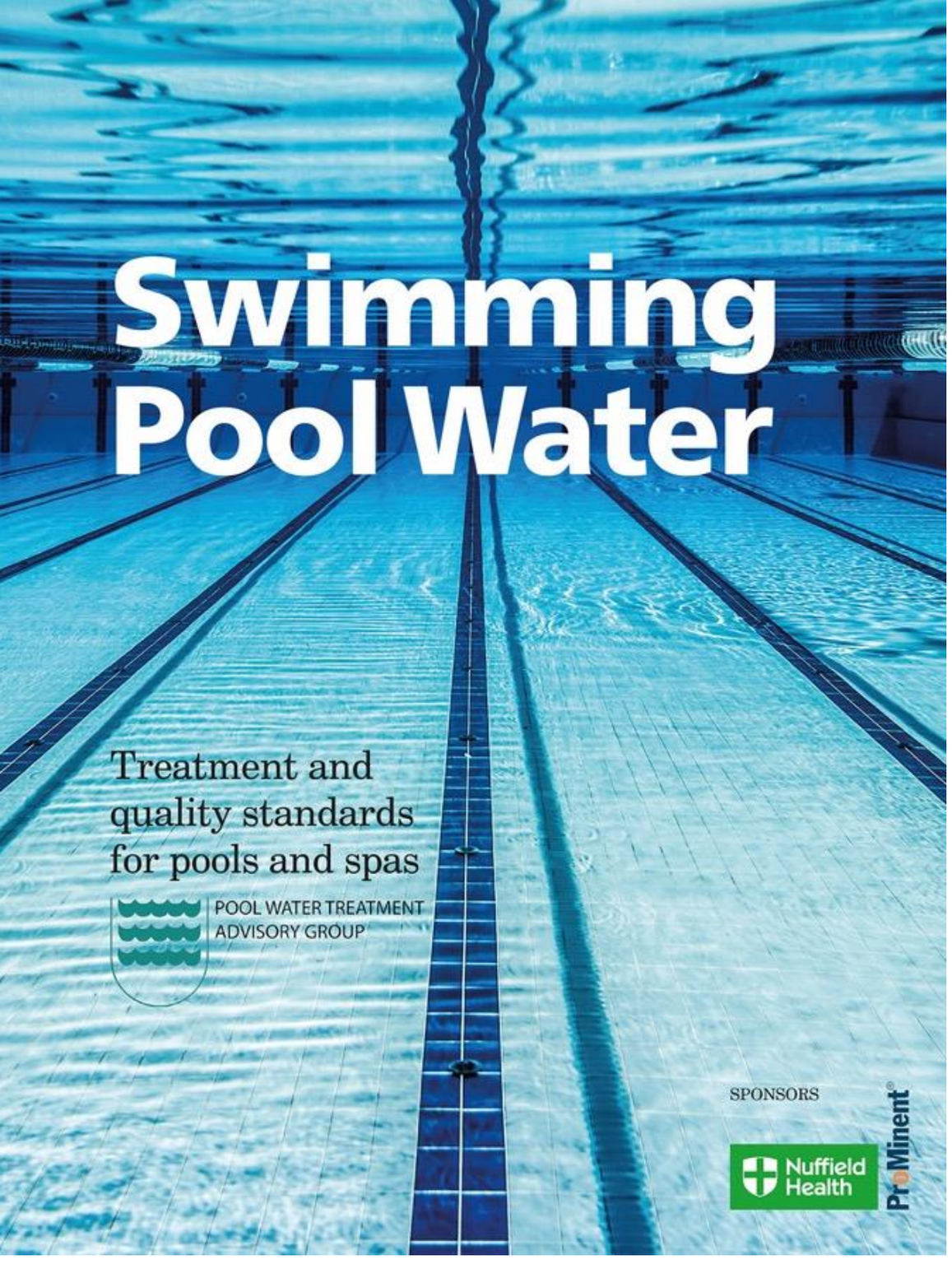


# Operational daily bathing load

***"it is not possible to give precise figures for maximum daily bathing loads. But a good rule of thumb is to use 25-50% of the [maximum] instantaneous bathing load multiplied by 12"***

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***CAN DO AWAY WITH THIS NOW!***

# Maximum Daily Bathing Load

**Now possible to give reasonably precise figures for maximum daily bathing loads:**

**PWTAG**

**Maximum bathing load per hour**

= Circulation rate ($m^3$/h)/1.7 $m^3$ water treated per bather

**Maximum daily bathing load**

= maximum bathing load per hour x no. hours pool is open.

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# Safety of Bathers in the Pool is Priority

**Adequate space in pool for each bather**

✓ Area of pool per bather

**Contaminants in water managed by pool plant**

✓ Removal of dirt and crypto by filtration

➡ ? Control of microbes by disinfectant

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# Safety of Bathers – Chlorine for Disinfection

A bather consumes 4-8 g Cl equivalent during a swim.

A typical bather will be exposed to >50 $m^3$ of water/chlorine equivalent if moving 25 m in a swim session. Equates to >75g Cl equivalent if 1.5 mg/l set point is being maintained by dosing system.

There's enough Cl in water around a bather for disinfection.

However, this needs to be replenished from the surrounding water…so dosing system needs to have adequate capacity and be functioning well

IF SET POINT NOT BEING MAINTAINED DUE TO DOSING SYSTEM FAILURE, THEN ACTION NEEDED – INCLUDING CONSIDERING RAISING OF CIRCULATION RATE

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# Safety of Bathers – Chlorine for Disinfection

## Local movement of pool water (eddies)

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# Safety of Bathers – Chlorine for Disinfection

Effect of local eddies – this type of turbulent transport is likely on its own to maintain adequate supplies of chlorine.

Bather movement will further assist this.


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# Safety of Bathers – Chlorine for Disinfection

## Importance of good Cl dosing

Properly maintained circulation system with automated Cl dosing should maintain chlorine concentration at Cl set point in the pool water a few metres from a bather.

## Conclusion:

Supply of Cl to each bather can be managed by ensuring adequate pool water circulation and automated Cl dosing.

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# Safety of Bathers in the Pool is Priority

**Adequate space in pool for each bather**

✓ Area of pool per bather

**Contaminants in water managed by pool plant**

✓ Removal of dirt and crypto by filtration

✓ Control of microbes by disinfectant

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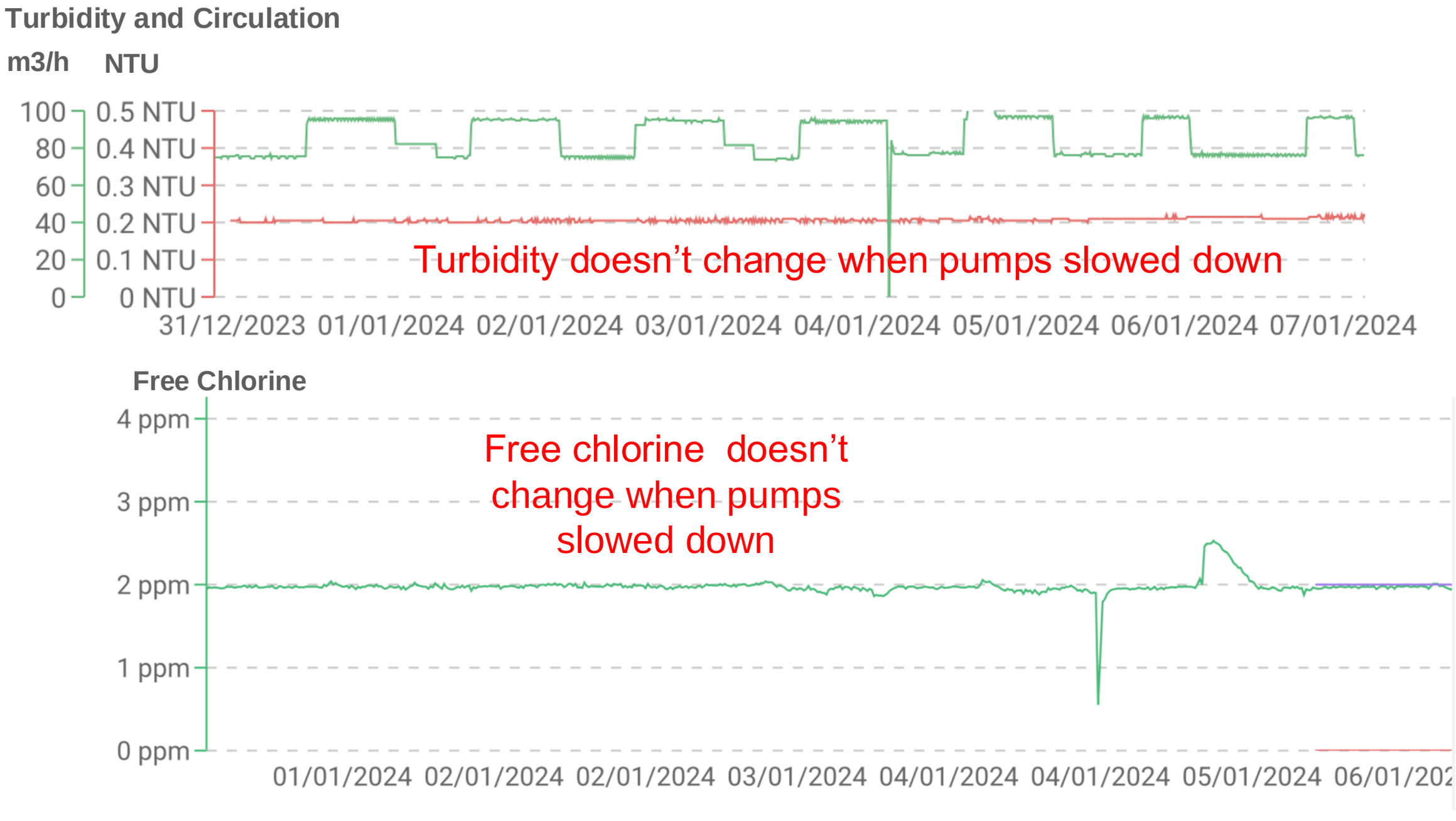
# Monitoring Turbidity, As Well As Cl, Provides Reassurance That Water Treatment is Satisfactory



# Final Considerations

Where there are multiple water bodies served by the same circulation system, need to ensure that the treatment requirement of 1.7 $m^3$ per bather is satisfied for each zone.

And BEWARE: even within pools where there is a single water body, the hydraulics can result in effectively separate pools (for example where there are opposing flows)

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Take a lesson from nature – where the Caribbean sea meets the Atlantic there is virtually no intermixing due to there being opposing directions of flow – despite there being an apparent continuous water body

Many pools behave like this so BE AWARE

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# Aims of New Technical Note

- Identifies areas of uncertainty in current guidelines
- Provides underpinning scientific rationale
- Harmonises PWTAG guidelines with HSG179, DIN 19643
- Circulation based on 1.7 $m^3$ water per bather
- Clarifies and simplifies PWTAG guidelines

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# Aims of New Technical Note

- Future-proofs pool water circulation for

  Safe bathing

  Optimum energy use

  Minimum cost consistent with above.

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# Take Aways

**Can safely link Circulation Rate to Bathing Load**

✓ 1.7 $m^3$ circulation per bather

✓ Dynamic control based on Cl demand or turbidity

✓ Maintain bulk water Cl concentration at set point

✓ Monitor free Cl and turbidity automatically.

**Check for partitioning of water bodies withing pool system**

✓ Manual readings of free Cl around the pool

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# Take Aways

**Intelligent Management of Circulation Rate linked to Bathing Load enables**

- ✓ 1.7 $m^3$ circulation per bather
- ✓ Dynamic management of pump speed
- ✓ Optimise energy used to circulate water
- ✓ Generate savings in energy bills
- ✓ And maintain safe water for bathers

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# Thank you!


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