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UNIVERSITY OF MARYLAND ENVIRONMENTAL FINANCE CENTER

Smart Solutions for Small Systems: Harnessing Technology for Efficiency, Compliance, and Sustainability

(Thursday, March 20, 2025)

This program is made possible under a cooperative agreement with US EPA.

Certificate of Completion

This session has **NOT** been submitted for pre-approval of Continuing Education Credits, but eligible attendees will receive a certificate of attendance for their personal record.

To receive a certificate:

- You must attend the entire session
- You must register and attend using your real name and unique email address - group viewing credit will not be acceptable
- You must participate in polls
- Certificates will be sent via email within 30 days

If you have questions or need assistance, please contact smallsystems@syr.edu.

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About Us

The **Environmental Finance Center Network (EFCN)** is a university- and non-profit-based organization creating innovative solutions to the difficult how-to-pay issues of environmental protection and water infrastructure.

The EFCN works collectively and as individual centers to address these issues across the entire U.S, including the 5 territories and the Navajo Nation. The EFCN aims to assist public and private sectors through training, direct professional assistance, production of durable resources, and innovative policy ideas.

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Environmental Finance Center
University of Maryland

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Advancing Finance Solutions | Building Local Capacity | Serving Communities

- Education | Training | Technical Assistance
- Research | Policy Analysis | Financial Assessment
- Community Outreach & Facilitation

Flagship Programs:

most

Municipal Online Stormwater Training Center

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Small Systems Technical Assistance

Drinking water, wastewater, and/or stormwater systems serving <10,000 people. Wider variety of topics and issues covered.

- Educational resources & trainings, plus technical assistance around U.S.: efcnetwork.org
- For technical assistance within Region 3, email or call Danish Kumar dkumar18@umd.edu (301) 405-9945

Today's Speakers

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Webinar Outline

1. Introduction
2. Smart infrastructure technologies
3. Benefits of Smart Technologies
4. Success Stories
5. Call to Action
6. Question & Answer

WWTPs: Wastewater treatment plants

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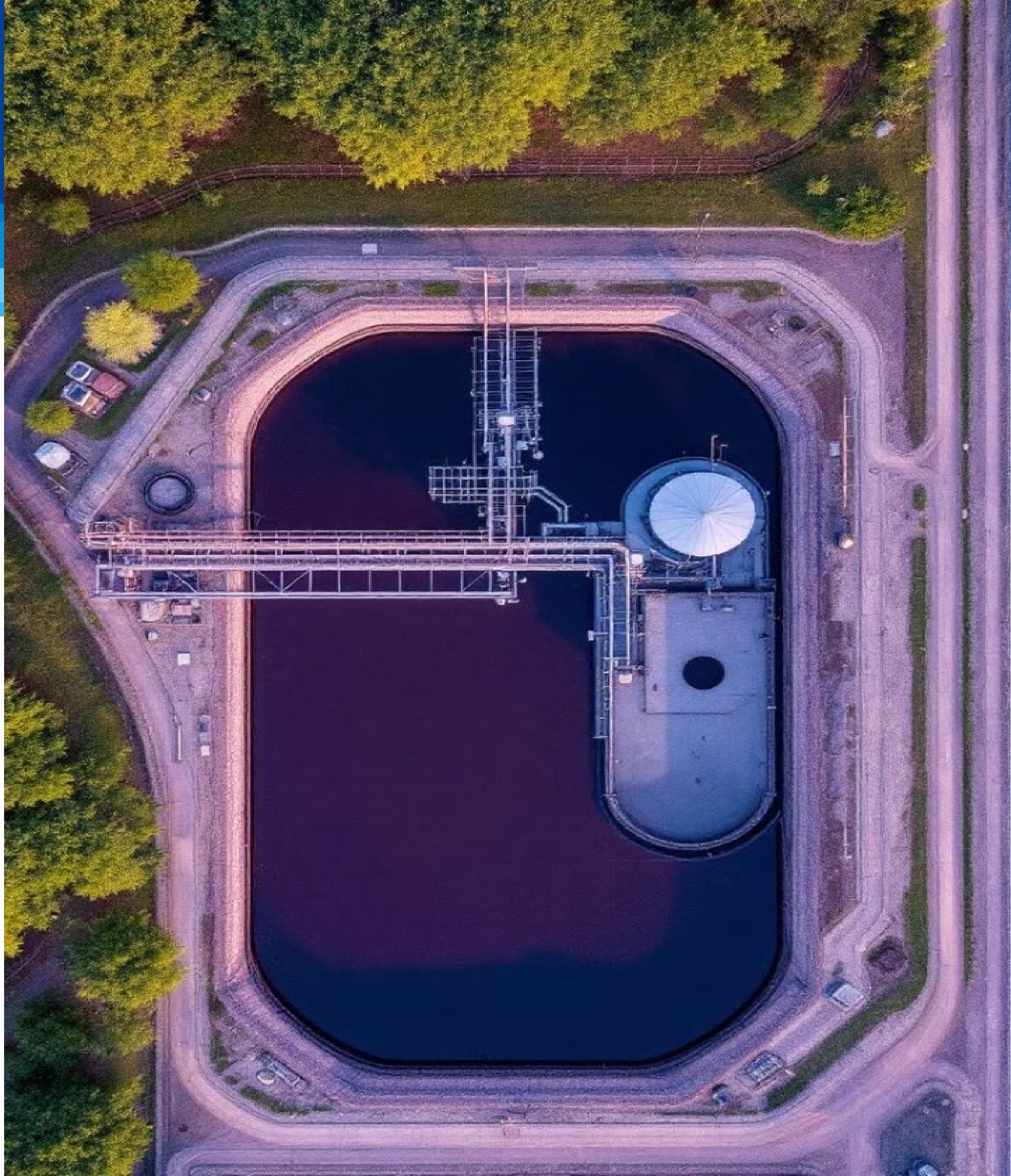
Importance of Small System Infrastructure

- Small Systems protect public health and the environment in rural and underserved areas

- There are around 12,000 publicly owned small WWTPs, making up 79% of all wastewater systems



Overview of Current Wastewater Treatment Challenges

Aging infrastructure

- Many systems rely on outdated equipment and pipes.

Staffing shortages

- Limited personnel to manage operations and compliance.

Rising compliance costs

- High expenses for upgrades, monitoring, and reporting.

Climate risks

- Extreme weather events (e.g., floods, droughts) strain systems.

Resources

- Can lack financial and technical resources to meet standards.

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Overview of Current Wastewater Treatment Challenges

Common Pollutants

Oxygen-demanding substances, suspended solids, pathogens, nutrients, and chlorine often exceed limits.

Reporting Issues

Many operators fail to submit required discharge monitoring reports or submit incomplete data.

Environmental Impact

Violations harm surface water quality and potentially affect drinking water supplies.

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Regulations and Compliance

Preparing for Change

Small wastewater systems need to adapt to evolving environmental regulations by staying informed, training staff, and exploring innovative technologies.

Financial Implications of Non-Compliance

Non-compliance with evolving regulations can lead to significant financial penalties and operational disruptions, highlighting the need for small systems to prioritize understanding and implementing regulatory changes effectively.

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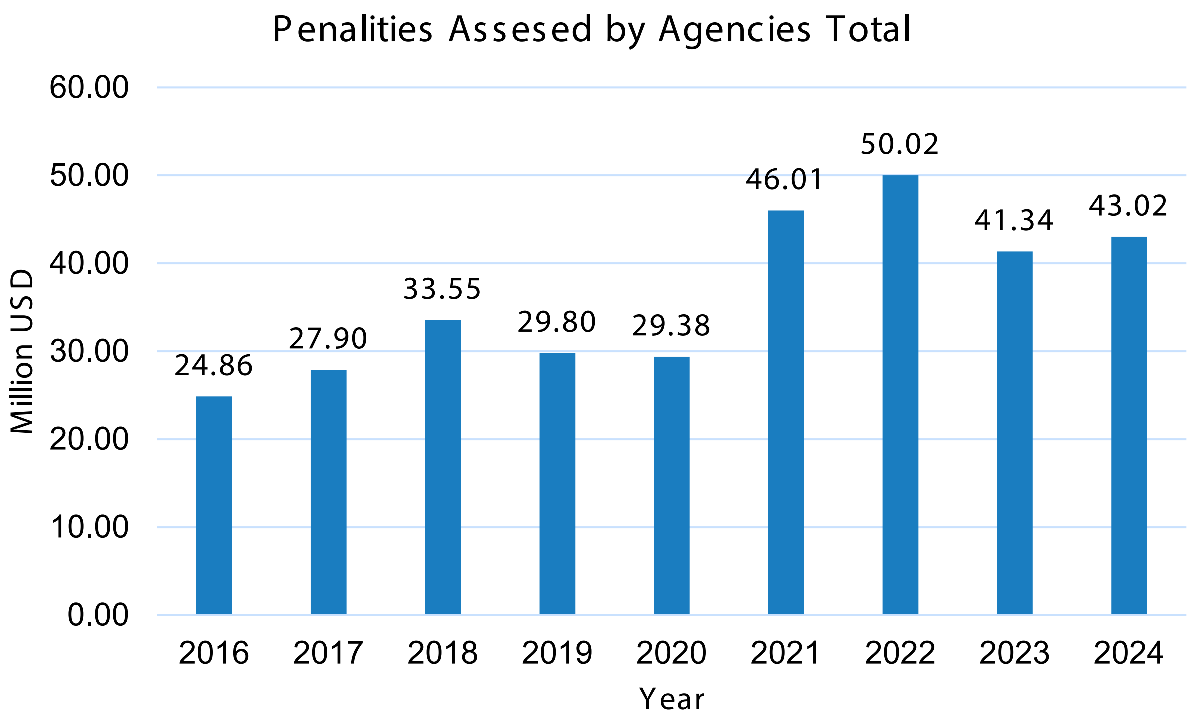
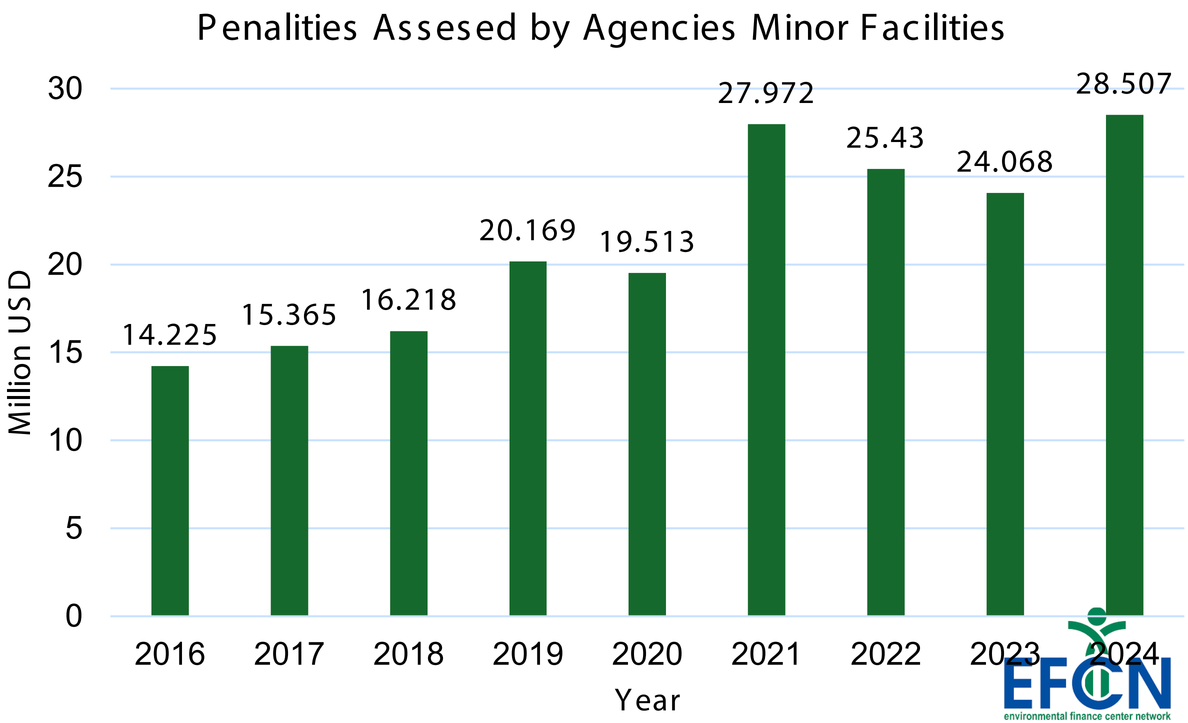
Enforcement and Compliance History

- Smaller WWTPs are a key focus to reduce significant non-compliance (SNC) since they account for 60% of recent NPDES SNC violations.





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Source: https://echo.epa.gov/trends/comparative-maps-dashboards

Smart Infrastructure Technologies

Smart Infrastructure Technologies

Smart Meters

Monitor water usage in real time. Identify leaks quickly, reducing water loss.

Sensors

Track water quality parameters instantly. Respond rapidly to any deviations or issues.

Internet of Things (IOT)

Connect devices and sensors to a centralized system for real-time data collection and analysis. E

Automation

Automated treatment systems utilize sensors and actuators to adjust processes, leading to reduced energy and chemical consumption.

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Small System can be Smart System

Pump station, valve, and aerator monitoring to spot early warning signs.

Environmental oversight (temperature, humidity, flood sensors) so you can intervene quickly.

Preventative protection against equipment damage by detecting overheating or pressure anomalies early.

Communication with Instant notifications via email, or text messages.

Small System can be Smart System

- **Enhanced Monitoring Capabilities**

The integration of smart sensors and IoT devices allows for continuous monitoring of wastewater parameters, enabling timely interventions and improved compliance with environmental regulations.

- **Data-Driven Decision Making**

Advanced analytics and big data applications can empower small systems to optimize treatment processes, predict maintenance needs, and enhance operational efficiency through informed, proactive management strategies.

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Role of IoT and Automation in Small Systems

- **Have fewer site visits** - Check data from your office (or your phone).
- **Pinpoint exact failures** - No more guesswork. Dispatch the right person with the right parts.
- **Improve response times** - Alerts give you a jump on the problem, so you can fix it before it spirals.

Role of IoT and Automation in Small Systems

Real-Time Data Utilization

Continuous data collection from IoT devices enhances operational insights, enabling timely adjustments to treatment processes and improving overall system performance.

Predictive Maintenance Strategies

Automation technologies facilitate predictive maintenance, reducing downtime and operational costs by addressing potential issues before they escalate into significant problems.

Sustainability and Resource Efficiency

The integration of IoT and automation promotes sustainable practices by optimizing resource usage, reducing waste, and supporting compliance with environmental regulations through efficient water management.

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Benefits of Real-Time Monitoring

Key Parameters

Continuous monitoring of flow rates, pH levels, and pollutant concentrations allows utilities to respond to issues promptly.

Optimization Benefits

Real-time data supports the optimization of treatment processes and helps reduce energy consumption.

Quick Response

Immediate insights facilitate quick detection and resolution of problems within wastewater systems.

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Enhancing Operational Efficiency through Automation

Streamlined Process Management

- Automation enables real-time adjustments to treatment processes, ensuring optimal performance and compliance with regulatory standards while minimizing manual intervention.

Improved Resource Allocation

- Automated systems optimize the use of chemicals and energy, leading to significant cost savings and enhanced sustainability in wastewater treatment operations.

Enhanced Data Analytics

- Integration of advanced analytics allows for better trend analysis and predictive maintenance, improving decision-making and operational reliability in small wastewater treatment facilities.

Cost Savings and Resource Optimization

Reduced Labor Costs

Automation minimizes the need for manual labor, leading to significant savings on overtime and staffing expenses in small wastewater treatment facilities.

Efficient Chemical Usage

Smart dosing systems ensure precise application of chemicals, reducing waste and lowering overall chemical costs while maintaining treatment effectiveness.

Enhanced Compliance Savings

Improved monitoring capabilities decrease the likelihood of regulatory violations, avoiding fines and penalties, and promoting long-term financial stability for small utilities

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Smart Infrastructure System Components

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System Monitoring and Operations Tools

Real-Time Continuous Monitoring

- This technology uses remote sensors to provide real-time insights into system conditions and operating status.
- Utilities install sensors throughout the system to collect information on flow, water level, rainfall, and other data.
- The sensors communicate their data to a central database.
- Utilities can use these analytics to dial in maintenance intervals, identify potential problem areas quicker, and inform decision-making for capital projects.

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System Monitoring and Operations Tools

Real-Time Decision Support Systems (RTDSS)

- RTDSSs combine hardware and software technologies, added to wastewater systems to inform operational decisions. An RTDSS generally consists of:
  - Sensors and other devices to measure system information, such as flow and water elevation.
  - Wired or wireless networks that transfer the collected data to software tools.
  - Software and analytics that process the data received and produce dashboards and actionable information for the system operator.
  - An RTDSS works with a supervisory control and data acquisition (SCADA) system, which is designed to receive and communicate data and control commands between central and remote locations in real time.

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System Monitoring and Operations Tools

Real-Time Controls (RTCs)

- RTCs help utilities control the level of wastewater in a system. Regardless of size or complexity, any RTC system includes:
  - Real-time flow or level monitoring devices.
  - A computerized system for receiving and analyzing data to inform control decisions.
  - Automated controls (e.g., gates, weirs, valves, pumps).
  - Utilities can strategically install RTCs in one place in response to a specific issue, in a region of a system, or throughout an entire system.
  - A typical RTC is automated with an RTDSS, which helps manage volume and route excess flow to offline overflow tanks, inline storage, or a treatment facility.

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System Condition and Capacity Tools

Condition Assessment Technologies	These technologies are used for sewer system inspection and can help operators identify defects and failures.
	Closed-circuit television has long been the industry standard for assessing system conditions and is still very widely used.
	However, newer tools are also now available that provide more detail and precision. They include digital, electrical, and laser-based scanning.

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System Condition and Capacity Tools

Condition Assessment Software and Analytic Tools	These tools automate some data collection and evaluation processes to provide more informative outputs.
	Better outputs can lead to more effective solutions for addressing system issues, such as inflow and infiltration.
	Condition assessment data and analytics can also be integrated with CMMS or EAM systems to help optimize asset costs and inform capital planning.

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System Condition and Capacity Tools

Enhanced Capacity and Performance Models	These models use information (e.g., RTC data) on flow dynamics, capacity, condition assessment, and performance to help utilities optimize operations and maintenance for existing infrastructure.
	They are also more accurate due to real-time monitoring, improved condition assessment technology, and advanced analytics.
	Models have become more user-friendly over time.

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Case Studies of Successful Implementations

Case Study

Cutting Cleaning Time and Costs

- Smart technology has helped **La Mesa, California** , retain a rigorous preventive maintenance cleaning routine while cutting costs and improving productivity.
- Before the city turned to a smart solution, technicians cleaned the entire collection system each year along with nearly 100 "hot spots."
- To better pinpoint where cleaning was really needed, the city embarked on a pilot project using real-time, remote monitors to assess site conditions.
- The city cleaned 12 times during the pilot—an 80 percent reduction from its prior schedule.
- The real-time remote monitors saved more than $19,000 and enabled staff to focus on other maintenance needs to help prevent sanitary sewer overflows.

Case Study

Tailoring Smart Sewer Investments

- Hawthorne, California, operates a small sewer system southeast of the Los Angeles Airport.
- It installed real-time remote sensors across about 2.5 percent of the sewer system (about 50 manholes).
- The sensors wirelessly connect to an analytics tool that allows the utility to see increasing water levels inside the system pipelines in real time.
- Since installing the system, the city has saved an estimated $2 million in fines and mitigation costs related to sewer overflows.

Case Study

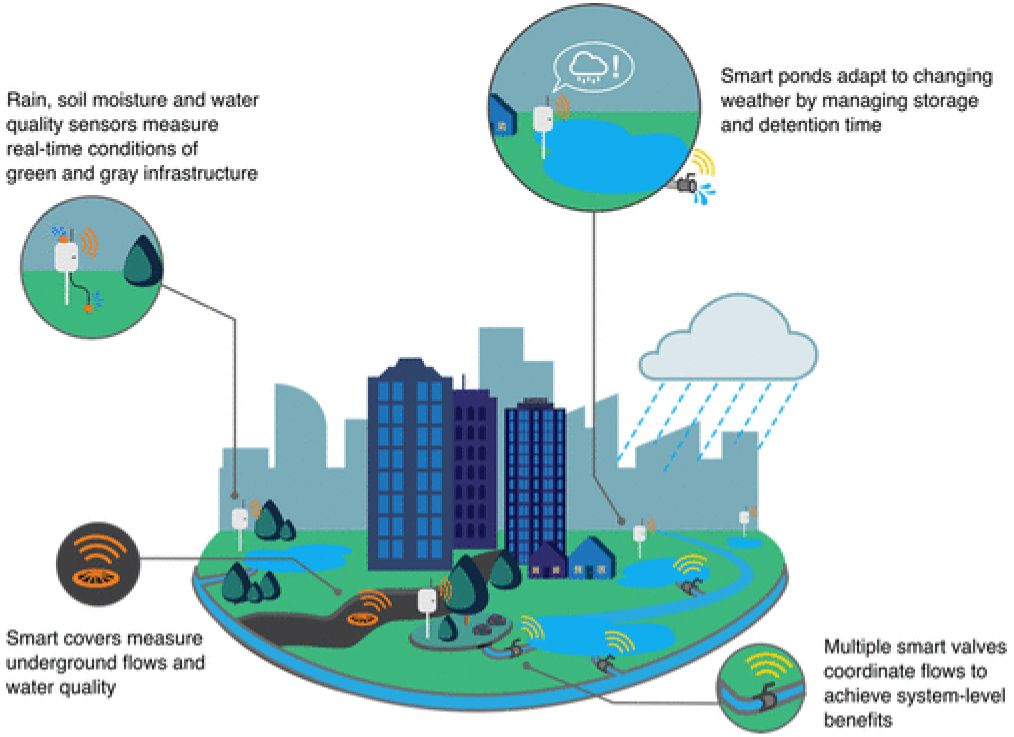
Using Real -Time Controls to Optimize Operations

- South Bend, Indiana, installed 120 smart sensors and actuators that trade available conveyance capacity in real time to avoid flooding and overflows.
- Since implementing its smart sewer program, South Bend has saved about $1.5 million in annual operating and maintenance costs and $500 million in avoided capital improvements.
- The program has also eliminated dry weather overflows and reduced combined sewer overflow volumes by more than 70 percent, or roughly 1 billion gallons per year.
- E. coli concentrations in the receiving water have also dropped by more than 50 percent on average, improving the water quality.

Case Study

Tailoring Smart Sewer Investments

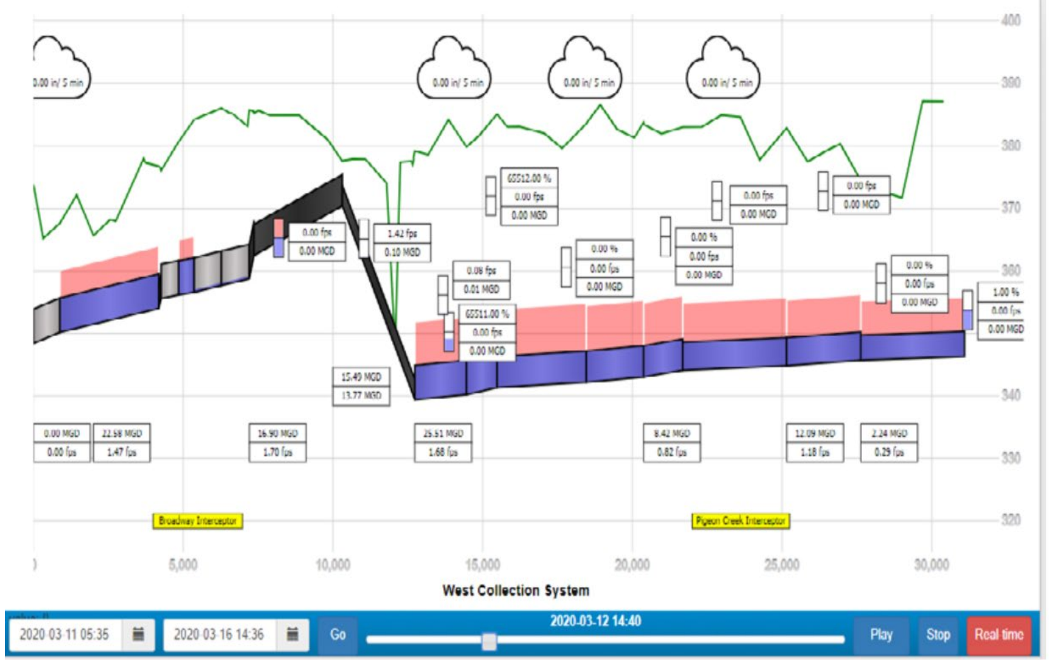
- Louisville and Jefferson County Metropolitan Sewer District in Kentucky implemented a system-wide smart sewer system.
- It installed real-time controls (RTCs) to optimize wastewater conveyance, storage, release, and transfer based on available system capacity.
- Optimization through RTCs has minimized overflows and relieved stress on the treatment system.
- As a result, the district has reduced combined sewer overflows by 1 billion gallons annually saved about $117 million from the original long-term control plan estimate of $200 million (a 58 percent reduction in capital investment).



Case Study

Taking the Guesswork Out of Wet Weather Events

- During heavy rainfalls, the aging combined sewers in Evansville, Indiana, often overflowed.
- To address the problem, the city built a real-time decision support system (RTDSS) using sensor networks, real-time monitoring, and artificial intelligence.
- Operators can now see the available capacity at the wastewater treatment plant up to an hour in advance along with recommended pumping rates.
- Evansville has reduced combined sewer overflows by more than 100 million gallons annually.
- Evansville estimates that achieving this reduction cost $0.01 per gallon per year with the smart technology and would have cost $0.23 per gallon without it—a savings of 95 percent.



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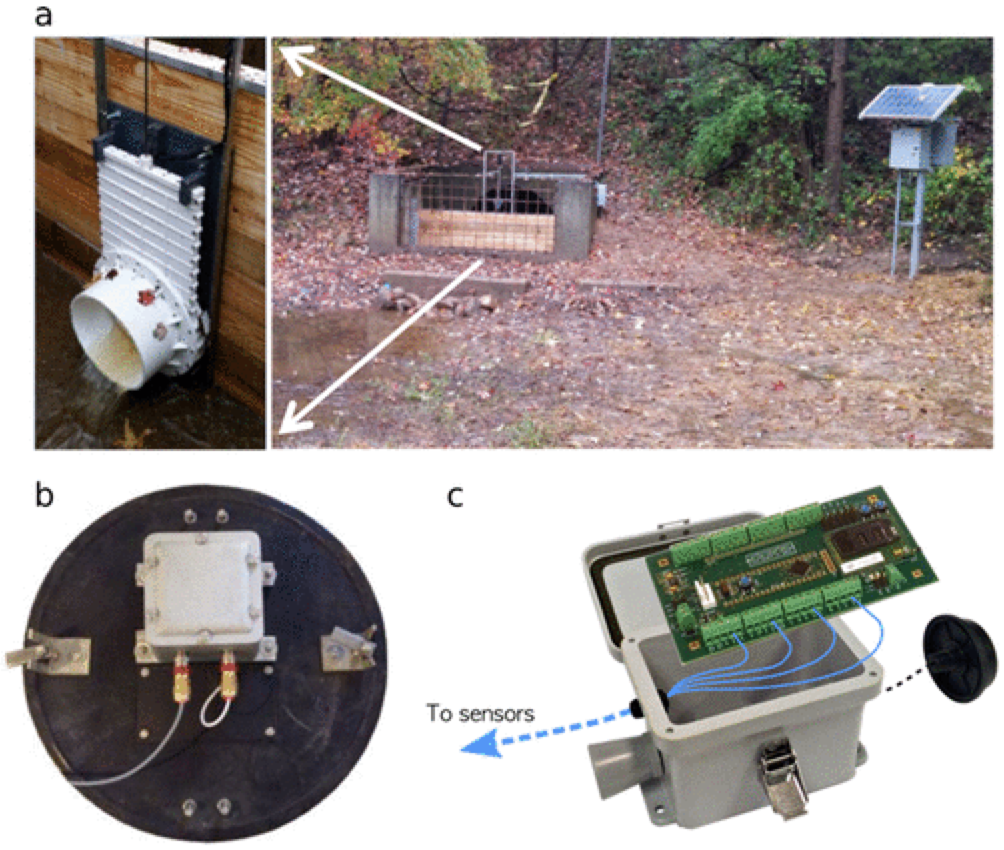
Case Study

Harmonizing Combined Sewer Operations

- The Metropolitan Sewer District of Greater Cincinnati in Ohio operates a sewer system with more than 200 combined sewer overflow outfalls.
- MSDGC implemented real time controls (RTCs) at strategic locations in the sewer system but then needed to choreograph these RTCs with the conditions and capacity at the wastewater treatment plant.
- MSDGC implemented a supervisory control and data acquisition (SCADA) system to create synergy among all of the utility components and maximize conveyance and treatment capabilities.
- Since then, their overflow volumes have dropped by 247 million gallons annually. MSDGC has achieved combined sewer overflow mitigation and saved tens of millions of dollars in capital investments.



Example sensing and control devices (a) Remote valve for basin control, (b) smart sensing manhole cover, and (c) an open-source sensor node for distributed measurement and control.

Case Study

Infrastructure Maintenance with Technology

Problem

- 3 miles of trunk sewer had capacity issues, causing basement flooding.
- No recent condition assessment or flushing program

Objective

- Identify pipe collapses, blockages, and solids buildup.
- Gather accurate data for a cost-effective cleaning bid.

Collected data on

- Pipe condition (sags, collapses).
- Unmarked or buried utility maintenance holes
- Water and debris levels.

Results & Impact

- Survey completed in 11 days despite challenges.
- Detailed data enabled 40% lower bid costs than initial estimates.
- Cleaning project completed faster than expected, reducing traffic disruption.

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Call to Action

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Overcoming Challenges in Small System Adoption

Assess Needs

- Identify pain points (e.g., aging infrastructure, compliance issues).
- Prioritize areas where smart tech can have the biggest impact (e.g., leak detection, energy optimization, resource utilization).

Plan Strategically

- Develop a phased roadmap for technology adoption (e.g., start with IoT sensors, then add automation).
- Align upgrades with long-term goals (e.g., compliance, sustainability).

Secure Funding

- Explore grants (e.g., EPA, USDA) and loans (e.g., State Revolving Funds).
- Partner with universities or NGOs for low-cost pilot projects.

Train Staff

- Provide hands-on training for IoT, automation, and data analytics.
- Foster a culture of innovation and adaptability.

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Driving Sustainability with Smart Solutions

Optimize Resource Use

- Use IoT sensors to monitor water quality and resource consumption in real time.
- Automate processes (e.g., chemical dosing, aeration) to minimize waste.

Energy Efficiency Approaches

- Integrate energy efficient equipment's in treatment plants.
- Pair renewables with smart controls for maximum efficiency.

Engage the Community

- Share real-time data through public dashboards to build trust.
- Educate residents on water conservation and sustainability efforts.

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Building Partnerships for Smart Solutions

Universities

- Collaborate on student-led sensor projects for cost-effective pilot programs.
- Engage capstone projects from community colleges and universities to develop tailored solutions.

EFCs/Community Organizations

- Access free technical assistance for system assessments and technology integration.
- Leverage expertise from organizations for training and funding assistance.

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Building Partnerships for Smart Solutions

Real-Time Public Dashboards

- Provide real-time updates on water quality, system performance, and compliance.
- Build trust by making data accessible and understandable to the community.

Transparency Turns Ratepayers into Allies

- Educate residents on wastewater challenges and solutions.
- Gain public support for infrastructure upgrades and sustainability initiatives.

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Future Trends

Technological Integration for Compliance

- The adoption of advanced technologies, such as AI and IoT, will enhance real-time monitoring and data analysis, ensuring small systems meet evolving compliance standards effectively and efficiently.

Resilience through Adaptive Strategies

- Small systems will need to adopt adaptive management strategies that enhance resilience against climate variability, ensuring compliance while maintaining operational efficiency in wastewater treatment.

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AI Tools

Generative AI Usage

- **Crafting Communications & Documentation**
  - AI tools like ChatGPT help draft professional communications (e.g., contractor negotiations) and simplify HR tasks, such as condensing job postings. This saves time for resource-constrained teams.
  - AI streamlines access to HR policies (e.g., PTO rules) and operational manuals, enabling quick answers for employees without manual searches.
- **Standard Operating Procedures (SOPs)**
  - AI generates or refines SOPs by analyzing uploaded documents (e.g., state guidelines, equipment manuals)
- **Predictive Maintenance (Advance AI)**
  - Analyzes historical data to predict equipment failures (e.g., pumps, valves) and prioritize maintenance.
  - AI evaluates asset lifespans and failure risks using historical data, helping utilities create data-driven capital improvement plans and justify budgets to governing boards.
  - AI identifies trends in inflow/infiltration, energy use, or treatment processes to optimize performance and reduce costs

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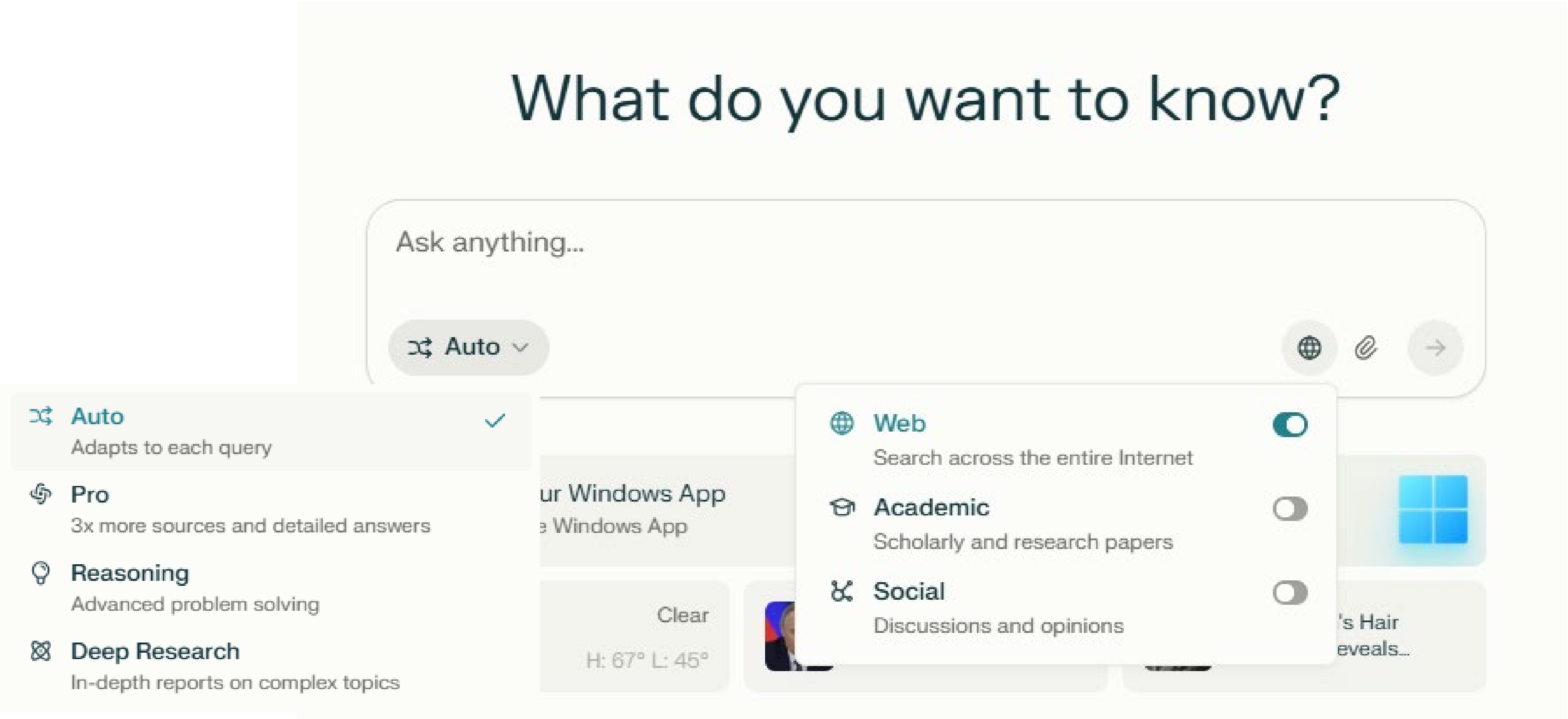
Perplexity

www.perplexity.ai/

- Provides comprehensive answers by synthesizing information from multiple sources.
- Offers personalized learning experiences and detailed explanations, summarization, and writing.



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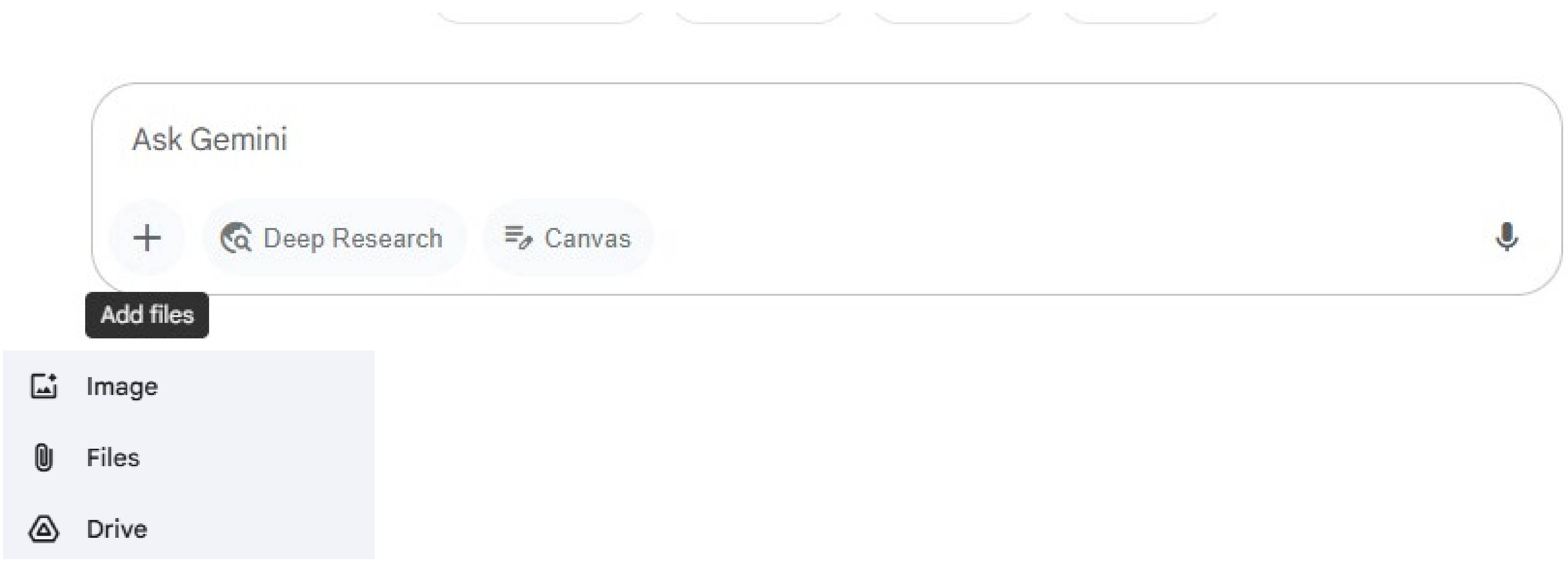
Gemini

gemini.google.com/app

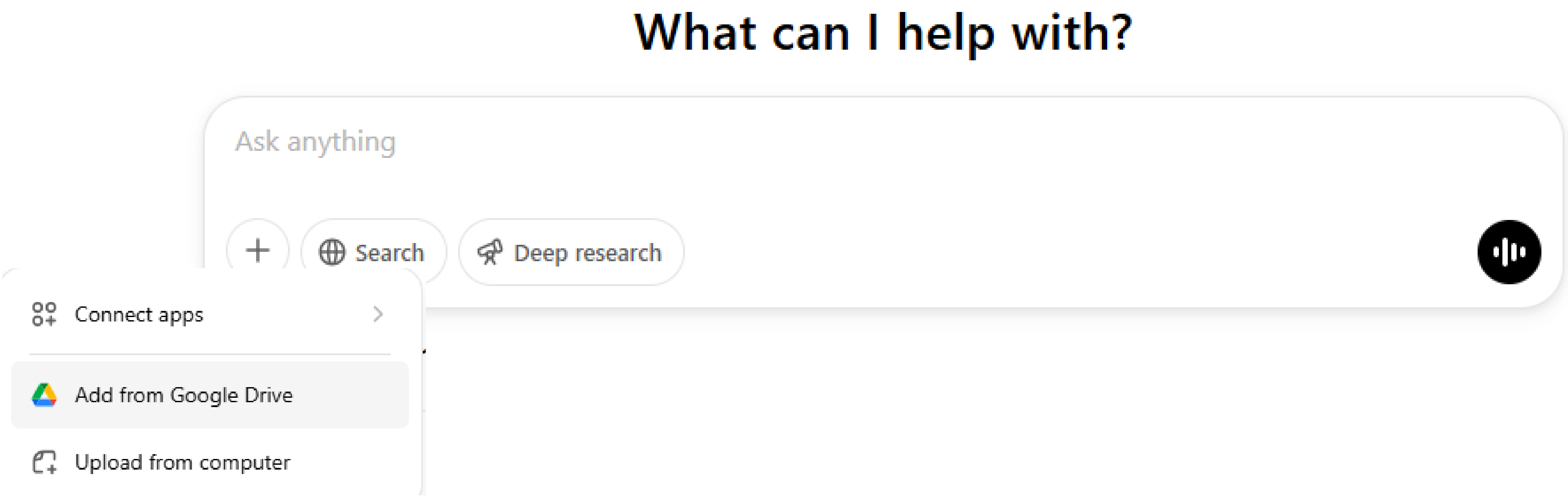
- Summarizes emails, and creates structured meeting agendas and meeting notes saving time
- Image to Text Conversion
- Analyze pdf information



ChatGPT

chatgpt.com/

- Translates text from one language to another, multilingual customer support and communication
- Generates content for websites, and social media platforms to enhance public engagement



Audience Experience

- Would you like to share your story if you are planning to or have already installed any smart system technology at your WWTP.
  - What inspired you to make that change
  - What impact did it have on your operations
  - Any lessons learnt that you would like to share or challenges you faced

Questions

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Poll Questions

1. What is the biggest challenge your small wastewater system is currently facing?
   - Aging infrastructure
   - Staffing shortages
   - Rising compliance costs
   - Lack of funding for upgrades
   - Climate risks (e.g., floods, droughts)
2. How familiar are you with smart infrastructure technologies like IoT sensors or automated treatment systems?
   - Very familiar (already using them)
   - Somewhat familiar (heard of them but not using)
   - Not familiar at all
3. How does your system currently monitor wastewater operations?
   - Manual checks (e.g., site visits)
   - Basic sensors (e.g., flow meters)
   - Advanced monitoring (e.g., real-time IoT systems)
   - We don't have a monitoring system
4. What's the biggest barrier to adopting smart technologies in your system?
   - High upfront costs
   - Lack of technical expertise
   - Uncertainty about ROI
   - Resistance to change
5. Question: How interested are you in using AI or machine learning for predictive maintenance or anomaly detection?
   - Very interested (we're already exploring it)
   - Somewhat interested (we'd like to learn more)
   - Not interested (it seems too complex or expensive

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