# Big Data, Big Insights in the Water Industry
## *Using Big Data to Make Water and Wastewater Infrastructure Management and Infrastructure Procurement Smarter*

Our massively fragmented water utility sector has been built more than half a century ago. Much of this old infrastructure is nearing the end of its life cycle and needs to be replaced. In addition, the growth of the population necessitates cities to provide larger networks of water services. One report by AWWA (American Water Works Association) predicts that the cost of repairing and expanding drinking water infrastructure will top $1 trillion by 2035.[1] This report also mentions that postponing infrastructure investment increases this cost by increasing the likelihood of water infrastructure failure. Therefore, water utilities could do much more with less by making their procurement and resource allocation processes smart, using big data and advanced predictive analytics with the help of new technologies such as IOT, sensor-embedded devices, etc. In this paper, we analyze five critical and promising areas where big data and analytics are starting to play significant roles in improving water infrastructure management and water infrastructure procurement.

### 1.  Trend Analysis

Advanced trend analytics at the high end of big data (i.e., massively large datasets) has the potential to make water infrastructure resource management smart by enabling decision makers to efficiently and accurately estimate, predict, and allocate their resources. Trend analysis, which relies on analytical techniques to capture the hidden patterns and trends underlying historic data to make future predictions, can help water utilities to set priorities on their capital assets, assess risks, monitor infrastructure components, and implement action plans based on more precise decision-making tools.

While widely applied by other verticals, the critical role of trend analysis and forecasting still seems undiscovered in the significantly fragmented water industry. This necessitates vendors and utilities to invest in building proper data acquisition systems for collecting, aggregating, and performing trend analytics of micro and macro data as the first step toward the optimization of infrastructure resource management and decision making in the water industry.

To demonstrate the applicability of trend analysis in the water and wastewater infrastructure industry, let's consider a simple example. Figure 1 shows the total water and wastewater bids made in 2016 by category. An advanced trend analysis and prediction performed by H2bid on these categories using data collected during a period of 5 years indicates that consulting services, chemicals, and pumps have had highest trends among these categories from 2012 to 2016. An advanced regression analysis predicts a 12% increase for chemical projects by 2018 within 95%

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[1] http://www.awwa.org/Portals/0/files/legreg/documents/BuriedNoLonger.pdf

confidence intervals. In addition, in spite of a slight decrease in bids on consulting services in 2016 relative to 2015, this analysis suggests that vendors and utilities should expect an up to 21% increase in bids related to consulting services by 2018. Several similar considerations such as geographic distribution, bid price, etc. could be considered by decision-makers to make their resource management processes smart and efficient.

H2bid predicts that trend analysis which is based on facts driven by big data will increasingly play critical roles in water infrastructure management in the upcoming years. This again highlights the importance of data in making informed smarter and more precise decisions in water infrastructure management.
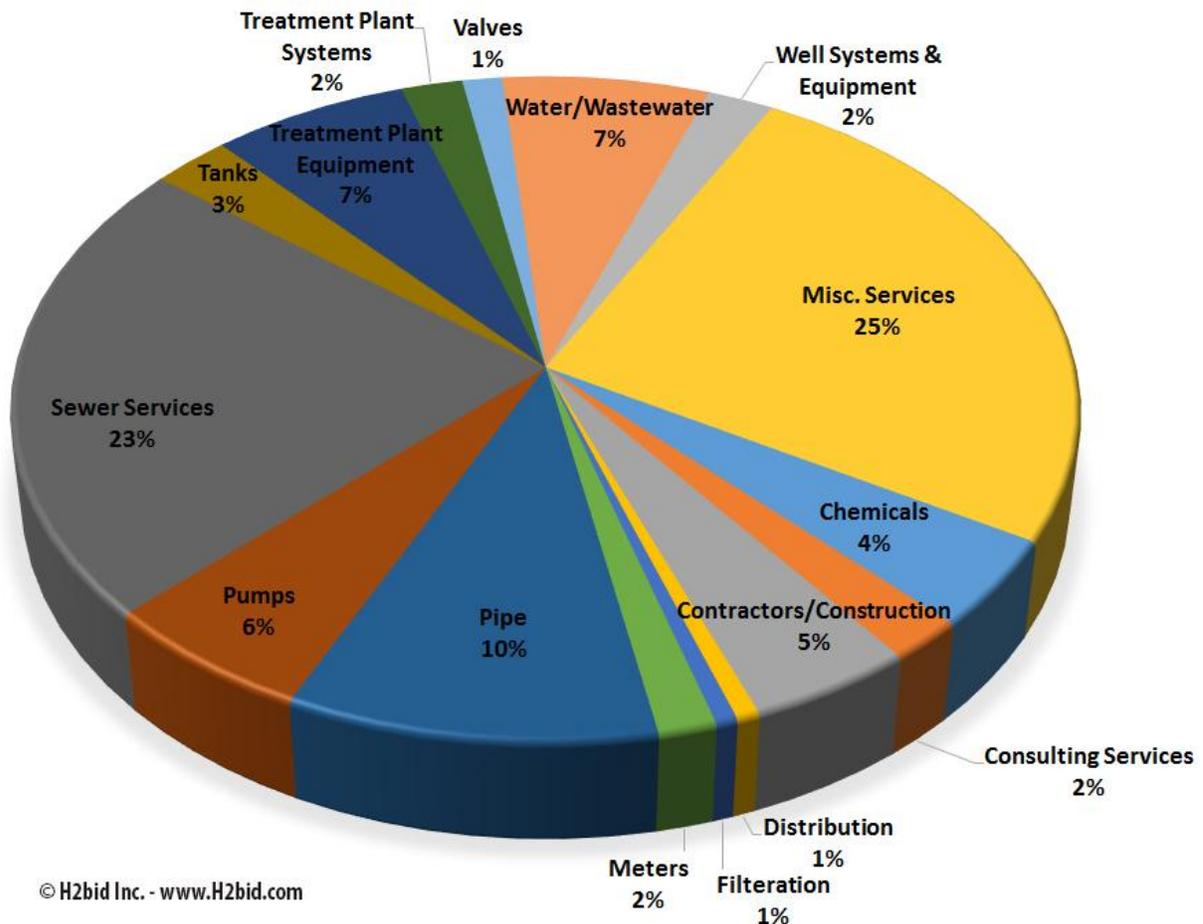


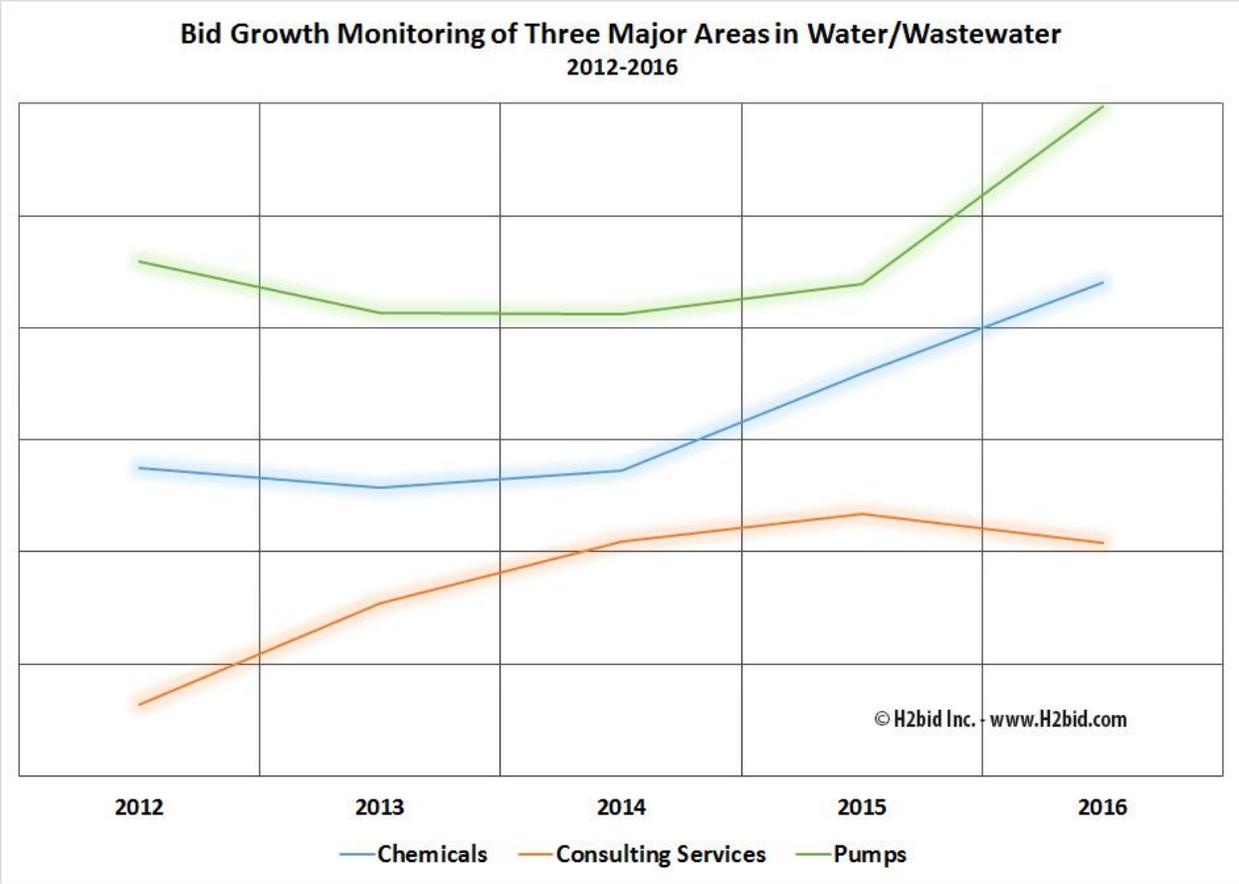**Figure 1: Water and Wastewater Bids by Category**

**Figure 2: Trend analysis of bids on chemicals, consulting services and pumps from 2012 to 2016**

## 2. Demand Prediction

Demand forecasting and prediction is one of the most essential steps in water infrastructure resource management. However, various social, economic, political, and environmental uncertainties are associated with these kinds of forecasts since different scenarios may result in completely different results and predictions. Advanced Big data analytics makes demand prediction feasible for high-level decision-makers by pattern recognition and modeling of a range of scenarios (instead of just one scenario) using system dynamic simulations and advanced machine learning algorithms.

To illustrate the applicability of demand analysis in water infrastructure management, let's consider Figure 3. This figure shows the total projects and bids in the water and wastewater industry made by states during a time period of six years, between 2011 and 2016. Based on H2bid's analysis performed on states with the largest number of bids during these years shows an anomaly for the state of California. As Figure 4. shows, the number of bids in the state of California significantly dropped between years 2012 and 2015 and gradually increased at the beginning of 2016. Capturing the hidden patterns and variables to investigate the reasons behind this strange behavior is the key to predicting the future demand of water projects, not only in

California but also in any other states or countries with the same variables involved. For example: is there any link between this model and the historic draught in California between 2012 and 2016? If so, did all categories damage at the same extend or it impacted some categories more than others? What categories would suffer most and may need more intelligent resource management tools if a similar situation happens again? Big data is the key to determining answers to these questions and facilitating demand modeling and predictions in the water and wastewater industry.
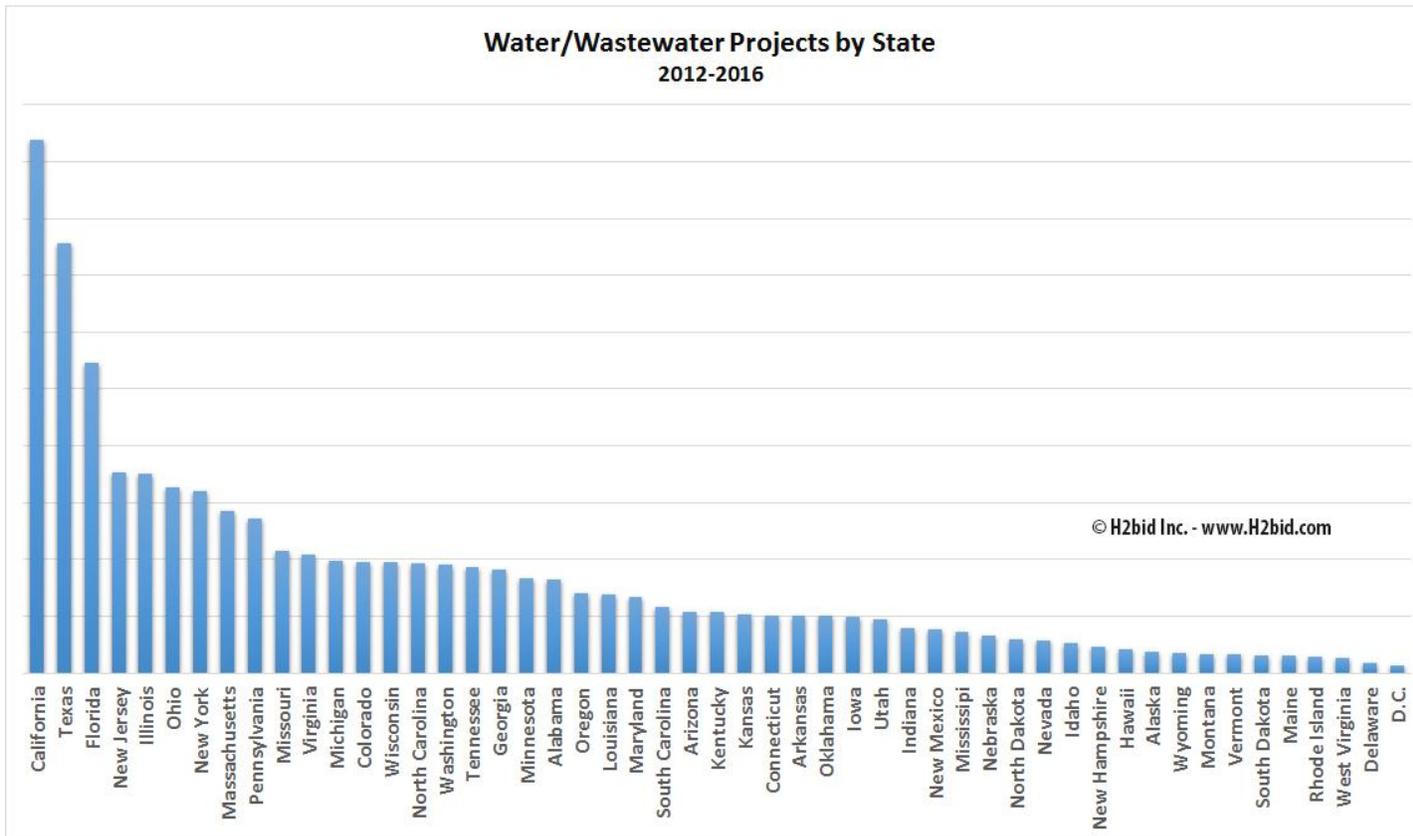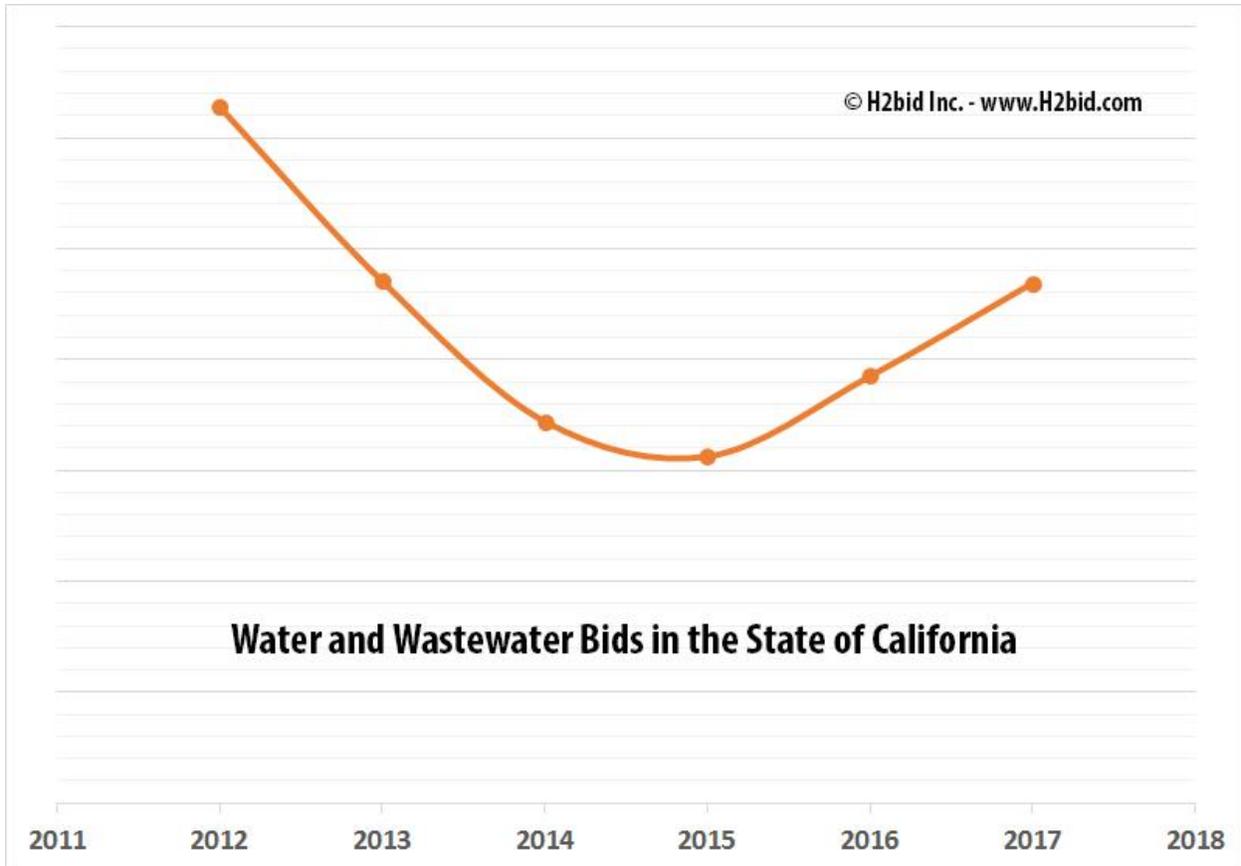


**Figure 3: Water and wastewater bids made between 2012 and 2016 by states**

**Figure 4: Bids made in the state of California 2012-2016**

Demand analysis and data-driven predictions will replace intuitive methods used to make marketing and strategic planning decisions. Three examples are highlighted below:

### 3. Water Consumption Behavior Analysis

Demand analysis has improved water infrastructure management by making water consumption behavior predictions more accurate and reliable for public and private utilities. Pattern recognition of water consumption behavior and usage enables vendors, utilities, and public entities to efficiently optimize and manage their infrastructure development processes and strategies. Advanced demand analytics built on big data factors in multiple data sets for predicting water consumption behavior such as demographic variables (population density, etc.), historical use patterns, climate (temperature, humidity, etc.), infrastructure (used technology, age, productivity, etc.), political, economic, social, and several other parameters. These components are considered as input variables to develop a predictive model capable of forecasting water consumption behavior (i.e., demand).

Demand analysis of water usage not only provides smart strategic action plans for infrastructure resource allocation and management, but also plays a critical role in finding effective solutions for water conservation. This can also be used to develop systems and methods to predict and prevent for water shortages. Digging into water consumption data to capture accurate predictive models capable of water demand prediction is an important step toward smart cities and unlocking the benefits of smart water infrastructure resource management in the near future.

### 4. Market Targeting and Prediction

Another significant contribution of demand analysis in water infrastructure resource management is its ability to target potential users for the potential demands. By evaluating the need, ability, and willingness of potential users to pay for the service, water utilities can size the feasibility of their infrastructure projects and assess their financial and economic capabilities (and estimate the support from ratepayers), to set the best marketing strategies for their infrastructure management and capital improvement plans. This will facilitate the prediction of the potential size of the customer market and the range of options for the level of service for water projects.

Targeting and forecasting the market using demand analytics has a key role in defining the scope of water projects and has to be taken into account at early stages of financial planning for infrastructure projects. Since market analysis and forecasting greatly relies on demand analysis and prediction, it should take several scenarios (such as worst-case scenario, most-likely scenario, etc.) and variables (environmental, economic, etc.) into account. This not only facilitates marketers and decision makers to assess the market and define the scope of their projects, but also helps them identify the risks associated with their decisions to make more-informed decisions.

### 5. Bid Strategy Forecasting & De-Fragmenting the Water Infrastructure Industry

Monitoring and modeling various interconnected factors to identify and target the potential market is fundamentally transforming the traditional platform for identifying and winning water infrastructure contracts. Big data predictive analytics and business intelligence are tools that can help utilities attract the right vendors and help vendors predict the right bids. The services in this area are delivered using bid forecasting platforms.

As big data and analytics become more prevalent, we expect that bid forecasting services will become valuable tools for vendors and contractors. The challenges associated with industry-wide data collection have made this an elusive area for the industry. Both quantity and quality of data play critical roles in bid forecasting. Although bid forecasting systems are very valuable to both vendors, they can also provide significant benefits to water utilities by enabling decision-makers to set the best bidding strategies for their resources management and prediction. Without a doubt, bid forecasting can be considered one of the newest and also among the most challenging application of big data in the water infrastructure procurement process.

A large part of the inefficiencies of the water industry are directly related to industry fragmentation, which can make it difficult to ensure open and fair competition for projects and also limit the number of bidders (which can mean higher prices, which get passed on to ratepayers). Through technology, it is now possible to establish an efficient ecosystem that enables maximum competition and may help lower water rate increases. One solution is the H2bid exchange which uses a web-based procurement platform specifically designed to connect water utilities with vendors and contractors more efficiently. The exchange has the largest database of vendors – which will ensure maximum competition and likely reduce prices. The exchange includes an electronic bidding platform that allows water and wastewater utilities to accept sealed bid/RFP responses and engage in full e-procurement in a user-friendly environment. The future will include a series of solutions that are leveraging data to help utilities and vendors make smarter decisions during the procurement process.

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About **H2bid, Inc.:** H2bid ([www.h2bid.com](www.h2bid.com)) is an exchange connecting water and wastewater utilities to vendors and contractors more efficiently. H2bid has the largest listing of municipal water and wastewater infrastructure contract opportunities. This includes a historical database of over 350,000 bids and RFPs, bid tabulations, and contract awards, dating back over 9 years. This data is a rich resource for trend analyses and demand prediction including bid forecasting, and price estimating. H2bid also has an electronic bidding platform that enables water utilities to access an e-bidding solution, access the largest database of water utility vendors and contractors, and conduct full e-procurement in a user-friendly software environment. H2bid seeks to help keep water and wastewater services affordable for years to come.