

Chapter 11 -- National Handbook of Recommended Methods for Water Data Acquisition



11.F. INDUSTRIAL

11.F.1. Description

Industrial water use includes water used to manufacture products such as steel, chemical, and paper, as well as water used in petroleum and metals refining. Industrial water use includes water used as process and production water, boiler feed, air conditioning, cooling, sanitation, washing, transport of materials, and steam generation for internal use (fig. 6). It does not include power generation for sale to other users, mining of minerals, or the extraction of crude petroleum and gases, which are included in other water-use categories.

Industrial water-use activities include water withdrawal from ground and surface water; deliveries from public water suppliers; consumptive use through evaporation and product incorporation (as in a bottling plant); water and wastewater treatment, recycling, releases to wastewater collection systems, and return flow to ground and surface water. Large industrial water users are more likely to obtain water directly from wells, rivers, lakes, and estuaries, and may supplement this with water purchased from public water suppliers. Small industries, especially in cities, are more likely to obtain water from public water suppliers. Even if water is purchased from a public water supplier, the water may be treated by the industry before use, especially if pure water is required, as in boiler feed.

Industrial consumptive use occurs either through evaporation during cooling and open-air washing, or through product incorporation, especially in food processing, such as bottling or canning. During the past two decades, industries have decreased water withdrawals as they began to recycle water within their plants to a greater extent than previously, primarily due to the high cost of wastewater treatment required to meet the provisions of the Clean Water Act. There is an increased consumptive-use rate associated with recycled water. More recently, industries have decreased water withdrawals in response to decreasing supply and an emphasis on decreasing use and production of hazardous-waste materials.

After use, wastewater may be treated onsite, released to wastewater-collection systems, returned directly to surface water or to septic systems, or a combination. Industrial Pretreatment Programs have been set up by the USEPA and maintained by wastewater-treatment facilities to regulate or monitor the type of contaminants released into the wastewater-collection systems.

Industrial water-use totals and trends can be dominated by a few large industries. One or two large industries may account for more than 50 percent of water used by industry in an area. Water use by industries also can change significantly over a short time interval due to a variety of socio-economic factors, such as changes in technology, water quality, consumer demand, layoffs, business failures and

start-ups, or seasonal variation in food processing. For these reasons, it's important to collect site-specific information on the largest industries.



Figure 6. Diagram of industrial water use.

The Standard Industrial Classification (SIC) codes included in industrial water use are identified in table 4. Nationwide, 4 major industry groups accounted for 84 percent of the water used by manufacturing establishments (U.S. Bureau of the Census, 1986, p. 3). These major groups are:

SIC 26, Paper and Allied Products

SIC 28, Chemicals and Allied Products

SIC 29, Petroleum Refining and Related Industries

SIC 33, Primary Metals Industries

In different sections of the country, different industries will predominate and additional groups (such as SIC 20, Food and Kindred Products) may need to be included to account for most of the water used. For example, wood processing is significant in the northern New England, Wisconsin, southeastern United States, and northwestern United States. Food processing is prominent in the midwest, the south, and California, and metal manufacturing in Michigan, Indiana, and Illinois.

Measured or estimated industrial water-use data are the rate of (1) withdrawal by source, (2) deliveries from public water supply, (3) evaporation and product incorporation, (4) release to wastewater collection systems, (5) recycled water, (6) deliveries of reclaimed wastewater, and (7) return flow.

Table 4. Industrial Standard Classification codes and product descriptions.

 A table with multiple columns and rows, containing industrial standard classification codes and their corresponding product descriptions. The text is too small to read accurately.

11.F.2. Sources of industrial water-use information

Sources of industrial water-use data are (1) the State agency responsible for compliance to the USEPA's Clean Water Act Program; (2) the State agency responsible for regulating withdrawals; (3) a manufacturers' data base; (4) State Department of Employment or Economic Development; (5) the U.S. Bureau of the Census; (6) public water suppliers; and (7) wastewater-treatment facilities. Individual industrial facilities also are an important source of information.

The State agency responsible for compliance to the USEPA's Clean Water Act Program is an important source for two primary types of information. The USEPA administers the Permit Compliance System

(PCS) database, which was designed to track permit, compliance, and enforcement status data for the NPDES program under the Clean Water Act. A NPDES permit is required for all point discharges into United States waterways. The PCS data base contains descriptive information on major industries, their location, and monthly return flows. The NPDES permit application and permit itself should include a detailed description of the plant which will provide basic information on all the sources of supply for the plant, the different ways in which water is used in the plant, and what water is included in the reported discharge values. Additionally, monthly return-flow data is available from PCS. Data on industrial water use can be found also in the Industrial Facilities Discharge (IFD), which monitors discharges into wastewater collection systems as well as to the waterways.

Many States have developed regulatory permit programs or reporting requirements or both for industries withdrawing greater than a specified threshold. Industrial water-use information often can be obtained from the State regulatory agency in States where permits or registration are required.

A third important source of industrial water-use data are manufacturers' data bases. Dunn and Bradstreet Information Services maintain an information base of almost ten million industrial, commercial, mining, and other business locations in the United States, including Puerto Rico and the Virgin Islands. Geographic, sales, employee population, product, and contact information is available. Many states may also maintain a manufacturers data base from which information may be purchased.

State Department of Employment or Economic Development may collect and disseminate data on manufacturers in their State. These data may include descriptions of major industries in each community, and (or) total number of employees by SIC code for each community or county. Frequently these data are based on data compiled by the U.S. Bureau of the Census, but may be significantly enhanced in some States.

The U.S. Bureau of the Census is required by law (Title 13 of the United States Code--section 131, 191, and 224) to take the economic census every 5 years, covering years ending in 2 and 7. These economic census consist of the Census of Retail Trade; Wholesale Trade; Service Industries; Transportation; Manufactures, Mineral Industries; and Construction Industries. The results of each of the economic census are available in printed reports, for sale by the U.S. Government Printing Office, and on microfiche, computer tape, compact discs with read-only memory, and flexible diskettes, for sale by the U.S. Bureau of the Census. The Census of Manufactures contains such statistics as number of establishments, employment, payroll, value added by manufacture, cost of materials consumed, and capital expenditures for each State and its important metropolitan areas, counties, and places, by industry groups and individual industries. Selected statistical totals for "all manufacturing" are available for metropolitan areas with 250 employees or more and for counties and places with 450 employees or more.

Finally industrial water-use data are available from customer records maintained by public water suppliers and wastewater-treatment facilities. Care must be taken to ensure that only industrial users are included, not large domestic (apartment complexes) or commercial (hospitals) users, and to take into account that small industrial users may be included in commercial or even domestic groupings because of the small meter size.

11.F.3. Measurement, estimation, and data-collection methods for industrial water use

Determining industrial water use has three main tasks: (1) identifying major industries; (2) determining

the water use of these industries; and (3) determining the water use of the small industries in the area of interest. Nationwide, industries that receive 20 Mgal/y (0.055 Mgal/d) or more of water represent only about 3 percent of the total number of industries, but account for about 95 percent of the total industrial withdrawals (U.S. Bureau of the Census, 1986). Therefore, it is important to identify the major users individually and compile site-specific information on them. The precise definition of a major user varies by State.

Most major industries can be identified by a retrieval of Major Industrial Facilities from the USEPA PCS data base and of Indirect Dischargers from the USEPA IFD data base. Checking this list against a list of industries with withdrawal permits (if the State has a permitting program) will provide a list of major industries with enough information to determine which are self supplied, publicly supplied, self disposed, and publicly disposed. If the State does not have a permitting program, then it will be necessary to contact the public water suppliers to identify the source of supply for the water.

The list of major industries should be compared with the other lists of industries, such as the Dunn and Bradstreet Information Base, the State Directory of Manufacturers, or the Chambers of Commerce. These data bases should assist in identification of industries that are major but were missed from the other sources and in determining medium and small industrial users. Major users can generally be separated from medium and small users on the basis of SIC code and number of employees. Detailed information on how each major industrial user uses water can be obtained by reviewing the NPDES file or by visits to individual facilities. Other approaches in obtaining information on industrial water users depend on surveys made by State agencies.

Since industrial water users can have their own well and surface-water intakes and be on public water supply, strategies for obtaining volume data must incorporate methods for combining quantities of water withdrawn directly by industries with data on the volume of water provided by public water suppliers. Recycling is an important factor in how industries currently use water because it reduces the volume of water withdrawn or distributed for industrial use, particularly if the estimates are based on national coefficients, and it will increase the consumptive use rate. Since industrial wastewater can have septic systems, onsite wastewater treatment, and release wastewater into public collection systems, strategies for obtaining volume data must incorporate methods for combining quantities of water returned by industries with data on the volume of water released to wastewater-collection systems.

11.F.3.a. Primary data acquisition

Site-specific data on major industrial users are essential for determining total industrial water use or total water use for a specific area because a single large industrial may dominate the water-use patterns. Most major industries are probably metered, but if not, direct or indirect methods for measuring the water use should be made. Most large industries meter withdrawals and deliveries from public water suppliers as part of efficient plant operation. If the project objective requires information on medium or even small industries, the need for primary data acquisition is greater because medium to small industries are less likely to have their own meters. Measurements of industrial withdrawals generally are made at the well or surface intake. Measurements of public water-supply deliveries to industries generally are made at the point where the water enters the industrial facility. Measurements of return flow generally are made as the wastewater enters the on-site treatment plant or as it leaves the site.

11.F.3.b. Secondary data acquisition

Considerable metered industrial water-use data may be available. States requiring withdrawal

permits usually require periodic withdrawal reports, frequently with metering requirements. Industries with NPDES direct discharge permits are required to meter and report discharges. However, care must be taken to decide which metered data to compile and how to evaluate the metered data for reliability.

In order to begin the industrial-use inventory, compile all metered data for major industrial users. This can be done efficiently by starting with State or Federal collections of data. Obtain all Statewide data sets on metered water use, including withdrawal (primarily from State permitting agencies), releases to wastewater-collection systems (IFD), and return flow (PCS data base). Compare these metered systems against your list of major users. Identify public water suppliers and wastewater treatment systems that distribute water to or collect water from the major industries and request metered data from them. Contact individual major industries for metered data that have not been obtained through the above methods. If time and money permit, metered data may be collected from medium users from public water suppliers or wastewater-treatment facilities.

While compiling metered data, also obtain information on the type of meter and its calibration history. This will provide information on the design accuracy of the meter and whether its still likely to be at that level. Inspect the metered data for obvious errors. Some users may inadvertently report the actual meter reading rather than the difference between successive meter readings which would indicate an increased use each month. Reported use may actually conform more closely with withdrawal and discharge permits than meter records, even if records are maintained (Burt, 1983). More refined evaluation of metered data will be done when they are combined with estimated data.

Industrial water-use surveys are commonly done in States without a withdrawal permitting program (Pennsylvania). Great care must be taken to effectively identify the population that would provide the most meaningful information for the least time and money. Cooperation and overall response by industries can be greatly enhanced by site visits and telephone follow-ups, but the cost also increases with such visits and follow-ups.

As with metered data, the reported water-use data must be accompanied by a description of the meter and the estimating method used. The number of returned questionnaires must be compared against the total sent out to determine whether a representative and unbiased sample has been returned. Records of production levels and indirect indicators of production such as water use may be considered confidential by industrial establishments (Burt, 1983) who may be reluctant to supply them. Estimates of withdrawal and use data, by county and hydrologic unit, are available from USGS District offices.

11.F.3.c. Derived data

Statistical sampling of industrial water users may be used to determine industrial water use if it isn't feasible to measure or even survey all industrial users in an area. A stratified sampling approach based on size and type of use would be appropriate. First determine the entire population of industries in the area by referring to the State Directory of Manufacturers. Rank the industries in each SIC code by number of employees. Use the correlation factor between employee number and SIC code (Appendix 1) to develop groups of industries with similar coefficients. Use statistical analysis to determine the appropriate number of industries that need sampling in each group for the desired degree of confidence. Randomly select industries in each group to inventory.

Another method of estimating industrial water use is based on applying a correlation factor for industrial water use with employment or production statistics. The primary source of information for deriving employment/industrial use statistics for estimating industrial water use is the most recent Census of Manufactures (U.S. Bureau of the Census, 1986). The census data were obtained from a special survey of 10,262 establishments reporting a total water intake of 20 million gallons or more. The coefficient for water use per employee per day (Appendix 1), determined from 5-year census reports (U.S. Bureau of the Census, 1981), can be multiplied by the number of workers published in the Census of Manufactures (U.S. Bureau of the Census, 1990) or State manufacturers' register to estimate water use in each industrial category.

However, wide ranges in water use by specific industries are a frequent occurrence due to factors such as age and conditions of plants, processes at each plant, and quality of cooling water (James and others, 1980, p. 5). Burt (1983) evaluated the accuracy of using national and statewide coefficients of water use per employee and per product unit by SIC codes and compared them with actual data. He concluded that the three data sets were not comparable. Therefore, extreme care needs to be exercised when using this method to ensure that estimates are within acceptable limits. It is not recommended to use coefficients to determine site-specific water use of major industries, but it can be used to categorize industries into small, medium, or large water users, or to estimate total water use for a large number of small industries in a specific area.

Coefficients derived from census of manufacturers may be improved locally through a number of approaches. Many states have their own surveys and reports, and numerous articles are available in the American Water Works Association Journal. Review of public water-supply meter-readings and employment statistics, such as in the State Directory of Manufacturers, can provide local coefficients for estimating public-supplied industrial water use. After meters are read for major users, coefficients may be applied to the remaining minor industries. Surveys such as those designed by Dziegielewski and others (1990, p. 13) also can be developed.

Consumptive use, discharge to septic systems, and releases into wastewater-collection systems are usually estimated. The accuracy of the estimates depends on the accuracy of the measurements upon which they are based, and the adequacy of the assumptions used in the estimation methods. Refinement of estimation methods will significantly improve the reliability of the estimates for consumptive water use by specific industries.

The U.S. Army Corps of Engineers' Institute for Water Resources Municipal and Industrial Needs Model (IWR-MAIN model) is an important tool for forecasting changes in industrial use that take into account economic factors (Davis and others, 1991, p. II40-II52). Public-supplied industrial water use is estimated by the model through application of coefficients for water use per employee for large and average-sized establishments to SIC codes, number of employees, and an adjustment for price change. Since the model was developed based on economic factors involved in public supplied industrial use, it is not recommended that the coefficients be applied to self-supplied industrial users.

11.F.3.d. Quality assurance

Quality assurance of industrial water use involves: (1) comparing reported water-use data from withdrawal permit/registration programs, public water suppliers, wastewater-treatment facilities, and NPDES permits; (2) comparing industrial employee population from a Manufacturers directory with those included in U.S. Bureau of the Census publications; (3) checking account names in meter readings of public water suppliers to ensure that only industrial users are

included.; and (4) ensuring that corporate headquarters for industries are placed in commercial use.

11.F.4. Industrial selected references

These references are supplemental to the ones in the General reference Section.

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