(1.) Data collection methods:

Discrete water quality stations are sampled by research vessel for mid-channel stations or accessed by vehicle for shore-based stations. On a monthly basis, field data is collected near the surface and bottom of the water column during high slack tide at fixed and floating stations in the San Francisco Estuary. A multiparameter instrument is used to measure water quality parameters from near surface (one meter below surface) and bottom (one meter above bottom) of the water column. At each station, the multiparameter instrument is deployed alongside the research vessel by a winch crane with a 100-foot cable that is connected to a computer. Once the instrument is equilibrated to the local conditions, the water quality data is recorded onto data sheets, then the instrument is returned onboard the vessel. A secchi disk is also used to determine light penetrations below the surface of the water. The presence of blue-green cyanobacteria Microcystis aeruginosa was documented on field data sheets when it was observed in the water.

The laboratory of the research vessel is equipped with a flow-through system that pulls the surrounding water from 1 meter below the surface. This flow-through system drains out of laboratory sinks where sample water is collected. For shore-based stations, water was collected either from a Van Dorn water sampler or via a pump installed at the station. For both mid-channel and shore-based stations, water gets collected into a churn splitter so that the sample water is homogenized during processing. For dissolved nutrients, sample water that passes through a 47 mm mixed cellulose ester filter with a pore size of 0.45 µm is collected. For chlorophyll a and pheophytin a, sample water passes through a 47 mm glass fiber filter with a pore size of 1.0 µm and the particles that accumulate on the filter get analyzed. For dissolved organic carbon, sample water that passes through a combusted 47 mm glass fiber filter with a pore size of 1.0 µm is collected.

The Entrapment Zone (EZ) stations are sampled monthly and have varying geographic locations that indicate the low salinity zone. This zone is sampled in two “floating” stations that represent the upper (upstream) and lower (downstream) boundaries, called EZ2 and EZ6, respectively. Station EZ2 is located where the bottom specific conductance falls within 10% of 2,000 µS/cm and station EZ6 is located where the bottom specific conductance falls within 10% of 6,000 µS/cm. During drought conditions, salinity intrusion causes the entrapment zone to travel upstream where it is split by the Sacramento and San Joaquin Rivers. In these conditions, EZ2-SJR and EZ6-SJR (located in the San Joaquin River) are sampled in addition to EZ2 and EZ6 (located in the Sacramento River).

(2.) Datasheet: available upon request (email data contact)

(3.) Instruments and equipment:

Field:

Dissolved Oxygen: For both shore-based and mid-channel (boat) stations, modified Winkler titrations with full-bottle technique was used from 2000 – May 2016 and from June 2016 - 2018, a 6150 ROX dissolved oxygen sensor on a YSI 6600 V2 instrument was used.

Water temperature: For stations accessed by boat, a thermistor from Seabird Scientific was used from 2000 – 2011 and a YSI 6560 probe on a YSI 6660 V2 instrument was used from 2012 - 2018. For shore-based stations, a YSI handheld instrument was used from 2000 – December 2015 and a YSI 6560 probe on a YSI 6600 V2 instrument was used from January 2016 – 2018.

Fluorescence: For stations accessed by boat, a Turner Designs Fluorometer 10-AU recorded fluorescence with a white lamp and narrow filter kit with optical kit 10-096R from 2000 – April 2004, a blue lamp was used on the same type of Fluorometer instrument from May 2004 - September 2011, and a YSI 6025 probe on a YSI 6600 V2 instrument was used from October 2011 - 2018. For shore-based stations, a YSI 6025 probe on a YSI 6600 V2 instrument was used from October 2016 – 2018.

Nephelometer/Turbidity: For stations accessed by boat, a Turner Designs Nephelometer was used to determine nephelometry from 2000 – September 2011 and from October 2011 – 2018, a YSI 6136 turbidity probe on a YSI 6600 V2 instrument was used to determine turbidity. For shore-based stations, a Hach 2100A was used from 2000 – March 2002, a Hach 2100P was used from April 2002 – December 2015, and a YSI 6136 turbidity probe on a YSI 6600 V2 instrument was used from January 2016 – 2018.

Specific Conductance: For stations accessed by boat, a Beckman RC-19 Conductivity Bridge was used from 2000 – February 2001, a Seabird Scientific was used from March 2001 – September 2011, and a YSI 6560 conductivity probe on a YSI 6600 V2 instrument was used from October 2011 - 2018. For shore-based stations, a Beckman RC-19 Conductivity Bridge was used from 2000 – March 2002, a YSI handheld instrument was used from April 2002 – December 2015, and a YSI 6560 conductivity probe on a YSI 6600 V2 instrument was used from January 2016 – 2018.

pH: For stations accessed by boat, a SympHony pH meter was used from February 2009 – August 2009 and a YSI 6589 fast response pH sensor on a YSI 6600 V2 instrument was used from September 2009 - 2018. For shore-based stations, a YSI handheld instrument was used from March 2009 – December 2015 and a YSI 6589 fast response pH sensor on a YSI 6600 V2 instrument was used from January 2016 – 2018.

Secchi disc: From 2000 – 2018, a 20 cm in diameter plastic disc with alternate black and white quadrants was used to measure water transparency.

Microcystis aeruginosa: Microcystis qualitative scores were recorded starting 8/1/2015. The qualitative score is a visual observation ranging from (1) meaning absent, (2) low-widely scattered colonies, (3) Medium-adjacent colonies, (4) High-contiguous to (5) Very High- concentration of contiguous colonies forming mats/scum.

Laboratory:

Dissolved Ammonia: From 2000 - 2018, EPA method 350.1 was used.

Dissolved Calcium: From 1/1/2011 – 2018, EPA method 200.7 (D) was used.

Dissolved Chloride: From 1/1/2000 – 10/19/2000, EPA method 325.2 was used. From 11/1/2000 - 2018, EPA method 300.0 was used.

Chlorophyll a and Pheophytin a: From 2000 - 2018, Standard method 10200 H was used.

Dissolved Nitrate + Nitrite: From 2000 - 2018, Standard method 4500-NO3-F (DWR Modified) was used. The modification is the extension of the holding time to 28 days and preservation by freezing.

Dissolved Organic Carbon: From 1/1/2011 – 2018, EPA method 415.1 (D) was used.

Total Organic Carbon: From 1/1/2011 – 2018, EPA method 415.1 was used.

Dissolved Organic Nitrogen: From 2000 - 2018, EPA method 351.2/350.1 (D) was used.

Dissolved Ortho-phosphate: From 2000 - 2018, EPA method 365.1 (DWR Modified) was used. The modification is the extension of the holding time to 28 days and preservation by freezing to -10 degrees Celsius.

Total Phosphorus: From 2000 - 2018, EPA method 365.4 was used.

Dissolved Silica (SiO2): From 2000 - 2018, EPA method 200.7 (D) was used.

Total Dissolved Solids: From 2000 - 2018, Standard method 2540-C was used.

Total Suspended Solids: From 2000 - 2018, EPA method 160.2 was used.

Volatile Suspended Solids: From 2000 - 2018, EPA method 160.4 was used.

Total Kjeldahl Nitrogen: From 2000 - 2018, EPA method 351.2 was used.

(4.) Analysis and methods (standard operating procedures): Data is in its original form and no calculations have been made. SOP’s for methods and quality checks are available upon request.

(5.) Project history (change in methods and locations):

All EMP discrete water quality stations are paired with a corresponding zooplankton station. Discrete water quality samples have historically been collected at the beginning locations of the zooplankton tow, except for four stations - D28A, D26, D8, and D4, which were historically collected at the mid-tow locations. However, EMP conducted an internal study in March 2016 to investigate if there were any significant differences in the water between the beginning tow and mid-tow locations for those four stations and found that the water was not statistically different. As a result, the water quality sampling locations for those four stations were moved to the beginning tow locations in June 2016 to establish consistency within the discrete water quality monitoring stations and between IEP projects. Prior to June 2016, dissolved oxygen measurements were obtained from a Winkler titration, but EMP began reporting dissolved oxygen measurements from a multiparameter sonde due to increased confidence and accuracy of the instrument. From 2000 – April 2016, water from shore-based stations was collected via a pump system that was installed at each station, but EMP determined that the location of the intake was unreliable during drought conditions when water levels were low. As a result, EMP switched to using a Van Dorn water sampler in May 2016 to obtain a more representative sample. Bottom measurements for mid-channel stations were not reported until January 2017, while bottom measurements for shore-based station were not reported until February 2017.

Most stations sampled at the beginning of this dataset in 2000 were maintained by the program and are still sampled by ongoing monitoring efforts. However, there are a few stations that have been added or replaced by nearby locations. Stations D41A in San Pablo Bay and D19 in Frank’s Tract were added to the program in May 2004. Stations C3 and C10 were replaced by C3A (Sacramento River at Hood) in October 2004 and C10A (San Joaquin River at Vernalis) in September 2005, respectively. Both C3A and C10A were located just upstream to their parent stations and provided better accessibility to the channel. These two new shore-based stations also had the ability to house continuous water quality instruments, increasing the amount of data collected there and establishing geographic consistency between IEP projects. Two other shore-based stations, C9 (Clifton Court) and D24 (Rio Vista), were added in October 2016. Due to the biological significance of the Sacramento River at Rio Vista location, D24 was ultimately replaced by the mid-channel station NZ068 in June 2017 so that zooplankton data could be collected alongside the discrete water quality data.

Sampling typically occurred on research vessels from the Department of Water Resources (DWR) or United States Bureau of Reclamation (USBR). From DWR, RV San Carlos (1997-2016) and RV Sentinel (2017-2018) were commonly used. From USBR, RV Compliance and RV Endeavor were utilized when DWR vessels were unavailable.

(6.) QA/QC: The data sheets are error checked after they are filled out and at the end of each sampling run by the water quality field leads. Field data for each run is then entered into the Field and Laboratory Management System (FLIMS) where it is housed while the laboratory data is being analyzed. After the laboratory data has been analyzed, it is combined with the field data and uploaded into the Water Data Library. The field and laboratory data is then exported into an Excel file from the Water Data Library and is verified with the field sheets by the QA representative.

The use and calibration of instrumentation follows the manufacture’s guidelines. The multiparameter instruments are calibrated with calibration standards prior to field runs and verified with another calibrated instrument during sampling. After returning from the field, the instruments are checked with calibration standards to ensure the instrument held its calibration and to validate the data collected with the instrument.

(7.) Contractor Information: All water quality sampling was conducted by staff from IEP’s Environmental Monitoring Program (EMP) primarily from the California Department of Water Resources and the United States Bureau of Reclamation.

(8.) External review process: An IEP Project Work Team reviewed the EMP’s sampling procedures during 2001-2002 and a summary report and recommendations was created in 2003.

(9.) Methods references:

[EPA] Method 170.1: Water Temperature

[EPA] Method 120.1: Conductance (Specific Conductance, μmhos at 25 C) by Conductivity Meter

[EPA] Method 150.1: pH by Electrometric of Membrane Electrode

[EPA] Method 180.1: Determination of Turbidity by Nephelometry

[EPA] Method 360.2: Dissolved Oxygen by Modified Winkler Titration

[EPA] Method 360.1: Dissolved Oxygen by Membrane Electrode

[EPA] Method 350.1 (D): Ammonia, Nitrogen (Dissolved)

[EPA] Method 351.2/350.1 (D): Dissolved Organic Nitrogen by Calculation

[EPA] Method 200.7 (D): ICP Metals and Trace Elements (Dissolved)

[EPA] Method 300.0 28d Hold: Inorganic Anions 28d hold (DWR)

Standard Method 4500-NO3-F (28Day): Nitrite, Nitrate (DWR Modified) (Dissolved)

[EPA] Method 415.1 (D): Organic Carbon (Dissolved) by Wet Oxidation

[EPA] Method 415.1 (T): Organic Carbon (Total) by Wet Oxidation

[EPA] Method 365.1 (DWR Modified): Ortho-phosphate (Dissolved)

[EPA] Method 365.4: Phosphorus (Total)

Standard Method 10200 H: Spectrometric Determination of Chlorophyll

Standard Method 2540 C: Total Dissolved Solids (TDS)

[EPA] Method 351.2: Total Kjeldahl Nitrogen

[EPA] Method 160.2: Total Suspended Solids

[EPA] Method 160.4: Volatile Suspended Solids