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A Survey of Databases Covering Specific Water-borne Diseases and Water Contaminants in the US-Mexico Border Region

Dear Reader,

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The assignment was intended to be a "quick turnaround" snapshot of data availability related to selected water quality parameters and water-borne diseases along the US-Mexico border. The project arose from binational discussion by the Border 2012 Environmental Health Workgroup during the 2005 National Coordinators Meeting and will provide important background information for the Water Environmental Public Health Indicators team that has been set up. More information about this task may be found at www.epa.gov/ehwg.

A Survey of Databases Covering Specific Water-borne Diseases and Water Contaminants in the US-Mexico Border Region

Summary Report Submitted to the Pan American Health Organization
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Introduction

The contractor was asked to investigate databases that cover diarrhea/diarrhea-causing pathogens, hepatitis A, amebiasis/amebas, shigellosis/shigella, typhoid/typhoid fever, lead/lead compounds, arsenic, chromium, and all types of pesticides as either health outcomes (poisoning or infection) or as water contamination (chemical or biological). Specifically, the contractor was provided with a variety of metadata parameters with which to describe each database. Those parameters can be found in the Water Metadata Spreadsheet accompanying this summary report. All databases/datasets included in this report contain data on the border region. No databases have been included that were determined to lack data on the border region. In a few cases (such as NHANES), it was not determined exactly how much of the nationally collected data (or state-collected data, in other cases) comes from the border area. The Water Summary Report, Metadata Spreadsheet, and Water Contact Spreadsheet are intended for use by members of the Environment Health Work Group and technical experts in their effort to develop appropriate environmental health indicators for the Border 2012 Initiative. This summary report is meant to provide an overview of the databases reviewed and an analysis and recommendations regarding the utility of each of the indicators. This Water Summary Report is organized as follows: Introduction, Methodology, Results (metadata collection strategy, review of collected databases), and Discussion (database coverage, utility of proposed indicators, suggested activities).

Methodology

The methodology broadly had three phases. The first phase consisted of web searches for academic studies on health outcomes and water quality, as well as establishing some contacts with relevant officials and academics in the border region. The second phase involved driving from San Diego to Brownsville over the course of two weeks (nine business days) to meet with some of the contacts made in Phase 1, as well as meet with contacts provided during the trip. Meetings with relevant officials were typically made one or two days before such meetings occurred. These meetings were arranged both by cell phone during transit, and by email at night from hotel rooms with wireless access. Sometimes these interviews included a viewing of the database, which sometimes provided clarification. Face-to-face interviews typically took between 30 minutes and 1 1/2 hours, since the interviews often involved more than one database, as well as suggestions of where else to look and whom else to contact. The third phase involved follow-up clarifications on the collected databases, as well as subsequent email and phone conversations with the contacts that had been provided by the people met during the two-week trip. This phase also consisted of web searches for national-level and other missed databases.

about web-encountered databases were verified through email or phone conversations with relevant officials. During all three phases, weekly phone calls were held with the Environmental Health Work Group to provide an update on progress, seek clarifications, and provide some contacts. Members of the Environmental Health Work Group sometimes assisted when an individual was difficult to contact.

Results

Metadata Collection Strategy
Metadata, contact information, and other potential source were most easily collected through face-to-face interviews. Most individuals were available, even on such short notice, although some were not. Phone calls and emails used to contact pertinent institutions and individuals during Phase 3 were somewhat less successful than the Phase 2 face-to-face meetings. This was even true if face-to-face contact had already been made in person on a prior occasion. Multiple messages were left with a number of individuals with no result. The short timeframe for the study produced part of that phenomenon, and individuals are still responding to queries after this summary report has been submitted. In addition, consultant status of the investigator may not garner the kind of respect or response that might be afforded an official at CDC, PAHO or the EPA. Contact information for individuals or institutions are provided in the accompanying Water Contact Spreadsheet, and are categorized as 1) very helpful, 2) assisted or responded, 3) did not respond, and 4) not contacted.

Databases Collected
Only databases that contain at least one data point in the border region are presented in this report. Sources that were reviewed but which did not produce relevant databases are listed in worksheet 'B. No Database' in the attached Water Metadata Spreadsheet.

The health outcomes and water contamination databases are presented below according to the geographic scope of data collection (i.e., national, state, local) within categories of potential utility to the Environmental Health Work Group. These categories consist of: 1) databases with ongoing monitoring, 2) databases of studies that cover a relatively large geographical range and might be considered baseline studies, 3) finer scale studies of particular environmental health problems, whether health outcomes or water contamination, and 4) meta-studies or bibliographic compilations of studies. The first and second sets of databases are presented next in some detail in this summary report. The presentation is meant to portray the range of databases and potential issues associated with them, but not re-list and discuss each of the databases that appear in the Water Metadata Worksheet. The third set of databases is discussed in more agglomerative terms, plus is listed in Appendix B; additionally, several fine-scale studies have been entered in the Water Metadata Spreadsheet. The fourth set of databases—potentially useful meta-studies—is listed in Appendix C. The following databases and discussions in this section are not exhaustive. The spreadsheet should be considered a more complete listing of databases, although Appendix D is a table of California Water Databases of which not all are included in the Water Metadata Spreadsheet.

Databases with Ongoing Monitoring

Health Outcomes Databases

Pathogens

National

National Notifiable Diseases Surveillance System (NNDSS), Centers for Disease Control and Prevention - reported at the county or regional level (within states) to the state departments of health, which submit the data electronically through the National Electronic Telecommunications System for Surveillance (NETSS). Data is maintained at the national level by the Department of Health and Human Service's Center for Disease Control and Prevention. Electronic data is maintained in some counties and states (see below and accompanying spreadsheet). The data available online will not be useful for the Environmental Health Work Group, as it is not search friendly, is not in database format, and does not segregate data by counties, only states. Data must be obtained through official requests. The National Electronic Disease Surveillance System (NEDSS) is going to replace some other CDC surveillance mechanisms, including the NETSS.

Sistema Unico de Información para la Vigilancia Epidemiológica (SUIVE), Secretaria de Salud - reported electronically at the level of jurisdicción through el Sistema Nacional de Vigilancia Epidemiológica (SINAVE). The Secretaria de Salud's Dirección General de Epidemiología maintains data at the national level. The database is accessible online, but similarly only provides state level data. Jurisdicción level data must be obtained through individual requests.

National Health and Nutrition Examination Survey (NHANES), Centers for Disease Control National Center for Health Statistics - This survey occurs biennially and has been done three times. It provides data on blood tests for hepatitis A and survey responses regarding prior hepatitis A vaccination. It is unclear how many of the cases in the sample come from the border area.

Border Infectious Disease Surveillance (BIDS), Centers for Disease Control National Center for Infectious Diseases – hepatitis A reported bi-nationally by laboratories in nine sentinel sites in the more urbanized areas of the border. The United States uses laboratory diagnoses. The Mexican side uses clinical diagnoses and thus probably lumps other hepatitis strains with hepatitis A. The Mexican sentinel sites typically report more reliably/regularly than do the United States sentinel sites. Digital data is available since 1999.

State

The states of Arizona, California, and New Mexico maintain reportable disease databases that can be segregated by county. This is a burden, since they have to enter the data twice. Texas' reporting system is a conduit directly into NEDSS and does not maintain a state database separate from NEDSS. Texas' Department of State Health Services Region 8 maintains its own database on its counties, as does Region 11 (both since 2004), but it was not determined whether or not Region 9/10 maintains a database on reportable diseases. Arizona is planning on having a local digital reporting mechanism by January called MEDSYS.

It is not clear whether the states of Baja California, Sonora, Chihuahua and Tamaulipas maintain databases that can be segregated by jurisdicción, but it is possible since a Pima County epidemiologist said that she used to have online access to Sonora data, and the Secretaria de Salud's national database (SUIVE, discussed later) has data segregated by municipalidad, jurisdicción and estado.

Local
Several US counties maintain their own databases of case investigation data, which they collect after receiving a reportable disease from a health care provider. This follow-up allows them to report accurately to the state. San Diego and Imperial Counties in California and Pima and Cochise counties in Arizona maintain digital databases of case investigation data, but Yuma keeps pap paper versions of case investigation data, and it was not determined which form Santa Cruz County maintains. New Mexico's notifiable diseases are reported directed to the state, and in Texas most health care providers report directly to one of the three Regional offices of the State Department of Health Services that cover the border. Some cities and counties collect notifiable data and then report it to the state. A few US cities and counties, not necessarily the same ones, maintain their own case investigation databases for pathogens. In Yuma County, there has been a publicity effort by the epidemiology office to increase the rate of reporting by health care providers, by sending a quarterly newsletter with disease totals and a yearly list of all the reportable diseases. Yuma also reported that some doctors are telling patients that it is the patient's responsibility to report their disease to the county health department, a practice which contributes, along with other factors, to lower rates of reporting than might be expected in that region.

Municipalidades do not normally collect health outcome data in Mexico, but broader jurisdicciones do collect reportable disease data on all of the pathogens of interest.

Poisoning

National
Childhood Lead Poisoning Prevention Program, Centers for Disease Control and Prevention. A compilation of child lead poisoning reported by states.

*National Health and Nutrition Examination Survey (*NHANES), Centers for Disease Control and Prevention's National Biomonitoring Program. Survey conducted biennially that provides survey data on potential exposure to lead and pesticides, soil and house dust data on lead, as well as blood and/or urine data on lead, chromium, arsenic and pesticides segregated by major grouping.

Toxic Exposure Surveillance System, Centers for Disease Control and Prevention, and American Association of Poison Control Centers. A compilation of poisoning reports by Poison Control Centers.

Adult Blood Lead Epidemiology and Surveillance (ABLES), Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health. A compilation of lead poisoning cases reported by states.

Pesticide Injury & Illness Surveillance, Centers for Disease Control's National Institute for Occupational Safety and Health. Data comes from participating state programs (Arizona, Texas, California). It is not clear from online documentation whether the data in this database can be segregated by county.

Sistema Único de Información para la Vi ilancia Epidemiológica (SUIVE), Secretaria de Salud. This Water Summary Report did not consider whether SUIVE contains data on pesticide or metal poisoning.

State
All of the US border states participate in the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health's Adult Blood Lead Epidemiology and Surveillance program and the Childhood Lead Poisoning Prevention Program. This data is

reported directly by labs, physicians or hospitals to the state level, where it can be disaggregated by county. California, Arizona and Texas also participate in the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health's Pesticide Injury & Illness Surveillance program. State poison control centers in the border states collaborate with the Centers for Disease Control in the Toxic Exposure Surveillance System. No state-level monitoring of chemical poisoning data was discovered for Mexico.

Local

Some cities and counties collect child lead surveillance data. Otherwise, very few databases for heavy metal poisoning or pesticide poisoning exist whose focus is long-term monitoring on a specific population. An Imperial County Health Department pilot program (based on a Mexican protocol) that is one-year old uses an algorithm to create a potential diagnosis of immigrant farm laborers based on reported symptoms.

Water Contamination Databases

National

National 1-Water Quality Assessment program, United States Geological Survey. There are several border sites in this database that regularly monitor the metals and pesticides of interest to the Environmental Health Work Group.

1-Water Quality Bulletins, International Boundary Waters Commission – it is unclear whether the Bulletins cover any of the relevant indicators. Each bulletin varies in its coverage of water quality parameters, but each site typically goes back to the early or mid-1990s.

National Stream 1-Water Quality Network (and Hydrologic Benchmark Network), United States Geological Society. Around 10 sites on the Rio Grande and the Colorado River have longitudinal data during the 1990s.

Safe Drinking Water Information System, Environmental Protection Agency. All public water systems in the U.S. analyze water quality continuously (larger systems that disinfect to avoid source monitoring), daily (smaller systems that disinfect to avoid source monitoring), or monthly (source monitoring), plus every three years (sanitary surveys). This data is stored by the states and by the Environmental Protection Agency. The Environmental Protection Agency, however, only stores data on violations.

STORET and Envirofacts, Environmental Protection Agency. These massive databases store data collected mainly by states, but also the national government. Studies range from monitoring to one-time investigations. They contain data that might be difficult to track down from other sources.

Comision Nacional de Agua – Some data is available for border area, though it is unclear whether the data is of a monitoring nature, or whether it is produced by focused studies.

State

1-Water Quality Database, Arizona Department of Environmental Quality. This database contains both monitoring and individual studies.

Surface and groundwater databases, New Mexico Environment Department. Studies survey large portions of watersheds; some are monitored, but once every 8 years. Digital data only exists for recent surveys.

1-Well Inventory Database, California Department of Pesticide Regulation. A few wells in each of the two border counties are monitored regularly for pesticides.

Comision Estatal de Servicios Publicos de Tijuana has conducted studies including the parameters of arsenic and lead for drinking water sources. The international water treatment plant for Tijuana may have monitoring data for arsenic and lead.

Surface Water Quality Monitoring program, Texas Commission on Environmental Quality. It is unclear whether this database monitors sites or if these are largely individual studies. There are a number of sites in the border area.

Discharges Registration Program, Department of Ecology of the Secretariat of Social Development of the State of Tamaulipas. This data may or may not be related to the national law promulgated in 2004 that requires industries to maintain discharge data.

As with the national level, there are several other databases that could be listed here. Please refer to the spreadsheet, and search under Scope of Study with code 1.

Non-Monitoring Broad Scale Databases that Might Serve as Baselines

Water Contamination Databases

<u>National</u>

National Water Information System, United States Geological Survey – a very large database of water studies from a variety of sites around the United States and northern Mexico. Most sites have been tested only once.

The International Boundary Waters Commission – several intensive studies on the major tributaries of the Rio Grande and Colorado Rivers have collected data at a variety of sites on both sides of the border.

Comision Nacional de Agua has produced a few individual studies that have not been accessed, but which seem to be significant studies.

<u>State</u>

Surface Water Database, California Department of Pesticide Regulation – has measured pesticides in the Salton Sea and Alamo River in Imperial County in both the early and late 1990s.

Comision Estatal de Servicios Publicos de Tijuana has conducted studies including the parameters of arsenic and lead for drinking water sources.

There are several other databases from the state environment departments that could be listed here. Please refer to the spreadsheet, and search under 'Scope of Study' for code 2.

<u>Local</u>

The county of San Diego and City of Tijuana have conducted several studies of the area that could serve as good baseline studies. The international water treatment plant for Tijuana may have consistent monitoring data for arsenic and lead.

Fine Scale Studies Focusing on Point Source Pollution or Disease Outbreaks

Health Outcomes Databases

Pathogens

Fine-scale studies regarding diagnosis of the specific pathogens are infrequent, although Hepatitis A was studied along the US side of the border in various places in the late 1990s in order to gain government support for immunization. Outbreaks of Shigella also show up in some fine-scale studies on both sides of the border.

Chemical Poisoning

Fine scale studies regarding the specific indicators tend to focus on lead and arsenic, especially the former. Lead poisoning has been of particular concern near industrial facilities. Metals and pesticides have been studied in areas that have seen clustering of a disease like lupus or leukemia. Some examples exist in Appendix B and in the accompanying Water Metadata Spreadsheet, although many more are likely to exist. Studies have been conducted in a few hospitals in Mexico on maternal-child blood lead levels. Arsenic is of geological concern in New Mexico. Pesticide studies have been more prevalent in important agricultural areas—four of the most agriculturally active counties in the United States lie along the border--Imperial County (CA), Yuma County (AZ), Hidalgo County (TX), and Cameron County (TX). Another focus of pesticide studies has been the exposure or potential exposure to household pesticides.

Water Contamination Databases

A considerable amount of data collection and analysis comes from one-time studies that are precipitated by concern about contamination of a waterway, the drilling of a new well into a groundwater source, etc. Examples can be found in Appendix B.

Other Metadata and Survey Studies

Despite having slightly different objectives than the current report, a few relevant metadata and survey studies have been done for the border area on the indicators of interest. Most of these studies concern water contamination, rather than health outcomes, and are listed in Appendix C.

Discussion

Here, the Environmental Health Work Group's selected indicators are reviewed first in broad terms of data quality and then in terms of potential utility of each indicator. These discussions are followed by a summary list of suggested activities for the Environmental Health Working Group.

Data Quality

Typically, only the counties immediately touching the border are included in this report. For the Health People 2010 program, those are the same counties for California and Arizona. However, technically, parts of one California and four Arizona counties also fall within the 100km border area. For Texas and New Mexico, the lack of county stipulation is not relevant for health outcomes data, because the counties do not keep data (the states do, as do some regions), although parts of three (of six) New Mexico counties fall within the border region, and parts of approximately 14 Texas counties lie within the border area. Texas, like Mexico, has several counties (municipalidades in Mexico) that lie fully within the 100km, but which do not touch the border. For water quality databases, data is usually collected and kept at the state or federal level in both countries along with identifying information, such as county and lat/long identifiers.

The designation of the border region as 100km on either side of the border ignores watersheds, which would be one theoretically more appropriate way of organizing the investigation of water contamination. In terms of health outcomes, the designation of the border region as 100km on either side of the border also ignores the fact that diseases—especially monitored diseases—are typically reported by political jurisdictions rather than by latitude/longitude coordinates. Studies of water contamination do typically record latitude and longitude, although it will require considerable effort to measure and decide whether or not each of these hundreds or thousands of sites lie within 100km of a meandering border. Typically each of these sites are also identified with their county in the U.S. and municipality in Mexico, which would make it very easy to include in the border area or not if the criterion was county/municipalidad instead of 100km. Perhaps only counties/municipalities with at least half of their population within the 100km mark should be included in the border area. Otherwise, cities like Phoenix (250km by road) will be considered border cities just because a small portion of their county falls with 100km.

Much of funding for environmental health research tends to be directed toward single studies for specific watersheds, sites of point source pollution, and epidemics or disease clusters. However, local health outcomes surveillance data is available through the states and national governments in both countries. The problem with reported infectious disease data is that it is vastly underreported, estimated to be as low as 20% of actual cases. Very few broad scale studies exist that attempt to statistically test and monitor actual rates of incidence.

Studies of water typically do not include the pathogens of interest to the Environmental Health Work Group, but water contamination monitoring does exist for the heavy metals throughout the border region. In Mexico, the national government is responsible for water monitoring, except drinking water, which is the responsibility of the states. In addition, water discharge permits in Mexico are given by the estados, which collect some water quality data.

Continued deliberations about desired scope, site selection, frequency and duration of monitoring, etc. are necessary between appropriate technical personnel and the Environmental Health Work Group in order to analyze gaps in existing coverage of the specified indicators. One way to look at the utility of these various indicators is to ask about their general vs. specific incidence. Are they ubiquitous, or are they typically localized to specific populations, aquifers or bodies of water? Do they present themselves in outbreaks and accidents, or at constant levels?

Similarly, evaluations of dissimilarities in intranational and international collection methods and data analysis should be undertaken by appropriate technical personnel. Analysis by different laboratories or by the same laboratory over many years—whether measuring health outcomes or water contamination—can result in potentially incompatible results, even for the same site. Thus, care should be taken in the use of multiple sites. Close examination of Quality Assurance/Quality Control for data will be important when sites/studies are aggregated or when sites are discontinued and replaced by nearby sites in the same or different study/monitoring program.

Database accessibility is generally high on both sides of the both, either through websites or contact personnel, and is typically available as spreadsheets or tab/space-delimited text files. Many of the websites do not allow an easy inquiry across the entire border or large sections of it, so contacting the database manager or person in charge of the data might be quicker than a website for obtaining clean and complete data.

Utility of Proposed Health Outcome Indicators

All of the health outcome indicators chosen by the Environmental Health Work Group are reportable conditions in both the U.S. and Mexico. One exception is that diarrhea is a diagnosis in Mexico, but not in the U.S. See 'Diarrhea' below for further discussion of this difference.

For all reportable diseases, the level of underreporting can be very high, due to lack of universal reporting by health care providers (particularly private physicians and emergency rooms on both sides of the border), lack of diagnosis or lack of accurate diagnosis, sub-clinical presentation of the disease, and frequent lack of seeking treatment by the infected individuals.

There is one major difference between the U.S. and Mexico water-borne pathogen data. Laboratory reports are more frequently the basis of a diagnosis by U.S. health care providers, whereas Mexican health care providers more frequently use clinical diagnosis. This will often result, all things equal, in higher rates of diagnosis for the Mexican side.

Another concern is that of people crossing the border to be treated in Mexico rather than the United States—regular data sharing does not necessarily occur, so that the one country does not know that a resident has been diagnosed with an infectious disease elsewhere. There may be confidentiality issues involved with such transfer of information, but in some cases will be important for monitoring activities.

There should probably be a mix between 1) pathogens that present themselves more typically in outbreaks, and 2) pathogens that present themselves more typically as chronic hazards. While water-borne pathogens can present themselves in both manners, it will be necessary for an epidemiologist to look at whether these two types of presentations of the diseases are discernible from the available data.

Hepatitis A

Serology testing in several border communities on the US side in the late 1990s, in order to receive CDC support for regular hepatitis A vaccines, have shown that resistance immediately jumped to over 60%. Hepatitis A vaccines are now required for U.S. border counties. Thus, hepatitis A will not make a good indicator of exposure. Although there are still many cases of the disease, it is not possible to discern whether people are being exposed or not.

Typhoid Fever

Levels of typhoid infection are very low in the U.S.-Mexico border area. Such small numbers are not large enough for parametric analysis, and thus it will not be possible to gauge whether increases or decreases in the rate of incidence are statistically significant or not. However, notable increases in cases may more clearly reflect 'outbreaks' than general increases in exposure or general deterioration of environmental health.

Shigellosis

Shigellosis cases typically appear as outbreaks on both sides of the border.

Amebiasis

Very few cases are reported on the U.S. side of the border. Many more on the Mexican side. This disease is particularly subject to sub-clinical presentation.

Diarrhea
Since Mexico uses diarrhea as a reportable condition and the U.S. does not, it may be hard to use this as a category for comparison. This is because health care providers may not be reporting on the same suite of environmental pathogens. Nonetheless, it is possible to aggregate the diarrhea- causing reportable pathogens in the U.S. (e.g., Salmonellosis, Giardiasis) into a diarrhea category. This will require data manipulation and will leave out many cases of gastrointestinal problems on the U.S. side that do not get reported, but should at least provide a category that can be monitored over time, although perhaps not comparable to Mexico in terms of levels of incidence or degree of change in the rates of incidence. Another possibility for a health outcome indicator might be rotavirus, which has been monitored in the United States since 2003, and may be an appropriate indicator on the US side for diarrhea.

In the U.S., lead is regularly examined in blood and/or urine tests due to the Centers for Disease Control and Prevention's child and adult lead poisoning surveillance programs. Many cities and counties, in addition to states, maintain data on lead poisoning. Some studies in Mexican hospitals have been done on maternal-infant lead poisoning.

Potential chromium poisoning is infrequently studied or monitored as a health outcome.

Potential arsenic poisoning is sometimes studied or monitored via urine tests. Measurement is usually in terms of μg/dL.

In the U.S., reported pesticide-poisoning data are compiled through the Center for Disease Control and Prevention's Pesticide Illness & Injury Surveillance program. Measurement is usually in terms of μg/dL (urine).

Utility of Proposed Water Contamination Indicators

The most frequent and consistent monitoring for lead, arsenic, chromium and pesticides occurs with public drinking water systems. The way the data is maintained at EPA, however, is in terms of violations. Sub-violation levels do not appear to be kept in the EPA Envirofacts database. Thus, changes in levels cannot be discerned in Envirofacts, but state drinking water offices have that data. Another frequent source of monitoring is in wastewater discharge. Sewage treatment plants in the United States test for metals and pesticides and report their data to the state PCS programs, which then report it to the EPA. The regularity with which these possible contaminants are monitored was not discerned. In Mexico, the estado of Tamaulipas tests wastewater regularly for its discharge permit system, though it is not clear which of the relevant indicators are measured. In June of 2004, the Mexico government passed a law that requires that industrial facilities record and report measurements on emissions of 104 chemicals that previously had only been subject to voluntary reporting. This report does not consider any databases that might be related to that law, which may soon or already be producing relevant environmental health data.

If resources were to be put into data collection by the Border 2012 initiative, it might be appropriate to piggy-back with current traditional water quality monitoring programs, by adding metals and/or pesticide tests to the various drinking and wastewater programs and/or increasing the regularity of testing/monitoring for these contaminants in existing state-level programs, especially surface and groundwater programs.

Biological Contamination

Few water contamination studies or monitoring programs cover water-borne pathogens, except *E. coli, Enteroccus,* and, occasionally, *Giardia* and cholera. An exception may be less-frequent panels conducted at wastewater treatment plants.

<u>Chemical Contamination</u>

The scope of monitoring and analysis projects varies widely. Basins, watersheds, and drainages are parsed into different sizes by different institutions and different researches. As an example, in a 2001 report on the water and wastewater infrastructure of the borderlands, the Environmental Protection Agency divided the region into seven different watershed basins. These are the Pacific Coastal, New River, Gulf of California, Colorado River, Northwest Chihuahua, Rio Grande, and Gulf of Mexico.

Lead, arsenic and chromium appear to be regularly examined in water tests for heavy metal loadings. The heavy metals monitored most frequently appear to be mercury, arsenic, cadmium, copper, lead and perhaps selenium. Chromium is less frequently studied or monitored. Lead is often under the control of separate offices than are other metals and pesticides. For example, in New Mexico, the lead and copper-testing program is separate from heavy metals testing. This may be because of US regulations on lead and copper levels in water. Attention will have to be paid to the form of metal studied, since there is some variation in forms of metals that are studied/monitored. For example lead and lead nitrate, or total vs. dissolved chromium.

Pesticides are monitored regularly by the USGS's National Water Quality Program and the state Safe Water Drinking Information Systems (EPA). The pesticides that seem to be most commonly studied, whether in monitoring studies or not, are the organophosphates and organochlorine pesticides. It may be relevant to consider whether any pesticides used as indicators for water contamination should be pesticides of relatively high persistence or not. For fish tissue, or human blood or urine surveillance of pesticides, that is a less important distinction to make.

Varying numbers and kinds of pesticides are studied in water and in health outcomes. One method of categorizing pesticides is by chemical composition—such as organophosphate, organochlorine, pyrethroid, carbamate, etc. The implication for the Environmental Health Work Group of such a technique of categorization is that the general differences in biochemical action between these groups of pesticides would be clear. Such a categorization is fairly gross, but might be better than the present lack of categorization, which leaves the reader not knowing whether there is any potential for understanding spatial or temporal trends in contamination by chemical pesticides of different types. Three other ways of categorizing pesticides that appear relevant would be the broad pesticide/herbicide/fungicide distinction, the household/commercial distinction (not always possible), or the persistent/non-persistent distinction. At the other end of the spectrum, it would be unwieldy for the spreadsheet accompanying this Water Summary Report to list, for every single database, the hundreds of pesticides and pesticide metabolites that are studied or monitored. The metadata in the accompanying spreadsheet are not consistent in the categorization of pesticides— sometimes all are listed if few in number, sometimes grouped by chemical composition (as above) if so reported, and sometimes labeled merely as pesticides or herbicides.

In terms of measurement of potential environmental toxins, both micrograms per liter (μg/L, also referred to as ppb or parts per billion) and milligrams per liter (mg/L) are common, although the former is used more frequently.

Some water quality monitoring programs are unable to meet the high laboratory costs of analyzing for hundreds of chemicals. Thus some, like the Chollas Creek program in San Diego, are using key species like the *Ceriodaphnia Dubia* crustacean to determine 'acute toxicity' of water bodies to aquatic organisms. Response by the organism may then prompt testing as needed.

Summary of Suggested Activities

1. Review available databases
2. Review 303(d) and 305(b) reports for other potential state-managed databases in US
3. Discuss scope of monitoring required to know something about environmental health
4. Discuss utility and form of each of the proposed indicators
5. Evaluate variation in methodologies, based on goals set for scope of monitoring
6. Evaluate gaps in databases, based on utility of the indicators, variation in methodologies, and the goals of the Environmental Health Work Group
7. Add to existing water monitoring programs as needed (whether biological or chemical contaminants in drinking water, wastewater, surface water or groundwater), especially on the Mexico side
8. Develop and conduct representative studies of health outcomes

Appendix A. Description of the Water Metadata Spreadsheet

The Water Metadata Spreadsheet is divided into three worksheets: water contamination databases, health outcomes databases, and source without relevant data. Searching the spreadsheet can be done on a variety of database characteristics. The most useful include: 1) the 'State/County' column that lists the nation or state and the locality of relevance, 2) the 'Scope of Study' column that categorizes studies as monitoring, baseline, localized, or meta-studies, and 3) the 'Indicator' and 'Indicator Category' columns which will help sort studies by broad metals/pathogens/pesticides categories, or by more specific indicators. For the health outcomes databases, the 'indicator category' column lists a different category for the vital statistics databases (ICD9 or ICD10) instead of metals, pathogens, or pesticides. The ID numbering system for the health outcomes data generally has the state, national or non-governmental institution as the first numeral, the county or locale as the second numeral, and the number of studies by that institution for that locale as the third numeral. The water contamination ID numbering system typically has the state, national or non-governmental institution as the first numeral, and the number of studies by that institution as the second or third numeral (with the other column holding spaces with 0s or 1s).

Some of the metadata about the databases have been left blank in the spreadsheet, although attempt has been made to provide adequate detail to evaluate whether an entry would be useful for follow-up. As such, the Water Metadata Spreadsheet is intended to be searchable and accessible to see what level of coverage of each of the indicators has in any given geographic region of the border. If the Environmental Health Work Group is interested in pursuing any particular indicator along the entire border or in any given border region, the next step would be to involve a person with the appropriate technical knowledge of the measurement of that indicator. That person would evaluate the comparability, compatibility and quality of the listed studies by examining the documentation that is usually easily available on websites, or can be made available by responsible parties.

Some examples of technical information omitted from this spreadsheet are: the collection method usually stipulates blood or urine for metal or pesticide poisoning, rather than the laboratory method. At this stage of this exercise in the exploration of environmental health indicators, it may be more important to know whether studies would be comparable in terms of material collected (e.g., blood or urine, soil) than to know the name of the laboratory method. Similarly, instead of ICD Revisions for "health-related event under surveillance," the column heading was replaced with general categorizing of pathogens, pesticides or metals so that the items could be easily grouped and sorted. Another example is regarding both health outcome and water contamination databases—instead of listing geo-spatial coordinates of reporting sites (which sometimes number in the dozens, hundreds, or thousands), the kind of geo-spatial coordinates were collected (address, map location, GPS coordinates, lat/long coordinates, etc).

Appendix B. Unverified Studies

The studies here were found by examining bibliographies, doing web searches, and scanning the websites of academic and non-profit environmental and health organizations. All of the studies appear to pertain to the border region and to environmental health, although none of these studies have been verified to necessarily have data on the proposed indicators other than via the title of the study or report. These studies range in scope from fine scale to metadata, but none appear to be studies involving monitoring. Many of these studies were funded by the Southwest Consortium (SCERP), and several others were funded by the Center for Border Health Research (CBHR). Many of them have been published in peer-reviewed journals, although there has not been an exhaustive attempt to search journal databases for potentially relevant studies. The studies are listed by geographical region, or by health outcome or water contamination (along with environmental health).

<u>Arizona /Sonora</u>

ADHS. Health risk assessment at Nogales Wash. Prevention Bull. 7: 2-3, 1993.

Castaneda, Mario. 1998. Binational Water Quality Monitoring Activities Along the Arizona-Sonora Border Region. Paper presented to the National Water Quality Monitoring Council Annual Conference. Phoenix, AZ: Water Quality Division, Arizona Department of Environmental Quality. http://www.nwqmc.org/98proceedings/Papers/34-CAST.html. Many other papers are available at http://water.usgs.gov/wicp/acwi/monitoring/

Coes, Alissa L; National Water-Quality Assessment Program (U.S.), and Geological Survey (U.S.). Ground-water quality in the upper Santa Cruz basin, Arizona, 1998. Tucson, Ariz, Denver, CO: U.S. Dept. of the Interior, U.S. Geological Survey. Information Services distributor; 2000. viii, 55 p (Water-resources investigations report; 00-4117).

Hains, Charles; Arizona; Dept. of Environmental Quality, and Water Quality Division. Groundwater quality study of the the [sic] upper Santa Cruz Valley. Phoenix, Ariz.: Hydrologic Support and Assessment Section, Water Quality Division, Arizona Dept. of Environmental Quality; 1997. 67, [51] leaves

López-Rios O, Lechuga-Anaya M. Contaminantes en los cuerpos de agua del sur de Sonora. Salud Publica Mex 2001;43:298-305. http://www.insp.mx/salud/43/eng/i434_6.pdf

Patten, Duncan T. Water Quality and Discharge Issues at Ambos Nogales: use of a Border Environmental Action Team to assist in Information Analysis, Problem Solving and Action Plan Development. www.scerp.org

Patten, Duncan T. Water and Riparian Resources of the Santa Cruz River Basin: Best Management Practices For Water and Resource Quality. www.scerp.org

Richardson, Thomas Clayton. A risk analysis approach to managing groundwater quality in the upper Santa Cruz basin. 1987. ix, 117 leaves.

United States; Bureau of Mines; Pima Association of Governments; Spokane Research Center (U.S.); Upper Santa Cruz Basin Mines Task Force; Arizona, and Dept. of Health Services. Ground-water monitoring in the Tucson copper mining district. Washington, D.C.: Bureau of Mines, U.S. Dept. of the Interior; 1983. 96, [3] p ([Open-file report] / Bureau of Mines, United States Department of the Interior: Open file report (United States. Bureau of Mines); 1984-185).

Upper Santa Cruz Basin Mines Task Force and Pima Association of Governments. Ground-water monitoring in the Tucson copper mining district ; and, Detailed Upper Santa Cruz Basin Mines Task Force Area recommendations. Arizona: The Task Force; 1983. 2v.

Upper Santa Cruz Basin Mines Task Force and Pima Association of Governments. Upper Santa Cruz groundwater quality baseline report. Tucson, Ariz: Pima Association of Governments; 1979. 2 v.

California/Baja California

Abbaszadegan, Morteza "Identification of Microbial Water Quality Bio-Markers in the New River. www.scerp.org

Densmore, Jill N. Water quality conditions in shallow subsurface waters, Imperial Valley, California. 1991. x, 178 leaves.

Gunier, Robert B., Martha E. Harnly, Peggy Reynolds, Andrew Hertz, and Julie Von Behren. Agricultural Pesticide Use in California: Pesticide Prioritization, Use Densities, and Population Distributions for a Childhood Cancer Study.

Rohy, David, and Alan Sweedler, Baja California Border Region and Development of a Transboundary Environmental Impact Assessment Process. www.scerp.org

California - Salton Sea, Imperial Valley

Boyle, Robert. 1996. Life -- or death -- for the Salton Sea? Large Polluted California Lake has Increasing Salinity and Pollution," *Smithsonian* 27(3):86.

Colburn, Ivan P. "Salton Sea is Dead-- Keep it That Way," www sci sdsu edu/salton/ColburnEditorialSS%20is%20Dead html, October 15, 1998.

Graham Jr., Frank.Lake Bono? *Audubon*, May 1998, volume 100, number 3, 86.

Hurlbert, Stuart H. "Salton Sea is Alive and Kicking -- Save It," www sci sdsu edu/salton/SaltonSeaAlive%26Kicking html. 15 October 1998.

LeClair, Patrick. "Can There Be a Sustainable Salton Sea?," darwin bio uci edu/—sustain/state/pleclair html

NAFTA Increases Chances to Clean Up Polluted New River. 1994. *Journal of Environmental Health* 56(7). Lexis Nexus Academic Universe Database.

Saving the Salton Sea: A Research Needs Assessment, Appendix B, "Deterioration of the Salton Sea: (Ten Year Chronology of Events and Actions Taken)," http://www.sci.sdsu.edu/salton/deterioration_salton_sea.htm, October 15, 1998.

United States Bureau of Reclamation, "The Source, Transport, and Fate of Selenium and other Contaminants in Hydrological and Biological Cycles of the Salton Sea Area," USBR Salton Sea Study, February 1998, http://www.lc.usbr.gov/—scao/index.html, October 15, 1998.

California/Baja California - San Diego/Tijuana

Comer, Katherine. Identification and Mapping of Potential Ground Water Contamination Sources in Urban Tecate. www.scerp.org

Gersberg, Richard. 1996. Monitoring and Modeling of Water Quality in the Tijuana River Watershed. www.scerp.edu

Gersberg, Richard. Predictive Modelling of the Interactions Between Land Use and Storm Water Quality in the Tijuana River Watershed. www.scerp.org

Gersberg, Richard. 2001. Fecal Coliforms and Pathogens from Land-based Sources into the Bight of the Californias.

Ponce, Victor Miguel. Hydroecological Characterization of Arroyo Alamar, Tijuana, Baja California, Mexico

Wright, Richard. 1997. Improving Community Access to Transborder Environmental Information in the San Diego. www.scerp.edu

Wright, Richard. Identifying Terrestrial Sources of Marine Pollution: The Bight of the Californias

Border Region. www.scerp.org

Zedler, J., C. Nordby, and B. Kus. 1992. The Ecology of Tijuana Estuary: A National Estuarine Research Reserve. Washington, DC: NOAA Office of Coastal Management, Sanctuary and Reserve Division.

New Mexico/Chihuahua

Borton, R. L; Borton, R. L; New Mexico, and State Engineer Office. Bibliography of ground-water studies in New Mexico, 1903-1982. Santa Fe, N.M: New Mexico State Engineer; 1983. 84 p (Special publication / New Mexico State Engineer: Special publication (New Mexico. State Engineer Office).

NMED. 2002. Bordering New Mexico: Major Environmental Issues along the State's International Border with Mexico.

Southwest Environmental Center (SWEC), *A Citizens' Guide to Pesticides Use and Regulation in New Mexico. Practical Information to protect yourself, your community and the environment from harm*. January. 2004.47 pp

Tanski, Janet. 1997. Rural Water Quality on the U.S. - Mexico Border: An Assessment of Columbus, NM and Palomas, Chi. http://www.nmsu.edu/~frontera/old_1997/jan97/197tanski.htm

Ward, Erin. n.d. Chapter III, State of the Environment: New Mexico-Chihuahua Border Region. http://www.scerp.org/bi/BIV/Ward.pdf

Texas/Chihuahua/Nuevo Leon/Tamaulipas

Childhood Pesticide Exposures on the Texas-Mexico Border: Clinical Manifestations and Poison Center Use. http://www.tdh.state.tx.us/border/pesticide article/ 1310-Belson-0803.pdf

Kelly, M. 2001. The Río Conchos: A Preliminary Overview. Texas Center for Policy Studies: Austin, Tx. U.S.

Texas State Soil and Water Conservation Board. (1991). *A Comprehensive Study of Texas Watersheds and their Impacts on Water Quantity and Water Quality*. Temple, Texas: Texas State Soil and Water Conservation Board.

Vogel, E. et al. (1994). Estudio Ambiental Integral: Nuevo Laredo Tamaulipas, Mexico. ITESM, Centro de Calidad Ambiental.

Texas/Chihuahua - El Paso/Juarez/Paso del Norte

Afseth, Daniel. 1995. The Development of a Multi-element Toxic Chemical Environmental Factor for a Southwestern New Mexico Target Region. M.A. Thesis. El Paso, TX: UTEP Department of Geological Sciences. (includes lead and chromium for Las Cruces area).

Amaya, M.A., Ackall, G., Pingitore, N., Quiroga, M., & Terrazas-Ponce, B. 1997. Lead poisoning in a U.S.-Mexico Border Community: Case study in environmental health nursing. Public Health Nursing, 14 (6): 353-360.

Barud-Zubillaga, Alberto. Small-scale Spatial Occurrence Trends of Arsenic in the Groundwater Resources of the Paso del Norte Region. www.scerp.org

Bristol, John R. Intestinal parasitic, H. pylori and enteroaggregative E. coli infection in relation to domestic fecal contamination in El Paso and Ciudad Juarez (funded in 2003 by CBHR).

Brown, Christopher. Vulnerability of Borderland Water Resources: Developing Indicators for Selected Watersheds on the U.S.-Mexico Border — The Paso del Norte Region. www.scerp.org

Carrasco, Leirad. Characterization and disinfection of primary treated wastewater in Ciudad Juárez, Mexico. Master's thesis / University of Texas at El Paso; no. 5613.

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El Paso and Dona Ana County Metals Survey Sampling Report. http://www.epa.gov/Arkansas/6sf/pdffiles/elpaso.donaana.finalreport.pdf (EPA has several other metals reportsfor soils in El Paso from this study)
El Paso County Metals Survey: Arsenic Soil Clean-up Levels July 2003. http://www.tdh.state.tx.us/epitox/hat/elpaso cnty arseniccleanup final.pdf (TCEQ has several other metals reports for soils in El Paso)
Flores Margez, Juan Pedro. Risk Factors Affecting the Human Food Chain and Human Health from Contaminants in Wastewater in the Juarez Valley (funded in 2002 by CBHR).
Gardea-Torresdey, J.L., S. Landsgerger, D. O'Kelly, K.J. Tiemann, and J.G. Parsons. 2001. Use of Neutron Activation to Determine Arsenic and Antimony Concentrations in Creosote Bushes Collected Near a Lead Smelter in El Paso, Texas, Journal of Radioanalytical and Nuclear Chemistry, 250/3 (583-586).
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Rios-Arana JV, Walsh EJ, Gardea-Torresdey JL. Assessment of arsenic and heavy metal concentrations in water and sediments of the Rio Grande at El Paso -Juarez metroplex region. Environ Int. 2004 Jan;29(7):957-71.
Streeter, Larisa. (Thesis) Analysis of Metals in Well Water, Tap Water, and Surface Water from Ciudad Juarez, Mexico.

Texas/Chihuahua/Nuevo Leon/Tamaulipas – Rio Grande
Alvarez, Maria E. A study of chemical and microbial contamination of the Rio Grande basin using a novel chemical assay (funded in 1999 by CBHR).
Alvarez, Maria E. An Assessment of Microbial Contamination and Chemical Toxicity of the Rio Grande Water Including Bacterial, Viral and Cryptosporidium Assays (funded in 2000 by CBHR).
Anderholm, Scott K; Geological Survey (U.S.), and National Water-Quality Assessment Program (U.S.). Water-quality assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas. Albuquerque, N.M, Denver, CO: U.S. Dept. of the Interior, U.S. Geological Survey. Can be purchased from U.S.G.S. Branch of Information Services; 1997. vii, 73 p (Water-resources investigations report; 97-4067).

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Case, Rober, and Carl Lieb. Eco-Toxicological Impact of Agricultural Chemicals on the Rio Grande Corridor. www. scerp.org

Garcia, S.S., Charles Ake, B.Clement, H.J. Huebner, K.C. Donnelly and S.L. Shalat. 2001. Initial results of environmental monitoring in the Texas Rio Grande Valley. Environment International. 26: 465-474.

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MMWR Morb Mortal Wkly Rep. Human lead absorption -- Texas.1997 Sep 19; 46(37):871-7. http://www.cdc.gov/mmwr/PDF/wk/mm4637.pdf
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Wright, Richard. Vulnerability Indicators for United States-Mexico Transborder Watersheds. www.scerp.org

Appendix C. Potentially Useful Metadata and Survey Studies

These studies concern water quality or potential problems with water quality. Surveys of health outcomes along the border are much less common. In addition to those reports listed below, the 303(d) and 305(b) state reports (required as part of the US Clean Water Act) probably will provide additional databases and metadata on water quality, as can be seen in Appendix D.

Barud, Alberto. 2004. Inventory of Agricultural Pesticides Used In The United States - Mexico Border Region. El Paso, TX: Pan-American Health Organization.

Good Neighbor Environmental Board. 2005. Water Resources Management on the US-Mexico Border. Washington, DC: Environmental Protection Agency. http://www.epa.gov/ocem/gneb/gneb8threport/gneb8threport.pdf

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ITESM, InfoMexus. 1998. Reporte del estado ambiental y de los recursos naturales en la Frontera Norte de México (Capitulo 3 - Salud Publica y Ambiental en la Frontera; Capitulo 6 - Agua). Mexico City: Instituto Nacional de Ecologia (available at http://www.ine.gob.mx/ueajei/publicaciones/consultaPublicacion.html?id_pub=109&id_tema=6&dir=Consultas). English version "Report on Environmental Conditions and Natural Resources on Mexico's Northern Border" available at http://americas.irc-online.org/rep-envt/index.html.

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Appendix D. TABLE 16: Groundwater Monitoring/Assessment Data (from California 305(b) report for 2002)

Types of Groundwater Data Collected	Spatial Coverage (Statewide/Regional/ Local)	Type of Sampling (Survey – one time effort, Monitoring – ongoing data collection but limited analysis, or Assessment – ongoing data collection and detailed analysis)	Data Format (Hard copy or Electronic; Application - Oracle, Access, Dbase, Excel, etc.)	Spatial Data (GIS) Availability
Dept. of Health Services (DHS)				
Public Water Well Locations and Water Quality	Statewide	Monitoring, Assessment	Electronic (Access); Hardcopy	Yes
Source Water Assessment Program Data	Statewide	Survey, Assessment	Electronic (Access)	Yes
Well Data	Statewide	Monitoring	Electronic (Access); Hardcopy	Yes
Water System Water Quality Monitoring Plan	Statewide	Monitoring, Assessment	Hardcopy	No
Groundwater Recharge with Recycled Water Monitoring Programs	Local	Survey, Monitoring	Hardcopy	No
Dept. of Pesticide Regulation (DPR)				
Well Inventory Database – Mandated by law that other state agencies report their pesticide well monitoring results to DPR. Other federal and local agencies are contacted for submission of data	Statewide	Collects survey and monitoring data	Electronic - Oracle	Yes. All databases are indexed according to the USGS Public Land Survey Coordinate System - Township/Range/Section (TRS)
Well Sampling Investigations - Well sampling conducted to comply with Pesticide Contamination Prevention Act. Study objectives are to: 1. Identify pesticide active ingredients in groundwater; 2. Identify vulnerable areas; 3. Determine relationship of detections with agronomic and geographic variables; 4. Determine trends in concentration to	Local to Statewide	Surveys and monitoring	Electronic - Oracle (captured in the Well Inventory Database)	Yes. Indexed to TRS

Types of Groundwater Data Collected	Spatial Coverage (Statewide/Regional/ Local)	Type of Sampling (Survey – one time effort, Monitoring – ongoing data collection but limited analysis, or Assessment – ongoing data collection and detailed analysis)	Data Format (Hard copy or Electronic; Application - Oracle, Access, Dbase, Excel, etc.)	Spatial Data (GIS) Availability
measure effective of regulations				
Pesticide Use Report Database – Beginning in 1990, all agricultural uses of pesticides are reported to DPR by Township, Range, and Section via the County Agricultural Commissioner	Statewide	Assessment (used to identify potential sampling sites)	Electronic - Oracle	Yes. Indexed to TRS
California Vulnerability Model (CALVUL) – Identify soil, climatic, depth to groundwater and other geographic properties of vulnerable areas	Statewide	Assessment (used to identify potential sampling sites)	Electronic - Oracle or Access	Yes. Indexed to TRS
Pesticide Chemistry Database – Registrants of pesticide active ingredients are required to submit data on the physical and chemical properties of pesticides including water solubility, soil adsorption coefficient (KOC), hydrolysis half-life, aerobic and anaerobic soil metabolism and dissipation of pesticides	Not Applicable	Assessment (used to identify potential sampling sites)	Electronic - Oracle or Access	Not Applicable
Dept. of Toxic Substances Control (DTSC)				
Hazardous Waste Management Program - Facility Permitting Division	Statewide (mostly urbanized areas)	Survey, Monitoring	Hard copy only	No. Spatial well information is not available
Site Mitigation Program - Statewide Cleanup Operations Division	Statewide (mostly urbanized areas)	Survey, Monitoring	Hard copy only	No. Spatial well information is not available
Site Mitigation Program - Emergency Response and Statewide Operations Division	Statewide (mostly urbanized areas)	Survey, Monitoring	Hard copy only except for Stringfellow site (data are currently in Access and will be moved to Equis in the near future)	Yes. for Stringfellow site. Otherwise, spatial well information is not available

Types of Groundwater Data Collected	Spatial Coverage (Statewide/Regional/ Local)	Type of Sampling (Survey – one time effort, Monitoring – ongoing data collection but limited analysis, or Assessment – ongoing data collection and detailed analysis)	Data Format (Hard copy or Electronic; Application - Oracle, Access, Dbase, Excel, etc.)	Spatial Data (GIS) Availability
Site Mitigation Program - Office of Military Facilities	Statewide (military bases)	Survey, Monitoring	Hard copy only	No. Spatial well information is not available
Dept. of Water Resources (DWR)				
Bulletin 118 groundwater basin and subbasin boundaries and associated numbers based on basin and subbasin data (some data in GIS)	Statewide	NA	ArcView	limited
Groundwater levels, available in hydrograph and tabular format on DWR's web page	Statewide	Monitoring	Hardcopy, electronic, Oracle, Access	limited
Groundwater quality analyses, available in tabular format on DWR's web page	Regional, Local	Monitoring, Assessment	Oracle, Access	limited
Inelastic and elastic subsidence	Regional, Local	Monitoring	Access	none
AB 303 Data (WC §10750)—The statute requires that any data collected as a result of the grant must be submitted to DWR.	Local	Survey, Monitoring, Assessment	Hardcopy, Electronic: (various applications)	Yes, varies with project
Well Completion Reports, commonly called Well Logs (DWR 188)	Statewide	NA	Electronic: Access	Yes, limited
Watermaster data for Central and West Coast Basins (Southern District)	Local, Regional	Monitoring	Electronic: Excel	No
Prop 13 Groundwater Storage and conjunctive management project specific data	Local, Regional	Survey, Monitoring, Assessment	Hardcopy, Electronic: (various applications)	Yes, varies with project
State and Regional Water Boards (SWRCB/RWQCBs)				
Groundwater Ambient Monitoring and Assessment (GAMA) Program, California Aquifer Susceptibility (CAS) Assessment - Low-level VOCs, groundwater age data	Statewide	Survey, Assessment	Oracle	Yes

Types of Groundwater Data Collected	Spatial Coverage (Statewide/Regional/ Local)	Type of Sampling (Survey – one time effort, Monitoring – ongoing data collection but limited analysis, or Assessment – ongoing data collection and detailed analysis)	Data Format (Hard copy or Electronic; Application - Oracle, Access, Dbase, Excel, etc.)	Spatial Data (GIS) Availability
GAMA Program, Voluntary Domestic Well Assessment Project - Private domestic drinking water well location and water quality data	Local	Assessment	Access	Yes
Location, release, water quality, and water level data for Leaking UST sites (Geotracker)	Leaking UST sites located statewide	Monitoring	Hard copy and Electronic: Oracle	Yes
Location, water quality, and water level data for Land Disposal Program sites	Land Disposal sites located statewide	Monitoring	Location (hard copy, limited electronic: Excel); Water quality (hard copy, limited electronic: Excel); Water level data (hard copy, limited electronic Excel)	Yes (Land Disposal site locations)
Location, water quality, and water level data for Dept. of Defense (DOD), Leaking Landfills, and Spills Leaks, Investigations, and Cleanup (SLIC) sites	DOD, landfills, and SLIC sites located statewide.	Monitoring	Electronic UST data in Geotracker. In general, site location (hard copy, limited electronic: Excel); Water quality (hard copy, limited electronic: Excel); Water level data (hard copy, limited electronic: Excel)	In progress
Hydrogeologic Vulnerability Areas (GIS) delineated based on published hydrogeologic data and information	Statewide	NA	Electronic: GIS	Yes
RWQCBs specific efforts: San Francisco Bay Regional Water Quality Control Board – Electronic Solvent Plume Reporting Project. Others – To be determined	Regional	Survey, Monitoring, Assessment	(San Francisco Bay Regional Water Quality Control Board, Electronic Solvent Plume Reporting Project - Excel)	Yes (San Francisco Bay Regional Water Quality Control Board, Electronic Solvent Plume Reporting Project)