Public Health Assessment

Public Comment Release

DONNA RESERVOIR AND CANAL SYSTEM

DONNA, HIDALGO COUNTY, TEXAS

EPA FACILITY ID: TX0000605363

Prepared by
Texas Department of State Health Services

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Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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The Texas Department of State Health Services
Under Cooperative Agreement with the
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This information is distributed by the Agency for Toxic Substances and Disease Registry for public comment under applicable information quality guidelines. It does not represent and should not be construed to represent final agency conclusions or recommendations.

Foreword

The Agency for Toxic Substances and Disease Registry (ATSDR) was established under the mandate of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. This act, also known as the "Superfund" law, authorized the U. S. Environmental Protection Agency (EPA) to conduct clean-up activities at hazardous waste sites. EPA was directed to compile a list of sites considered potentially hazardous to public health. This list is termed the National Priorities List (NPL). Under the Superfund law, ATSDR is charged with assessing the presence and nature of health hazards to communities living near Superfund sites, helping prevent or reduce harmful exposures, and expanding the knowledge base about the health effects that result from exposure to hazardous substances [1].

In 1984, amendments to the Resource Conservation and Recovery Act of 1976 (RCRA) – which provides for the management of hazardous waste storage, treatment, and disposal facilities – authorized ATSDR to conduct public health assessments at these sites when requested by the EPA, states, tribes, or individuals. The 1986 Superfund Amendments and Reauthorization Act (SARA) broadened ATSDR's responsibilities in the area of public health assessments and directed ATSDR to prepare a public health assessment (PHA) document for each NPL site. In 1990, federal facilities were included on the NPL. ATSDR also conducts public health assessments or public health consultations when petitioned by concerned community members, physicians, state or federal agencies, or tribal governments [1].

The aim of these evaluations is to determine if people are being exposed to hazardous substances and, if so, whether that exposure is potentially harmful and should be eliminated or reduced. Public health assessments are carried out by environmental health scientists from ATSDR and from the states with which ATSDR has cooperative agreements. Because each NPL site has a unique set of circumstances surrounding it, the public health assessment process allows flexibility in document format when ATSDR and cooperative agreement scientists present their findings about the public health impact of the site. The flexible format allows health assessors to convey important public health messages to affected populations in a clear and expeditious way, tailored to fit the specific circumstances of the site. [Note: Appendix A provides a list of abbreviations and acronyms used in this report and Appendix B provides information regarding the public health assessment process.]

Comments

If you have any questions, comments, or unanswered concerns after reading this report, we encourage you to send them to us. Letters should be addressed as follows:

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Table of Contents

Foreword i
Summary 1
Purpose and Health Issues 3
Background 3
Site Description 3
Site History 4
Site Visit 5
Demographics 6
Land and Natural Resource Use 7
Environmental Contamination 8
Drinking Water 8
Surface Water and Bottom Sediments 8
Suspended Sediments 8
Biota (Fish Tissue) 9
Chemicals of Concern for the Site 10
Pathways Analysis 11
Public Health Implications 11
Polychlorinated Biphenyls 11
Community Health Concerns Associated with the Donna Reservoir and Canal System site 13
Health Outcome Data 13
Children's Health Considerations 14
Conclusions 14
Recommendations 16
Public Health Action Plan 16
Actions Completed 16
Actions Planned 17
Authors, Technical Advisors, and Organizations 18
References 19
Certification 20
Appendix A: Acronyms and Abbreviations 21
Appendix B: The Public Health Assessment Process 23
Appendix C: Figures 30
Appendix D: Tables 33
Appendix E: Fish Consumption Risk Report - 2007 35

Summary

Introduction

The Donna Reservoir and Canal System site is located in Donna, Hidalgo County, Texas. On September 19, 2007, the site was proposed to the National Priorities List (NPL), commonly known as "Superfund", due to polychlorinated biphenyl (PCB) contamination in fish. In cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), the Texas Department of State Health Services (DSHS) has evaluated the public health significance of this site and determined that the PCBs found in fish taken from the site pose a public health hazard.

The discovery of the PCBs in the fish goes back to 1993 when the United States Environmental Protection Agency (EPA) measured an extremely high PCB concentration in a fish. The fish was reportedly caught in the Donna Canal by a family from Brownsville, Texas. The fish was reportedly taken from the Donna Canal near Donna, Texas. In response to this sample result and the results of analyses from subsequent fish taken from the Donna Reservoir and Canal System, DSHS concluded that the site posed a public health hazard and issued Aquatic Life Order 9 (AL-9). This order banned the possession of fish taken from the Donna Irrigation System (aka Donna Reservoir and Canal System). Subsequent sampling events have confirmed the continued presence of PCBs in fish from this site at levels exceeding those used by DSHS to ensure protection of public health from adverse systemic health effects.

DSHS placed warning signs along the canal and irrigation system to advise people of the fishing ban. The signs warned that fish caught from the reservoir and canal system may contain harmful chemicals and that keeping the fish may result in a fine of up to $500.00. Upon visiting the site we observed that many of the warning signs either were missing or damaged. Additionally, after talking with local area residents and observing evidence of fishing, it was apparent that there was a high probability that people were still consuming fish from the site. Based on available information we have concluded that as long as there are fish in the Donna Reservoir and Canal System and the warning signs are ignored, the presence of PCBs in fish at this site would continue to pose a hazard to public health.

The source of the PCBs is not known; however, PCBs also were detected in suspended sediments. Based on available information and reasonably plausible exposure scenarios we have concluded that the PCBs found in the suspended sediments do not pose a hazard to public health. PCBs were not detected in any other media.

As long as people continue to eat contaminated fish from this site, the site will continue to pose a public health hazard. Currently, DSHS, the EPA, and local agencies are working with area residents to inform citizens about the potential health risks associated with consuming the contaminated fish. Additionally, EPA and the United States Fish and Wildlife Service (USFWS) are in the process of removing fish from the canal system. Future exposure to PCBs in the fish, and by inference the public health conclusion category for this site, will depend on the efficiency of the fish removal operation, locating the source(s) of the PCBs, and the effectiveness of improving public awareness.

As data become available, DSHS and ATSDR will re-evaluate the public health significance of this site, particularly as conditions change.

CONCLUSIONS	DSHS and ATSDR reached two conclusions in this health assessment:
Conclusion 1	Based on the PCBs results, DSHS concluded that consumption of any of the sampled fish species from the Donna Irrigation System are expected to harm people's health.
Basis for conclusion	All fish species sampled from the Donna Irrigation System contained PCBs at levels exceeding those concentrations used by the DSHS to ensure protection of public health from the adverse health effects associated with these contaminants. Additionally, consumption of channel catfish, common carp, and smallmouth buffalo from the Donna Irrigation System, heavily contaminated with PCBs, markedly increased the calculated excess lifetime risk of cancer in people who eat these fish.
Next steps	Although Phase I and Phase II of the EPA removal actions have been completed this will not prevent long-term recontamination of the remaining fish. However, it did assist in removing the immediate health risk to the public. EPA will continue long-term management and removal of the contamination source. DSHS will continue to work with EPA and evaluate any future sampling data as is becomes available. DSHS will continue educational outreach with the public and physicians regarding the potential PCB exposures related to eating fish.
Conclusion 2	DSHS concluded that eating fish with multiple contaminants taken from the Donna Irrigation System are not expected to harm people's health.
Basis for conclusion	Cumulative adverse health effects from eating fish with multiple contaminants, taken from the Donna Irrigation System, are not likely. Fish from the Donna Irrigation System do not contain concentrations of metal-like contaminants, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), or organochlorine pesticides at concentrations that exceed the DSHS guidelines for protection of human health.
Next steps	No public health actions are needed.
FOR MORE INFORMATION	If you have concerns about your health, you should contact your health care provider. You may also call Texas Department of State Health Services at (800) 588-1248 and ask to speak with someone in the health assessment program.

Purpose and Health Issues

This public health assessment (PHA) was prepared for the Donna Reservoir and Canal System (DRCS) site in accordance with the Interagency Cooperative Agreement between the Agency for Toxic Substances and Disease Registry (ATSDR) and the Texas Department of State Health Services (DSHS). In preparing this PHA, no independent sediment, fish, or other samples were collected and/or analyzed. DSHS and ATSDR used sample data previously collected by the Texas Commission for Environmental Quality (TCEQ), the United States Environmental Protection Agency (EPA), the United States Geological Survey (USGS), and the Seafood and Aquatic Life Group (SALG) at DSHS. The primary contaminants of concern associated with the Donna Reservoir Canal System are the class of compounds known as polychlorinated biphenyls (PCBs). The primary route of exposure evaluated in this PHA is the consumption of PCB-contaminated fish. For this site, the air, soil, water, bottom sediment, and suspended sediment exposure routes were not considered significant pathways of exposure. This PHA presents conclusions about whether a health threat is present for the identified routes of exposure.

Background

Site Description

The Donna Reservoir and Canal System site is located in south Texas, in Hidalgo County. The county borders the Rio Grande River which serves as the international boundary between the United States of America and Mexico. The site includes the Main Canal (beginning at the Rio Grande), the Donna Reservoir (East and West sections), and interconnecting canals north of the reservoir [2].

Diesel driven pumps are used by the Donna Irrigation District #1 in two pumping facilities to lift the water from the Rio Grande into the approximately 7 mile (11.3 kilometer) long canal [2]. The original pumping plant was built in 1906 [3]. The volume and velocity of the water entering the canal system can be controlled by the number of pumps in operation. The Main Canal is an open earthen canal which carries water northward by gravity flow. The canal system contains approximately 168 miles of lateral canals and pipelines. Once it is pumped from the Rio Grande, the water flows under the U.S. Highway 281 bridge to a shallow stream, the Arroyo Colorado. At this point the Main Canal is buried under the Arroyo Colorado and travels for approximately 1,600 feet through an enclosed concrete structure known as the Siphon. After exiting the Siphon, the Main Canal resurfaces north of the Arroyo Colorado and continues on towards the Donna Reservoir. The level of water in the reservoir is maintained by controlling the pumping from the Rio Grande [3].

The Donna Reservoir is comprised of East and West sections that were constructed in 1964 and 1954 respectively. The combined sections cover 400 acres and are divided by Farm-to-Market (FM) 1423, also known as Valley View Road. The East and West sections are connected via two conduits under FM 1423 [3]. Water is pumped from the West section into the canal system to provide drinking water for the City of Donna, the North Alamo Water Supply Plant #5, and agricultural irrigation throughout the area.

Periodically the canal is dredged to remove sediment and maintain its structure. In 1990 to 1991, the Main Canal, south of the Siphon, was dredged to an estimated depth of 30 inches. The dredge material was placed on the banks of the canal [3]. The reservoir and canal system is surrounded by a series of levees (or dikes) which prevent flooding of the system during major weather events such as hurricanes.

Site History

In 1991, there was an unusual cluster of neural tube defects in infants born in South Texas. In 1993, as part of an investigation into potential causes of the cluster, EPA conducted an exposure study of nine families in Cameron and Hidalgo counties. During the study, the EPA collected and sampled fillets from a common carp (*Cyprinus carpio*) in the possession of a family from Brownsville, Texas. The fish, reportedly taken from the Donna Canal near Donna, Texas, had an estimated PCB concentration of 399 parts per million (ppm). Blood and urine samples collected from the family as part of the study confirmed that the family had been exposed to PCBs [3, 4].

Subsequent sampling of fish, conducted in 1993 and 1994, by the Texas Department of Health (TDH, predecessor of DSHS) and the Texas Natural Resource Conservation Commission (TNRCC, predecessor of TCEQ) found elevated levels of PCBs in fish collected from the Donna Reservoir and Canal System [5]. PCBs were not detected in fish taken from Delta Lake, Hidalgo Settling Basin, Llano Grande, Mercedes Main Canal, and Mercedes Settling Basin (bodies of water near the Donna Reservoir and Canal System area). On February 4, 1994, the TDH deemed the presence of the PCBs in the fish to pose a public health hazard and issued Aquatic Life Order 9 (AL-9). This order banned the possession of fish taken from the Donna Irrigation System (aka Donna Reservoir and Canal System). The area covered by the ban encompasses the irrigation canal beginning at the Rio Grande, up to and including the reservoir [Appendix C Figure 1].

In July 1997, TCEQ analyzed 10 additional fish samples obtained from the Canal and East Reservoir and confirmed the continued presence of high concentrations of PCBs. In 1998, TCEQ collected thirty-eight soil and sediment samples and two shallow groundwater samples downgradient from an unauthorized waste disposal site near the northwest corner of the reservoir and one sludge sample from the Donna Irrigation District pumps and did not detect PCBs in any of the samples. TCEQ also collected and analyzed 13 fish samples from the Rio Grande above and below the Donna Irrigation District pump intake and did not detect any PCBs. Because the design of the intake pump prevents migration of sediment or fish back into the Rio Grande these data suggested that the source of the contamination was likely associated with the Donna Irrigation Canal System [3].

From February 1999 through July 2000, the United State Geological Survey (USGS) collected twenty-one suspended sediment water samples from the Main Canal and found PCBs in the samples. They narrowed the probable location of the source to a 35 meter (115 foot) long area north of the Siphon outlet on the eastern bank. PCBs also were detected in suspended sediments collected near the 90° bend of the canal [3].

In April 2001, TCEQ conducted sampling activities for EPA to document releases or potential release of PCBs from the soil, surface water, bottom sediments, and/or suspended sediments in the reservoir and canal system. TCEQ found PCBs (Aroclor 1254) in the suspended sediment samples and not in any of the soil, surface water, or bottom sediment samples [3].

From December 2005 through January 2006, the DSHS SALG collected 30 fish samples from the canal system and reservoir. Samples were analyzed for inorganics, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and PCBs. SALG and the DSHS Environmental and Injury Epidemiology and Toxicology Branch concluded that the inorganics, VOCs, SVOCs, and pesticides posed no apparent public health hazard. However, they concluded that fish from the Donna Irrigation System continued to pose a public health hazard because of PCBs [4]. A copy of the report is included in Appendix E**.**

The Donna Reservoir and Canal System site was proposed to the National Priorities List on September 19, 2007; it was added to the final list on March 19, 2008 [6, 7]. Inclusion on the NPL allows federal funds and personnel to become available to further assess the nature and extent of public health and environmental risks associated with the site. Currently, EPA, DSHS, TCEQ, and the USFWS are working with the City of Donna and area residents to locate the source of the PCBs, inform community members about the potential health risks of consuming the contaminated fish, and to remove fish from the canal system.

Site Visit

The DSHS Health Assessment and Toxicology Program visited the Donna Reservoir and Canal System area in August and November of 2007, August of 2008, and in February and July of 2009. During the August 2007 site visit we saw evidence that people were still fishing in the reservoir and canal. Approximately 80% of the roads along the reservoir and canal system banks provide area residents access for fishing [3]. Signs warning people of the hazards associated with eating the fish had been displayed in the past but many either were missing or damaged. Two warning signs, approximately 8-10 feet above the ground, were posted on telephone poles but were partially obscured by plant growth. A few people indicated that they thought the warning signs were put in place to scare some fishermen off so that only Donna Water District employees could fish. DSHS staff talked with families found fishing along the canal system and near the reservoir about the fish ban that has been in place for many years. Most of the people we spoke to indicated that they were not aware of the consumption ban. DSHS staff distributed approximately 150 educational brochures, in English and Spanish, explaining the potential health risks associated with eating PCB contaminated fish.

On November 15, 2007, personnel from the EPA, TCEQ, USFWS, DSHS and the City of Donna met to discuss the Superfund site. Personnel from the Donna Irrigation District accompanied us on a tour of the irrigation system operations. During the tour we were able to view the water source (the Rio Grande), pump houses, canals, and distribution system. Active farming operations (plowing, field/crop maintenance) were occurring in the fields near the canal system. When people were found fishing along the canal DSHS staff would inform them about the ban and the dangers of eating fish from the canal system and distribute educational materials.

In August 2008, we visited the site with representatives from EPA, USFWS, TCEQ, DSHS, and the Donna Irrigation District. During the site visit we observed the USFWS removing fish from the Donna Main Canal by using an electric pulse in the area surrounding the boat to temporarily stun nearby fish. As the stunned fish surfaced, USFWS personnel retrieved them with dip nets. Periodically the USFWS returned to a collection station to identify, measure, and weigh all fish prior to disposal or preparation for analysis at an off-site laboratory. The purpose of the removal action was to try to eliminate fish from the canal at the Rio Grande pump station and northward (downstream) to U.S. Highway 281. Metal fence barriers were placed at the south side of U.S. Highway 281 and at the Siphon outlet to prevent fish from traveling downstream.

Later in the month DSHS returned to Donna at the request of the Donna Rotary Club. DSHS presented on what our involvement entailed and what future steps we would be taking. We visited local health clinics to ask physicians to inform parents of young children of the dangers of eating the fish caught in the reservoir or canal system. DSHS staff created door hangers with information regarding the fish ban that health clinics could distribute to their patients. Approximately 250 door hangers were distributed on this trip.

In February 2009, DSHS attended an EPA sponsored community meeting where DSHS staff: gave a presentation of our involvement; addressed community concerns; and distributed educational factsheets. Staff met with city officials as well as local law enforcement officers to address the problem of citizens continuing to fish from the reservoir and canal system. DSHS supplied local law enforcement with educational materials that they agreed to distribute to locals that were found fishing along the irrigation system.

During the week of July 27, 2009, DSHS staff assisted EPA with notifying citizens, living adjacent to the west canal of the Donna Reservoir that removal actions were going to begin in the west reservoir and canal. DSHS staff went door to door in the community to discuss the fish consumption ban and the potential health risks associated with consuming fish from the site. DSHS distributed 750 site specific fact sheets, both in English and in Spanish throughout the community. A physician from Texas A & M Health Science Center Harlingen reproduced our fact sheet and distributed approximately 600 copies at a nursing conference that was held in Harlingen that week.

Demographics

The 2000 United States Census reported the total population for Hidalgo County and the city of Donna as 569,463 and 14,768 respectively [8]. The Census reported 3,917 people residing in 2,187 housing units within a 1-mile radius of the site. At the time of the census, there were 516 children under the age of six, and 2,187 women of child-bearing age (15 to 44 years old) residing in this area [Appendix C Figure 2].

Land and Natural Resource Use

The water supplied by the Donna Reservoir and Canal System is obtained from the Rio Grande, approximately one mile downstream of the Reynosa, Mexico, Wastewater Treatment Plant outfall. Raw water is pumped by the Donna Irrigation District #1 to the Main Canal which then flows over a 7 mile distance northward to the reservoir [9]. The reservoir is located ½ mile southwest of the City of Donna [Appendix C Figure 1].

The reservoir and canal system is located in the Nueces-Rio Grande Coastal Basin in the lower Rio Grande Valley. The land slopes towards the east and northeast away from the Rio Grande. Only one percent of Hidalgo County drains towards the Rio Grande. Most of the drainage in the valley is to the Arroyo Colorado which runs over the buried Main Canal at the Siphon. Some seepage from the Arroyo Colorado into the Siphon may occur. However, analyses of water and sediment samples collected from the Arroyo Colorado do not indicate it to be a factor for the Donna Reservoir and Canal System PCB contamination. The Rio Grande's flow is determined by water releases from Falcon Reservoir which is approximately 85 miles upstream from the Donna Irrigation water intake. Groundwater flow through the Lower Rio Grande Valley is from the northwest to the southeast at approximately 150 meters (492 feet) per year. Depth to groundwater is approximately 3 meters (10 feet) [3].

The land use surrounding the reservoir and canal system is intensive commercial farming and agricultural. Irrigation water is provided by the Donna Irrigation District from the Main Canal for farming operations. The Main Canal, which is elevated above the surrounding cropland, provides water to other branching irrigation canals. Irrigation is primarily achieved by flooding the fields. During site visits to the area, crops such as cabbage, grapefruit, oranges, and sugarcane were observed in the fields adjacent to the canal and reservoir.

In addition to providing water for commercial agricultural uses, the Donna Irrigation District #1 makes water available to the City of Donna and to the North Alamo Water Supply Corporation Plant #5. These public water systems (PWS) treat the raw water to make it suitable for human consumption. The City of Donna Public Water System (PWS ID #1080002) and the North Alamo Water Supply Corporation (PWS ID #1080029) serve populations of 15,000 [10] and 94,592 [11] respectively.

The Donna PWS and the North Alamo Plant #5 obtain their water from intakes located north of and downstream from the Reservoir. As part of the April 2001 sampling event, the TCEQ collected water samples from the drinking water intakes (pre and post treated) of the City of Donna (801 South Hutto Road) and North Alamo Water Supply Plant #5 (Victoria Road and Mile 11. 5 Road northeast of Donna) and did not detect PCBs in the samples [3, 9].

Environmental Contamination

Drinking Water

Summary: *Laboratory analyses of public drinking water samples indicate that chemicals do not exceed regulatory limits and health-based standards.*

In 1974, the U.S. Congress passed the Safe Drinking Water Act (SDWA) which required the EPA to determine safe levels of chemicals in public water. The EPA and the TCEQ require all public water systems in the state of Texas to periodically test water which is supplied to the public for human consumption. The DSHS Health Assessment and Toxicology Program reviewed water quality testing data of the City of Donna Public Water System (PWS) for the years 1997 to 2008. We compared the concentrations of chemicals from the Donna water system to ATSDR's Health Assessment Comparison (HAC) values and the EPA's Maximum Contaminant Levels (MCLs). The MCLs are based on MCL Goals (MCLG), which are contaminant levels that would not cause any potential health problems. For possible carcinogens, the MCLG is set at 0 parts per billion (ppb). The MCL is then set as close to the MCLG as possible, considering the ability of public water systems to detect and remove contaminants using suitable treatment technologies. The current MCL for PCBs is 5 ppb. Analytical test results for inorganic chemicals (metals) and trihalomethanes, a byproduct of the water treatment process, in the drinking water did not exceed ATSDR's HAC values or EPA's MCLs. Analysis results of samples collected in February 2007 and January 2008 indicated that pesticides, phthalates, and polycyclic aromatic hydrocarbons (PAHs) were not detected [12]. Analysis of water samples collected before and after treatment from the Donna PWS and the North Alamo Water Supply Plant #5 did not detect PCBs [3].

Surface Water and Bottom Sediments

Summary: *Surface water and bottom sediments collected from the Donna Reservoir and Canal System do not contain PCBs.*

From 1994 to 2001, the TCEQ collected samples of surface water and bottom sediment from the canal and reservoir. Surface water at the site is currently used for drinking water, food preparation, bathing, and for commercial/business purposes. Sampling data indicate that surface water and bottom sediments from the Donna Reservoir and Canal System do not contain PCBs [3, 13].

Suspended Sediments

Summary: *The concentrations of PCBs in suspended sediments vary depending on the location in the Donna Reservoir and Canal System.*

PCBs tend to bind strongly to sediments, particularly sediments with a diameter of less than 0.15 millimeters (mm) or 0.006 inches suspended in water. The primary route of PCB movement through the environment is by sediment transfer within water bodies. Eventually the suspended sediments end up as bed (bottom) sediments. Flooding or dredging may cause the bottom sediments to be resuspended and possibly become redistributed. [3].

In April 2001, the TCEQ collected seventeen suspended sediment samples beginning at the Rio Grande pump house, in the canal, the reservoir, the water intakes for the City of Donna Water Treatment Plant, and the North Alamo Water Supply Plant #5 [Appendix D Table 1].

Suspended sediment samples from the canal between the Rio Grande pump house and downstream (northward) to the Siphon entrance did not contain PCBs. Samples collected from the canal at the Siphon outlet, the West Reservoir, the Upper Canal (north of reservoir), and at the water intake for the City of Donna Water Treatment Plant contained PCBs (Aroclor 1254) at concentrations that ranged from 15 ppb to 53 ppb. The two highest measured concentrations, 52 and 53 ppb, were collected at the Siphon outlet and just downstream from the 90° bend of the canal, which is the portion of the canal system that is considered to be a probable source area. [3]. The suspended sediment sample collected at the intake of North Alamo Water Treatment Plant #5 was 9.9 ppb of PCB. Based on the 2001 suspended sediment sample analysis the PCB contamination appears to extend approximately 5 ¾ miles (9.25 kilometers) from the Siphon outlet downstream to the Donna Reservoir, Upper West Canal, Upper East Main Canal, and to the intake for the City of Donna Water Treatment Plant [9]. In general, PCB contamination in the suspended sediment is greatest near the 90° bend downstream from the Siphon and the least near the intake to the public water supply [Appendix D Table 1]. From February 1999 to April 2001, the USGS collected twenty-nine suspended sediment samples from the canal and reported concentrations ranging from not detected to 130 ppb [Appendix D Table 2]. The USGS concluded that the source(s) of the PCB contamination is/are likely located between the Siphon outlet and the 90° bend in the canal [13].

Biota (Fish Tissue)

Summary: *PCB concentrations in fish collected from the Donna Reservoir and Canal System continue to be a public health concern.*

In 1993 and 1994, a joint investigation was conducted by the DSHS (formerly the Texas Department of Health) and Texas Commission on Environmental Quality (TCEQ, formerly the Texas Natural Resource Conservation Commission) to determine the extent of PCB contamination in fish from the Donna Reservoir and Canal System. PCBs (primarily Aroclor 1254) were detected in twelve of thirteen fish caught from the Donna Main Canal, three of sixteen fish caught from the reservoir, and eight of eleven caught from the adjacent Arroyo Colorado; the levels ranged from 0.055 to 24 ppm (55 ppb to 24,000 ppb) [5]. PCBs were not detected in any of the surface water or sediment samples collected from the canal, reservoir, Arroyo Colorado, and the Rio Grande [3]. In June and July 1993, DSHS also collected 30 fish from bodies of water near the Donna Reservoir and Canal System area: i.e., Delta Lake, Hidalgo Settling Basin, Llano Grande, Mercedes Main Canal, and Mercedes Settling Basin. PCBs were not detected in any of these fish samples. In July 1997, TCEQ analyzed 10 additional fish samples obtained from the Canal and East Reservoir and confirmed the continued presence of PCBs at concentrations up to 20 ppm (20,000 ppb) [3].

From December 2005 through January 2006, the DSHS Seafood and Aquatic Life Group (SALG) collected 30 fish samples from the canal system and reservoir (Appendix C Figure 3). Samples were analyzed for inorganic compounds, volatile organic compounds (VOCs), semi-volatile

organic compounds (SVOCs), pesticides and PCBs. A complete description of the sampling results is included in the DSHS SALG Report available in Appendix E. A brief summary of the results is presented below.

Samples from the Donna Irrigation System contained no detectable arsenic or cadmium (data not shown). The inorganic contaminants present at measurable levels in one or more fish included copper, mercury, lead, selenium, and zinc (Appendix E, Table 2). Six of 30 fish contained some level of lead; four contained measurable quantities of lead and two contained estimated concentrations. The remaining 24 fish were reported only as "less than the reporting limit" for the sample. Mercury was found in 30 fish tissue samples with an average concentration of 0.229±0.112 milligrams per kilogram (mg/kg)[1]. The highest concentration of mercury found in the fish was 0.467 mg/kg. All 30 samples contained copper, selenium, and zinc with mean concentrations of 0.271±0.258 mg/kg, 0.547±0.135 mg/kg, and 5.766±2.601 mg/kg, for copper, selenium and zinc, respectively (Appendix E, Table 2). Seven fish had measurable concentrations of 4,4'-DDD. All samples contained 4,4'-DDE with concentrations ranging from 0.005 mg/kg-1.432 mg/kg). Two samples contained measureable concentrations of 4,4'-DDT and chlordane was reported in seven samples with a mean concentration of 0.014 mg/kg±0.021 mg/kg). One sample had a measurable 0.0146 mg/kg chlorpyrifos. Ten samples contained measurable concentrations of Dacthal ranging from 0.0012 to 0.062 mg/kg. VOCs were tested for in five fish. One fish contained a trace of benzene (0.001 mg/kg, method detection limit MDL=0.020 mg/kg). Toluene was present at estimated levels (below the MDL) in four fish. All five fish contained naphthalene with an average concentration of 0.031 mg/kg. SVOCs were not reported in any of the samples at concentrations above the minimum detection limits.

Samples of five fish species were collected from five sites within the Donna Irrigation System for PCB analysis. The sampling sites were Donna Canal SH 281 (Site 1), Donna Canal Siphon Outlet (Site 2), Donna Canal FM 1423 (Site 3), Donna Reservoir West (Site 4), and Donna Reservoir East (Site 5). The average concentration of PCBs found in fish from each of the sampling sites is: Site 1 – 0.018±0.018 mg/kg; Site 2 – 4.219±6.553 mg/kg; Site 3 – 0.568±0.838 mg/kg; Site 4 – 0.51±0.01 mg/kg; Site 5 – 0.025±0.007 mg/kg (Appendix E, Table 3).

In August 2008, the U.S Fish & Wildlife Service (USFWS) began fish removal operations from the Donna canal system. The removal area encompassed the canal from the Rio Grande pumping station to the entrance of the western reservoir. Of the fish removed, forty-one samples were submitted to a laboratory by EPA for PCB analysis. Concentrations of Aroclor 1254, ranged from not detected to 410 ppb (or 0.410 mg/kg). Fish collected from the canal area located near the 90° bend had the highest average Aroclor 1254 concentration of 79.8 ppb (or 0.0798 mg/kg).

Chemicals of Concern for the Site

The primary contaminants of concern associated with the Donna Reservoir Canal System are the class of compounds known as PCBs. However, other contaminants have been detected in fish collected from the site. A thorough analysis of data for these other contaminants by DSHS SALG and the DSHS Environmental and Injury Epidemiology and Toxicology Branch concluded that

1 milligrams per kilogram (mg/kg) and parts per million (ppm) are equal , i.e. 1 mg/kg = 1 ppm.

they posed no apparent public health hazard, even when consumed along with PCBs in the fish (Appendix E).

Pathways Analysis

Soil, water, or bottom sediment samples did not contain contaminants of concern; thus, these pathways were eliminated from further consideration. Air samples were not collected; however, because of the nature of the contaminants of concern, their low volatility and their high affinity for soil particles, this pathway also was eliminated as a plausible pathway of concern. Although contaminants of concern were detected in suspended sediments, the probability of regular contact with these suspended particles or ingestion of water containing these particles is low – contaminants were not found in any of the water samples associated with the public water systems – therefore, the suspended sediment pathway was not considered a significant pathway of exposure for this PHA and would pose no apparent public health hazard.

Contaminants of concern were found in the tissue of fish taken from the Donna Reservoir and Canal System. Although Aquatic Life Order-9 continues to be in effect and possessing fish from the reservoir could result in a fine of up to $500, there was evidence that people continue to fish at the site. Thus, we consider the fish consumption pathway to be complete. This pathway is the basis for the public health conclusions and recommendations reached in this PHA.

Public Health Implications

Polychlorinated Biphenyls

Background

Polychlorinated biphenyls (PCBs) are man-made chemicals that can be liquid or solid. Most are oily liquids that are clear to light yellow with no smell or taste. They were mainly used as coolants and lubricants in electrical equipment. Their physical properties as good insulators, which enabled them to withstand high heat without breaking down or burning easily, made them ideal for use in transformers and capacitors. PCBs also were used in fluorescent lighting fixtures, hydraulic fluids, flame retardants, inks, adhesives, paints, and as pesticides extenders. PCB manufacturing in the U.S. began in 1929 and ceased in 1977. The peak annual production was 85 million pounds in 1970. In 1976, the regulation of PCBs was placed under the authority of the U.S. EPA. In 1978, regulation of the storage and disposal of PCBs began. Also that same year, all U.S. manufacture and importation of PCBs was prohibited.

Usually PCBs are not found as a pure chemical but as mixtures of different PCBs. There are 209 different types of PCB compounds which are called “congeners”. Congeners which have the same number of chlorine atoms are called homologs. Homologs having the same number of chlorine atoms but in different positions are called isomers [14].

Approximately 99 % of PCBs used by the U.S. industry were produced by the Monsanto Chemical Company. Aroclor was the commercial trade name of PCBs produced by Monsanto. Different types of Aroclors were produced which contained the trade name followed by numbers such as, 1016, 1221, 1254, and 1260. The first two digits indicated the number of carbon atoms contained

in the particular PCB molecule. The second two digits indicated the percentage of chlorine contained in the molecule. For example, Aroclor 1254 is approximately 54% chlorine. In general, the higher the degree of chlorination; the more toxic the Aroclor. PCBs also were produced by other countries with trade names such as; Clophen (Germany), Fenclor (Italy), Kanechlor (Japan), and Phenclor (France) [14].

PCBs are persistent and can exist in the environment for long periods of time. If released into the environment as a gas, PCBs can accumulate in the leaves and the above ground parts of plants. PCBs bind strongly and do not partition very easily to water; thus, they are not usually transported from the release site by water (i.e. runoff) to other areas. In water, PCBs will attach themselves to the bottom sediment or to particles floating in the water, commonly referred to as suspended sediments.

Generally, background levels of PCBs are higher in aquatic environments (lakes, rivers) than in terrestrial environments (soil). Because of their lipophilic tendency (having an affinity for fat tissue), they tend to readily accumulate in fish tissue. After ingesting contaminated fish, the human body absorbs the PCBs into the bloodstream and quickly removes them from the blood stream to be stored in body fat. The biological half-life (the time it takes for ½ of a substance that enters a body to be eliminated) of PCBs is approximately one year [4].

Exposure to PCBs generally occurs by inhalation or ingestion. PCBs in air can enter the lungs and pass into the bloodstream, but it is not known how fast or how much will enter into the blood. Contact with contaminated soil or sediments from where PCBs have been released into the environment can lead to exposure. The most common way for PCBs to enter the body is through ingestion of fish or meat containing PCBs.

Adverse Health Effects

High exposures of humans to PCBs will result in acne and rashes. Such occurrences are usually in an industrial workplace. Rats exposed to large amounts of PCBs for a short period of time had liver damage. Rats exposed to small amounts for several months had stomach and thyroid injuries, changes to their immune systems, and behavioral changes.

PCBs are not known to cause human birth defects. Pregnant women exposed to high amounts of PCBs, from the workplace or from eating fish with high PCBs had children with lower birth weight. The children had lessened motor skills and decreased immune systems. The most likely PCB exposure of infants is from breast milk which contains PCBs. However, the benefits of breast feeding outweigh the PCB risk from breast milk.

Most people already have PCBs in their body because PCBs are in the environment. Tests are available to determine if PCBs are in the blood, body fat, or breast milk. However, these tests are not routinely performed. The tests can show if PCB levels are elevated, which would indicate past exposure, but cannot identify where the PCBs came from or how long the exposure has been occurring. Once in the body the PCBs can change into other related chemicals called metabolites. Some of the metabolites can leave the body within a few days, but others can remain in the body fat.

Substances that are capable of causing cancer are known as carcinogens. There is limited, and therefore inadequate, evidence that PCBs are human carcinogens. However, there are sufficient studies and evidence that PCBs are carcinogenic to animals. The U.S. Department of Health and Human Services (DHHS), National Toxicology Program (NTP) view PCBs as being reasonably anticipated to be a human carcinogen. The U.S. EPA and the International Agency for Research on Cancer (IARC) believe PCBs are probably carcinogenic to humans.

In August 2007, DSHS SALG and the DSHS Environmental and Injury Epidemiology and Toxicology Branch staff evaluated the results from the 2005-2006 fish samples. The primary reason for evaluating these samples was to re-assess the potential risks to public health from consuming fish from the Donna Irrigation System, a body of water that has a long history of PCB contamination. The August 2007 DSHS report found that concentrations of PCBs in several species of fish from the site exceeded the noncancer and cancer HAC values for PCBs. Fish from the site contained no other contaminants at concentrations that would be expected to be of importance to human health if consumed over the long term or in large quantities. A complete description of the analysis and findings of the report is available in Appendix E.

Community Health Concerns Associated with the Donna Reservoir and Canal System site

As part of the public health assessment process, DSHS and ATSDR try to learn what health-related concerns people in the area might have about the site. Consequently, we actively gather information and comments from people who live or work near the site. During the site visits we spoke with local fishermen at the reservoir and canal. None indicated that they had health concerns that they would relate to the site.

We made additional attempts to collect community health concerns at an August 12, 2008 availability session that we attended with representatives from the EPA, USFWS, and TCEQ. At that session the NPL process, site status, fish removal, and public health issues were discussed. We explained the PHA process and queried citizens for any health concerns that they may have. We did not receive any health-related questions.

On August 29, 2008, we met with people from the local business community and provided them with information about the fishing ban. We also provided them with information on the potential health effects associated with exposure to PCBs. Community members stated they had health concerns about cancer risks and health risks for children. We also met with nurses, and nurse's aides, and office staff from local health clinics and pediatrician offices to provide them with literature, in English and Spanish, advising the public not to eat fish from the Donna Reservoir and Canal System.

DSHS staff went door to door in the community on July 27 - 30, 2009, to discuss the fish consumption ban and the potential risks associated with consuming fish from the site.

Health Outcome Data

Health outcome data record certain health conditions that occur in populations. These data can provide information on the general health of communities living near a hazardous waste site. They

also can provide information on patterns of specified health conditions. Some examples of health outcome databases are cancer registries, birth defects registries, and vital statistics. Information from local hospitals and other health care providers also can be used to investigate patterns of disease in a specific population. DSHS and ATSDR look at appropriate and available health outcome data when a completed exposure pathway or community concern exists. The Donna Reservoir and Canal System site covers a very large area and the fish eating population is not easily identified. Therefore, the nature of the exposure pathways associated with this site makes it difficult to isolate the exposures to a specific population; thus, health outcome data were not evaluated for this site.

Children's Health Considerations

In communities faced with air, water, or food contamination, children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. A child's lower body weight and higher intake rate result in a greater dose of hazardous substance per unit of body weight. Sufficient exposure levels during critical growth stages can result in permanent damage to the developing body systems of children. Children are dependent on adults for access to housing, for access to medical care, and for risk identification. Consequently, adults need as much information as possible to make informed decisions regarding their children's health. ATSDR and DSHS evaluated the likelihood for children to be exposed to the site contaminants at levels of health concern. Exposure of children to the PCB contaminants will most likely be from the consumption of fish taken from the Donna Reservoir and Canal System. DSHS tries to protect children from the possible negative effects of toxicants in fish by using exposure scenarios specific to children. Further, when considering the fish consumption pathway and when appropriate, DSHS recommends that this potentially sensitive subgroup consume smaller quantities of contaminated fish or shellfish than adults consume.

Conclusions

The analysis and conclusions reached in the DSHS August 2007 fish consumption risk report were based on the most recent DSHS fish sampling data and are pertinent to this PHA; thus, a reanalysis of the data was not warranted. DSHS and ATSDR reached two conclusions in this health assessment.

DSHS concluded that consumption of any of the sampled fish species from the Donna Irrigation System poses a public health hazard. All fish species sampled from the Donna Irrigation System contain PCBs at levels exceeding those concentrations used by the DSHS to ensure protection of public health from the adverse health effects associated with these contaminants. Systemic adverse health effects were considered to be the more sensitive endpoint in calculating the likelihood of adverse health outcomes from consuming contaminated fish or shellfish. Additionally, consumption of channel catfish, common carp, and smallmouth buffalo, which were heavily contaminated with PCBs, from the Donna Irrigation System, markedly increased the calculated excess lifetime risk of cancer in people who eat these fish.

DSHS concluded that cumulative adverse health effects from eating fish with multiple contaminants, taken from the Donna Irrigation System, are not likely. Fish from the Donna

Irrigation System do not contain concentrations of metal-like contaminants, VOCs, SVOCs, or organochlorine pesticides at concentrations that exceed the DSHS guidelines for protection of human health.

Recommendations

Based upon DSHS' and ATSDR's review of the Donna Reservoir and Canal System data and the concerns expressed by community members, the following recommendations are appropriate and protective of public health:

1. Until such time that the PCBs in the fish decrease to below levels of health concern or the removal action is successful and all fish are removed from the site, DSHS should continue Aquatic Life Order-9, banning the possession of fish from the Donna Irrigation System.
2. EPA and the TCEQ should continue to sample and analyze suspended sediments in the surface water of the Donna Reservoir and Canal System and continue their attempts to identify the source(s) of the PCB contamination.
3. Fish removal operations should continue as determined by the EPA.
4. DSHS SALG should continue periodic fish sampling in the Donna Reservoir and Canal System to monitor PCB concentrations in fish tissue.
5. DSHS and other state, federal, and local agencies should continue to educate the public regarding the fish possession ban and the potential health effects associated with eating fish from the Donna Reservoir and Canal System.
6. DSHS and ATSDR should review any additional environmental sampling data results as they become available.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by DSHS, ATSDR, and other government agencies at the site. The purpose of the public health action plan is to ensure that this public health assessment both identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, drinking, or touching hazardous substances in the environment. Included is a commitment on the part of DSHS and ATSDR to follow up on this plan to ensure that it is implemented.

Actions Completed

1. From 1994 to the present, DSHS has maintained a ban on the possession of any fish from the Donna Reservoir and Canal System due to PCB contamination.
2. The Donna Reservoir and Canal System site became finalized as a National Priorities List (NPL) site on March 19, 2008. Inclusion on the NPL allows federal funds and personnel to become available to further assess the nature and extent of the public health and environmental risks associated with the site.
3. The USFWS began removal of fish on August 11, 2008 from the Donna Main Canal. The area of operation included the main canal at the Rio Grande pump station and northward (downstream) to U. S. Highway 281.

4. The EPA conducted a public availability session on August 12, 2008 to provide community members with information about contamination of the Donna Reservoir and Canal System and the superfund process.
5. DSHS heightened awareness of the site by making several trips to the site in order to meet with Donna business people, nursing staff from local health clinics and pediatrician offices, local fishermen, and community members to discuss the fish ban, health effects of PCBs, and community health concerns involving the potential health risks associated with the site. Copies of literature, in English and Spanish, advising the public not to consume fish from the Donna Reservoir and Canal System were distributed.
6. In July 2009, DSHS staff assisted EPA with notifying citizens, living adjacent to the west canal of the Donna Reservoir that removal actions were going to begin in the west reservoir and canal. DSHS staff went door to door in the community to discuss the fish ban, health effects of PCBs, and community health concerns involving the potential health risks associated with consuming fish from the site. DSHS distributed 750 site specific fact sheets, both in English and in Spanish throughout the community.
7. In August 2009, the EPA and USFWS completed a year long removal of fish from the Donna Reservoir and Canal System. A total of 35,250 fish weighing 14,845 pounds (6,733 kg) were removed and disposed [15].

Actions Planned

1. This document will be made available to the community and local government officials for public comment. Comments received during the public comment period will be addressed by DSHS and ATSDR.
2. EPA will continue to work with other state and local authorities to continue with long-term management and removal of the contamination source. All collected fish will be properly disposed of.
3. DSHS plans to provide education about the contaminated fish in the Donna Reservoir and Canal System by working with local schools, civic organizations, and health care providers.

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Certification

This public health assessment for the Donna Reservoir and Canal System site located in Donna, Hidalgo County, Texas was prepared by the Texas Department of State Health Services (DSHS) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methods and procedures existing when the time the public health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.

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Alan Yarbrough
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Appendix A: Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
AL-9	Aquatic Life Order 9
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CREG	Cancer Risk Evaluation Guide
CSF	Cancer Slope Factor
CSL	Contaminant Screening Level
DHHS	United States Department of Health and Human Services
DRCS	Donna Reservoir and Canal System
DRV	Dose-Response Value
DSHS	Texas Department of State Health Services
e.g.	[*exempli gratia*] : for example
EMEG	Environmental Media Evaluation Guide
EPA	United States Environmental Protection Agency
ESL	Effects Screening Level
FM	Farm-to-Market road
FSAS	Fish Sampling Advisory Subcommittee
GI	Gastrointestinal
HAC	Health Assessment Comparison
HEAST	Health Effects Assessment Summary Table
HSDB	Hazardous Substance Data Bank
IARC	International Agency for Research on Cancer
i.e.	[*id est*] : that is
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDL	Method Detection Limit
µg/l	microgram per liter
$\mu g/m^3$	microgram per cubic meter
mg/kg	milligram per kilogram
mg/kg/day	milligram per kilogram per day
mm	millimeters
MRL	Minimal Risk Level
NLM	National Library of Medicine
NPL	National Priorities List
NTP	National Toxicology Program
ORNL	Oak Ridge National Laboratories
OSF	Oral Slope Factor
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PHA	Public Health Assessment
ppb	parts per billion
ppbv	parts per billion by volume
ppm	parts per million

PRP	Potentially Responsible Party
PWS	Public Water System
QA/QC	Quality Assurance/Quality Control
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act of 1976
REG	Risk Evaluation Guide
REL	Reference Exposure Level
RfC	Reference Concentration
RfD	Reference Dose
RMEG	Reference Dose Media Evaluation Guide
RSL	Regional Screening Level
SALG	Seafood and Aquatic Life Group
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SVOC	Semi-Volatile Organic Compound
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health (now called DSHS)
TNRCC	Texas Natural Resource Conservation Commission (now called TCEQ)
TSCC	Toxic Substances Coordinating Committee
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compound

Appendix B: The Public Health Assessment Process

The public health assessment process for NPL and other hazardous waste sites frequently involves the evaluation of multiple data sets. These data include available environmental data, exposure data, health effects data (including toxicologic, epidemiologic, medical, and health outcome data), and community health concerns.

Environmental Data

As the first step in the evaluation, ATSDR scientists review available environmental data to determine what contaminants are present in the various media to which people may be exposed (e.g., air, soil, sediment, dust, surface water, groundwater, vegetation, etc.) and at what concentrations. ATSDR generally does not collect its own environmental sampling data, but instead, reviews information provided by other federal or state agencies and/or their contractors, by individuals, or by potentially responsible parties (PRPs) [i.e., companies that may have generated the hazardous waste found at an NPL site, shippers that may have delivered hazardous waste to the site, and individuals or corporations that own (or owned) the property on which the site is located]. When the available environmental data is insufficient to make an informed decision about the public health hazard category of the site, the report will indicate what further sampling data is needed to fill the "data gaps."

Exposure Data

Pathway Analysis

The presence of hazardous chemical contaminants in the environment does not always mean that people who spend time in the area are likely to experience adverse health effects. Such effects are possible only when people in the area engage in activities that make it possible for a sufficient quantity of the hazardous chemicals to be transported into the body and absorbed into the bloodstream. This transport process is required in order for there to be a true exposure; thus, the assessment of real and potential exposures defines the real and potential health hazards of the site and drives the public health assessment process.

As the second step in the health assessment process, ATSDR scientists conduct an evaluation of the various site-specific pathways through which individuals may become truly exposed to site contaminants and be at risk for adverse health effects. Chemical toxicants can be transported into the body through the lungs, through the gastrointestinal (GI) tract, or directly through the skin by dermal absorption. People can be exposed to site contaminants by breathing air containing volatile or dust-borne contaminants, by eating or drinking food or water that contain contaminants from the site (or through hand-to-mouth activities with contaminated soil, dust, sediment, water, or sludge present on the hands), or by coming into direct skin-contact with contaminated soil, dust, sediment, water, or sludge resulting in dermal absorption of toxicants.

To conduct a pathways analysis ATSDR scientists review available information to determine whether people visiting the site or living nearby have been, currently are, or could be exposed (at some time in the future) to contaminants associated with this site. To determine whether people are exposed to site-related contaminants, investigators evaluate the environmental and human behavioral components leading to human exposure. The five elements of each exposure pathway that agency scientists evaluate are:

1) The contaminant source (i.e., the reservoir from which contaminants are being released to various media),
2) The environmental fate and transport of contaminants (i.e., how contaminants may dissipate, decay, or move from one medium to another,
3) The exposure point or area (i.e., the location(s) where people may come in physical contact with site contaminants),
4) The exposure route (i.e., the means by which contaminant gets into the body at the exposure point or area), and
5) The potentially exposed population (i.e., a group of people who may come in physical contact with site contaminants).

Exposure pathways can be **complete**, **potential**, or **eliminated**. For a person to be exposed to site contaminants, at least one exposure pathway for those contaminants must be complete. A pathway is **complete** when all five elements in the pathway are present and exposure has occurred, is occurring, or will occur in the future. If one or more of the five elements of a pathway is missing, but could become completed at some point in the future, the pathway is said to be a **potential** pathway. A pathway is eliminated if one or more of the elements are missing and there is no plausible way of it ever being completed, then the pathway has been **eliminated**.

Exposure Assessment Scenarios

After pathways have been evaluated, ATSDR scientists construct a number of plausible exposure scenarios, depicting a range of exposure possibilities, in order to determine whether people in the community have been (or might be) exposed to hazardous materials from the site at levels that are of potential public health concern. To do this, they must take into consideration the various contaminants, the media that have been contaminated, the site-specific and media-specific pathways through which people may be exposed, and the general accessibility to the site. In some cases, it is possible to determine that exposures have occurred or are likely to have occurred in the past. However, a lack of appropriate historical data often makes it difficult to quantify past exposures. If scientists determine that combined exposures from multiple pathways (or individual exposures from a single pathway) are posing a public health hazard, ATSDR makes recommendations for actions that will eliminate or significantly reduce the exposure(s) causing the threat to public health.

Health Effects Data

Even when chemical contaminants come into contact with the lungs, the GI tract, or the skin, adverse health effects may not occur if the contaminant is present in a form that is not readily absorbed into the bloodstream or it does not pass readily through the skin into the bloodstream. Since exposure does not always result in adverse health effects it is important evaluate whether the exposure could pose a hazard to people in the community or to people who visit the site. The factors that influence whether exposure to a contaminant or contaminants could potentially result in adverse health effects include:

- The toxicological properties of the contaminant (i.e., the toxicity or carcinogenicity),
- The manner in which the contaminant enters the body (i.e., the route of exposure),
- How often and how long the exposure occurs (i.e., frequency and duration of exposure),
- How much of the contaminant actually gets into the body (i.e., the delivered dose),
- Once in (or on) the body, how much gets into the bloodstream (i.e., the absorbed dose),
- The number of contaminants involved in the exposure (i.e., the synergistic or combined effects of multiple contaminants), and
- Individual host factors predisposing to susceptibility (i.e., characteristics such as age, sex, body weight, genetic background, health status, nutritional status, and lifestyle factors that may influence how an individual absorbs, distributes, metabolizes, and/or excretes the contaminants).

Thus, as the third step in the health assessment process (often done in conjunction with the pathway analysis and exposure assessment scenarios described above); ATSDR scientists review existing scientific information to evaluate the possible health effects that may result from exposures to site contaminants. This information frequently includes published studies from the medical, toxicologic, and/or epidemiologic literature, ATSDR's Toxicologic Profiles for the contaminants, EPA's online Integrated Risk Information System (IRIS) database, the National Library of Medicine's (NLM's) Hazardous Substance Data Bank (HSDB), published toxicology textbooks, or other reliable toxicology data sources.

Health Assessment Comparison (HAC) Values

To simplify the health assessment process, ATSDR, EPA, Oak Ridge National Laboratories (ORNL), and some of the individual states have compiled lists of chemical substances that have been evaluated in a consistent, scientific manner in order to derive toxicant doses (health guidelines) and/or toxicant concentrations (environmental guidelines), exposures to which, are confidently felt to be without significant risk of adverse health effects, even in sensitive sub-populations.

Health Guidelines

Health guidelines are derived from the toxicologic or epidemiologic literature with many uncertainty or safety factors applied to insure that they are amply protective of human health. They are generally derived for specific routes of exposure (e.g., inhalation, oral ingestion, or dermal absorption) and are expressed in terms of dose, with units of milligrams per kilogram per day (mg/kg/day).

Media-specific HAC values for non-cancer health effects under oral exposure routes are generally based on ATSDR's chronic oral minimal risk levels (MRLs) or EPA's oral reference doses (RfDs). Chronic oral MRLs and RfDs are based on the assumption that there is an identifiable exposure dose (with units of mg/kg/day) for individuals, including sensitive subpopulations (such as pregnant women, infants, children, the elderly, or individuals who are immunosuppressed), that is likely to be without appreciable risk for non-cancer health effects over a specified duration of exposure.

Environmental Guidelines

Environmental guidelines for specific media (e.g., air, soil/sediment, food, drinking water, etc.) are often derived from health guidelines after making certain assumptions about 1) the average quantities of the specific media that a person may assimilate into the body per day (i.e., inhale, eat, absorb through the skin, or drink) and 2) the person's average body weight during the exposure period. Environmental guidelines are expressed as chemical concentrations in a specific medium with units such as micrograms per cubic meter ($\mu g/m^3$), milligrams per kilogram (mg/kg), micrograms per liter (µg/L), parts per million (ppm), or parts per billion (ppb). If these values are based on ATSDR's oral MRLs, they are known as environmental media evaluation guides (EMEGs); if they are based on EPA's RfDs, they are called reference dose media evaluation guides (RMEGs).

For airborne contaminants, ATSDR health assessors frequently use ATSDR's inhalation minimal risk levels (inhalation MRLs) or EPA's inhalation reference concentrations (RfCs). Inhalation MRLs and RfCs are all based on the assumption that there is an identifiable exposure concentration in air [with units of $\mu g/m^3$ or parts per billion by volume (ppbv)] for individuals, including sensitive subpopulations (such as pregnant women, infants, children, the elderly, or individuals who are immunosuppressed), that is likely to be without appreciable risk for non-cancer health effects over a specified duration of exposure. Since it is already in the form of a concentration in a particular medium, the inhalation MRL is also called the EMEG for air exposures.

These environmental guidelines are frequently referred to as "screening values" or "comparison values" since the contaminant concentrations measured at a Superfund or other hazardous waste site are frequently "compared" to their respective environmental guidelines in order to screen for those substances that require a more in-depth evaluation. Since comparison values are health-based (i.e., derived so as to be protective of public health) and they are frequently employed in conducting public health assessments, they are frequently referred to as health assessment comparison values or HAC values.

Other HAC value names have been coined by the various EPA Regions or other state or federal agencies including EPA Regional Screening Levels (RSLs), EPA's health effects assessment summary tables (HEAST) "dose-response values" (DRVs), California's "reference exposure levels" (RELs), and Texas Commission on Environmental Quality's "effects screening levels" (ESLs). These values are occasionally used when there are no published MRLs, RfDs, or RfCs for a given contaminant.

HAC values for non-cancer effects (specifically ATSDR's oral and/or inhalation MRLs) may be available for up to three different exposure durations: acute (14 days or less), intermediate (15 to 365 days), or chronic (366 days or more). As yet, EPA calculates RfD or RfC HAC values only for chronic exposure durations.

HACs for Cancer Effects

When a substance has been identified as a carcinogen, the lowest available HAC value usually proves to be the cancer risk evaluation guide (CREG). For oral exposures, the CREG (with units of mg/kg or ppm) is based on EPA's chemical-specific cancer slope factor (CSF) (also referred to as oral slope factor or OSF) and represents the concentration that would result in a daily exposure dose (in mg/kg/day) that would produce a theoretical lifetime cancer risk of 1×10^{-6} (one additional cancer case in one million people exposed over a 70 year lifetime).

For inhalation exposures, the CREG (in $\mu g/m^3$) is based on the EPA's inhalation unit risk (IUR) value and is calculated as CREG = $10^{-6} \div$ IUR. The inhalation CREG represents the ambient air concentration that, if inhaled continuously over a lifetime, would produce a theoretical excess lifetime cancer risk of 1×10^{-6} (one additional cancer case in one million people exposed over a 70 year lifetime).

Imputed or Derived HAC Values

The science of environmental health and toxicology is still developing, and sometimes, scientific information on the health effects of a particular substance of concern is not available. In these cases, ATSDR scientists will occasionally look to a structurally similar compound, for which health effects data are available, and assume that similar health effects can reasonably be anticipated on the basis of their similar structures and properties. Occasionally, some of the contaminants of concern may have been evaluated for one exposure route (e.g., the oral route) but not for another route of concern (e.g., the inhalation route) at a particular NPL site or other location with potential air emissions. In these cases ATSDR scientists may do what is called a route-to-route extrapolation and calculate the inhalation RfD, which represents the air concentration (in $\mu g/m^3$) that would deliver the same dose (in mg/kg/day) to an individual as the published oral RfD for the substance. This calculation involves making certain assumptions about the individual's inhalation daily volume (in m^3/day), which represents the total volume of air inhaled in an average day, the individual's body weight (in kg), a similarity in the oral and inhalation absorption fraction, and – once the contaminant has been absorbed into the bloodstream – that it behaves similarly whether it came through the GI tract or the lungs. Because of all the assumptions, route-to-route extrapolations are employed only when there are no available HAC values for one of the likely routes of exposure at the site.

Use of HAC Values

When assessing the potential public health significance of the environmental sampling data collected at a contaminated site, the first step is to identify the various plausible site-specific pathways and routes of exposure based on the media that is contaminated (e.g., dust, soil, sediment, sludge, ambient air, groundwater, drinking water, food product, etc.). Once this is done, maximum values for measured contaminant concentrations are generally compared to the most conservative (i.e., lowest) published HAC value for each contaminant. If the maximum contaminant concentration is below the screening HAC value, then the contaminant is eliminated from further consideration, but if the maximum concentration exceeds the screening HAC, the contaminant is identified as requiring additional evaluation. However, since the screening HAC value is almost always based on a chronic exposure duration (or even a lifetime exposure duration, in the case of comparisons with CREG values) and the maximum contaminant concentration represents a single point in time (which would translate to an acute duration exposure), one cannot conclude that a single exceedance (or even several exceedances) of a HAC value constitutes evidence of a public health hazard. That conclusion can be reached only after it has been determined that peak concentrations are exceeding acute-exposure-duration HAC values, intermediate-term average concentrations are exceeding intermediate-exposure-duration HAC values, or long-term average concentrations are exceeding chronic-exposure-duration HAC values.

Community Health Concerns

If nearby residents are concerned about specific diseases in the community, or if ATSDR determines that harmful exposures are likely to have occurred in the past, health outcome data may be evaluated to see if illnesses are occurring at rates higher than expected and whether they plausibly could be associated with the hazardous chemicals released from the site. Health outcome data may include cancer incidence rates, cancer mortality rates, birth defect prevalence rates, or other information from state and local databases or health care providers. The results of health outcome data evaluations may be used to address community health concerns. However, since various disease incidence, mortality, and/or prevalence rates can (and do) fluctuate randomly over space and time, care must be taken not to attribute causality to a real or theoretical exposure possibility when rates are slightly higher than expected (any more than one would attribute a protective effect to an environmental exposure if disease rates were lower than expected).

ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the public comments that related to the public health assessment document are addressed in the final version of the report.

Conclusions

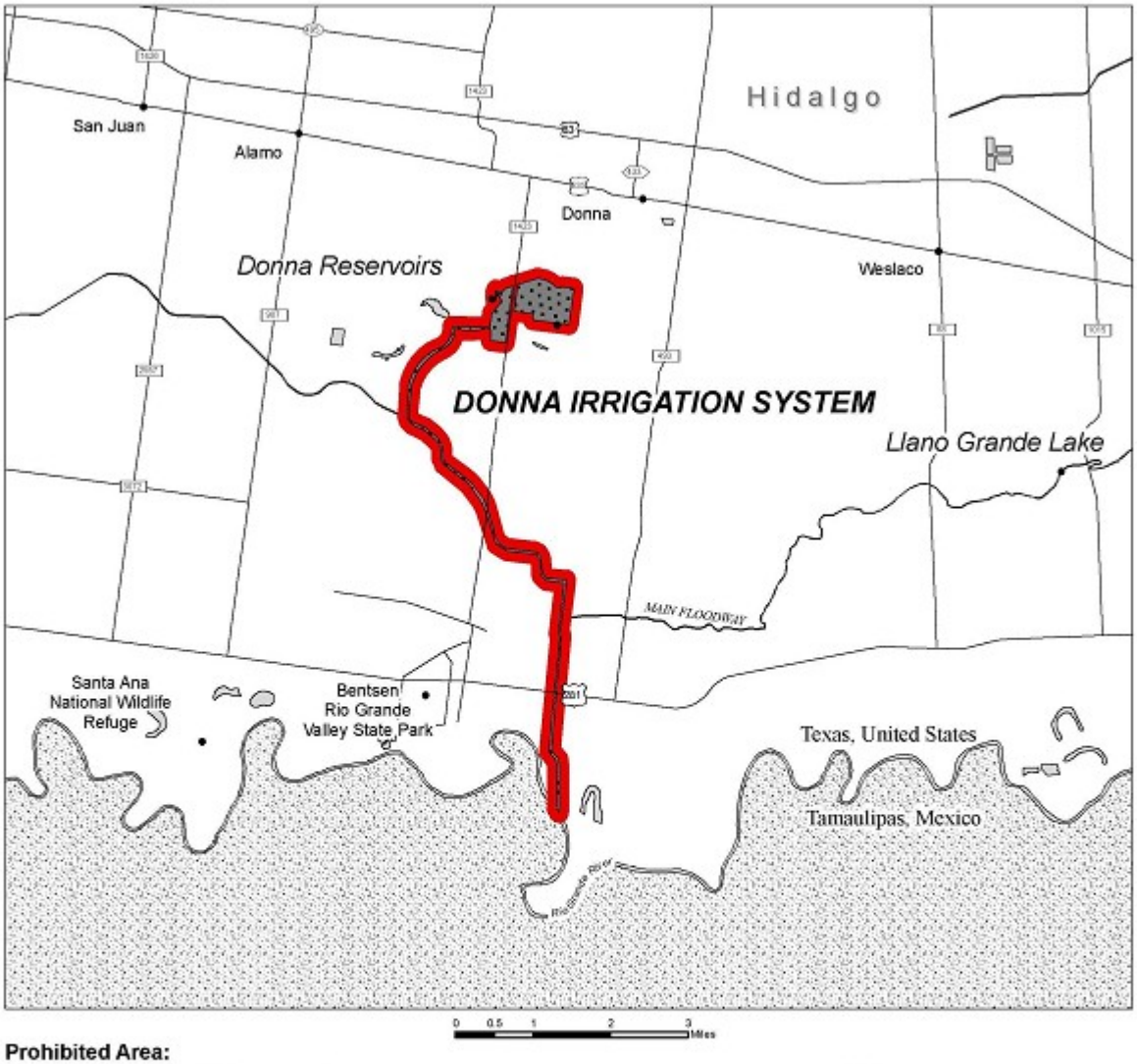
The public health assessment document presents conclusions about the nature and severity of the public health threat posed by the site. Conclusions take into consideration the environmental sampling data that have been collected, the available toxicologic data regarding the contaminants identified, the environmental media that are affected, and the potential pathways of exposure for the public. If health outcome data have been evaluated, conclusions are also presented regarding these data evaluations.

Recommendations

If the conclusions indicate that the site represents a public health hazard, the ATSDR will make recommendations to the state or federal environmental agencies regarding steps that can be taken to stop or reduce the exposures to the public. These steps are presented in the public health action plan for the site. However, if the public health threat is urgent, the ATSDR can issue a public health advisory, warning people of the danger. ATSDR can also recommend health education activities or initiate studies of health effects, full-scale epidemiology studies, exposure investigations, disease registries, disease surveillance studies, or research studies on specific hazardous substances.

Appendix C: Figures

Figure 1. Fish Ban of Donna Irrigation System.



Prohibited Area:
Donna Reservoir and interconnecting canal system

Contaminants of Concern:
Polychlorinated Biphenyls (PCBs)

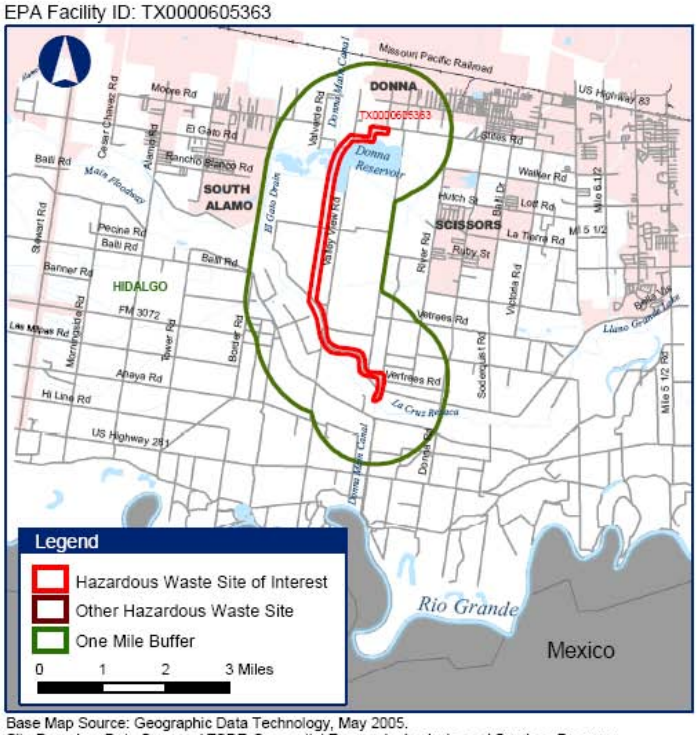
Restricted Species:
Persons are prohibited from possessing any species of fish from these waters.

Figure: Seafood and Aquatic Life Group, Texas Department of State Health Services

Figure 2. Site Location and Demographic Statistics.

Donna Reservoir and Canal System
Donna, TX

EPA Facility ID: TX0000605363



Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane Texas South FIPS 4205 Feet

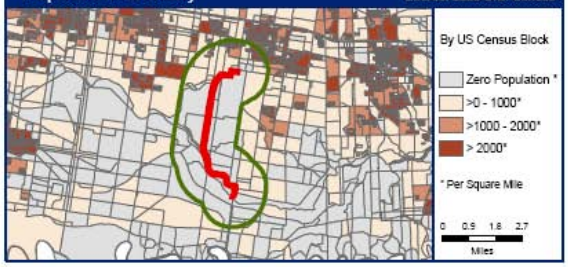
Site Location: Hidalgo County, TX

Demographic Statistics
Within One Mile of Site*

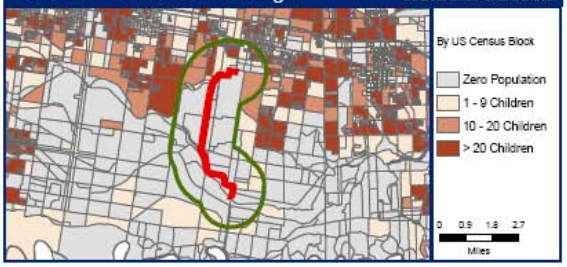
Total Population	3,917
White Alone	3,431
Black Alone	16
Am. Indian & Alaska Native Alone	21
Asian Alone	10
Native Hawaiian & Other Pacific Islander Alone	0
Some Other Race Alone	366
Two or More Races	72
Hispanic or Latino**	3,322
Children Aged 6 and Younger	516
Adults Aged 65 and Older	560
Females Aged 15 to 44	832
Total Housing Units	2,187

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

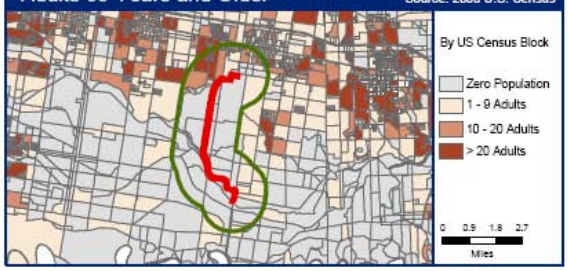
Population Density — Source: 2000 U.S. Census



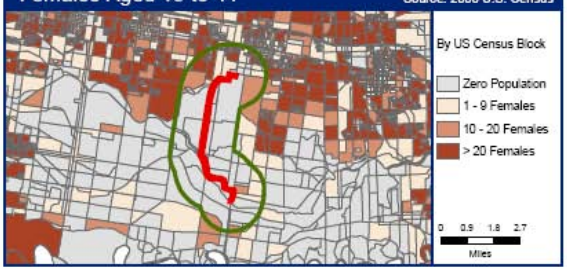
Children 6 Years and Younger — Source: 2000 U.S. Census



Adults 65 Years and Older — Source: 2000 U.S. Census



Females Aged 15 to 44 — Source: 2000 U.S. Census



<project=03229><userid=JXA0><geo=Hidalgo County, TX><keywords=TX0000605363, Donna, Reservoir>

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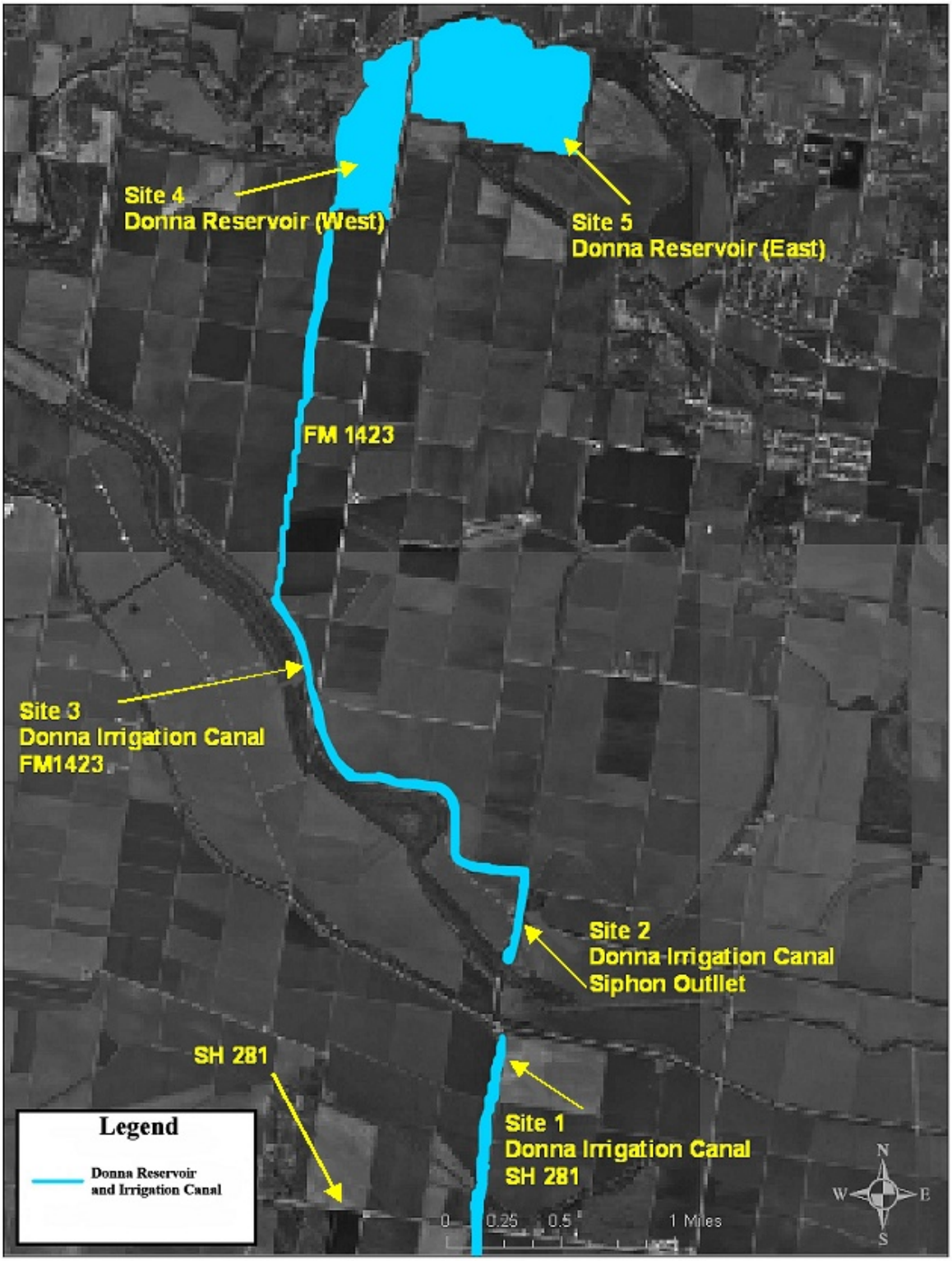
Figure 3. DSHS Fish Sampling - December 2005 - 2006



Adapted from Seafood and Aquatic Life Group, Texas Department of State Health

Appendix D: Tables

Table 1

Suspended Sediment Sampling Results
PCB (Aroclor 1254)
April 9-13, 2001

Sample Number	Result (ppb)	Sample Description
SS-01	nd	background - Main Canal - between Rio Grande pump station & US Hwy 281
SS-02	nd	background - duplicate of SS-01
SS-03	nd	background - Main Canal - between US Hwy 281 & Siphon entrance
SS-04	nd	background - Main Canal - between US Hwy 281 & Siphon entrance
SS-05	53	Main Canal - downstream (north) of the Siphon outlet
SS-06	24	duplicate of SS-05
SS-07	28	downstream (north) of SS-05, SS-06
SS-08	29	downstream (north) of SS-07 & south of bridge
SS-09	52	just past (west of) the 90° turn of the canal
SS-10	45	duplicate of SS-09
SS-11	47	at bridge on Valley View Road - (the road bisects the reservoirs)
SS-12	41	near entrance to West Reservoir
SS-13	41	re-lift pumping plant at West Reservoir
SS-14	15	crossover canal downstream of confluence with Upper West Canal
SS-15	24	duplicate of SS-14
SS-16	17	water intake to City of Donna Water Treatment Plant
SS-17	9.9	water intake to North Alamo Water Supply Plant #5

nd = not detected
ppb = parts per billion

Table 2.

Suspended Sediment Sampling of Donna Main Canal
PCB (Aroclor 1254)
February 1999 to April 2001

Date	#detected per total samples	results◈ (ppb)	general location
February 1999	0/4	nd	Rio Grand Pump house, Arroyo Colorado
		nd	Arroyo Colorado
		nd	Siphon inlet
		nd	Siphon outlet
July 1999	4/4	102	just past (west of) 90° bend
		42	downstream of 90° bend and prior to Valley View Road
		35	at Valley View Rd (FM 1423) bridge
		37	prior to entry into West Reservoir
January 2000	3/4	nd	Siphon inlet
		37	between Siphon outlet and bridge
		130	between bridge and 90° bend
		52	downstream from (west of) 90° bend
July 2000	8/8	12	Siphon outlet
		80, 56, 50, 25	east bank - between Siphon outlet and bridge south of 90° bend
		29, 26, 29	west bank - between Siphon outlet and bridge south of 90° bend
April 2001	9/9	53 -	east bank - between Siphon outlet and bridge
		23, 72, 54	east bank - between bridge and 90° bend
		11	west bank - between Siphon outlet and bridge
		80, 41, 35	west bank - between bridge and 90° bend
		77	downstream from (west of) 90° bend

◈ = results are listed in order from upstream (southward) to downstream (northward)
nd = not detected
ppb = parts per billion

Appendix E: Fish Consumption Risk Report - 2007

Characterization of Potential Adverse Health Effects Associated with Consuming Fish from the

DONNA IRRIGATION SYSTEM

Hidalgo County, TX

August 2007

Department of State Health Services
Austin, Texas
Seafood and Aquatic Life Group
Policy, Standards, and Quality Assurance Unit
Division for Regulatory Services
and the
Environmental and Injury Epidemiology and Toxicology Branch

INTRODUCTION

Description of the Donna Irrigation System and History of the Extant Possession Ban

The Donna Irrigation District reservoirs are located in the Hidalgo County, one of the Texas Rio Grande Valley counties directly bordering Mexico. The Donna District Reservoirs (Donna Irrigation System (DIS) Donna Reservoirs; Donna West and a larger Donna East) lie slightly southwest of the town of Donna, TX. The main canal winds its way south between County Roads 907 and 493 traveling for a distance with the main floodway. East of Bentsen Rio Grande Valley State Park, the canal crosses U.S. Highway 281, from which point the channel runs almost due south to empty into the Rio Grande a few miles south of U.S. Highway 281.[i]

The United States Environmental Protection Agency (USEPA) first detected PCBs in fish from the Donna Canal in 1993. In an environmental study of the Lower Rio Grande Valley of Texas, the agency sampled *cooked* fish from representative households in the valley, taking blood and urine from families who participated. Laboratory analyses of fish from this study revealed high concentrations of PCBs, with one carp – reportedly from the Donna Canal – containing 399 milligrams PCBs per kilogram tissue – some 1500 times the concentration that, if consumed, was thought to pose a hazard to human health. Blood from people who ate that particular fish contained excessive concentrations of PCBs. Upon receiving this information, the Texas Commissioner of Health informed the Seafood Safety Division of the Texas Department of Health (TDH). The SSD quickly confirmed the information and sent a collection team to the Donna Reservoir to sample fish. Fish collected by the TDH at that time contained high concentrations of PCBs consistent with Aroclor® 1248, 1254, and 1260.[ii],[iii] On February 9, 1994, consequent to this finding, the TDH issued Aquatic Life Order #9 (AL-9). AL-9 prohibited possession of any fish species from the DIS.[iv] Despite this possession ban, evidence abounds that the DIS remains a popular fishing spot for residents of Hidalgo County. For instance, in 2002, the USGS published a document with photographs of locals fishing outside the Donna Canal pump house and at the Donna Reservoir.[iii] Although the source of the PCBs in the DIS remains a mystery, in that document, the USGS outlined a 600-meter reach in the northernmost 90-degree curve of the canal, suspended sediment from which has the highest PCB concentrations identified in the system. From these data, the USGS proposed that 600-meter reach as likely to contain the source of PCBs in the DIS. Fish caught from this same area have historically contained high levels of PCBs.[iii]

The Seafood and Aquatic Life Group (SALG) of the Department of State Health Services (DSHS, formerly the Texas Department of Health) – with funding from the Total Maximum Daily Load (TMDL) Program of the Texas Commission on Environmental Quality (TCEQ) collected fish in 2005 and 2006 from the DIS (DIS). The analytical results from those fish form the basis for this report. The report, written some 13 years after AL-9 prohibited possession of fish from the DIS, describes results, presents conclusions from the study, addresses implications to public health from consumption of contaminated fish from the DIS, recommends public health actions, and supplies the TMDL Program with needed data. In the present study (2005-2006), DSHS again characterized PCB contamination in fish from the DIS. The 2005-2006 tissue data show that fish from the DIS continue to contain PCBs in excess of the health-related concentrations used by the DSHS to protect public health. Interestingly, PCBs in fish collected for this report from sites in the DIS

positively correlate with PCB concentrations in sediments from the same sites as measured by the USGS for PCBs.[iii]

The TMDL Program at the TCEQ and the Relationship between DSHS Consumption Advisories or Possession Bans and TMDLs

The TCEQ enforces federal and state laws that promote judicious use of water bodies under state jurisdiction and protects state-controlled water bodies from pollution. Pursuant to the federal Clean Water Act, Section 303(d),[v] all states must establish a "total maximum daily load" (TMDL) for each pollutant contributing to the impairment of a water body for one or more designated uses. A "TMDL" is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources, and including a margin of safety to ensure the usability of the water body for all designated purposes, accounting for seasonal variation in water quality. States, territories, and tribes define the uses for a specific water body (e.g., drinking water, contact recreation, aquatic life support [fish consumption] along with the scientific criteria designated to support each specified use). The Clean Water Act, section 303, which promulgates rules that promote water quality, orders the states to establish TMDLs and implementation plans for impaired waters.[v] Fish consumption is a recognized use for many waters. A water body is impaired if fish from that water body contain contaminants that make those fish unfit for human consumption or if consumption of those contaminants potentially could harm human health. Although a water body and its aquatic life may spontaneously clear toxicants over time with removal of the source(s), it is often necessary to institute some type of remediation such as those devised by the TMDL Program. Thus, when the DSHS prohibits possession of environmentally contaminated fish, the TMDL Program automatically places the water body on its current draft 303(d) List.[v] TMDL staff members then prepare a TMDL for each contaminant present at concentrations that, if consumed, would be capable of negatively affecting human health. Once the TMDLs are approved, the group prepares an Implementation Plan – a "remediation" plan, if you will – for each contaminant. Upon "implementation," these plans facilitate rehabilitation of the water body. Successful remediation should result in return of the water body to conditions compatible with all stated uses, including consumption of fish from the water body. When the DSHS lifts a possession ban, people may once again keep and consume fish from the water body. If fish in a water body are contaminated, one of the several items on an Implementation Plan for a water body on a state's 303(d) list might be the periodic reassessment of contaminant levels in fish. For the DIS, the TMDL Program does specify such periodic reassessments.

Demographics of Hidalgo County and the Likelihood of Subsistence Fishing in the Area of the Donna Irrigation System

The USEPA suggests that, along with ethnic characteristics and cultural practices of an area's population, the poverty rate could contribute to any determination of the rate of subsistence fishing in an area.[vi] In Hidalgo County, TX, the 2005 population was 671,967 people.[vii]. Of this population, 5,099 claimed Asian heritage or ethnicity. Of the 252,000+ people in the labor force, 12.6% were unemployed. The median household income in 2005 inflation-adjusted figures was $24,501. For the year 2005, 41% of people in Hidalgo County lived in poverty. Fifty-two percent of related children less than 18 years of age lived below the poverty level, while 29% of those 65 years or older lived below the poverty level. Thirty-six percent of all families and 55% of families

with a female householder (no husband present) had incomes below the poverty level. Of those people over 25 years of age, 42% had less than a 9th grade education but 58% had at least a high school diploma (or an equivalency). Fifteen percent had a bachelor's degree or higher. Of people in Hidalgo County with a mortgage, 46% pay more than 30% of their income for housing, leaving less money for other essentials such as food. Finally, about one in six individuals over five years of age claimed a disability, with the percentage increasing with increasing age.[viii] Disabilities affect income. All of these demographic variables may affect the likelihood of subsistence fishing. Why is it important to know whether and how many subsistence fishers are residents of the area? The USEPA and the DSHS believe it important to consider subsistence fishing as occurring at any water body because subsistence fishers (as well as recreational anglers and certain tribal and groups of certain ethnicities) may consume more locally caught fish than the general population. As shown by the above demographics, many Hidalgo County residents have characteristics of subsistence fishers. These groups sometimes harvest fish or shellfish from the same water body over many years to supplement caloric and protein intake. Should local water bodies contain chemically contaminated fish or shellfish, people who routinely eat fish from the water body or those who eat large quantities of fish from the same waters, could increase their risk of adverse health effects. The USEPA suggests that states assume that at least 10% of *licensed* fishers in any area are subsistence fishers. The DIS is a popular fishing "hole" for residents of the area. Subsistence fishing, while not explicitly documented by the DSHS, likely occurs along the Donna System. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the USEPA.[vi]

METHODS

Fish Sampling, Preparation, and Analysis

The DSHS SALG collects and analyzes edible fish from the state's public waters to evaluate potential risks to the health of people consuming contaminated fish or shellfish. Fish tissue sampling follows standard operating procedures from the DSHS *Seafood and Aquatic Life Group Survey Team Standard Operating Procedures and Quality Control/Assurance Manual*.[ix] The SALG bases its sampling and analysis protocols, in part, on procedures recommended by the USEPA in that agency's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1*.[x] Advice and direction are also received from the legislatively mandated *State of Texas Toxic Substances Coordinating Committee (TSCC) Fish Sampling Advisory Subcommittee (FSAS)*.[xi] Samples usually represent species, trophic levels, and legal-sized specimens available for consumption from a water body. When practical, the DSHS collects samples from two or more sites within a water body to better characterize geographical distributions of contaminants.

Fish Sampling Method and Description of the Donna Irrigation System 2005-2006 Sample Set

In December 2005 and January 2006, the field collection team from SALG collected 30 fish samples from sites along the DIS. That system includes two small reservoirs and a canal from which irrigation water is drawn. The SALG selected six sample sites to provide spatial coverage of the study area (Figure 1). Sites 1, 2, and 3 were in the canal proper. Sites 4 and 5 were in the reservoirs: Site 4 in the West Reservoir and Site 5 in the East Reservoir. Table 1 also shows exact latitudes and longitudes for each site.

The collection team targeted species for collection from the DIS through fish-tissue sampling protocols developed over many years by the SALG. Species collected represent two distinct ecological groups (i.e. predators and bottom-dwellers) that have some potential to bio-accumulate chemical contaminants, have a wide geographic distribution, are of local recreational fishing value, and/or which anglers and their families commonly consume. The 30 fish collected from the DIS in December 2005 and January 2006 represented all species targeted for collection from this water body. Table 1 presents date collected, sample number, species, collection site, length and weight of each sample. The table lists the samples by site: largemouth bass (12), common carp (10), smallmouth buffalo (3), freshwater drum (3), and channel catfish (2).

During each day of sampling, staff set gill nets in late afternoon and fished those overnight, collecting samples from the nets early the following morning. Gill nets were set to maximize available cover and habitat. SALG staff stored captured fish retrieved from the nets on wet ice until processed. The staff returned to the reservoir or canal system any remaining live fish culled from the catch. Staff also properly disposed of fish found dead in the gill nets.

The SALG utilized a boat-mounted electrofisher to collect fish. SALG staff conducted electrofishing activities during daylight hours, using pulsed direct current (Smith Root 5.0 GPP electrofishing system settings: 4.0-6.0 amps, 60 pulses per second [pps], low range 360 volts, 80% duty cycle) to stun fish that crossed the electric field in the water in front of the boat. Staff used dip nets over the bow of the boat to retrieve stunned fish, netting only fish pre-selected as target samples. Staff immediately stored retrieved samples on wet ice in large coolers to ensure interim preservation of tissues.

SALG staff processed fish from the DIS at the sites from which the samples came. Staff weighed each sample to the nearest gram on an electronic scale and measured total length (tip of nose to tip of tail fin) to the nearest millimeter. After weighing and measuring a fish, staff used a cutting board covered with aluminum foil and a fillet knife to prepare two skin-off fillets from each fish. The foil was changed and the filleting knife cleaned with distilled water after each sample was processed, after which the fillet(s) was wrapped in two layers of fresh aluminum foil, placed in an unused, clean, pre-labeled plastic freezer bag, and stored on wet ice in an insulated chest until further processing. At the end of each sampling trip, SALG staff transported tissue samples on wet ice to their Austin, TX, headquarters, where the samples were stored temporarily at -5° Fahrenheit (-20° Celsius) in a locked freezer. The freezer key is accessible only to authorized SALG staff members to ensure the chain of custody remains intact while samples are in the possession of agency staff. The week following each collection trip, frozen fish tissue samples were shipped by

commercial carrier (UPS next-day air) to the Geochemical and Environmental Research Group (GERG) Laboratory, Texas A&M University, College Station, TX, for contaminant analysis.

Analytical Laboratory Information

The GERG laboratory notified the SALG when samples from the DIS arrived. Upon receipt of the samples, the laboratory recorded the DSHS sample number – assigned by the collection team – and noted the condition of each fillet.

Utilizing USEPA-sanctioned methodology, the laboratory analyzed the 30 samples for common inorganic and organic contaminants, including seven metals – cadmium (Cd), copper (Cu), lead (Pb), selenium (Se), zinc (Zn), total arsenic (As), and total mercury (Hg). The GERG laboratory analyzed each fish for total (inorganic arsenic + organic arsenic = total As) arsenic. Although the proportions of each form of arsenic may differ among species, under different water conditions, and, perhaps, with other variables, the literature suggests that well over 90% of arsenic in fish is likely organic arsenic – a form that is virtually non-toxic to humans. Taking a conservative approach, DSHS estimates that 10% of arsenic in a fish is inorganic arsenic and derives estimates of inorganic arsenic concentrations by multiplying total arsenic concentration in each fish by a factor of 0.1.[xii] Virtually all mercury in upper trophic level fish three years of age or older is methylmercury.[v] Thus, total mercury concentration in a fish of legal size for possession in Texas serves well as a surrogate for methylmercury. Because methylmercury analyses are difficult to perform well and are more expensive than analysis of total mercury, the USEPA recommends that states determine total mercury concentration in a fish and that – to protect human health – states conservatively assume that all reported mercury in fish or shellfish is methylmercury. The GERG laboratory analyzed fish tissues for total mercury. In its risk characterizations, the DSHS may interchangeably utilize the terms “mercury”, “methylmercury”, or “organic mercury” to refer to methylmercury in fish.[xiii]

The laboratory analyzed tissues for several classes of pesticides such as organophosphates, organochlorines, and carbamates. The laboratory also analyzed 30 fish tissue samples for PCBs, while it analyzed five of the 30 for panels of semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs).

PCB Analyses and the Measurement of PCB Congeners instead of Aroclors

The GERG laboratory reports the presence and concentrations of 209 PCB congeners using detection limits that are, typically, around 1 µg/kg. Although only about 130 congeners existed in mixtures commonly used in the U.S. (Aroclors®), it may be useful to have measured all 209 congeners for examining the effects of “weathering” on the PCB mixture presumed originally disseminated.

Despite USEPA’s suggestion that the states analyze PCB congeners rather than Aroclor or homolog analyses, the toxicity literature does not reflect this state-of-the-art laboratory science. To handle this dilemma, DSHS empirically uses recommendations from the National Oceanic and Atmospheric Administration (NOAA)[xiv] and from McFarland and Clarke,[xv] along with the USEPA’s guidance documents for assessing contaminants in fish tissues[x,xvi] to address the toxicity

of PCB congeners in fish tissues, summing concentrations of 43 PCB congeners to derive a "total" PCB concentration. The DSHS averages the summed congeners to derive a mean PCB concentration. The authors of the preceding references utilized congeners for their likelihood of occurrence in fish, the likelihood of significant toxicity – based on structure-activity relationships – and for the relative environmental abundance of those congeners.[xiv,xv] Using only a few PCB congeners to determine "total PCBs" could underestimate PCB concentrations in fish tissue. Nonetheless, the above-described method complies with expert recommendations on evaluation of PCBs in fish. Therefore, SALG risk assessors compare average PCB concentrations with information in the USEPA's (Integrated Risk Information System) IRIS database.[xvii] IRIS currently contains systemic toxicity information for five Aroclor mixtures: Aroclor 1016, 1242, 1248, 1254, and 1260, as well as supplying one or more cancer potency factors (CPFs) – also known as slope factors (SFs) - for mixtures of PCBs, (not all information is available for all mixtures).[xvii] Systemic toxicity estimates in this document reflect comparisons with the Reference Dose (RfD) for Aroclor 1254 because IRIS contains an RfD for Aroclor 1254 but not for Aroclor 1260. As of yet, IRIS does not contain toxicity information on individual PCB congeners. Risk assessors may be unable to determine the originally-present Aroclor® mixture or whether the PCBs observed even originated from Aroclors® as U.S. companies used PCB mixtures imported from abroad as well as U.S.- produced PCBs. Additionally, airplanes and ships from foreign countries entered U.S. waters and may have discharged foreign-made PCB mixtures into U.S. portal waters.

Statistical Analysis

SALG risk assessors employed SPSS® statistical software, version 13.0 installed on IBM-compatible microcomputers (Dell, Inc) to generate descriptive statistics (mean, standard deviation, median, range, and minimum and maximum concentrations) on all measured compounds in each species of fish from each sample site.[xviii] SALG risk assessors utilized ½ the detection limit for all analytes not detected (ND) or estimated (J)2 concentrations in computing descriptive statistics. SALG risk assessors imported previously edited Excel data files into SPSS® to generate means, standard deviations, median concentrations, and minimum and maximum concentrations of each measured analyte. SALG used the descriptive statistical results to generate the present report. SALG protocols do not require hypothesis testing. Nevertheless, when data are of sufficient quantity and quality, and, should it be necessary, the SALG utilizes SPSS® software to determine significant differences in contaminant concentrations among species and/or collection sites. The SALG risk assessors did not test hypotheses on differences among species from the DIS because all samples contained PCBs, and most were above the HAC_{nonca}. The SALG employed Microsoft Excel® spreadsheets to generate figures, to compute health-based assessment comparison values (HAC_{nonca}) for contaminants, and to calculate hazard quotients (HQ), hazard indices (HI), cancer risk probabilities, and meal consumption limits for fish from the DIS.[xix] When lead data are of sufficient quality, concentration, and interest, the SALG utilizes the USEPA's Interactive Environmental Uptake Bio-Kinetic (IEUBK) model to determine whether consumption of lead-contaminated fish could cause children's blood lead (PbB) level to exceed the federally set 10 micrograms/deciliter.[xx]

2 "J-value" is standard laboratory nomenclature for analyte concentrations detected and reported, which reported concentration is an estimate, quantitation of which may be suspect and may not be reproducible. The DSHS treats J-Values as "not detected" in its statistical analyses of a sample set.

Derivation and Application of Health-Based Assessment Comparison Values (HAC_{nonca} or HAC_{ca})

The effects of exposure to any hazardous substance depend on the dose, the duration of exposure, the manner in which one is exposed, one's personal traits and habits, and whether other chemicals are present.[xxi] People who regularly consume contaminated fish or shellfish conceivably suffer repeated exposures to relatively low concentrations of contaminants over extended times. Such exposures are unlikely to result in acute toxicity but may increase risk of subtle, chronic, and/or delayed adverse health effects that include cancer, benign tumors, birth defects, infertility, blood disorders, brain damage, peripheral nerve damage, lung disease, and kidney disease, to name but a few.[xxi] Presuming people to eat a diet of diverse fish or shellfish from a water body if species variety is available, the DSHS routinely collapses data across species and sampling sites to evaluate mean contaminant concentrations of toxicants in all samples. This approach intuitively reflects consumers' likely exposure over time to contaminants in fish or shellfish from a water body, but may not reflect reality at a specific water body. The agency thus reserves the right to examine risks associated with ingestion of individual species of fish or shellfish from separate collection sites or at higher concentrations (e.g., the upper 95 percent confidence limit on the mean concentration. Confidence intervals are derived from Monte Carlo simulation techniques with software developed by Dr. Richard Beauchamp, of the DSHS).[xxii] The DSHS evaluates contaminants in fish by comparing the mean, and – when appropriate – the 95% upper confidence limit on the mean concentration of a contaminant to its HAC value (measured in milligrams of contaminant per kilogram of edible tissue – mg/kg) derived for non-cancer or cancer endpoints. To derive HAC values for systemic (HAC_{nonca}) effects, the department assumes a standard adult weighs 70 kilograms and that adults consume 30 grams of edible tissue per day (about one 8-ounce meal per week). The DSHS uses USEPA's oral RfDs[xxiii] or the Agency for Toxic Substances and Disease Registry's (ATSDR) chronic oral minimal risk levels (MRLs)[xxiv] to generate HAC values used in evaluating systemic (noncancerous) adverse health effects. The USEPA defines a contaminant's RfD as

> *An estimate of a daily oral exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime.*[xxv]

EPA also states that an RfD

> … *is derived from a BMDL* (benchmark dose lower confidence limit), *a NOAEL* (no observed adverse effect level*), a LOAEL* (lowest observed adverse effect level), *or another suitable point of departure, with uncertainty/variability factors applied to reflect limitations of the data used. [Durations include acute, short-term, subchronic, and chronic and are defined individually in this glossary]*" and "*RfDs are generally reserved for health effects thought to have a threshold or a low dose limit for producing effects.*[xxv]

The ATSDR uses a similar technique to derive MRLs.[xxiv] The DSHS compares the estimated daily dose (mg/kg/day) – derived from the mean of the measured concentrations of a contaminant – to the contaminant's RfD or MRL, using HQ methodology as suggested by the USEPA.

A HQ, defined by the EPA, is

> *…the ratio of the estimated exposure dose of a contaminant (mg/kg/day) to the contaminant's RfD or MRL (mg/kg/day).*[xxvi]

Note that a linear increase in the hazard quotients for a site or species usually does *not* represent a linear increase in the likelihood or severity of systemic adverse effects (i.e., a substance having an HQ of 2 is not twice as toxic as if the substance had an HQ of 1.0. Similarly, a substance with a HQ of 4 does not imply that adverse events will be four times more likely than a HQ of 1.0). As stated by the USEPA, a HQ (or an HI) of less than 1.0 "is no cause for concern, whereas an HQ (or HI) greater than 1.0 should indicate some cause for concern." Thus, risk managers at the DSHS utilize a HQ of 1.0 as a "jumping-off point," not for decisions concerning likelihood of occurrence of adverse systemic events, but as a point of departure for management decisions that assume, in a manner similar to EPA decisions, that fish or shellfish having a HQ of less than 1.0 are unlikely to be cause for concern. Since the chronic oral RfD derived by the USEPA represents chronic consumption, eating fish with a toxicant-to-RfD ratio (the HQ) of less than 1.0 is not likely to result in adverse health effects, whereas routine consumption of fish where the HQ for a specific chemical exceeds 1.0 represents a qualitatively unacceptable increase in the likelihood of systemic adverse health outcomes.

Although DSHS preferentially utilizes an RfD derived by federal scientists for each contaminant, should no RfD be available for a specific contaminant, the USEPA advises risk assessors to consider using an RfD determined for a contaminant of similar molecular structure, or mode or mechanism of action. For instance, DSHS – as specifically directed by the USEPA – uses the published reference dose for Aroclor 1254 to assess noncarcinogenic effects of Aroclor 1260, for which no reference dose is available – the USEPA has derived one other reference dose for Aroclors – that of Aroclor 1016. However, Aroclor 1016 is not as clearly like Aroclor 1260 as is Aroclor 1254. In the past, when DSHS had access only to the relatively crude measurement of Aroclors, the agency did not attempt to determine the dioxin equivalent toxicity of coplanar PCBs found in fish. The SALG recently adopted PCB congener analysis, as is suggested by the USEPA. This change in methodology allows the agency to identify coplanar or dioxin-like PCBs and to apply toxicity equivalency factors (TEFs) to PCBs in fish should SALG staff consider this a priority.

The constants (RfDs, MRLs) the DSHS employs to calculate HAC_{nonca} values are derived by federal agencies from the peer-reviewed literature (which the federal agencies routinely re-examine). These values incorporate built-in margins of safety called "uncertainty factors" or "safety factors" as mentioned in EPA reference materials.[xxv] In developing an oral RfD or MRL, federal scientists review the extant literature on the toxicant to determine an experimentally-derived NOAEL, a LOAEL, or, in some cases, a benchmark dose (BMD). Once the NOAEL, LOAEL, or BMD is determined, the scientist then utilizes uncertainty factors to minimize potential systemic adverse health effects in people exposed through consumption of contaminated materials. The uncertainty factors account for certain conditions that are undetermined by the experimental data. The classic four uncertainty factors are (1) extrapolation from animals to humans (interspecies variability), (2) intra-human variability, (3) using a subchronic study rather than a chronic study to determine the NOAEL, LOAEL, or BMD, (4) using a LOAEL instead of a

NOAEL to determine the RfD. Recently, a fifth uncertainty factor, (5) database insufficiencies for the toxicant, was added.[xxiii] Vulnerable groups – women who are pregnant or lactating, women who may become pregnant, the elderly, infants, children, people with chronic illnesses, those with compromised immune systems, or those who consume exceptionally large servings, collectively called "sensitivities" by the EPA, also receive special consideration in calculations of the RfD.[xxv, xxvii]

The SALG calculates cancer-risk comparison values (HAC_{ca}) from the EPA's CPFs – also known as SFs – derived through mathematical modeling of carcinogenicity studies. For carcinogenic outcomes, the DSHS calculates a theoretical lifetime excess risk of cancer for specific exposure scenarios for carcinogens, using a standard 70-kg body weight and assuming an adult consumes 30 grams of edible tissue per day. The SALG risk assessors incorporate two additional factors into determinations of theoretical lifetime excess cancer risk: (1) an acceptable lifetime risk level (ARL) [xxv] of one excess cancer case in 10,000 persons whose average daily exposure is equal and (2) daily exposure for 30 years. Comparison values used to assess the probability of cancer, thus, do not contain "uncertainty" factors as such. However, conclusions drawn from those probability determinations infer substantial safety margins for all people by virtue of the models utilized to derive the slope factors (cancer potency factors). For instance, the USEPA suggests the use of a tiered approach to determine the potency of PCB mixtures to cause cancer in exposed individuals. This approach depends on information available from the IRIS database.[xvii] Three tiers of carcinogen slope factors (SFs) used to assess the impact of environmental PCBs exist. The first tier, with an upper bound slope factor of 2.0 and a central tendency slope factor of 1.0, is used for PCBs with "high risk and persistence." Criteria for using this most restrictive slope factor include (1) exposure via food, (2) ingestion of sediment or soil, (3) inhalation of dust or aerosols (4) dermal exposure – if an absorption factor was applied – (5) the presence of dioxin-like, tumor-promoting, or persistent PCB congeners, and, perhaps most importantly, (6) the possibility of early-life exposure. Because the potential implications of early-life exposures include factors such as possibly greater perinatal sensitivity, or the likelihood of interactions between PCBs and normal functions (such as PCB-mediated depletion of thyroid hormones, an effect that can result in irreparable damage to the developing brain) of development, the USEPA concludes that early-life exposures may be associated with increased risks.[xvii] The DSHS, in agreement with the federal agency, utilizes the upper bound slope factor of the "high risk" tier for all exposures to PCBs in fish.

The calculated comparison values (HAC_{nonca} and HAC_{ca}) are quite conservative, so adverse systemic or carcinogenic health effects are unlikely to occur, even if exposures are consistently greater or last longer than those used to calculate comparison values. Moreover, comparison values for adverse health effects (systemic or carcinogenic) do not represent sharp dividing lines (bright-line divisions) between safe and unsafe exposures. The *perceived* strict demarcation between acceptable and unacceptable exposures or risks is primarily a tool to assist risk managers to make decisions that ensure protection of the public's health. For instance, the DSHS considers it unacceptable when consumption of four or fewer meals per month of contaminated fish or shellfish would result in exposure to contaminant(s) in excess of a HAC value or other measure of risk even though most such exposures are unlikely to result in adverse health effects. The department further advises people who wish to minimize exposure to contaminants in fish or shellfish to eat a variety of fish and/or shellfish and to limit consumption of those species most

likely to contain toxic contaminants. DSHS aims to protect vulnerable subpopulations with its consumption advice. The DSHS assumes that advice protective of vulnerable subgroups will also minimize the impact to the general population of consuming contaminated fish or shellfish.

Children's Health Considerations

The DSHS recognizes that fetuses, infants, and children may be uniquely susceptible to the effects of toxic chemicals and suggests that exceptional susceptibilities demand special attention. [xxviii, xxix] Windows of special vulnerability; known as "critical developmental periods," exist during development. Critical periods occur particularly during early gestation (weeks 0 through 8), but can occur at any time during pregnancy, infancy, childhood, or adolescence – indeed, at any time during development – times when toxicants can impair or alter the structure or function of susceptible systems.[xxx] Unique early sensitivities may exist because organs and body systems are structurally or functionally immature – even at birth – continuing to develop throughout infancy, childhood, and adolescence. Developmental variables may influence the mechanisms or rates of absorption, metabolism, storage, or excretion of toxicants, any of which factors could alter the concentration of biologically effective toxicant at the target organ(s) or that could modulate target organ response to the toxicant. Children's exposures to toxicants may be more extensive than adults' exposures because, in proportion to their body weights, children consume more food and liquids than adults do, another factor that might alter the concentration of toxicant at the target. Infants can ingest toxicants through breast milk – an exposure pathway that often goes unrecognized (nonetheless, the advantages of breastfeeding outweigh the probability of significant exposure to infants through breast milk. Women are encouraged to continue breastfeeding and to limit exposure of their infants by limiting intake of the contaminated foodstuff). Children's behaviors (i.e., hand to mouth behaviors) might expose them to more toxicants or higher concentrations of a toxicant than adults.[xxxi]Children may experience effects at a lower exposure dose than might adults because children's organs may be more sensitive to the effects of toxicants. Stated differently, children's systems could respond more extensively or with greater severity to a given dose than would an adult organ exposed to an equivalent dose of a toxicant. Children could be more prone to developing certain cancers from chemical exposures than are adults.[xxxii] In any case, if a chemical – or a class of chemicals – is observed to be – or is thought to be – more toxic to the fetus, infants, or children than to adults, the constants (e.g., RfD, MRL, or CPF) are usually further modified to assure protection of the immature system's potentially greater susceptibility.[xxiii] Additionally, in accordance with the ATSDR's *Child Health Initiative*[xxxiii] and the USEPA's *National Agenda to Protect Children's Health from Environmental Threats,*[xxxiv] (In recognition of the possibly greater vulnerability of children to harmful substances, USEPA has established the Office of Children's Health Protection (OCHP). The OCHP ensures that all standards set by USEPA will protect children from any heightened risks and that newly developed policies address children's health concerns)[xxxv]the DSHS further seeks to protect children from the possible negative effects of toxicants in fish by suggesting that this potentially sensitive subgroup consume smaller quantities of contaminated fish or shellfish than adults consume. Thus, DSHS recommends that children weighing 35 kg or less and/or who are 11 years of age or younger limit exposure to contaminants in fish or shellfish by eating no more than four ounces per meal of the contaminated species. The DSHS also recommends that consumers spread these meals over time. For instance, if the DSHS issues consumption advice that suggests consumption of no more than two meals per month of a contaminated species, those children should eat no more than 24 meals of the

contaminated fish or shellfish per year and, ideally, should not eat such fish or shellfish more than twice per month.

RESULTS

Laboratory Analytical Results

The GERG laboratory submitted electronic copies of the analytical results on fish from the DIS (Donna Canal and Donna Reservoir) to the SALG between December 2005 and February 2006. As SALG requested, the laboratory analyzed 30 fish for pesticides, metal-like constituents and for PCBs. The laboratory reported data for VOCs and SVOCs measured in five samples. Information about the samples is presented in Table 1.

Inorganic Contaminants

Arsenic, Cadmium, Copper, Mercury, Lead, Selenium, Zinc

Samples from the DIS contained no detectable arsenic or cadmium (data not shown). Inorganic contaminants present at measurable levels in one or more fish from the DIS included copper, mercury, lead, selenium, and zinc (Table 2). Six of 30 fish contained some level of lead. Four fish contained measurable quantities of lead; two contained estimated concentrations. The remaining 24 fish were reported only as “less than the reporting limit” for the sample.

The laboratory reported mercury in 30 fish tissues (Table 2). The average mercury concentration in all fish combined was 0.229±0.112 mg/kg. The highest mercury value in the sample data set was 0.467 mg/kg (Table 2). One sample contained an estimated concentration of mercury (a J-value).

Copper, selenium, and zinc are all essential nutrients. Thirty of 30 samples contained copper. The mean copper concentration for all fish was 0.271±0.258 mg/kg. The minimum concentration of copper (reported below the detection limit as a J-value) was 0.041 mg/kg and the maximum concentration was.0.916 mg/kg. Selenium and zinc were present in all fish, as is often observed (Table 2). Average selenium concentration across all fish was 0.547±0.135 mg/kg, ranging from 0.268-0.931mg/kg (Table 2). The mean zinc concentration was 5.766±2.601 mg/kg with a spread of 2.364 to 13.261 mg/kg (Table 2).

Organic Contaminants

The GERG laboratory analyzed 30 fish tissue samples from the DIS for commonplace and/or legacy pesticides and PCBs. The laboratory also analyzed five of the samples for SVOCs and VOCs.

Pesticides

The laboratory analyzed fish tissue from the DIS for 34 pesticides representing legacy and/or major pesticide groups such as organochlorines, organophosphates, and carbamates. The following pesticides were observed at some levels in one or more fish.

Organophosphates were reported present in fish from the DIS. All but one sample from the 2005-2006 DIS dataset contained trace quantities of 4,4′-DDD; 22 samples had estimated concentrations (J-values) below the laboratory's reporting limit. Seven fish had measurable concentrations of 4,4'-DDD. One sample contained no detectable 4,4'-DDD. All samples contained 4,4'-DDE (minimum value to maximum value = 0.005 mg/kg-1.432 mg/kg). Four samples contained 4,4'-DDT, two at estimated (J-value) concentrations and two as measured concentrations. Other samples (26 fish) did not contain detectable 4,4'-DDT, according to the laboratory report. 2,4'-DDD, DDE, and DDT were present in a number of samples but are not addressed in this report because EPA has not established RfDs or cancer slope factors for these isomers of DDT, it's metabolites, or breakdown products. The procedural blanks revealed no 4,4'-DDT, 4,4'-DDE, or 4,4'-DDT.

Measurable concentrations of chlordane were reported present in seven samples (0.014 mg/kg± 0.021 mg/kg). Fourteen samples contained chlordane at detectable concentrations below the analytical method detection limit (MDL). Nine samples had detectable, but not quantifiable chlordane (reported only as < the MDL). The laboratory does not utilize chlordane in its quality control (QC) procedure.

Three fish tissues contained estimated concentrations of the organochlorine pesticide chlorpyrifos. One sample had a measurable 0.0146 mg/kg chlorpyrifos. Twenty-six samples contained chlorpyrifos at some concentration below the laboratory MDL.

Another organochlorine, dacthal, was also present in fish from the DIS. All 30 samples contained some level of dacthal. Twenty samples contained estimated (J-values) of dacthal, while ten samples contained measurable concentrations of Dacthal (0.015±0.024 mg/kg, ranging from 0.0012 to 0.062 mg/kg). Twenty samples contained Dacthal at levels below the laboratory's reporting limit.

One sample (DIC15, a common carp) contained traces of 1,2,3,4-tetrachlorobenzene and 1,2,3,5-tetrahlorobenzene. The laboratory reported no other pesticides in any sample from the DIS.

Volatile Organic Compounds (VOCs)

Four of five fish tested for VOCs contained acetone at levels below the laboratory's MDL; one fish, a common carp contained a quantifiable level of acetone (5.22 mg/kg; MDL = 0.200 mg/kg). Four of five samples contained quantifiable methylene chloride. Although the reporting limit for methylene chloride is 0.050 mg/kg, these levels were around 0.032 mg/kg – below the MDL. One fish contained an estimated concentration of a magnitude similar to those reported as firm measurements. A single fish contained a trace of benzene (0.001 mg/kg, MDL=0.020 mg/kg). Toluene was present at estimated levels (below the MDL) in four fish. All five fish contained naphthalene, three at levels above the MDL (0.020 mg/kg).The average concentration of naphthalene in the five fish was 0.031 mg/kg However, acetone, methylene chloride, and naphthalene were also identified in the procedural blanks, an indication, perhaps, of handling or laboratory contamination. When these contaminants were identified in the samples, they were usually equal to, or higher than those of the procedural blank were. It is possible these contaminants could have been byproducts of sample necrosis (data not presented).

Semi-volatile Organic Compounds (SVOCs)

No SVOCs were present in any fish at levels above the laboratory's MDL, although some SVOCs occurred sporadically at levels below the MDLs. All five fish contained one or more phthalate esters: diethylphthalate, di-n-butyl phthalate, and/or di-(2-ethylhexyl) phthalate, albeit at low levels. The procedural blank contained all three phthalates at levels similar to or higher than the samples. Three fish contained traces of dibenz(a,h)anthracene. The procedural blank contained this substance at a level higher than the sample concentrations. One fish also contained a trace of 3-methylcholanthrene, as did the procedural blank. Both compounds are polycyclic aromatic hydrocarbons (PAHs), common sources of which include asphalt sealers, shampoos, medications, roofing materials, and other tar-like materials. Finally, four fish contained marginal levels of phenol (estimated concentrations below the MDL for phenol). The laboratory reported no phenol in the procedural blank. The authors did not present data for these sporadic and low SVOCs.

Polychlorinated Biphenyls (PCBs)

For the DIS, the present study marks the first analysis of PCB congeners instead of analysis of samples for Aroclors®. Thus, the reader should not compare PCB levels among this and previous risk characterizations for the DIS. As described in the methods section, the survey team collected fish for PCBs from five sites within the DIS: Three sites were within the canal system and two were within Donna Reservoirs, one in the West Reservoir and one in the East Reservoir.

Representatives of five fish species were collected from five sites within the DIS. Survey staff did not collect all species from each site. Table 3 presents PCB concentration in each species at each site. Table 3 also gives the average concentration of PCBs at each site. SALG staff noted that the highest PCB concentrations tended to cluster about Canal Site 2. Canal Sites 1 and 3, Reservoir West Site 4, and Reservoir East Site 5 had much lower concentrations of PCBs than did Canal Site 2.

The PCB data from this site could be further partitioned to illustrate species at each site contained the highest PCB concentrations. Risk assessors cannot know a person is fishing sites or how many different species a fisher might collect from each site. However, most species at each site contained some level of PCBs. Therefore, any fisher could choose to eat any number of species from any site recently sampled. Nonetheless, visual inspection of the data suggested that PCBs were at their highest concentrations in fish collected near Canal Site 2, with a gradient in both directions from this site. Canal Site 1, closest to the Rio Grande, has the lowest average concentration of PCBs. The gradient is as follows- from highest PCB concentrations to lowest: Canal Site 2 > Canal Site 3 > Reservoir Site 4 >Reservoir Site 5> Canal Site 1.

Assuming fish containing the highest concentrations of PCB to have accumulated those PCBs from areas having the highest PCB concentrations in dissolved solids, [iii] the partitioned data could assist the USGS [iii] and other agencies to definitively locate the elusive source of PCBs in the DIS.

DISCUSSION

Risk Characterization

The actual risk of adverse health outcomes from exposure to toxicants based on experimental or epidemiological data is subject to the known variability of individual and population responses. Thus, calculated risks can be orders of magnitude above or below the actual risks of systemic or local effects of toxicants. The variability depends upon many factors: the target organ; the species of animal used in the study; different exposure periods; different doses; or other variations in conditions.[xxiii] Nevertheless, the DSHS calculated a number of risk parameters for potential toxicity to humans who consume contaminated fish from the DIS. Conclusions and recommendations predicated upon the stated goal of the DSHS to protect human health follow this discussion of findings.

Characterization of Possible Systemic (Noncancerous) Health Effects Related to Consumption of Fish from the Donna Irrigation System

The RfD for PCBs – the primary contaminant of concern in the DIS – comes from the findings of ocular exudates, inflamed and prominent Meibomian glands, distorted growth of finger and toenails, decreased antibody (IgG and IgM) response to sheep erythrocytes in clinical and immunologic studies conducted in monkeys.[xxxvi] The LOAEL was 0.005 mg/kg-day. Researchers applied several uncertainty factors: a full factor of 10 for intra-human variability (sensitive subgroups), a factor of three to account for extrapolation to humans from monkeys. To account for use of a subchronic study (approximately 25% of the animal's life); an uncertainty factor (UF) of three was used. Risk assessors at the federal level used a minimal LOAEL to determine the RfD, using a partial uncertainty factor of approximately 3.3. The composite uncertainty factor was 300. The modifying factor was 1.0. To calculate the RfD for Aroclor 1254, use the following:

$$RfD = LOAEL \div UFs * MF$$

Therefore, the RfD for Aroclor 1254 is

$$0.005 \div 300 * 1.0 = 0.00002 \text{ mg/kg-day (2E-05 mg/kg-day).}$$

Using the SALG's assumptions, the HAC_{nonca} for systemic effects for Aroclor 1254 is 0.047 mg/kg (mg Aroclor per kg of edible tissue). Risk assessors derive hazard quotients from the toxic substance's RfD or MRL and that substance's measured concentration in tissue, as described earlier. Table 4 contains hazard quotients for each species of fish examined at the DIS. Since PCBs were the only contaminants of concern in fish collected in 2005 from the DIS to exceed a HAC value, the HQs in Table 4 refer only to PCBs. Even though one cannot assume a linear relationship for HQs, one observes from this table that HQs are greater than 1.0 by a large margin for some fish (smallmouth buffalo, channel catfish, and common carp), while for others (largemouth bass, freshwater drum) the margin is not so different from 1.0. Nonetheless, all HQs are greater than 1.0, suggesting that all species from this reservoir have some potential to harm those who regularly consume fish from the DIS. The DSHS interprets this table as evidence of a continuing danger to those who regularly eat fish from the DIS and for continuing the possession ban in force for this water body.

Characterization of Excess Lifetime Cancer Risk from Consumption of Fish from the Donna Irrigation System

Table 5 outlines the probability of cancer from regular, long-term, or, perhaps, repeatedly large meals of one or more fish species collected from the DIS, containing the calculated probability of one excess cancer in X number of people exposed to PCBs in different species of fish from the DIS. The probability that DSHS utilizes to make risk management decisions about fish or shellfish contaminated with chemicals that have carcinogenic potential is 1 excess cancer in 10,000 equally exposed people. Only largemouth bass and freshwater drum do not exceed a 1 in 10,000 calculated theoretical lifetime risk of cancer (Table 5). This finding indicates that three fish species from the DIS contain PCBs at concentrations that may be capable of causing or contributing to cancer in people who regularly consume these fish. Although two species that do not exceed the cancer risk level used by the DSHS to ensure protection of public health (largemouth bass and freshwater drum), these species may already pose a hazard to health from the noncarcinogenic or systemic effects of long-term, low-level consumption of PCBs present in these fish.

Characterization of Cumulative Systemic Health Effects and Cumulative Excess Lifetime Cancer Risk from Consumption of Fish from the Donna Irrigation System

Because only one contaminant (PCBs) occurred in fish from the DIS at concentrations approaching or exceeding DSHS' health-based guidelines for protection of human health, the SALG determined it neither necessary nor possible to accurately predict or determine cumulative effects from consuming multiple chemicals in one or more species of fish from the DIS. If more than one contaminant of concern acting on the same target organ, by the same mode or mechanism of action, or that caused cancer had reached biological or toxicological significance, SALG risk assessors would have discussed those cumulative effects in this document.

CONCLUSIONS

SALG risk assessors prepare risk characterizations to determine public health hazards from consumption of fish and shellfish harvested from Texas water bodies by recreational or subsistence fishers, and – if indicated – may suggest strategies for reducing risk to the health of those who eat contaminated fish or seafood to risk managers at DSHS, including the Texas Commissioner of Health.

The primary reason for conducting this study was to re-assess the potential risks to public health from consuming fish from the DIS, a body of water that has a long history of PCB contamination, only one example of which is PCB-contaminated fish. Risk assessors from the SALG and the Environmental and Injury Epidemiology and Toxicology Branch (EIETB) confirmed that PCBs in several species from the DIS exceed the HAC_{nonca} or the HAC_{ca} for PCBs. All samples contained some PCBs. Fish from the DIS contained no other contaminants at concentrations that would be expected to be of importance to human health if consumed over the long term or in large quantities. Thus, risk assessors from the SALG and the EIETB conclude from this characterization of risks possibly associated with consuming fish from the DIS

1. That all fish sampled species from the DIS contain PCBs at levels exceeding those concentrations used by the DSHS to ensure protection of public health from adverse systemic health effects of these contaminants. Although some species from some sites appear not to contain high concentrations of PCBs, this finding is not consistent, meaning the fish could previously been in waters the sediment of which were heavily contaminated with PCBs, having lately traveled to the collection site. Therefore, consumption of any of the sampled fish species and, presumably all fish species from the DIS continues to **pose an apparent hazard to human health,** systemic adverse health effects being the more sensitive endpoint in the SALG calculations of the likelihood of adverse health outcomes from consuming contaminated fish or shellfish. Additionally, consumption of channel catfish, common carp, and smallmouth buffalo from the DIS, heavily contaminated with PCBs, markedly increases the calculated lifetime excess risk of cancer in people eating these fish.

2. That cumulative adverse health effects from consuming fish from the DIS are not likely. Fish from the DIS do not contain concentrations of metal-like contaminants, VOCs, or SVOCs at concentrations in excess of DSHS guidelines for protection of human health. In fact, with the exception of metallic contaminants – which frequently were present in low, presumably nontoxic concentrations – contaminants of other chemical classes were present only sporadically and in low concentrations. Therefore, consumption of fish containing these compounds in addition to PCBs should not increase the risk to human health already posed by the PCBs. To reiterate: metalloid contaminants, VOCs and SVOCs observed in fish from the DIS are not likely to **pose no apparent human health hazard**, even when consumed along with PCBs in fish from the DIS.

3. That fish from the DIS do not appear to contain organochlorine pesticides at concentrations of significance to human health. Therefore, consumption of fish containing only these pesticides at levels observed in sample tissues – were that possible – would **pose no apparent human health hazard.**

RECOMMENDATIONS

Risk managers at the DSHS have established criteria for issuing fish consumption advisories based on approaches suggested by the USEPA.[x, xvi] If a risk characterization confirms that people can eat four, or fewer than four, meals per month (adults: eight ounces per meal; children: four ounces per meal) of fish or shellfish from the water body under investigation could lead risk managers at DSHS to recommend consumption advice for fish or shellfish from that water body. Alternatively, the department may ban possession of fish from the affected water body. Fish or shellfish possession bans are enforceable under subchapter D of the Texas Health and Safety Code, part 436.061(a).[xxxvii]. Declarations of prohibited harvesting areas are enforceable under the Texas Health and Safety Code, Subchapter D, parts 436.091 and 436.101.[xxxvii] DSHS consumption advice carries no penalty for noncompliance. Consumption advisories, instead, inform the public of potential health hazards from consuming contaminated fish or shellfish from Texas waters. With this information, members of the public can make informed decisions about whether – and how much – contaminated fish or shellfish they wish to consume. Risk assessors from the SALG and the EIETB conclude from this risk characterization that consuming fish from the DIS apparently **poses a continuing public health hazard**. Based on these observations, the SALG and the EIETB recommend

1. That the DSHS continues to enforce AL-9 – which bans possession of fish from the DIS and that is currently in force for this water body because every sampled fish species contained PCBs in concentrations that could increase the likelihood of experiencing adverse systemic health outcomes. Additionally, several sampled species contained PCBs at concentrations high enough to increase the theoretical lifetime excess risk of cancer if eaten regularly or in bulk.

2. That the DSHS continues to monitor fish from the DIS for PCBs until these contaminants decrease to a level, consumption of which would likely not interfere with the health of those consuming such fish.

3. That the DSHS analyze fish from the DIS for dioxins and furans.

PUBLIC HEALTH ACTION PLAN

Communication to the public of new and continuing possession bans or consumption advisories – or the removal of either – are essential to effective management of risk from consuming contaminated fish. In fulfillment of the responsibility for communication, the Texas Department of State Health Services (DSHS) takes several steps. The agency irregularly publishes fish consumption advisories and bans in a booklet available to the public through the Seafood and Aquatic Life Group (SALG). To receive the booklet and/or the data, please contact the SALG at 1-512-834-6757.[xxxviii] The SALG also posts the most current information about advisories, bans, and the repeal of such on the Internet at http://www.dshs.state.tx.us/seafood. The SALG regularly updates this web site. The Texas Department of State Health Services also provides the U.S. Environmental Protection Agency (http://epa.gov/waterscience/fish/advisories/), the Texas Commission on Environmental Quality (TCEQ; http://www.tceq.state.tx.us), and the Texas Parks

and Wildlife Department (TPWD; http://www.tpwd.state.tx.us) with information on all consumption advisories and possession bans. Each year, the TPWD informs the fishing and hunting public of consumption advisories and fishing bans on it's Web site and in an official hunting and fishing regulations booklet available at many state parks and at all establishments selling Texas fishing licenses.[xxxix] Readers may direct questions about the scientific information or recommendations in this risk characterization to risk managers at the (SALG) at 512-834-6757 or may find the information at the SALG's website (http://www.dshs.state.tx.us/). Secondarily, one may address inquiries to the Environmental and Injury Epidemiology and Toxicology Branch of the Department of State Health Services (512-458-7269). The EPA's IRIS Web site (http://www.epa.gov/iris/) contains much information on environmental contaminants found in food and environmental media. The Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology (888-42-ATSDR or 888-422-8737 or the ATSDR's Web site (http://www.atsdr.cde.gov) supplies brief information via ToxFAQs.® ToxFAQs are available on the ATSDR website in either English http://www.atsdr.cdc.gov/toxfaq.html) or Spanish (http://www.atsdr.cdc.gov/es/toxfaqs/es_toxfaqs.html). The ATSDR also publishes more in-depth reviews of many toxic substances in its *Toxicological Profiles.* To request a copy of available *Toxicological Profiles*, readers may telephone the ATSDR at 1-404-498-0261 or email requests to atsdric@cdc.gov. Many *Toxicological Profiles* are also available for downloading at ATSDR's website.

TABLES

Table 1. Fish samples collected from five sites within the Donna Irrigation System in December 2005 and January 2006.

Sample Number	Species	Length (mm)	Weight (g)
Site 1 Donna Irrigation Canal			
DIC40	Common Carp	647	3501
DIC41	Common Carp	520	2283
DIC42	Largemouth Bass	358	737
DIC43	Largemouth Bass	362	723
DIC44	Smallmouth Buffalo	673	5244
Site 2 Donna Irrigation Canal			
DIC24	Largemouth Bass	406	1163
DIC25	Common Carp	553	2294
DIC26	Largemouth Bass	382	858
DIC27	Largemouth Bass	364	717
DIC12	Largemouth Bass	445	1127
DIC15	Common Carp	535	1919
DIC28	Channel Catfish	399	684
DIC29	Smallmouth Buffalo	735	6612
DIC30	Common Carp	647	3640
DIC31	Smallmouth Buffalo	655	4902
Site 3 Donna Irrigation Canal			
DIC18	Freshwater Drum	450	1133
DIC20	Largemouth Bass	371	698
DIC21	Common Carp	582	2905
DIC22	Common Carp	550	2237
DIC23	Largemouth Bass	368	882
Site 4 Donna Irrigation Canal			
DIC1	Channel Catfish	357	405
DIC2	Largemouth Bass	434	1479
DIC3	Largemouth Bass	415	1498
DIC4	Largemouth Bass	397	1278
DIC5	Common Carp	660	4082
Site 5 Donna Irrigation Canal			
DIC6	Largemouth Bass	438	1445
DIC7	Freshwater Drum	487	1783
DIC8	Freshwater Drum	455	1268
DIC9	Common Carp	595	2179
DIC10	Common Carp	622	3410

Table 2. Inorganic Contaminants (mg/kg) in Fish Collected in December 2005 and January 2006 from the Donna Irrigation System.

Contaminant	# Detected/ # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)3	Basis for Comparison Value
Copper				
Channel catfish	2/2	0.202±0.073 (0.150, 0.253)	333	National Academy of Science Upper Limit: 0.143 mg/kg–day
Common carp	10/10	0.479±0.232 (0.157-0.811)		
Freshwater drum	3/3	0.061±0.026 (BDL4-0.091)		
Largemouth bass	12/12	0.149±0.246 (BDL-0.916)		
Smallmouth buffalo	3/3	0.317±0.091 (0.231-0.413)		
All Fish Combined	30/30	0.271±0.258 (BDL-0.916)		
Lead				
Channel catfish	1/2	0.076±0.047 (ND5-0.109)	0.6	USEPA IEUBKwin
Common carp	2/10	0.070±0.076 (ND-0.285)		
Freshwater Drum	0/3	ND		
Largemouth bass	1/12	0.045±0.003 (ND-BDL)		
Smallmouth buffalo	2/3	0.324±0.327 (ND-0.692)		
All fish combined	6/30	0.083±0.127 (ND-0.692)		
Mercury				
Channel catfish	2/2	0.126±0.126 (0.108,0.143)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg–day
Common carp	10/10	0.212±0.137 (BDL-0.467)		
Freshwater drum	3/3	0.158±0.053 (0.098-0.194		
Largemouth bass	12/12	0.246±0.084 (0.165-0.453)		
Smallmouth buffalo	3/3	0.358±0.093 (0.252-0.427)		
All Fish Combined	30/30	0.229±0.112 (BDL-0.467)		
Selenium				

3Derived from the MRL or RfD for noncarcinogens or the USEPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of $1x10^{-4}$.
4 BDL: Below Detection Limit — Estimated concentrations reported were less than the laboratory's method detection limit (J-values).
5 *ND: Not Detected above the method detection limit or reporting limit (method specific).*

Table 2. Inorganic Contaminants (mg/kg) in Fish Collected in December 2005 and January 2006 from the Donna Irrigation System.

Contaminant	# Detected/ # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)3	Basis for Comparison Value
Channel catfish	2/2	0.315±0.066 (0.268,0.361)	6	EPA chronic oral RfD: 0 .005 mg/kg–day
Common carp	10/10	0.666±0.113 (0.496-0.931)		
Selenium, continued				
Freshwater drum	3/3	0.504±0.042 (0.457-0.538)		ATSDR chronic oral MRL: 0.005 mg/kg–day NAS UL: 0.400 mg/day (0.005 mg/kg–day) RfD or MRL/2: (0.005 mg/kg –day/2= 0.0025 mg/kg–day) to account for other sources of selenium in the diet
Largemouth bass	12/12	0.476±0.074 (0.379-0.640)		
Smallmouth buffalo	3/3	0.632±0.064 (0.573-0.700)		
All Fish Combined	30/30	0.547±0.135 (0.268-0.931)		
Zinc				
Channel catfish	2/2	5.312±0.599 (4.888,5.735)	700	EPA chronic oral RfD: 0.3 mg/kg–day
Common carp	10/10	8.391±2.845 (5.140-13.261)		
Freshwater drum	3/3	3.193±0.742 (2.364-3.797)		
Largemouth bass	12/12	4.516±.0.9269 (3.220-6.138)		
Smallmouth buffalo	3/3	4.894±1.053 (3.838-5.943)		
All Fish Combined	30/30	5.766±2.601 (2.364-13.261)		

Table 3. Polychlorinated Biphenyls (PCBs) (mg/kg) in Fish by Species and Site from Donna Irrigation System, 2005-2006.

Contaminant	# Detected/ # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)[3]	Basis for Comparison Value
Site 1 (Donna Canal SH 281)				
Common carp	2/2	0.012 ± 0.003 (0.010-0.014)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Largemouth bass	2/2	BDL[4]		
Smallmouth buffalo	1/1	**0.049**		
All Sampled Fish, Site 1	5/5	0.018 ± 0.018 (BDL-0.049)		
Site 2 (Donna Canal Siphon Outlet)				
Channel catfish	1/1	**2.509**	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	3/3	**3.777** ± 5.202 (0.129-9.733)		
Largemouth bass	4/4	**0.195** ± 0.159 (BDL-0.401)		
Smallmouth buffalo	2/2	**13.782** ± 9.002 (7.417-20.148)		
All Sampled Fish, Site 2	10/10	**4.219**± 6.553 (BDL-20.148)		
Site 3 (Donna Canal FM 1423)				
Common carp	2/2	**1.276** ± 1.063 (0.524-2.027)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Freshwater drum	1/1	**0.175**		
Largemouth bass	2/2	**0.056** ± 0.035 (0.032-0.081)		
All Sampled Fish, Site 3	5/5	**0.568** ±0.838 (0.032-2.027)		
Site 4 (Donna Reservoir West)				
Channel catfish	1/1	**0.057**	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	0.043		
Largemouth bass	3/3	**0.052** ± 0.012 (0.039-0.063)		
All Sampled Fish, Site 4	5/5	**0.051** ± 0.010 (0.039-0.063)		
Site 5 (Donna Reservoir East)				
Common carp	2/2	0.031 ± 0.010 (0.024-0.038)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Freshwater drum	2/2	BDL		
Largemouth bass	1/1	0.023		
All Sampled Fish, Site 5	5/5	0.025 ± 0.007 (BDL-0.038)		

Table 3 continued. Polychlorinated Biphenyls (PCBs) (mg/kg) in Fish by Species from Donna Irrigation System, 2005-2006.

Contaminant	# Detected/ # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)[3]	Basis for Comparison Value
All Sites (Sample Sites Combined)				
Channel catfish	2/2	**1.283** ± 1.734 (0.057-2.509)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	10/10	**1.401** ± 3.012 (0.010-9.733)		
Freshwater drum	3/3	**0.072** ± 0.089 (BDL – 0.175)		
Largemouth bass	12/12	**0.090** ± 0.115 (BDL-0.401)		
Smallmouth buffalo	3/3	**9.205** ± 10.168 (0.049-20.148)		
All Sampled Fish, All Sites	30/30	**1.516** ± 4.152 (BDL-20.148)		

Table 4. Hazard quotients (HQ) for PCBs in fish Collected from Lake The Donna Irrigation System in 2005-2006 along with suggested consumption rates for adults eating fish (8-oz per meal) containing PCBs at concentrations near those found in these samples.6

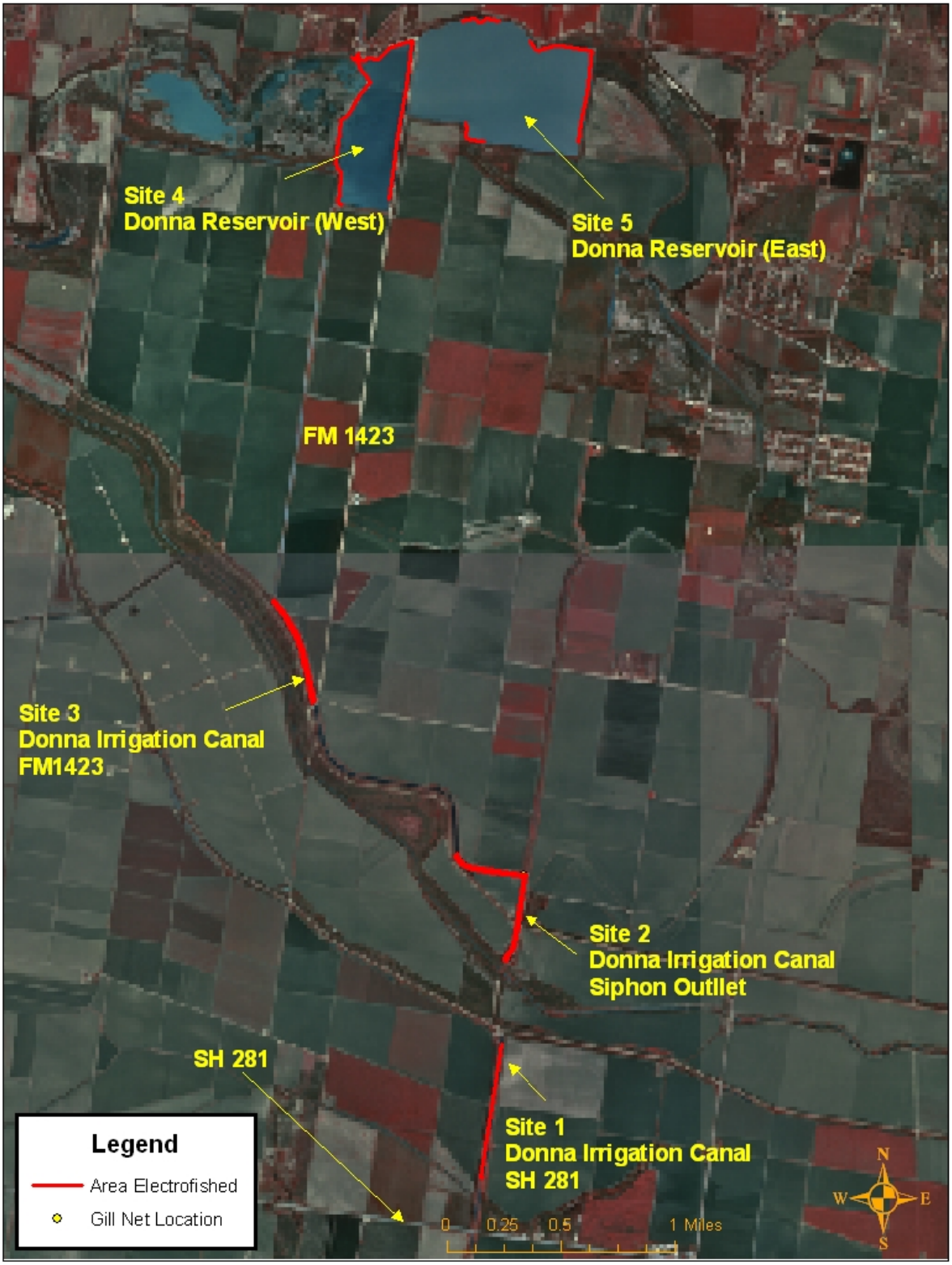
Species	Hazard Quotient	Meals per Week
Channel catfish	**27.5**	**0.0**
Common carp	**30.0**	**0.0**
Freshwater drum	**1.5**	**0.6**
Largemouth bass	**1.9**	**0.5**
Smallmouth buffalo	**197.2**	**0.0**
All Fish Combined	**32.5**	**0.0**

6 DSHS assumes that children under the age of 12 years and/or those who weigh less than 35 kg eat 4-ounce meals.

Table 5. Theoretical lifetime excess cancer risk for each PCB-contaminated species collected in 2005 from the Donna Irrigation System along with suggested weekly (8 oz per meal) consumption rates for 70-kg adults who eat each species of fish.[6]

Species/Contaminant	Theoretical Lifetime Excess Cancer Risk		Meals per Week
	Risk	1 excess cancer per number of people exposed	
Channel catfish	**4.7E-04**	**2122**	**0.2**
Common carp	**5.1E-04**	**1943**	**0.2**
Freshwater drum	2.6E-05	37809	3.5
Largemouth bass	3.3E-05	30047	2.8
Smallmouth buffalo	**3.4E-03**	**296**	**0.0**
All Fish Combined	**4.4E-03**	**226**	**0.2**

Figure 1. Donna Irrigation System Sample Site Map



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