PRE-CERCLA SCREENING ASSESSMENT
DELRAY CHEMICAL COMPANY – ATLANTIC AVENUE
5283 ATLANTIC AVE
DELRAY BEACH, PALM BEACH COUNTY, FLORIDA
COMET SITE ID # 321756

Prepared By:

Florida Department of Environmental Protection
Division of Waste Management
Waste Cleanup Program
CERCLA Site Screening Section

Caroline Horton
Environmental Specialist III
December 22, 2014

PRE-CERCLA SCREENING ASSESSMENT CHECKLIST/DECISION FORM

This checklist can assist the site investigator during the Pre-CERCLA screening. It will be used to determine whether further steps in the site investigation process are required under CERCLA. Use additional sheets, if necessary.

Checklist Preparer: Caroline Horton (Name/Title) — December 22, 2014 (Date)

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Tallahassee, FL 32399-2400

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Site Name: Delray Chemical Company – Atlantic Avenue

Previous Names (if any):

Site Location: 5283 Atlantic Avenue (Street)

Delray Beach (City), FL (ST) 33484 (Zip)

LATIDUE & LONGTIDUE INFORMATION

Table 1 Latitude/Longitude Information	
Data Element	**Domain/Specific Name**
Latitude	N: 26 27' 30.82" / N: 26.4586°
Longitude	W: -80 7' 37.49" / W: -80.1271°
Accuracy in Meters +/-	<0.02 meter (+/- 0.01 meter)
Source Map Scale	1:24000
Collection Method	DMAP– Digital Map Interpolation
Reference Datum	NAD83 – North American Datum of 1983

Complete the following checklist. If "yes" is marked, please explain below.	**YES**	**NO**
1. Does the site already appear in EPA's Database?		X
2. Is the release from products that are part of the structure of, and result in exposure within, residential buildings or businesses or community structures?		X
3. Does the site consist of a release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, from a location where it is naturally found?		X
4. Is the release into a public or private drinking water supply due to deterioration of the system through ordinary use?		X
5. Is some other program actively involved with the site (i.e., another Federal, State, or Tribal program)?		X
6. Are the hazardous substances potentially released at the site regulated under a statutory exclusion (i.e., petroleum natural gas, natural gas liquids, synthetic gas usable for fuel, normal application of fertilizer, release located in a workplace, naturally occurring, or regulated by the NRC, UMTRCA, or OSHA)?		X

7.	Are the hazardous substances potentially released at the site excluded by policy considerations (e.g., deferral to RCRA Corrective Action)?		X
8.	Is there sufficient documentation that clearly demonstrates that there is no potential for a release that could cause adverse environmental or human health impacts (e.g., comprehensive remedial investigation equivalent data showing no release above ARARs, completed removal action, documentation showing that no hazardous substance releases have occurred, EPA approved risk assessment completed)?		X

Please explain all "yes" answer(s), attach additional sheets if necessary: _____

Site Determination:

☒ Enter the site into EPA's Database. Further assessment is recommended (explain below).

☐ The site is not recommended for placement into EPA' (explain below).

DECISION/DISCUSSION/RATIONALE:

The United States Environmental Protection Agency (U.S. EPA) requested a review of inactive pesticide formulators to be performed by Florida Department of Environmental Protection (FDEP) for potential entry in EPA's database in a letter received by FDEP on May 21, 2003. Delray Chemical Company, Inc. is included in the listing of inactive pesticide formulators. Information and documents collected or generated from this Pre-CERCLA Screening Assessment (PSA) will be included into the FDEP OCULUS™ database.

1.0 Site Description

Delray Chemical Company, Inc. - Atlantic Ave, ("the site"), is located at 5283 Atlantic Avenue, Delray Beach, Palm Beach County, Florida in Section 14, Township 46 South Range 42 East. The geographical coordinates of the site are 26°27'30.82"N (26.4586°N) latitude and -80°07'37.49"W (-80.1271°W) longitude.

The building was permitted for construction in December 1969 as a 75,000 square foot warehouse located on a 4.5 acre parcel. The building layout included chemical research, manufacturing, distribution, storage and office space.

Delray Chemical Company, Inc. was in operation at the site from approximately 1969 to 1978. In 1978, Delray moved to 1220 Tangelo Terrace [Preliminary Assessment (PA) performed on this site Fiscal Year (FY) 2014]. The site is currently occupied by The Big Apple Shopping Bazaar which opened in 2014, replacing the former Carnival Flea Market that was established at the site in approximately 2005.

The site is surrounded by residential properties on the north, an industrial park complex (Executive Square Plaza) to the west, a shopping center and commercial complex (Marketplace at Delray owned by Ramco-Gershenson Properties) to the east and Atlantic Ave directly to the south with additional commercial properties further south (Figures 1-4).

2.0 Ownership Information

According to the Palm Beach County Property Appraiser, the current property owner is West Atlantic Commercial Properties, LTD (West Atlantic LTD). The Registered Agent for West Atlantic LTD is Joseph Reamer, who also serves as the business and account manager of The Pugliese Company. The corporate address for both companies is listed at 101 Pugliese's Way in Delray Beach, Florida.

3.0 Site History

It is known that exotic chemicals for industry, research laboratories and various state and private college laboratories as well as domestic use chemicals were manufactured on site. Some of the chemicals handled by this facility included Mil-Kil (Active Ingredient: Diiodomethyl p-tolyl sulfone), a product that controls mildew in closed homes, Trimethylsilylmethyl Sulfide, Calcium Chloride, Thiophene compounds, and Concrete pigments. Laboratory work to create and research new chemical compounds was conducted on site. The facility was also a distributor for Matheson Coleman & Bell (chemical company), which had a reported over 3,000 available products.

4.0 Waste Characteristics

The facility on site operated from 1969 to 1978, prior to the promulgation of environmental laws. As such, contamination from the blending, mixing and packaging activities on site may have resulted in soil, surface water and/or groundwater contamination. Facilities that conduct research, manufacturing, distribution and storage of multiple chemicals have the potential to generate a number of wastes. These wastes are produced by decontamination of mixing, blending and storage equipment, housekeeping and quality control laboratory testing. This includes leftover raw materials, dust and volatile organic compounds (solvents), spills, liquid waste, waste water and contaminated storm water runoff.

5.0 Exposure Pathways

5.1 Groundwater Migration Pathway

Palm Beach County drinking water is supplied almost entirely by groundwater sources. The surficial aquifer system is the primary source of fresh water in Palm Beach County. The Biscayne aquifer is the most productive unit of this system in southern Palm Beach County.

There are 74 potable water supply (PWS) wells, managed by seven water treatment operators, and five private wells within a 4-mile target distance limit (TDL)[1] of the site. The proximity of the wells within a 4-mile radius and the apportionment of population per well is summarized in Table 2. Delray Beach Water Department operates a total of 30 supply wells for a total system population of 60,200, Palm Beach County Water Utilities operates a total of 91 wells serving a population of 416,303, with 27 wells residing within a 4-mile radius of the site. Colonial Estates Mobile Home Park operates two wells serving a population of 450.

[1] The target distance limit is the distance over which targets are evaluated in the Hazard Ranking System (HRS). For the ground water pathway, the target distance limit is generally a four-mile radius from the sources at the site, except: Any drinking water well with an observed release attributed to the site is evaluated, regardless of its distance from the source.

Boca Raton Water Treatment Plant operates 50 wells serving a population of 128,000, with eight wells residing within a 4-mile radius of the site.

The Village of Golf operates three wells serving a population of 3,505. Highland Beach Water Plant operates three wells serving a population of 4,100. These wells are completed in the Floridan Aquifer. Bedner Labor Camp operates one well serving a population of 28. With the exception of the Highland Beach Water Plant, all wells within a 4-mile radius are completed in either the East Coast Surficial or Biscayne Aquifer.

Five private drinking water wells were identified within 4-miles of the site. It is likely that additional private drinking water wells exist in the site area, especially in more remote areas of Palm Beach County.

Based on the information gathered during the file review, the groundwater migration pathway is potentially a pathway of concern at the site.

5.2 Surface Water Pathway

The site is approximately 17 feet above mean sea level and is located in the 500 year floodplain. The area immediately surrounding the building is paved to the north, west, and east with an asphalt parking lot extending from the building to the south. Vegetation is present on the boundary lines of the property to the north, west and east and within parking lot landscape islands to the south. There are storm drains to remove surface water run-off located in the parking lot at the south end of the building. The City of Delray Beach does not have combined sewage and stormwater systems. Stormwater in the area is channeled into the stormwater management system.

The Intracoastal Waterway (ICW) exists within a 4-mile radius to the east, with the Atlantic Ocean further east. Existing within a 2-mile radius to the east of the site is the El Rio Canal (E-4 Canal). The E-4 Canal is oriented in a north/south direction and connects to Lake Ida, north of the site and the Delray Canal (C-15 Canal) to the south. The C-15 canal trends east and discharges into the ICW approximately 4.6 miles southeast of the site. Recreational fishing for Largemouth bass (*Micropterus salmoides*), Sunshine bass (*Hybrid*), Bluegill (*Lepomis macrochirus*) and Redear Sunfish (*Lepomis microlophus*) occurs in Lake Ida and the Delray and El Rio Canals. Several sensitive species and environments are found within a 4-mile radius of the site. These include, but are not limited to, the Loggerhead Sea Turtle (*Caretta caretta*), Gopher Tortoise (*Gopherus polyphemus*), Burrowing Owl (*Athene cunicularia*), Florida Mouse (*Podomys floridanus*), the federally-designated endangered Florida Scrub Jay (*Aphelocoma coerulescens*) and West Indian manatee (*Trichechus manatus*), as well as rare cutthroat grass, hand fern, nodding pinweed, and the oak scrub community, which is the habitat for the Florida Scrub Jay.

It is likely soils underneath the site are highly permeable. Highly permeable soils would absorb most stormwater and surface water originating from the site prior to reaching these sensitive areas. Additionally, there would be a high dilution rate associated with large perennial waterways such as the ICW. Therefore, the surface water migration pathway is not a pathway of concern at this time.

5.3 Soil Exposure and Air Migration Pathways

A 34,030 square feet concrete structure exists on site. The structure is subdivided into multiple smaller stores to accommodate the 51 on site merchants. The area immediately surrounding the building is paved to the north, west, and east with an asphalt parking lot extending from the building to the south. There is a chain link fence partially enclosing the property to the north, west and east. Vegetation is present on the boundary lines of the property to the north, west and east and within parking lot landscape islands to the south.

There are currently no day care centers, schools or residents on site. A breakdown of the general population within a 4-miles radius from the site is presented in Table 3. No site-attributable soil contamination has been documented to exist in subsurface soils at this time. The majority of the site surrounding the building is paved and exposure to the presence or likely presence of toxic hazardous waste constituents in on-site surface soils in low. As a result, the soil exposure and air migration pathways are of minor concern at this time.

6.0 Conclusions and Recommendations

Facilities that conduct research, manufacturing, distribution and storage of multiple chemicals have the potential to generate a number of wastes. Palm Beach County drinking water is provided almost entirely by groundwater sources within the Biscayne Aquifer. Based on the findings of this PSA and a review of EPA CERCLA Superfund criteria, the groundwater migration pathway is a pathway of concern, and a CERCLA Preliminary Assessment (PA) is recommended.

Regional EPA Reviewer:

COREY HENDRIX

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State Agency/Tribe:

Horton_C

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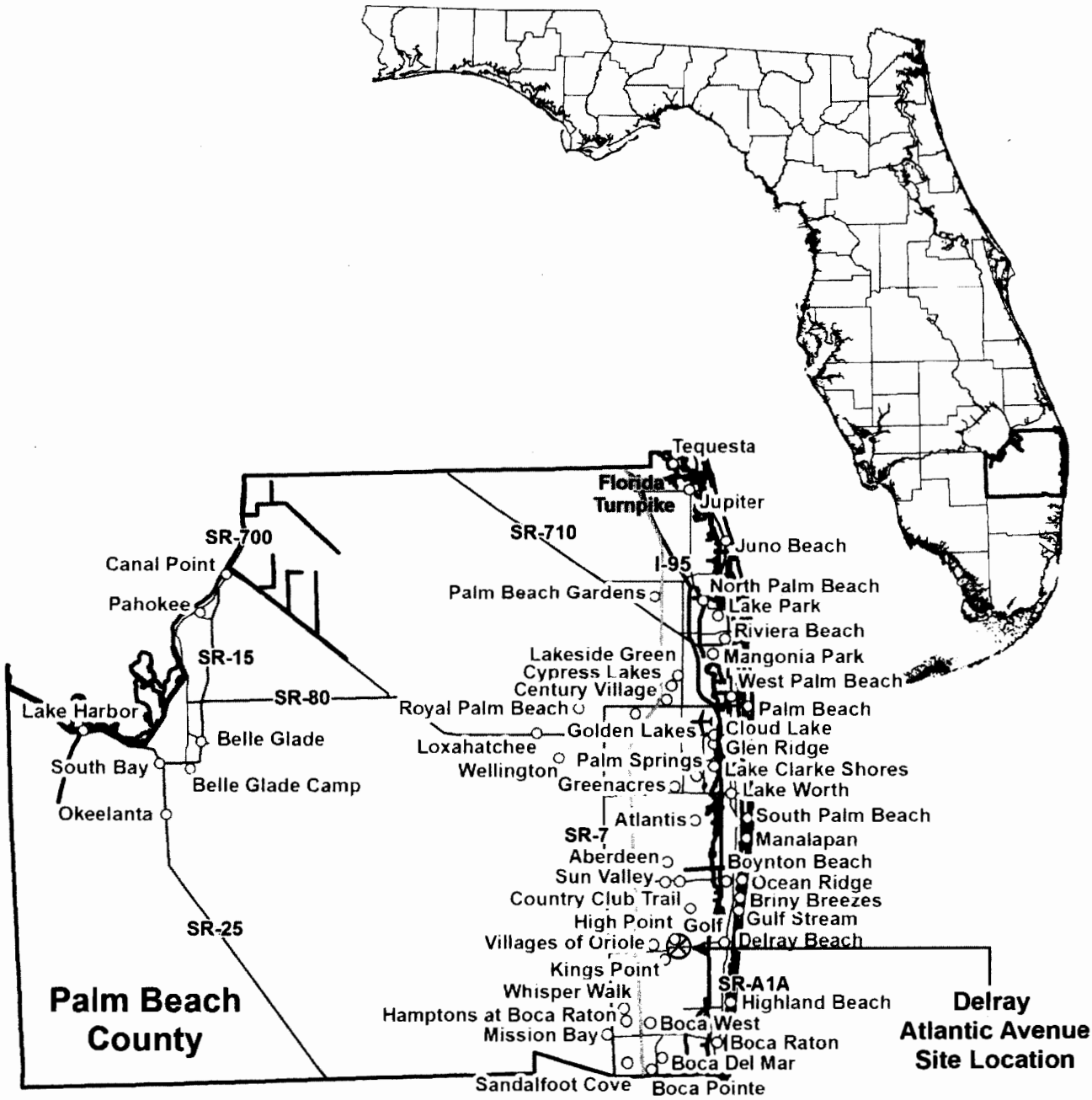
DN: o=Florida Dept of Environmental Protection, email=Caroline.Horton@dep.state.fl.us, cn=Horton_C
Date: 2014.12.31 14:06:28 -05'00'

Table 2 - Estimated Number of Potable Wells/ Population Served AOC: Biscayne Aquifer						
Wells	**0-1/4 mile**	**1/4-1/2 mile**	**1/2-1 mile**	**1-2 miles**	**2-3 miles**	**3-4 miles**
Delray Beach Water Dept[1]	0	0	0	5 / 10,033	13 / 26,087	12 / 24,080
Palm Beach County Water Utilities[2]	0	0	0	5 / 22,874	13 / 59,472	9 / 41,173
Colonial Estates MHP[3]	0	0	0	0	2 / 450	0
Boca Raton WTP[4]	0	0	0	0	0	8 / 20,480
Village of Golf[5]	0	0	0	0	0	3 / 3,505
Highland Beach Water Plant[6]	0	0	0	0	0	3 / 4,100
Bedner Labor Camp[7]	0	0	0	0	0	1 / 28
Private[8]	0 / 0	1 / 3	1 / 3	1 / 3	1 / 3	1 / 3
Totals	0	1 / 3	1 / 3	11 / 32,910	29 / 86,012	37 / 93,369

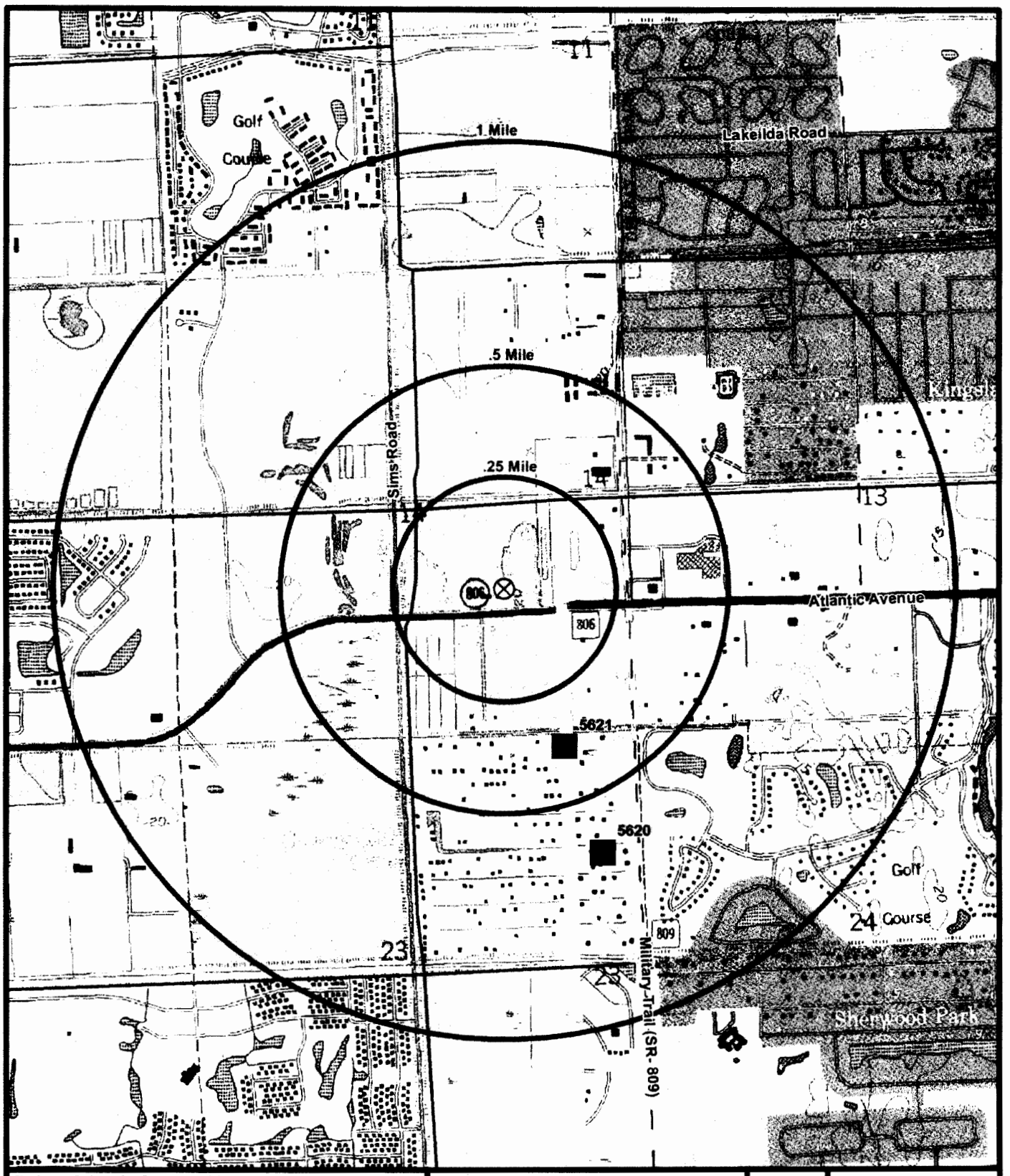
Estimated population served by wells within 4-miles = 212,297

1. The Delray Beach Water Department operates 30 supply wells for a total system population of 60,200 ∴ Apportionment: Population/# wells = population per well or 60,200/30 = 2,006 people per well.
2. The Palm Beach County Water Utilities operates 91 supply wells for a total system population of 416,303 ∴ Apportionment: Population/# wells = population per well or 416,303/91 = 4,574 people per well.
3. The Colonial Estates MHP operates 2 supply wells for a total system population of 450 ∴ Apportionment: Population/# wells = population per well or 450/2 = 225 people per well.
4. The Boca Raton WTP operates 50 supply wells for a total system population of 128,000 ∴ Apportionment: Population/# wells = population per well or 128,000/50 = 2560 people per well.
5. The Village of Golf operates 3 supply wells for a total system population of 3,505 ∴ Apportionment: Population/# wells = population per well or 3,505/3 = 1168 people per well.
6. The Highland Beach Water Plant operates 3 supply wells for a total system population of 4,100 ∴ Apportionment: Population/# wells = population per well or 4,100/3 = 1366people per well.
7. The Bedner Labor Camp operates 1 supply well for a total system population of 28 ∴ Apportionment: Population/# wells = population per well or 28/1 = 28 people per well
8. The private wells are open to upper portions of the Biscayne aquifer. It is likely that additional private wells exist in more remote areas of Delray Beach and unincorporated Palm Beach County. Average persons per household in Palm Beach County = 2.25.

Table 3 - Population Surrounding Site Delray Chemical Company Site 5283 Atlantic Ave Delray Beach, Palm Beach County, Florida 33484 Section: 41 Township: 46S Range: 42E	
Miles	**Population**
0 to 0.25	529
0.25 to 0.50	2,267
0.50 to 1	9,727
1 to 2	38,830
2 to 3	50,107
3 to 4	82,757



Delray Atlantic Avenue Site
Figure 1: Site Location Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
Prepared by: B.K. McClain Date: 12/1/2014



Delray Atlantic Avenue Site
Figure 2: One Mile Buffer Topographic Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
(Digital Raster Graphics (24k) (quad maps))
Prepared by: B.K. McClain Date: 12/17/2014

Delray Atlantic Avenue Site Location
DOH Private Wells Location
Water Lines
.25, .5, 1 Mile Buffers

0 0.125 0.25 0.5 Miles

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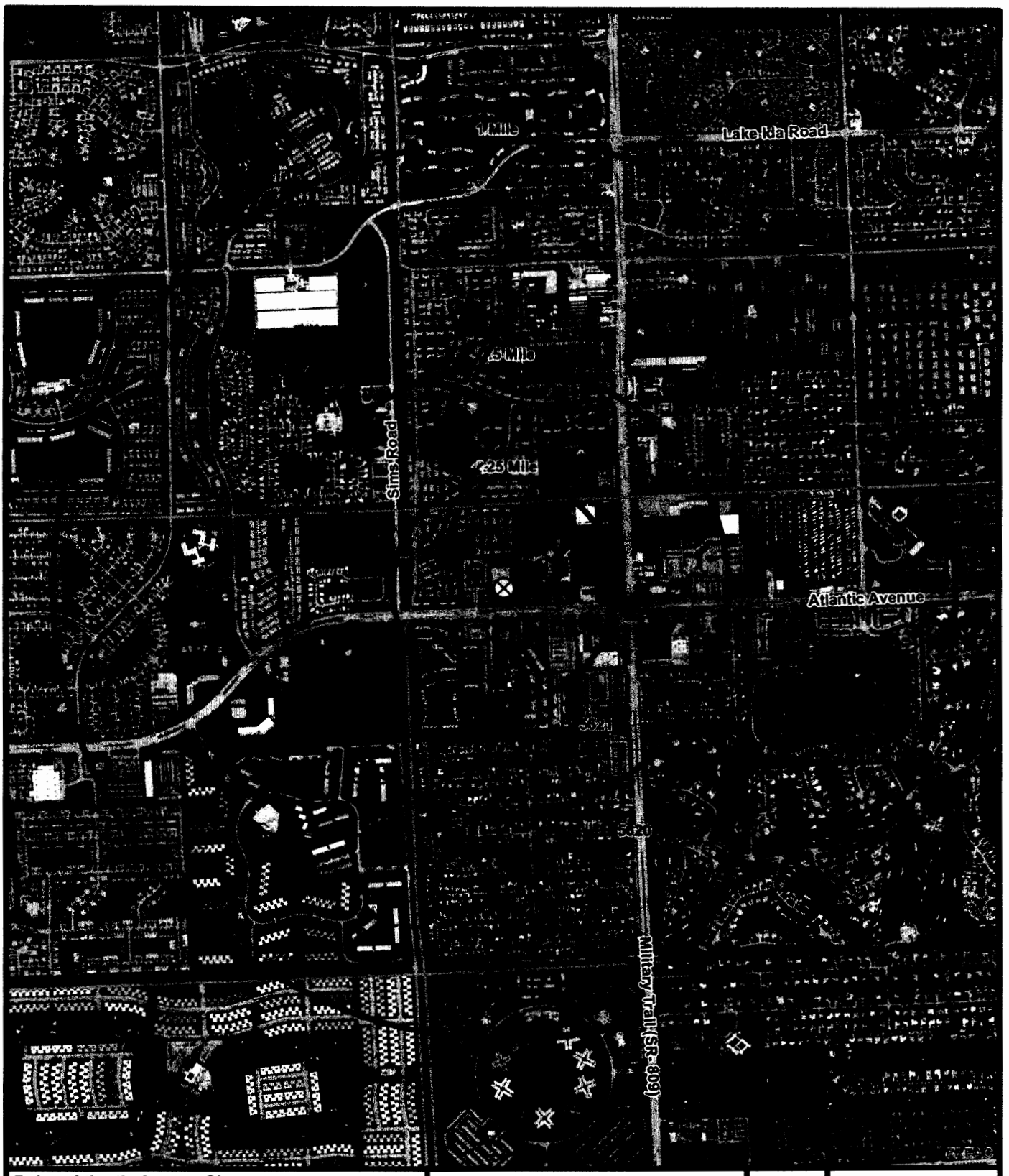
FLORIDA



Delray Atlantic Avenue Site
Figure 3: One Mile Buffer Aerial Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
(Aerial Imagery 2011-2013)
Prepared by: B.K. McClain Date: 12/17/2014

Delray Atlantic Avenue Site Location
DOH Private Wells Location
Water Lines
.25, .5, 1 Mile Buffers

0 0.125 0.25 0.5 Miles

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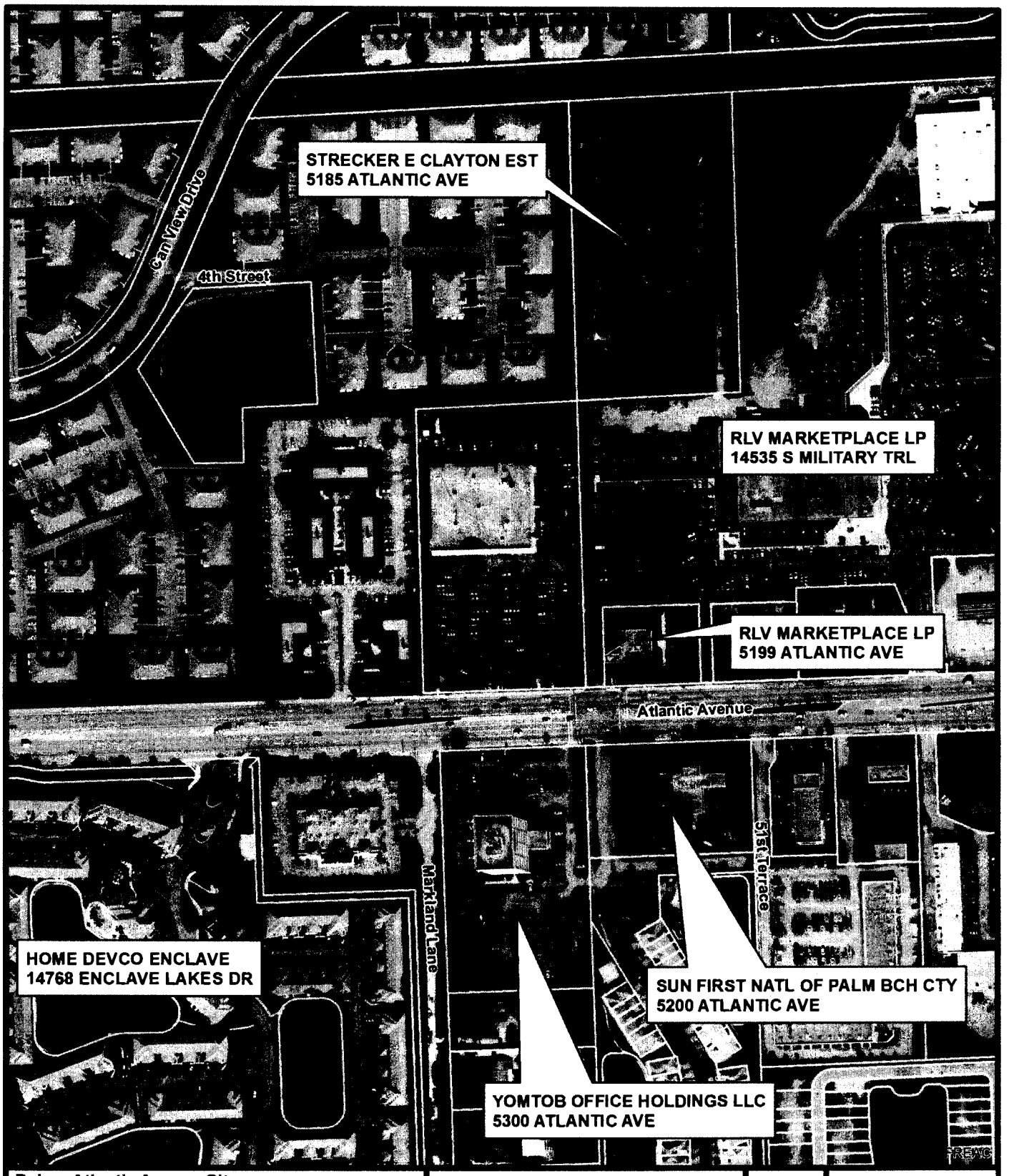

Delray Atlantic Avenue Site
Figure 4: Site Vicinity Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
(Aerial Imagery 2011-2013)
Prepared by: B.K. McClain Date: 12/1/2014

Former Delray Chemicals Building Location

Cadastral 2013 (Property Appraiser Parcels)

0 0.025 0.05 0.1 Miles

N W E

DEPARTMENT OF ENVIRONMENTAL PROTECTION FLORIDA

PRELIMINARY ASSESSMENT
DELRAY CHEMICAL COMPANY – ATLANTIC AVENUE
5283 ATLANTIC AVE
DELRAY BEACH, PALM BEACH COUNTY, FLORIDA

EPA ID #: FLN000403223
COMET SITE ID # 321756

Prepared By:

Florida Department of Environmental Protection
Division of Waste Management
Waste Cleanup Program
CERCLA Site Screening Section

Caroline Horton
Environmental Specialist III

February 27, 2015

Delray Chemical Company- Atlantic Avenue
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1. INTRODUCTION

This Preliminary Assessment (PA) report was prepared by the Florida Department of Environmental Protection's (FDEP) Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Site Screening Section (CSSS) pursuant to the CERCLA of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986. The purpose of the PA was to gather and evaluate available file information, to determine the potential for a release of hazardous substances into the environment, and to assess exposure pathways that might be affected by the site. The information in the PA report was used to determine whether or not a CERCLA Site Inspection (SI) is warranted at the site, pursuant to Superfund regulations. The site was also evaluated using EPA's Hazard Ranking System (HRS) model[1]. The FDEP CSSS reviewed files from the State of Florida Library, Florida DOT historical aerial photograph database, Palm Beach County Property Appraiser, Florida Department of State Division of Corporations database, FDEP OCULUS™ database and U.S Environmental Protection Agency (USEPA) Region 4 Record Center among others.

On January 02, 2015, FDEP CSSS completed a Pre-CERCLA Screening Assessment (PSA) for the "Delray Chemical Company- Atlantic Ave". This included a review of the available file materials and a cursory receptor survey. With EPA's concurrence, a PA was recommended for this site [FLN000403223].

2. SITE LOCATION, CLIMATE, DESCRIPTION, OPERATIONAL & REGULATORY HISTORY AND WASTE CHRACTERISTICS

2.1 Location

Delray Chemical Company, Inc. - Atlantic Ave, ("the site"), is located at 5283 Atlantic Avenue, Delray Beach, Palm Beach County, Florida in Section 14, Township 46 South Range 42 East. The geographical coordinates of the site are 26°27'30.82"N (26.4586°N) latitude and -80°07'37.49"W (-80.1271°W) longitude [9].

[1] The HRS is the scoring system used by the EPA's Superfund program to assess the relative threat associated with actual or potential releases of hazardous substances. The HRS is the primary screening tool for determining whether a site is to be included on the National Priorities List (NPL)

Table 1 Latitude & Longitude Standards Data	
Data Element	**Domain/Specific Name**
Latitude	N: 26 27' 30.82" / N: 26.4586°
Longitude	W: -80 7' 37.49" / W: -80.1271°
Accuracy in Meters +/-	<0.02 meter (+/- 0.01 meter)
Source Map Scale	1:24000
Collection Method	DMAP– Digital Map Interpolation
Reference Datum	NAD83 – North American Datum of 1983
Reference Point	CENTR - Center of Site or Facility containing Object of Interest Location
Collection Date	YYYYMMDD 20141127

2.2 Climate

The climate in Palm Beach County varies from Equatorial Monsoon in the southern part of the county to Equatorial Rainforest in northern Palm Beach County. The climate is characterized by mild winters and long, warm, humid summers. In addition to its low southern latitude, the Atlantic Ocean has a moderating influence on the maximum and minimum temperatures in summer and winter, respectively. However, these effects diminish quickly inland of the coast. Colder temperatures during the winter are closely tied to the advance of cold fronts emanating from the north. However, this cold continental air must pass over water and much of peninsular Florida before reaching Palm Beach County. As such, the cold air is appreciably modified during that journey. During the summer, temperatures are also tempered by the ocean breeze and shade provided by the formation of cumulus clouds and rain showers. Based on weather records from West Palm Beach, the Average Monthly Mean temperature ranges from 65.5°F in January to 82.3°F in August. Rainfall is highly variable from place to place, particularly in an east-west direction. The Mean Annual Rainfall is 62.06 inches. Between 65-70% of the rainfall occurs during the rainy season from June to October. Thunderstorms occur about every other day during the summer, usually in the late afternoon. Thunderstorms also account for the summer rainfall totals. Some of the heavy thunderstorms can account for 2 to 3 inches of rainfall over a 1 to 2 hour period. Tropical storms or depressions and hurricanes occasionally strike the area in September and October. Net Precipitation is approximately 9 inches and the 2-Year 24 Hour rainfall is approximately 5.5 inches. For most of the year, the prevailing winds are generally from the east direction varying from southeast to east-northeast. However, during December and January, they are typically from a northwesterly direction [13, 34, 35].

2.3 Site Description

Delray Chemical Company, Inc. ("Delray") was in operation at the site from approximately 1969 to 1978. The original address of the site was known to be 5065 Atlantic Ave in 1978, and was georeferenced through old aerial photographs to confirm that the current address of 5283 Atlantic Ave is the same site location. In 1978, Delray moved to 1220 Tangelo Terrace [Preliminary Assessment (PA) performed on this site by CSSS in Fiscal Year (FY) 2014]. The original building on the site was permitted for construction in December 1969 as a 75,000 square foot warehouse located on a 4.5 acre parcel (Real Estate Parcel Number 00-42-46-14-00-000-5300). The building layout included chemical

research, manufacturing, distribution, storage and office space. The current structure on site is a 34,030 square foot department store and was built in 1981.

The site is surrounded by residential properties on the north, an industrial park complex (Executive Square Plaza) to the west, a shopping center and commercial complex (Marketplace at Delray owned by Ramco-Gershenson Properties) to the east and Atlantic Ave directly to the south with additional commercial properties further south (Figures 1-4) [2, 9, 10, 14].

2.4 Operational History

The site was discovered during a file review conducted by the FDEP CSSS to locate potential pesticide formulator sites in Florida. Delray originally filed with the State Division of Corporations on October 17, 1958. Delray was originally issued a permit to build a 75,000 square foot warehouse on December 30, 1969 at the location on West Atlantic Avenue in Delray Beach, Florida. The building layout included chemical research, manufacturing, distribution, storage and office space. The site is currently occupied by The Big Apple Shopping Bazaar which opened in 2014, replacing the former Carnival Flea Market that was established at the site in approximately 2005. The property is owned by West Atlantic Commercial Properties, LTD [1, 2, 3, 8, 11, 14, 16, 27].

Limited information exists regarding the actual day to day operations at the site. Prior to the promulgation of environmental regulations in 1980, and for some time afterward, waste disposal by businesses was unregulated. This often resulted in releases of chemicals to the soil and groundwater. According to an article in the Palm Beach Post, dated April 25, 1971, it is known that exotic chemicals for industry, research laboratories and various state and private college laboratories as well as domestic use chemicals were manufactured on site. Some of the chemicals handled by this facility included Mil-Kil (Active Ingredient: diiodomethyl p-tolyl sulfone), a product that controls mildew in closed homes, trimethylsilylmethyl sulfide, calcium chloride, thiophene compounds, sodium hypochlorite (bleach), and concrete pigments. According to an article in the Miami Herald dated April 17, 1983, Mil-Kil was manufactured by Delray for 20 years, and distributed in five pound bags. Due to the timeframe of manufacturing at this facility, it is possible that such pesticides as dieldrin, toxaphene and aldrin were onsite. From the 1950s to the 1970s, aldrin and dieldrin were widely used pesticides, however due to concerns about damage to the environment and potentially to human health, EPA banned all uses of aldrin and dieldrin in 1974, except to control termites, and for all uses in 1987. As a replacement to DDT, toxaphene was one of the most heavily used pesticides in the Unites States until 1982, when it was discontinued for most uses. Toxaphene was used primarily in the southern United States to control insects on cotton and other crops. Laboratory work to create and research new chemical compounds was known to be conducted on site. The facility was also a distributor for Matheson Coleman & Bell (chemical company), which had a reported over 3,000 available products [14, 18, 19, 21, 25, 26, 28, 37, 43].

2.5 Regulatory History

In a letter received by FDEP May 21, 2003, the U.S. EPA requested a review of inactive pesticide formulators to be performed by FDEP for potential entry in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). Delray was included in the

listing of inactive pesticide formulators. The Delray Chemical Company, Inc. site at the Park Ten Industrial Park [EPA ID #: FLN000400869] had a Preliminary Assessment (PA) performed during Fiscal Year (FY) 2014. No other information with regards to regulatory history was found for the site [27].

2.6 Waste Characteristics

Delray was a facility that blended, stored and sold pesticides, including Mil-Kil, and other chemicals such as trimethylsilylmethyl sulfide, calcium chloride, thiophene compounds, sodium hypochlorite (bleach), and concrete pigments, as well as distributing for Matheson Coleman & Bell (chemical company), which had a reported over 3,000 available products [14, 18, 19, 25, 26, 28].

Delray Chemical Company registered Mil-Kil, sodium hypochlorite (a.k.a. bleach), and diazinon with the National Pesticide Information Center (NPIC) in 1973, 1975 and 1982 respectively. Mil-Kil is a powdered pesticide used to control mold and mildew on fabric surfaces, in household and boat premises with an active ingredient of diiodomethyl p-tolyl sulfone [19, 25, 26, 28, 38, 39].

Organochlorine pesticides (OCPs) such as dieldrin, aldrin and toxaphene were banned for use in the United States during the 1980s and early 1990's due to health concerns including possible or suspected carcinogens. Toxaphene was used on vegetable crops in south Florida and since 1969, was determined to be one of the most likely chemical contaminants in south Florida. Organic arsenic compounds are also used in pesticides and herbicides, though they began being phased out by the EPA in 2009. This site had the potential of handling these substances based on the time period in which they were in operation at this location [18, 22, 43, 44].

Facilities that store, distribute and formulate pesticides potentially generate a number of waste products including pesticide or solvent contaminated wastewater. There are three types of pesticide formulations; solvent-based, water-based and solid-based. In solvent and water-based formulations, the solvent, water, or emulsion of solvent and water, serves as the carrier solution for the pesticide ingredient. Typical solvents are light aromatics such as xylene, chlorinated organics such as methyl chloroform (1,1,1-trichloroethane), and mineral spirits. Solid-based pesticides are prepared by blending a solid active ingredient with an inert solid such as clay and sand, or by absorbing liquid active ingredients with a solid carrier material. Wastes are produced by decontamination of mixing and storage equipment, blending, mixing and packaging activities, housekeeping and quality control laboratory testing. This includes leftover raw materials, dust and volatile organic compounds (solvents), spills, waste water and pesticide contaminated storm water runoff. These wastes have the potential to result in soil and/or groundwater contamination [21].

3. GROUND WATER PATHWAY

3.1 Hydrogeologic Setting

This site is located on the Atlantic Coastal Ridge geomorphologic feature of the Southern or Distal Geomorphologic Province of Florida. Three hydrostratigraphic units exist in Palm Beach County. These

include: the surficial aquifer system, intermediate aquifer system/confining unit and the Floridan aquifer system [13].

3.1.1 Karst Terrain Evaluation

The western and southwestern parts of Palm Beach County are situated on bare or thinly covered limestone. Sinkholes are few. When present, solution sinkholes dominate. They are generally shallow and broad. The sinkholes in this area tend to develop gradually. In the northwestern, northeastern and eastern parts of the County, including the West Palm Beach, Lake Worth and Boynton Beach areas, the cover varies between 30 and 200 feet thick. The cover consists of incohesive, permeable sand. Sinkholes are generally few, shallow and of small diameter. They also tend to develop gradually. In this area, when present, cover-subsidence sinkholes prevail [13].

3.1.2 Surficial Aquifer System/Biscayne Aquifer

The Surficial aquifer system is the primary source of fresh water in Palm Beach County. The Biscayne aquifer is the most productive unit of this system. Under Section 1424(e) of the Safe Drinking Water Act of 1974, the Biscayne aquifer was designated as a sole-source aquifer. This was based on the fact that it supplies at least 50% of the drinking water in the area and that there are no alternative drinking water sources. This aquifer system is composed of sand, sandstone, shell, silt, calcareous clay (marl) and limestone of Pliocene to Holocene age. Poorly consolidated sand, shell and sandy limestone sediments predominate in the western two-thirds of the County. The sediments of western Palm Beach County may contain trapped seawater. The surficial aquifer system consists of, in ascending order, the upper part of the Tamiami Formation (Fm), Caloosahatchee Fm, Fort Thompson Fm, Anastasia Fm and undifferentiated sediments. The Lake Flint Marl, a fresh water unit of Pleistocene to Holocene age, overlies these deposits in the western portion of the County. The Lake Flint Marl is a low permeability unit of well indurated, cherty limestone that varies in thickness from a few inches to 5 feet. This limestone commonly contains numerous solution holes and is overlain by organic (peat) soils. The aquifer exists under unconfined to semi-confined conditions throughout the County and is recharged primarily by rainfall and seepage from canals. Some recharge may take place from Lake Okeechobee in the northwest part of the County. The aquifer system has two permeable zones in the eastern portion of the County. The most permeable zone is characterized by highly developed secondary porosity and is frequently referred to as the "cavity-riddled zone". This zone ranges in depth from sea level to about 220 feet below sea level. It has been classified as a karstic aquifer by the USGS. The two zones of the surficial aquifer system are considered a single hydrogeologic unit. The depth to the water table is generally less than 10 feet below land surface (BLS) and the aquifer is approximately 250 feet thick in the Delray Beach area [13, 15, 40].

3.1.3 Intermediate Aquifer System/Confining Unit

The Surficial aquifer system is underlain by the Miocene Epoch impermeable/semipermeable marls (calcareous clays) and carbonates (limestone and dolostone) of the Hawthorn Group. The Peace River and Arcadia Formations comprise the Hawthorn Group in South Florida. These sediments are approximately 750 feet thick in the site area and comprise the intermediate aquifer system/confining

unit. These sediments isolate the underlying Floridan aquifer system from the Surficial aquifer system [13, 41].

3.1.4 Floridan Aquifer System

The Floridan aquifer system consists of carbonates of Oligocene and Eocene Epoch. The Floridan aquifer system is comprised of, in ascending order, the Oldsmar Fm, Avon Park Fm, Ocala Limestone and the Suwannee Limestone. The top of the Floridan aquifer system is found approximately 900 feet below mean sea level in the Delray Beach area. The Floridan aquifer system is not generally a major source of potable water in the area due to high salinity [13, 41].

3.1.5 Site-Specific Geology and Hydrogeology

No information regarding on-site soil borings or monitoring wells was discovered during the file review of Delray. No site specific geology or hydrogeology is available for this site. Florida Geological Survey (FGS) lithology well log for well number W-17630 is located two sections west of the site, in Section 16, Township 46 South, Range 42 East, and was used for reference. The nearby FGS lithology log W-17630 shows grayish brown to dark yellowish brown, medium grained, high permeability quartz sand down to 10 feet. The depth to the water table is effectively the top of the Biscayne Aquifer. However, light grey to mod light grey, fossiliferous limestone was encountered at 100 feet BLS in nearby FGS well log W-17630 which is indicative of a Karst aquifer. No significant clay layers down to 100 feet in W-17630 were noted [24].

A Supplemental Groundwater Quality Report conducted at nearby Marketplace of Delray (aka Majestic/Royal Mart Gas Station) FDEP Facility ID 508943661, located 0.3 miles east of the site at 14683 South Military Trail was prepared by URS Corporation in November 2011. The observed direction of groundwater flow was established as east-southeast with an average groundwater elevation of approximately 9 feet during the fieldwork conducted for this report [23].

3.2 Ground Water Targets

Palm Beach County drinking water is supplied almost entirely by groundwater sources. The surficial aquifer system is the primary source of fresh water in Palm Beach County. The Biscayne aquifer is the most productive unit of this system in southern Palm Beach County [13].

There are 74 potable water supply (PWS) wells, managed by seven water treatment operators, and five private wells within a 4-mile target distance limit[2] (TDL) of the site. The closest well to the site is a private well located within 0.5 miles, and the closest PWS is located within 1 mile. The proximity of the wells within a 4-mile radius and the apportionment of population per well is summarized in Table 2. Delray Beach Water Department operates a total of 30 supply wells for a total system population of 60,200, Palm Beach County Water Utilities operates a total of 91 wells serving a population of 416,303,

[2] The target distance limit is the distance over which targets are evaluated in the Hazard Ranking System (HRS). For the ground water pathway, the target distance limit is generally a four-mile radius from the sources at the site, except: Any drinking water well with an observed release attributed to the site is evaluated, regardless of its distance from the source

with 27 wells residing within a 4-mile radius of the site. Colonial Estates Mobile Home Park operates two wells serving a population of 450. Boca Raton Water Treatment Plant operates 50 wells serving a population of 128,000, with eight wells residing within a 4-mile radius of the site. The Village of Golf operates three wells serving a population of 3,505. Highland Beach Water Plant operates three wells serving a population of 4,100. Bedner Labor Camp operates one well serving a population of 28. With the exception of the Highland Beach Water Plant, all wells within a 4-mile radius are completed in either the East Coast Surficial or Biscayne Aquifer. Five private drinking water wells were identified within 4-miles of the site. It is likely that additional private drinking water wells exist in the site area, especially in more remote areas of Palm Beach County [17, 30, 42].

3.3 Ground Water Conclusions

The surficial aquifer system is the primary source of drinking water in Palm Beach County and the site is situated in an area of Karst terrain. As such, breaches in the confining layer likely exist. There are 74 PWS wells serving a large population within a 4-mile radius of the site. The likely presence of pesticides, chlorinated solvents and potentially other COC's blended and distributed from the site is a concern. Based on the findings of this PA, the groundwater migration pathway is a pathway of concern at this time.

4. SURFACE WATER PATHWAY

4.1 Hydrologic Setting

The site is approximately 17 feet above mean sea level (msl) and is located within the 500 year floodplain. The area immediately surrounding the building is paved to the north, west, and east with an asphalt parking lot extending from the building to the south. Vegetation is present on the boundary lines of the property to the north, west and east and within parking lot landscape islands to the south (Figure 4). There are storm drains to remove surface water run-off located in the parking lot at the south end of the building. The City of Delray Beach does not have combined sewage and stormwater systems. Stormwater in the area is channeled into the stormwater management system. Much of the storm water runoff from the site is likely routed to two retention ponds located northwest and northeast of the site. [5, 6, 12, 31] (Figure 3).

The E-3 Canal, a tributary of the Hillsboro Canal (G-08), exists within a .25-mile radius to the west of the site, running north and south along Sims Road. The Intracoastal Waterway (ICW) exists within a 4-mile radius to the east, with the Atlantic Ocean further east. Existing within a 2-mile radius to the east of the site is the El Rio Canal (E-4 Canal). The E-4 Canal is oriented in a north/south direction and connects to Lake Ida, north of the site and the Delray Canal (C-15 Canal) to the south. The C-15 canal trends east and discharges into the ICW approximately 4.6 miles southeast of the site [32].

4.2 Surface Water Targets

There are no PWS potable surface water intakes along the Surface water migration pathway. However, there are fisheries and sensitive environments from the probable point of entry (PPE) to the 15-mile

TDL[3]. Recreational fishing for Largemouth bass (*Micropterus salmoides*), Sunshine bass (Hybrid), Bluegill (*Lepomis macrochirus*) and Redear Sunfish (*Lepomis microlophus*) occurs in Lake Ida and the Delray and El Rio Canals. Several sensitive species and environments are found within a 4-mile radius of the site. These include, but are not limited to, the Loggerhead Sea Turtle (*Caretta caretta*), Gopher Tortoise (*Gopherus polyphemus*), Burrowing Owl (*Athene cunicularia*), Florida Mouse (*Podomys floridanus*), the federally-designated endangered Florida Scrub Jay (*Aphelocoma coerulescens*) and West Indian manatee (*Trichechus manatus*), as well as rare cutthroat grass, hand fern, nodding pinweed, and the oak scrub community, which is the habitat for the Florida Scrub Jay [29, 32, 33, 42].

4.3 Surface Water Conclusions

Fishable waterways such as the Hillsboro Canal system and the ICW, as well as, other sensitive environments are within the TDL from the site, however, stormwater and surface water originating from the site is apparently directed into a storm water management system prior to reaching these sensitive areas. Additionally, there would be a high dilution rate associated with large perennial waterways such as the Hillsboro Canal and ICW. Based on the findings of this PA, the surface water migration pathway is not a pathway of concern at this time.

5. SOIL EXPOSURE AND AIR PATHWAYS

5.1 Physical Conditions

A 34,030 square feet concrete structure currently exists on site. It is now the location of The Big Apple Shopping Bazaar, and is reportedly open for vendors and the public Tuesdays through Sundays. The building structure is subdivided into multiple smaller stores to accommodate the 51 on-site merchants. The area immediately surrounding the building is paved to the north, west, and east with an asphalt parking lot extending from the building to the south. There is a chain link fence partially enclosing the property to the north, west and east. Vegetation is present on the boundary lines of the property to the north, west and east and within parking lot landscape islands to the south (Figure 4). Aerial photographs from 1968 and 1969 show no structure on the site, while aerial photographs from 1973 and 1975 show the original Delray Chemical Company structure. The 1970s photographs show a large retention pond between the Atlantic Ave roadway and the on-site building, a dirt driveway and an auxiliary building to the north, and wooded vegetation along the west, east and north boundaries. An aerial photograph from 1986 shows the current structure on site (Appendix A) [9, 10, 20, 36].

5.2 Soil and Air Targets

Based on historical practices at other pesticide formulators, pesticide surface soil contamination may exist. However, no site-attributable soil contamination has been documented to exist in subsurface soils at this time. In addition, direct contact to any potential soil contamination is mitigated by the asphalt

[3] The 15 mile TDL Distance over which the in-water segment of the hazardous substance migration path is evaluated. The target distance limit extends 15 miles from the probable point of entry (PPE), which is located in a perennial water body, in the direction of flow (or radially in lakes, oceans, or coastal tidal waters) or to the most distant sample point establishing an observed release, whichever is greater

parking lot and impervious structures. A residential population of 9,727 exists within a 1-mile radius of the site, and a breakdown of the general population within a 4-miles radius from the site is presented in Table 3. The number of on-site workers is unknown at this time, however there are currently no day care centers, schools, residents or terrestrial sensitive environments currently located on-site. However, residential condominium housing of the High Point of Delray subdivision is located adjacent to the site to the north and north-northwest [7, 17].

5.3 Soil Exposure and Air Pathway Conclusions

There does not appear to be any residential housing, schools, day care centers, or other terrestrial sensitive environments on-site. However, some residential housing exists to the north of the site. There is a worker population, however, the majority of the site surrounding the building is paved and exposure to the potential presence of toxic hazardous waste constituents in on-site surface soils is low. There have been no indications of any reported odors or air emissions from the site. Based on the findings of this PA, the soil exposure and air migration pathways are not a pathway of concern at this time.

6. SUMMARY AND CONCLUSIONS

The surficial aquifer system (Biscayne aquifer) is the primary source of drinking water in Palm Beach County and the site is in an area of moderate karst terrain and underlain by a karst aquifer. A population of 82,757, served by 74 PWS wells exists within a 4-mile TDL of the site. Given the discontinuous presence of any clay retarding layers, the surficial aquifer system is considered a single hydrogeologic unit. No previous investigation of the groundwater at the site was discovered during the file review. Based on the findings of this PA and the results of a scenario-driven Hazard Ranking System (HRS) evaluation, the groundwater migration pathway is the pathway of concern. Therefore, based on the findings of this PA and a review of EPA CERCLA Superfund criteria, the groundwater migration pathway is a pathway of concern, and a CERCLA Site Inspection (SI) is recommended.

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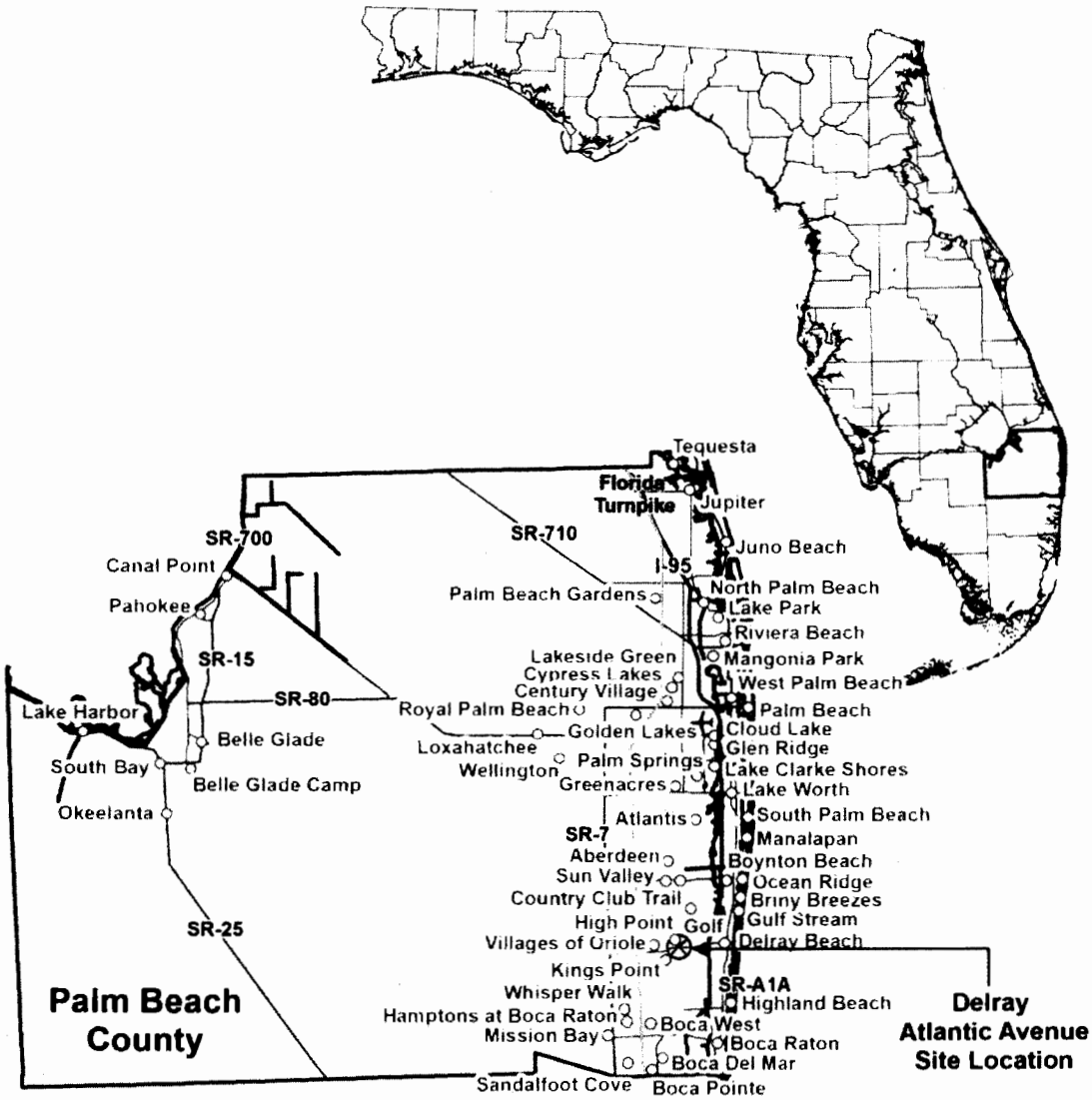
Table 2 - Estimated Number of Potable Wells/ Population Served AOC: Biscayne Aquifer [42]						
Wells	**0-1/4 mile**	**1/4-1/2 mile**	**1/2-1 mile**	**1-2 miles**	**2-3 miles**	**3-4 miles**
Delray Beach Water Dept[1]	0	0	0	5 / 10,033	13 / 26,087	12 / 24,080
Palm Beach County Water Utilities[2]	0	0	0	5 / 22,874	13 / 59,472	9 / 41,173
Colonial Estates MHP[3]	0	0	0	0	2 / 450	0
Boca Raton WTP[4]	0	0	0	0	0	8 / 20,480
Village of Golf[5]	0	0	0	0	0	3 / 3,505
Highland Beach Water Plant[6]	0	0	0	0	0	3 / 4,100
Bedner Labor Camp[7]	0	0	0	0	0	1 / 28
Private[8]	0 / 0	1 / 3	1 / 3	1 / 3	1 / 3	1 / 3
Totals	0	1 / 3	1 / 3	11 / 32,910	29 / 86,012	37 / 93,369

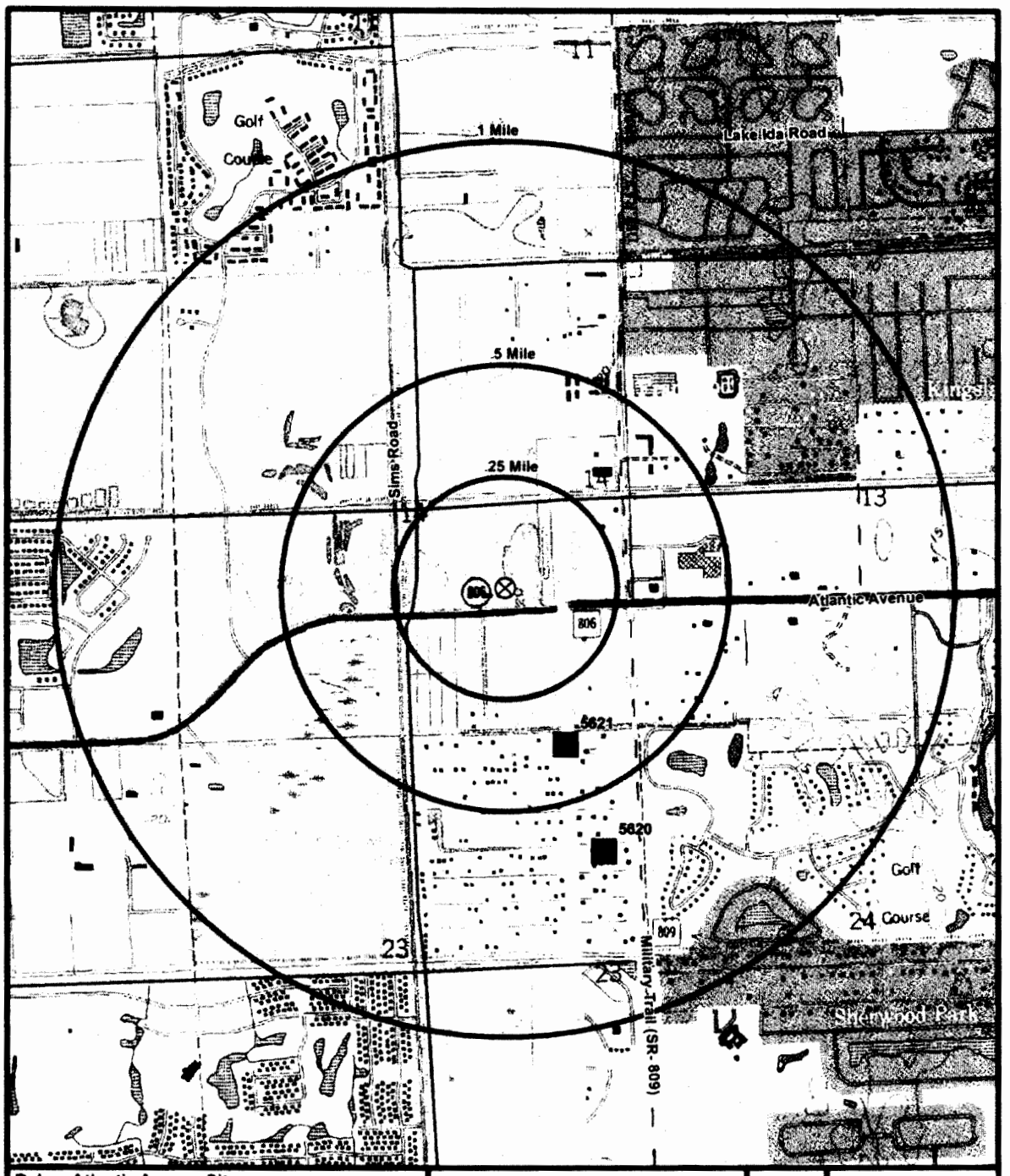
Estimated population served by wells within 4-miles = 212,297

1. The Delray Beach Water Department operates 30 supply wells for a total system population of 60,200 ∴ Apportionment: Population/# wells = population per well or 60,200/30 = 2,006 people per well.
2. The Palm Beach County Water Utilities operates 91 supply wells for a total system population of 416,303 ∴ Apportionment: Population/# wells = population per well or 416,303/91 = 4,574 people per well.
3. The Colonial Estates MHP operates 2 supply wells for a total system population of 450 ∴ Apportionment: Population/# wells = population per well or 450/2 = 225 people per well.
4. The Boca Raton WTP operates 50 supply wells for a total system population of 128,000 ∴ Apportionment: Population/# wells = population per well or 128,000/50 = 2560 people per well.
5. The Village of Golf operates 3 supply wells for a total system population of 3,505 ∴ Apportionment: Population/# wells = population per well or 3,505/3 = 1168 people per well.
6. The Highland Beach Water Plant operates 3 supply wells for a total system population of 4,100 ∴ Apportionment: Population/# wells = population per well or 4,100/3 = 1366people per well.
7. The Bedner Labor Camp operates 1 supply well for a total system population of 28 ∴ Apportionment: Population/# wells = population per well or 28/1 = 28 people per well
8. The private wells are open to upper portions of the Biscayne aquifer. It is likely that additional private wells exist in more remote areas of Delray Beach and unincorporated Palm Beach County. Average persons per household in Palm Beach County = 2.25.

Table 3 - Population Surrounding Site Delray Chemical Company Site 5283 Atlantic Ave Delray Beach, Palm Beach County, Florida 33484 Section: 41 Township: 46S Range: 42E [17]	
Miles	**Population**
0 to 0.25	529
0.25 to 0.50	2,267
0.50 to 1	9,727
1 to 2	38,830
2 to 3	50,107
3 to 4	82,757



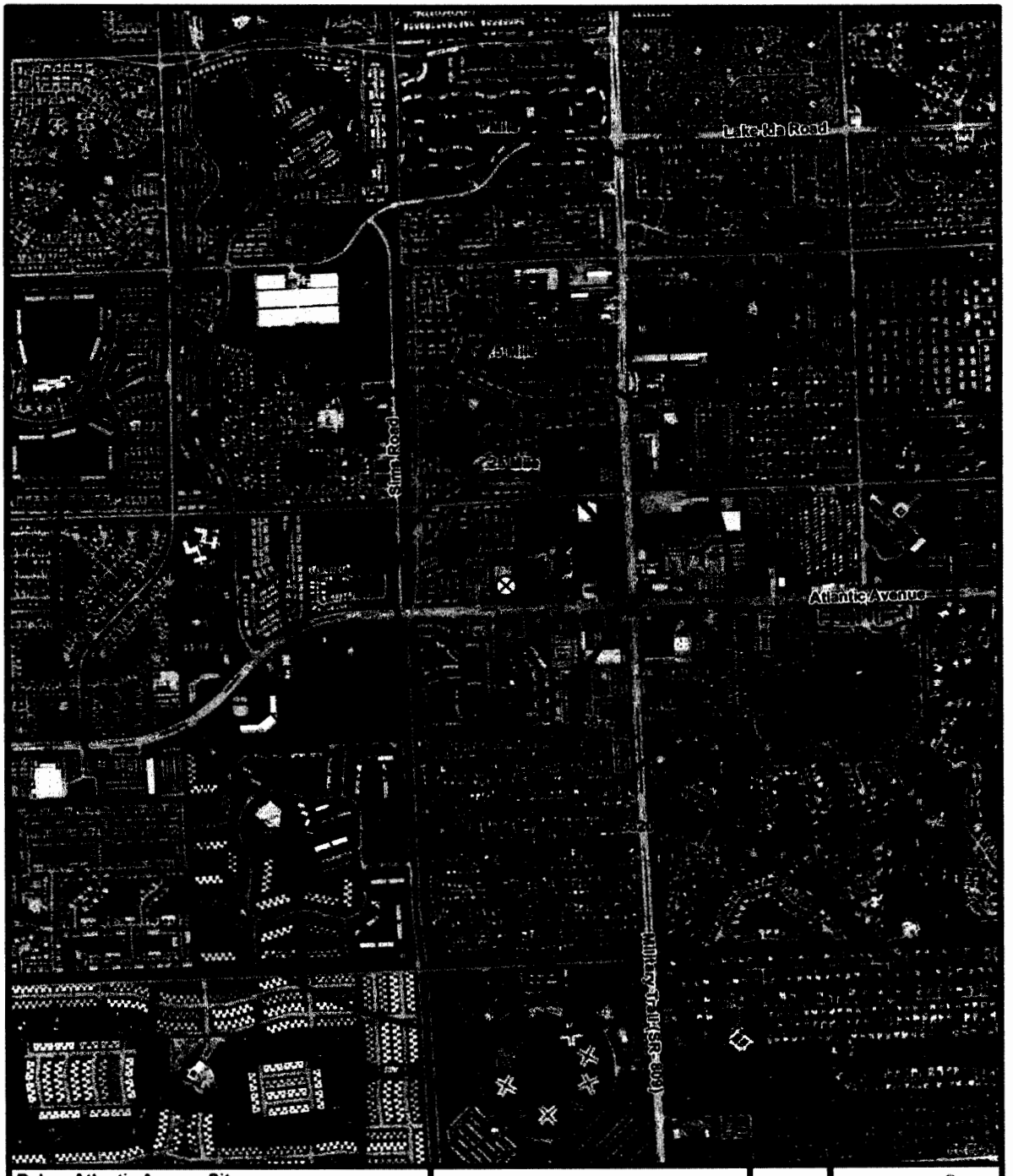
Delray Atlantic Avenue Site
Figure 1: Site Location Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
Prepared by: B.K. McClain Date: 12/1/2014



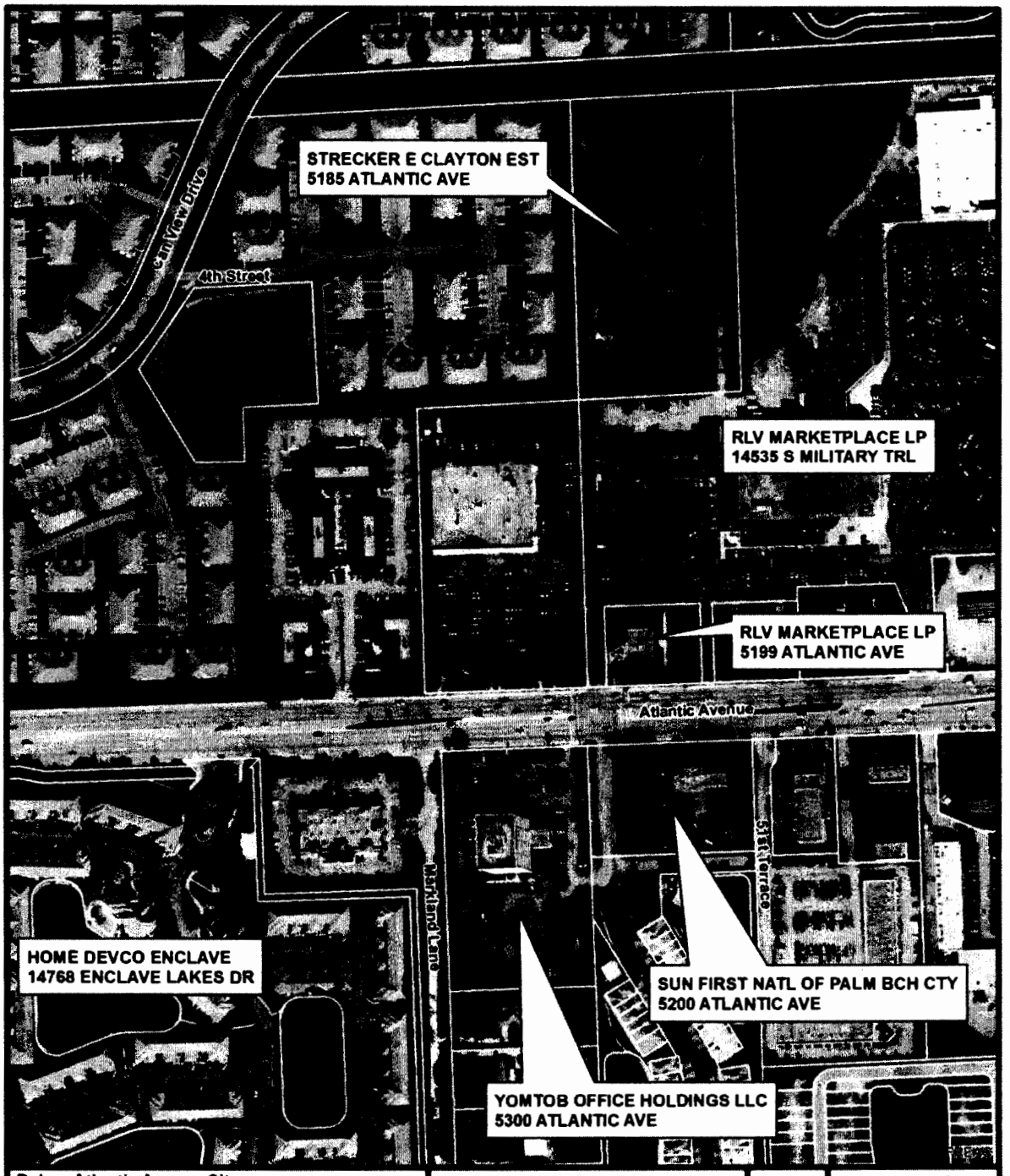
Delray Atlantic Avenue Site
Figure 2: One Mile Buffer Topographic Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
(Digital Raster Graphics (24k) (quad maps))
Prepared by: B.K. McClain Date: 12/17/2014

Delray Atlantic Avenue Site Location
DOH Private Wells Location
Water Lines
.25, .5, 1 Mile Buffers

0 0.125 0.25 0.5 Miles



Delray Atlantic Avenue Site
Figure 3: One Mile Buffer Aerial Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
(Aerial Imagery 2011-2013)
Prepared by: B.K. McClain Date: 12/17/2014



Delray Atlantic Avenue Site
Figure 4: Site Vicinity Map
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
(Aerial Imagery 2011-2013)
Prepared by: B.K. McClain Date: 12/1/2014

Former Delray Chemicals Building Location
Cadastral 2013 (Property Appraiser Parcels)

0 0.025 0.05 0.1 Miles

Appendix A – Historical Aerials

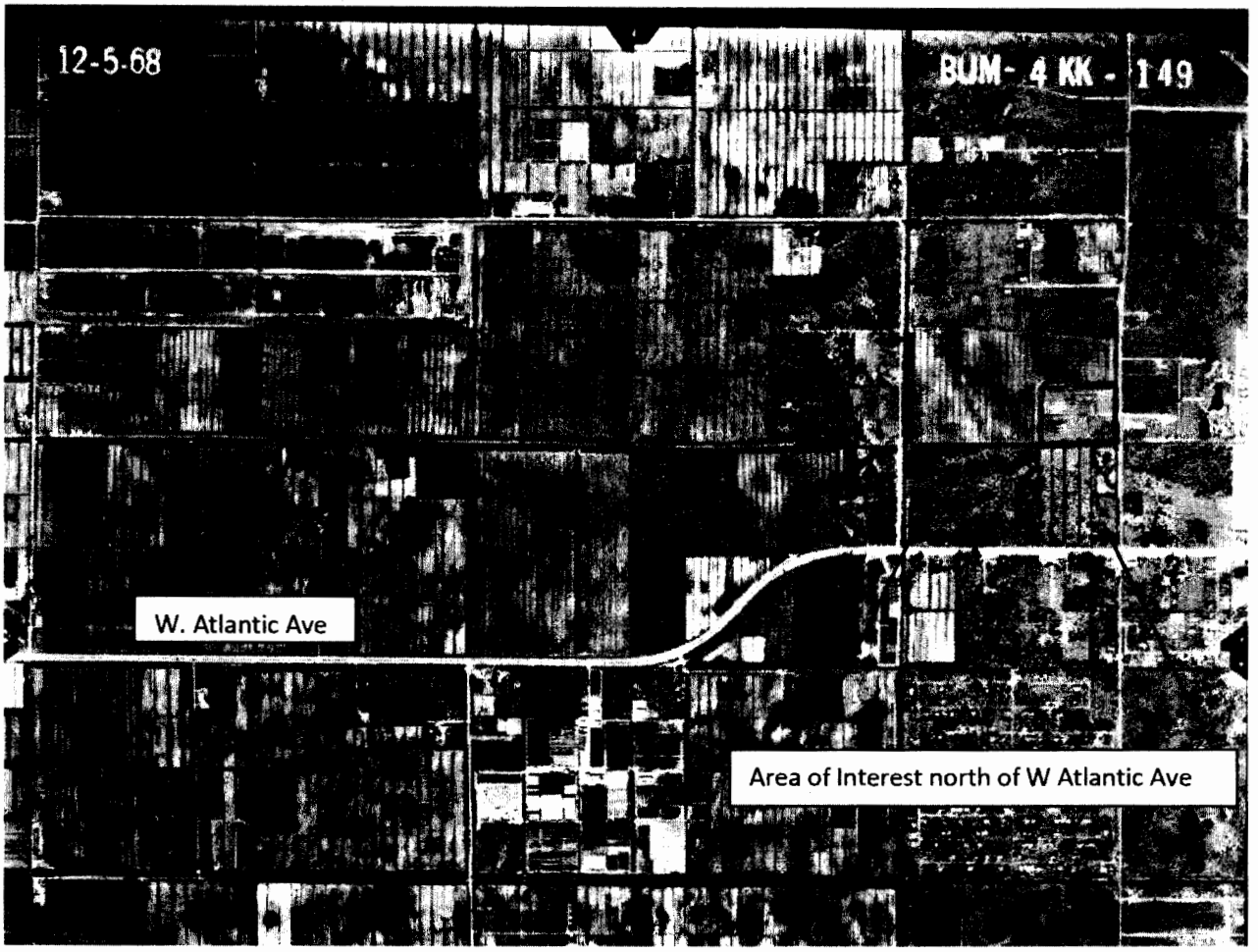


Photo 1: December 5, 1968

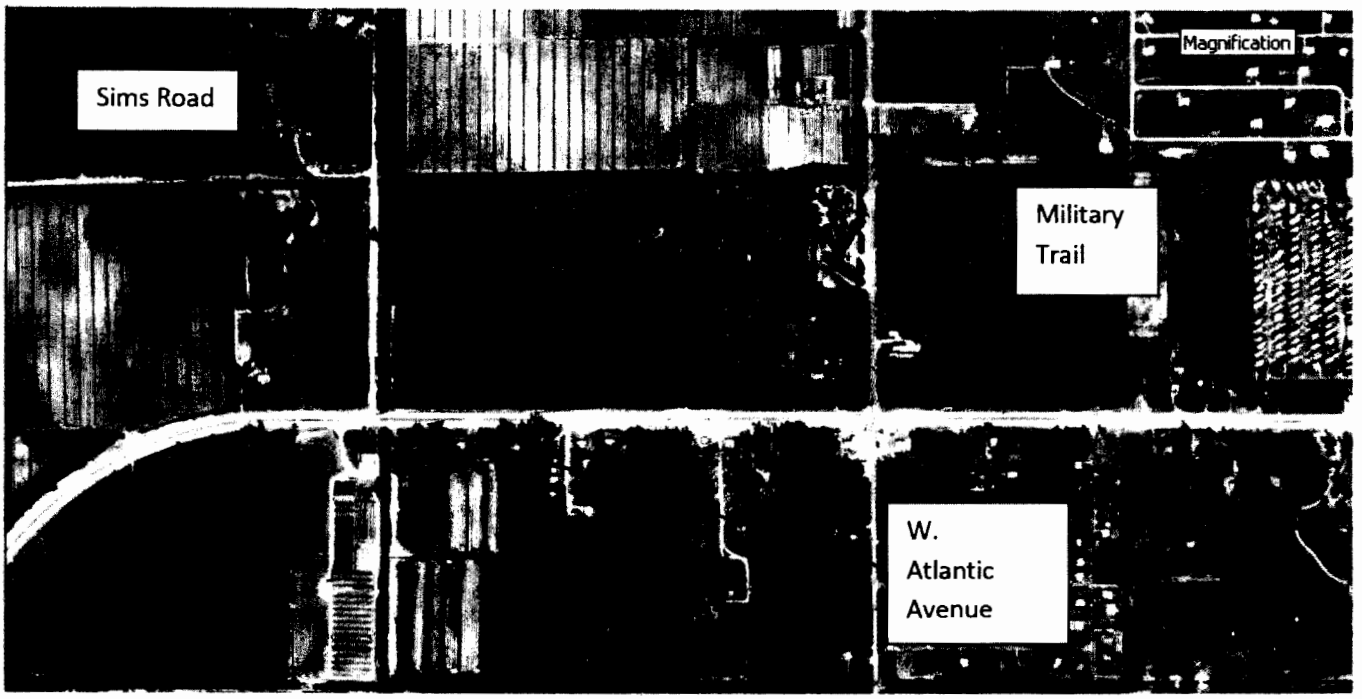


Photo 2: November 6, 1969

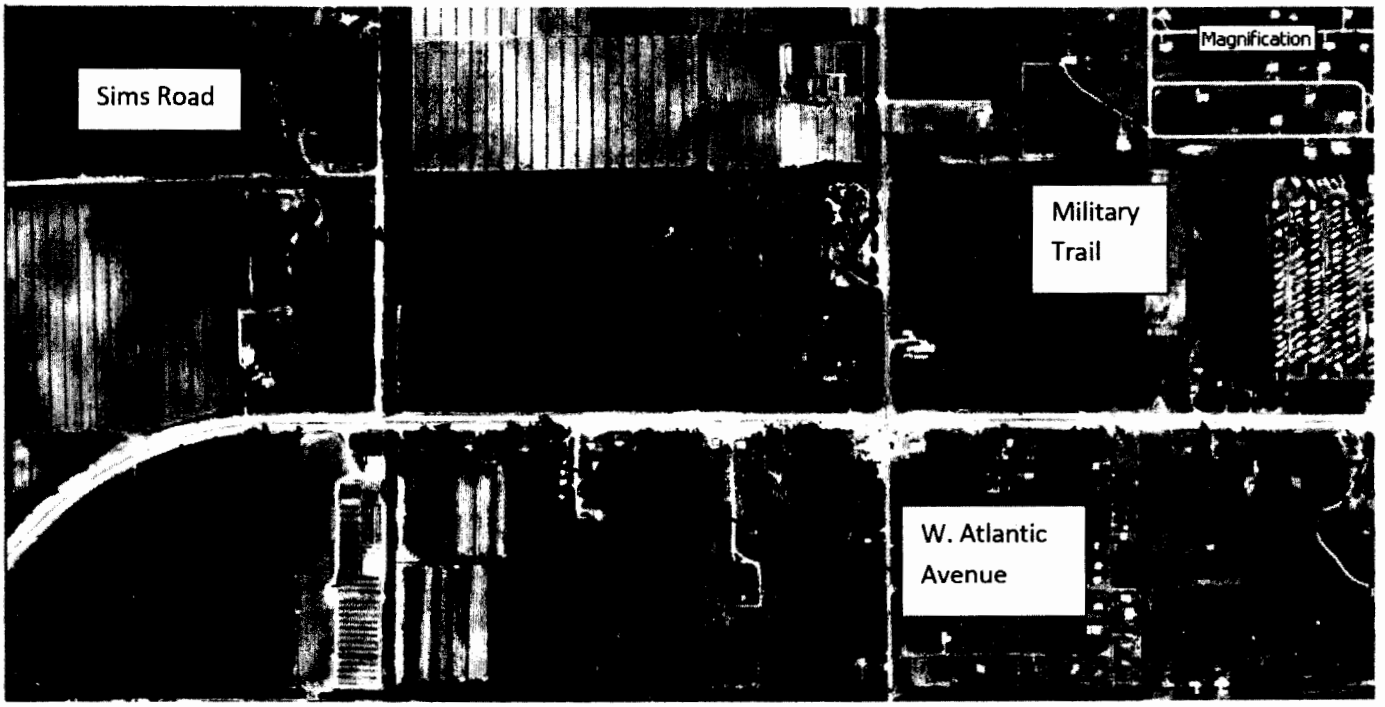


Photo 3: November 6, 1969 (Magnified)

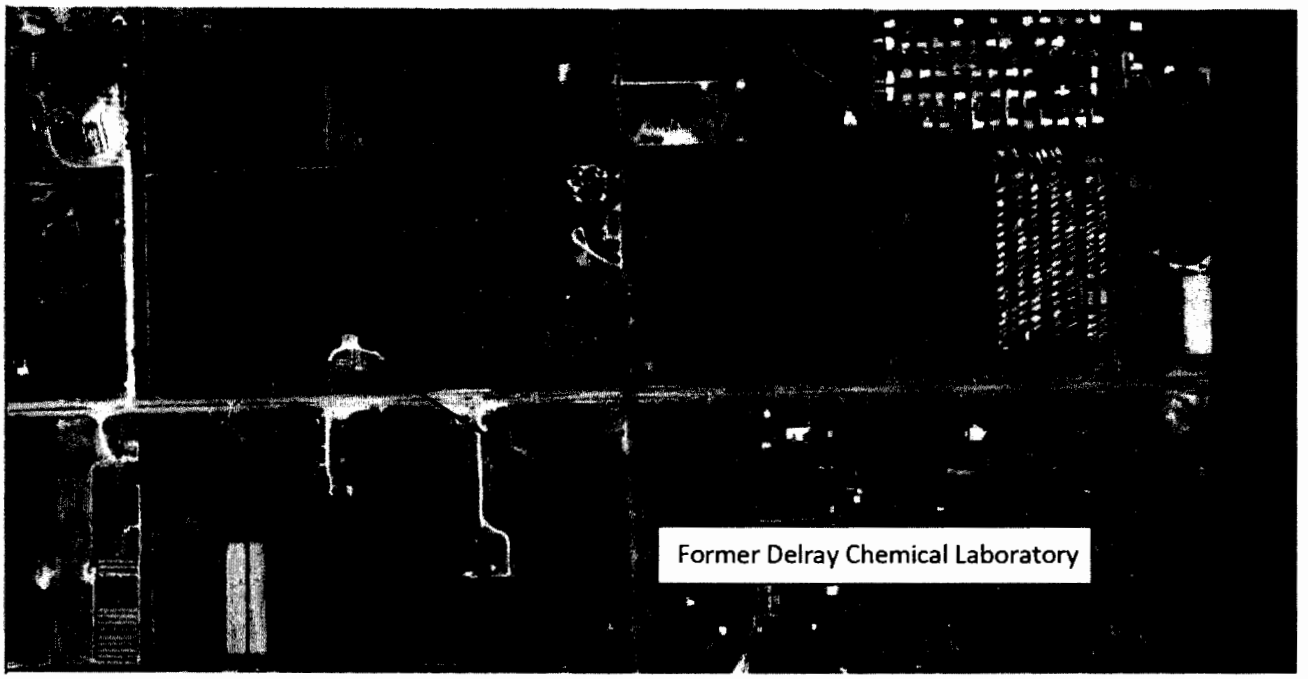


Photo 4: April 17, 1973

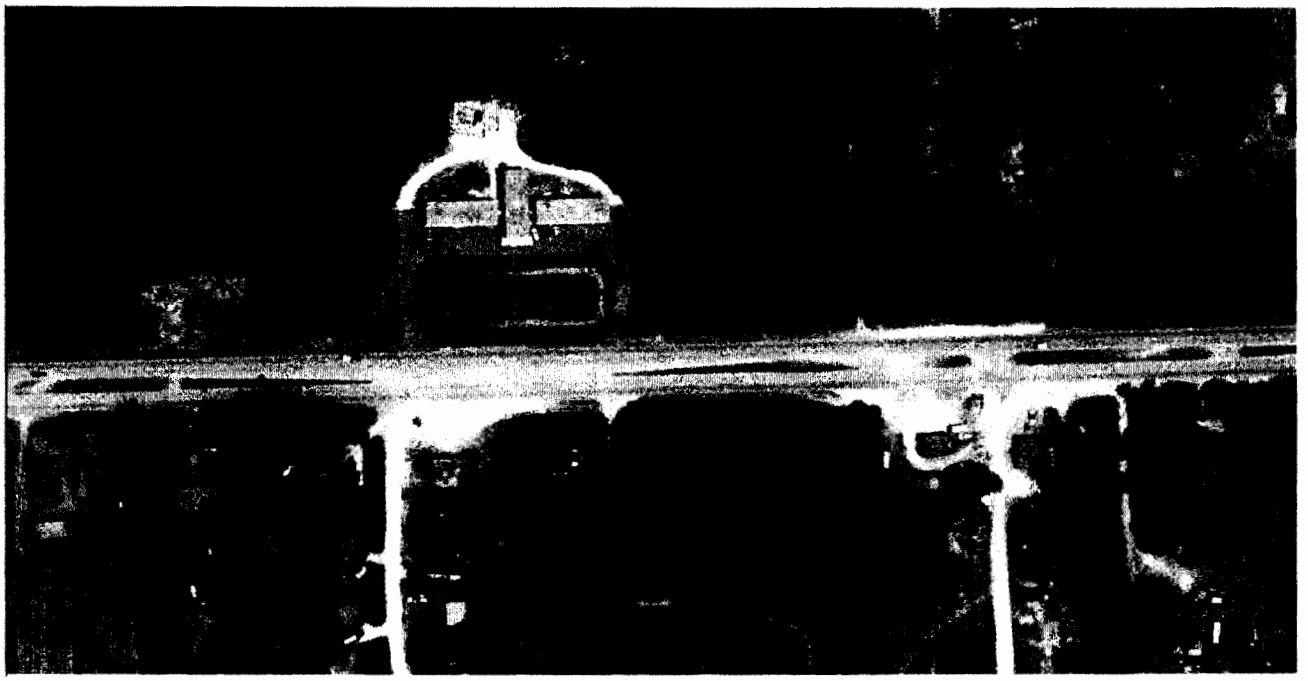


Photo 5: April 17, 1973 (Magnified)

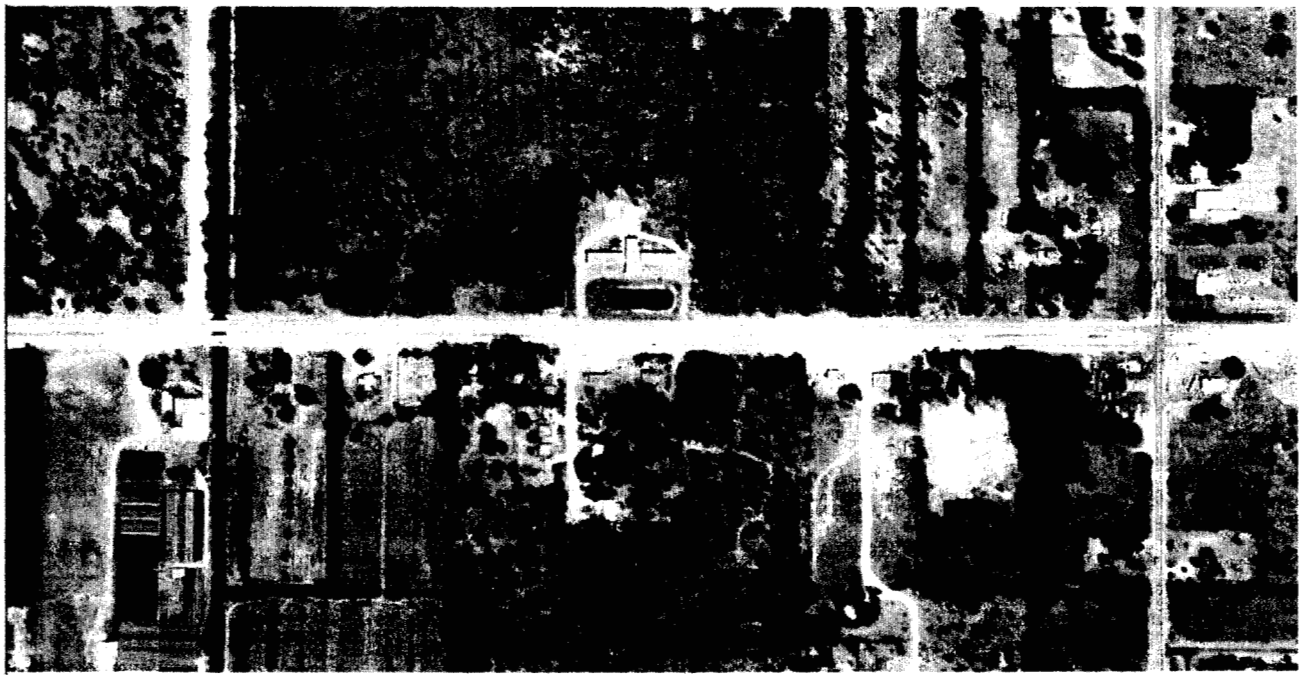


Photo 6: April 4, 1975

Photo 7: April 23, 1986

Wysk Company Profile for

WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.

Florida Limited Partnership | Wysk # JUTE8GH

United States Florida Delray Beach

Business Registration | Florida (Home State)

Florida Dept. of State

Data updated June 25, 2014

Business Registration

Business Name:	WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.
Business Type:	Limited Partnership
Citizenship:	Domestic
State of Incorporation:	FL
Principal Address:	101 PUGLIESE'S WAY DELRAY BEACH, FL 33444
Filing Status:	Active
Document Number:	A98000002768
Filing Date:	09/30/1998

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Corporate Officers, Directors and C-Level Executives for

WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.

Florida Limited Partnership | Wysk # JUTE8GH

United States Florida Delray Beach

Officers | Florida (Home State)

Florida Dept. of State

Data updated June 25, 2014

Name	Title	Address
WACP, INC.		101 PUGLIESE'S WAY DELRAY BEACH , FL 33444

Officer Report

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Wysk Company Profile for

WACP, INC.

Florida For-Profit Corporation | Wysk # 3V7MLJA

United States Florida Delray Beach

Business Registration | Florida (Home State)

Florida Dept. of State **Data updated June 25, 2014**

Business Registration

Business Name:	WACP, INC.
Business Type:	For-Profit Corporation
Citizenship:	Domestic
State of Incorporation:	FL
Principal Address:	101 PUGLIESE'S WAY DELRAY BEACH, FL 33444
Filing Status:	Active
Document Number:	P98000084316
Filing Date:	09/30/1998

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Corporate Officers, Directors and C-Level Executives for

WACP, INC.

Florida For-Profit Corporation | Wysk # 3V7MLJA

United States Florida Delray Beach

Officers | Florida (Home State)

Florida Dept. of State **Data updated June 25, 2014**

Name	Title	Address	
LAURA K PUGLIESE	President	101 PUGLIESE'S WAY DELRAY BEACH, FL 33444	Officer Report

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From: Mekeel, Deborah <Deborah.Mekeel@DOS.MyFlorida.com>
Sent: Tuesday, December 09, 2014 2:46 PM
To: Horton, Caroline
Subject: RE: Address Search
Attachments: Delray Beach - Big Apple-Carnival -5283 W Atlantic.pdf

Hello Caroline,

I checked our collection of City Directories, but we did not have directories for Delray Beach for the time period from 1992-present.

I was able to look up the two businesses names in the Florida Business Directory for years 1993-present. This directory does not allow you to look up an address to find out who was there at the time, but you can look up a name to see what address was listed. In all of the listings as mentioned below, the address was consistently listed as 5283 W. Atlantic Ave. Please note that these directories are published at the beginning of the time period included in the dates of the directory, so when you see changes occurring between editions of the directory, you are working with a range of dates (an approximation) not an exact date.

The first listing for Carnival Flea Market I found was in the 1999/2000 edition of the directory. It was listed as "Carnival Flea Market at Delray". There was no listing at all for Big Apple Shopping Bazaar.

In the 2009/2010 edition of the directory, the listing changed. Carnival Flea Market at Delray was still listed, and an additional name "Carnival's Atlantic City Arc" (presumably the last word is Arcade) was listed at the same address. Still no Big Apple.

Then in the 2012/2013 directory, the Atlantic City Arcade listing is gone and Carnival Flea Market at Delray is listed by itself again.

Finally, in the 2015/2015 directory, Big Apple Shopping Bazaar is listed at the address, and Carnival Flea Market is no longer listed at all.

Please see the attached PDF file for copies of the pages of the Florida Business Directory editions where I found the information above.

I hope this information is helpful,
Deborah

Deborah Mekeel
Reference
State Library of Florida
Phone: 850.245.6668
E-mail: Deborah.Mekeel@dos.myflorida.com

How well has the State Library of Florida served you? Please complete the survey at this Web address: http://www.surveymonkey.com/s.asp?u=195062237895. When you have completed the survey, click on the link titled "Done." You will be directed to the State Library of Florida's home page. Thank you for your time.

From: Horton, Caroline [mailto:Caroline.Horton@dep.state.fl.us]
Sent: Monday, December 08, 2014 1:43 PM
To: Mekeel, Deborah
Subject: Address Search

Ms. Mekeel,

I am writing to request a search for the name/business listed for the address 5283 Atlantic Ave per the Palm Beach County property appraiser, (though it is also listed on some sites as 5283 W Atlantic Ave), Delray Beach, Florida from 1992-present. Is it possible that you might have time to look into that for me? I believe the site is currently occupied by The Big Apple Shopping Bazaar (formerly Carnival Flea Market). Knowing the history of when the Big Apple Shopping Bazaar came to be on the site and what was there prior to that in recent history would be helpful.

Thank you so much for your time, and for any information you can provide.

Caroline Horton
Department of Environmental Protection
Waste Cleanup Program
CERCLA Site Screening Section
2600 Blair Stone Road, MS 4535
Tallahassee, FL 32399-2400
Office: (850) 245-8986
Fax: (850) 245-8976
Caroline.horton@dep.state.fl.us
Please consider the environment before printing this email.

@ItsWorkingFL

What's Working TODAY

The Department of State is committed to excellence.
Please take our Customer Satisfaction Survey.

66,860,160 COMPANIES 54,142,227 PRINCIPALS

HOME COMPANY SEARCH PEOPLE SEARCH TRADEMARK SEARCH ADDRESS SEARCH APPS PRO SEARCH BLOG

Introduction

WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.

FLORIDA DOMESTIC LIMITED PARTNERSHIP

Florida Department Of State Business Registration - Data Updated April 17, 2014

UCC SEARCH FOR WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.

West Atlantic Commercial Properties, Ltd. is a Florida Domestic Limited Partnership filed on September 30, 1998. The company's filing status is listed as Active and its File Number is A98000002268.

The Registered Agent on file for this company is Reamer Joseph and is located at 101 Pugliese's Way Delray Beach, FL 33444. The company's principal address is 101 Pugliese's Way Delray Beach, FL 33444 and its mailing address is 101 Pugliese's Way Delray Beach, FL 33444.

Company Information

Company Name:	WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.
File Number:	A98000002268
Filing State:	Florida (FL)
Filing Status:	Active
Filing Date:	September 30, 1998
Company Age:	16 Years, 3 Months
Registered Agent:	Reamer Joseph 101 Pugliese's Way Delray Beach, FL 33444
Principal Address:	101 Pugliese's Way Delray Beach, FL 33444
Mailing Address:	101 Pugliese's Way Delray Beach, FL 33444

Company Contacts

This company has not listed any contacts yet.

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http://search.sunbiz.org/Inquiry/CorporationSearch/SearchResultDetail/EntityName/domp-216448-aa7e9101-267d-45d6-a61a-c9cc4335dfdc/delray%20chemical/Page1

FLORIDA DEPARTMENT OF STATE
DIVISION OF CORPORATIONS

Events **No Name History**

Entity Name S Search

Return to Search Results

Detail by Entity Name

Florida Profit Corporation DELRAY CHEMICAL COMPANY INC
Filing Information

Document Number216448 FEI/EIN Number590864134 Date Filed10/17/1958 StateFL StatusINACTIVE Last EventADMIN DISSOLUTION FOR ANNUAL REPORT Event Date Filed10/09/1992 Event Effective DateNONE

Principal Address

1065 SW 15TH AVE.
SUITE 5
DELRAY BEACH, FL 33444

Changed: 02/09/1990

Mailing Address

1065 SW 15TH AVE.
SUITE 5
DELRAY BEACH, FL 33444

Changed: 02/09/1990

Registered Agent Name & Address WALKER, JAMES

1065 SW 15TH AVE.
SUITE 5
DELRAY BEACH, FL 33444

Name Changed: 11/15/1991

Address Changed: 02/09/1990

Officer/Director Detail **Name & Address**

Title P

WALKER, KAREN

1065 SW 15 AVE.
DELRAY BEACH, FL

Title D

WALKER, JAMES

1065 SW 15 AVE.
DELRAY BEACH, FL

Annual Reports

Report Year	**Filed Date**
1989	02/17/1989
1990	02/09/1990
1991	11/15/1991

Document Images

No images are available for this filing.

Events **No Name History**

Entity Name S Search

Return to
Search Results

Copyright and Privacy Policies
State of Florida, Department of State

Events

DELRAY CHEMICAL COMPANY INC

Document Number 216448

Date Filed 10/17/1958

Effective Date None

Status Inactive

Event Type	Filed Date	Effective Date	Description
ADMIN DISSOLUTION FOR ANNUAL REPORT	10/09/1992		
REINSTATEMENT	11/15/1991		
ADMIN DISSOLUTION FOR ANNUAL REPORT	10/11/1991		

Return to Detail Screen

Image capture: May 2011 © 2014 Google

Search...

Stormwater

Print (http://mydelraybeach.com/print/125) PDF (http://mydelraybeach.com/pdf/125)

What is stormwater and where does it go?

Stormwater is rainwater that washes through our property and streets, taking with it any debris that may be in its path. This mixture of rain, debris, oil and waste is known as "runoff". In the past municipalities, as well as other public and private agencies, worked to get stormwater off the roads as quickly as possible to avoid flooding. Today these same agencies are working to not only reduce and often eliminate flooding, but to prevent pollution by the elements picked up by runoff.

When you pass a storm inlet, do you know where the water goes? Do you think it is channeled to a treatment plant the way sewage is? Think again! Up north, there may still be some existing combined sewer systems, where both sewage and stormwater are channeled to the local sewage treatment plant. Here in Florida, we do not have combined systems. In fact, in most areas of the Country inflow and infiltration (I/I) studies are done to find ground water and rainwater leaks in sanitary sewer systems and repair any damage. Sewage treatment costs money, and treating large amounts of added stormwater would be very expensive. South Florida is surrounded by water bodies such as the Intracoastal Waterway, finger canals, lakes and the Atlantic Ocean, and that is exactly where most stormwater runoff goes.

The next time you pass an inlet, remember that it most likely discharges into a body of water that may be near where you live, swim or fish! Do not add to the pollution problem by pouring anything down the storm drain, and remember that the drain is for stormwater only!

Learn more about stormwater, and support your stormwater assessment program. This program is working for all of us and will enable our future generations to enjoy cleaner water. This webpage will help to explain more about NPDES, BMPs, assessments, construction, and what you can do to help.

What is NPDES?

How It Began

Section 402(p) of the 1987 Federal Clean Water Act required the U.S. Environmental Protection Agency (EPA) to establish the National Pollutant Discharge Elimination System (NPDES (http://pbco-npdes.org/)) stormwater permit program. This program requires local governments to obtain permits for their existing stormwater drainage systems, and for stormwater from certain industrial activities. This includes all construction projects that will disturb one or more acres of land, government owned landfills, power plants, airports, vehicle maintenance facilities and wastewater treatment plants.

How This Effects the City of Delray Beach

The NPDES regulations are directed at local governments, which are liable, for the pollutants discharged from their stormwater systems into the waters of the United States. Delray Beach is one of 40 co-permittees in Palm Beach County responsible for developing a long term, comprehensive stormwater program to reduce the pollutant loading from their systems caused by non-point sources. Non-point sources are polluting sources other than direct discharges from factories and industries. Automotive oil and grease, herbicides and pesticides used in lawn maintenance, and runoff from City streets are a few examples of non-point sources of pollution.

The City has already developed an inventory of its stormwater management system. Currently infrastructure deficiencies are being identified and appropriate repairs completed.

Best Management Practices (BMPs)

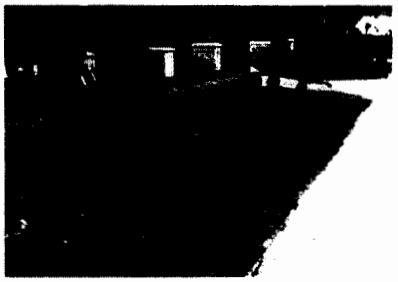
The state Stormwater Rule, Chapter 17-25 Florida Administrative Code, was implemented by the Department of Environmental Regulation in 1982. The rule requires the use of BMPs to treat the first flush of stormwater to remove 80% of the annual average pollutant load. A good example of a BMP is the construction of swales.

S.O.S. - Save our swales!

Swales and Stormwater Runoff

In the past, the plan for rainwater was to get it off the streets and into nearby canals as quickly as possible. When it rains, the water runs off paved surfaces and takes with it the oils, greases, animal wastes and debris, and deposits it in our canals, rivers and lakes. Today we know that stormwater runoff is a primary source of water pollution. In fact, Federal and State legislation have been enacted requiring cities throughout the country to develop comprehensive stormwater management programs.

Swales are generally defined as the strip of land in front of your homes and adjacent to the street. Although you may never have stopped to think about it before, swales are important to the protection of our environment and the appearance of our neighborhoods. Swales are an important tool used to slow down the water runoff and allowing it to pool in the grassy areas. The water is then filtered by the grass and percolates into the ground recharging our water supply. Swales also help to reduce erosion and can be used in other sensitive areas of the yard or commercial property.



Landscaping behind the swale is beautiful and effective.

Working Together

The City realizes that you may need to make certain changes to your swale. We would like you to follow current City guidelines that will protect our environment and your neighborhood:

Paving: If you need to pave your swale for driveway access, pave only the section you need and leave the rest of the swale in its natural state. Remember that paving requires a City permit, since pavement is considered to be a permanent structure.

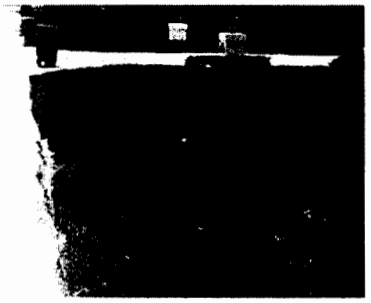
Plantings: Landscaping your front swale may be pleasing to the eye, but it does disrupt the natural drainage features of your neighborhood. Installing your plantings behind your property line, away from the road, adds beauty to your home and leaves the swale intact.

Parking: Avoid continual parking of vehicles on your swale to allow healthy grass to develop and keep the soil loose so water can percolate into the ground.

Driveways: Make sure your driveway's design allows water to drain toward your swale.
Debris: Keep your swale free of leaves, limbs, and other vegetation. Properly dispose of debris and oil rather than placing them in your swale.

Remember:

- Runoff should temporarily pond in the swale for 24 to 36 hours; mosquitoes won't breed until water ponds for at least 72 hours.
- Keep healthy, aerated grass growth.
- Minimize the use of fertilizers, pesticides and herbicides.
- Do not pave the swales as this reduces percolation of runoff.
- Do not park vehicles in the swale as this compacts the soil and reduces percolation.



Driveways should be designed to channel rainwater into swales.

Cleaner Water

By following these few simple steps, the City will be working towards cleaner water for all of us while recharging our system.

Stormwater Assessments

Why Assessments?

The Federal government requires compliance with the NPDES (http://pbcn.npdes.org/) stormwater permit program. This means funding for maintenance, repair and construction of stormwater systems. Previously, the financial source was the City's general fund, which meant the stormwater program would compete with more popular programs such as fire and police. Stormwater was a low priority, except when it rained!

Today, removing stormwater from our streets is only part of the issue. Stormwater is polluting the country's water bodies and the Federal government is requiring each local governing entity be involved with the cleanup. Non-ad valorem assessments allow separate funding dedicated to the stormwater program. An example is the City's swale construction project as it is an important means of not only removing storm runoff, but also allowing the runoff to filter through grass to recharge our water supply.

Is It Fair?

All government entities do a great deal of research and communicate with each other in their goal to make assessments fair to all residents, and to comply with Federal and State laws. Stormwater assessments and utilities are relatively new and there have been many changes over the years for most municipalities. There may be more changes in the future in response to new and better technologies.

How Does Delray Beach Calculate Assessments?

Almost all governments using assessments calculate by land areas and/or impervious areas and there is a set amount for an Equal Residential Unit (ERU). When the City's non-ad Valorem assessment was created in 1990, 2,502 square feet was considered the average size of a Single Family Residence (SFR) in the City. Currently, the amount for one ERU is $63.96 for 2,502 square feet. Delray Beach has five formulas for assessment calculations:

Single Family Residential	1 ERU	= $63.96
Single Family Residential with common elements within the platted subdivision	1 ERU plus the pro-rated assessment amount of the platted subdivision common elements divided by the total number of parcels within the subdivision	= $ Amount
Condominium	Sq. Ft. impervious area divided by 2,502, multiplied by 1 ERU, divided by number of units	= $ Amount
Developed non-residential, Multi-Family Dwelling	Sq. Ft. impervious area divided by 2,502, multiplied by 1 ERU	= $ Amount
Unimproved Land	Total Acres multiplied by 1.2 ERUs ($76.75)	= $ Amount

Common elements within a platted subdivision will not be assessed to the subdivision associations. However, the assessment amount of the common elements will be pro-rated among the parcels within the subdivision.

If the assessed property lies within the Lake Worth Drainage District, it receives a 25% discount. If the property has a privately maintained stormwater system, approved by the City

Engineer, it receives a 25% discount. This means a property may receive up to a 50% discount off its annual assessment.

When will I Receive My Assessment?

The Palm Beach County Property Appraiser will mail residents a notice of proposed property taxes in mid-August, called the TRIM (Truth In Millage) Notice. On November 1st, the County Tax Roll is open for collections. Non-ad valorem assessments are not based on millage and will appear on the bottom of the Notice of Ad valorem and Non-ad valorem Assessments.

The Goal:

According to the Environmental Protection Agency (EPA), stormwater from urban runoff and storm sewers is the second leading source of water quality impairment for lakes and estuaries and the third for rivers. Dedicated funding, whether assessments or utilities, is extremely important to enable local governments to clean up our water supplies.

What you can do as a resident

In order for us to understand how we can help the environment, we must first understand what Pointless Personal Pollution is and how it effects us in our daily lives.

Pointless Personal Pollution

Stormwater pollution is categorized into two groups: point source and non-point source. Point source pollution comes from industrial businesses and sewage treatment facilities, and is monitored by government permit. Non-point source pollution is contributed by homes, businesses and farms. Non-point source pollution is important to us since we are the cause, and we can stop it! Pointless Personal Pollution is caused by many of our day-to-day activities, and is washed into the state's waters by irrigation and rain runoff. Some examples of these pollutants are:

- Soil erosion caused by a lack of ground cover.
- Uncontrolled construction activities.
- Automotive and lawn equipment oil leaks, degreasers, and improper disposal of used oils other products into storm drains.
- Litter.
- Yard trash, especially piled onto, or placed near a storm inlet.
- Grass clippings blown into the street.
- Garbage not cleaned up around dumpsters and garbage cans.
- Pet and livestock wastes.
- Sewer and septic overflows.

Pointless Personal Pollution Affect Us in Many Ways:

Nutrients from septic tanks, fertilizers and animal wastes cause excessive growth of algae and aquatic weeds. Many of our boaters are dismayed at finding these weeds tangled in their propellers! Sewage, litter and garbage reduce oxygen levels in the water, killing aquatic life. Sediments from soil erosion clog fish gills and shellfish filtering systems, suffocating them. Pesticides and heavy metals contaminate water body sediments and kill aquatic life. Pathogens from animal waste and septic tanks contaminate shellfish and lead to the closing of swimming areas. How do we go about improving our waters individually?

Easy, Important Ways to Help Us Reduce Pointless Personal Pollution:

- We can start by shopping wisely. Buy products that are labeled non-toxic, biodegradable, non-phosphorus, or water soluble.
- Store products safely by keeping toxic products in their original containers and keep them in safe places that cannot be accessed by children or pets.
- Properly maintain septic systems by annual inspections, pump out as needed and avoid disposing caustic cleaners, chemicals or solvents, as they destroy beneficial bacteria and clog absorption fields.
- Do not place yard clippings, branches or other debris on top of the storm drain. Grass clippings left on the grass make excellent mulch, while blowing clippings into the street add to pollution of the lakes and canals.
- Service vehicles and lawn equipment regularly, and dispose of used oils and antifreeze at the local service station.
- Find your roof drains and route the water away from your driveway towards a grassy part of your yard.

- Fertilize with a low nitrogen mix, and don't apply it before the rains - most of it will runoff and the benefit to your lawn will be lost. Spray pesticides infrequently, using an eco-friendly substitute.
- Wash your car in the grass, not in your driveway. Soap will act as a safe pesticide for your lawn, but not safe for your canal or lake.
- Never pour anything down an inlet, no matter how harmless it may seem to you. These systems are intended for rainwater only!

These simple steps will go a long way to help keep our canals, lakes and ground water clean. For more information refer to the Florida Yards and Neighborhoods (http://hort.ufl.edu/fyn/) web site provided by the University of Florida Extension.

Citizen Reporting of Hazardous Spills and Illicit Dumping

Unfortunately, there are occasions where there are accidents with hazardous materials, or intentional dumping of toxic wastes. Sometimes the incident may be as simple someone dumping an unknown (or known) waste product into an inlet. All of these situations must be dealt with swiftly, and as citizens of Delray Beach, we must get involved to keep our area beautiful and prevent pollution of our waters. If you see something suspicious, or witness such an accident, there are simple steps to take and phone numbers available.

The Delray Beach Fire Department has highly trained Hazmat personnel equipped to suit up, analyze substances, contain and clean up hazardous spills and releases. If you witness such a spill or release, call 911 immediately and give an address and description of what happened. If you see someone pour an unknown substance down an inlet, or if you see or smell an unknown substance in an inlet, call the Fire Department immediately (911) and give the dispatcher a description of the scene and an address. The Fire Department will determine further steps needed for containment and clean up. Never try to get samples of the substance yourself, leave that task to the professionals!

If you see someone pouring a substance into an inlet, and you know what the substance is, such as dirt, debris, concrete, motor oil or paint, call the Code Enforcement Department (243-7219) immediately and give a detailed description of the scene with the closest address to the inlet.

Print and place the following table near your phone or tape onto your refrigerator:

Scene	Description	Call
Hazardous spill or release	Spill or intentional release of unknown substance	911
Unknown substance in inlet	Someone pouring unknown substance into inlet, or unknown substance found in inlet	911
Known substance in inlet	Known substances such as oil, paint, concrete, trash, household products found in inlet	243-7219

Whether a hazardous spill or an illicit dumping is an accident or intentional, it is the responsibility of all of us to respond swiftly to protect the environment that surrounds our beautiful city, and all we need to do is pick up the phone!

EPA's Explorers' Club for Kids!

Go to the EPA's website for kids! (http://www.epa.gov/kids/) There are many great sites such as the "Students' Site", "Teachers' Site", "Ask EPA" and more. Other topics include "Plants & Animals", "You and Your Environment", "Water", "Games", "Science Room", "Art Room" "Garbage & Recycling" and much, much more. There are downloadable coloring books, interactive pages, competitions, contests and a place to display your artwork. Check it out for learning about your environment while having fun. Even more information and fun may be found at EPA's Water for Kids! (http://www.epa.gov/water/kids/waterforkids.html) Webpage.

Construction within a MS4

A MS4 means a Municipal Separate Storm Sewer System, and relates to any stormwater conveyance system that discharges into State or Federal waters. Our NPDES permit requires that if small construction activities of one to five acres, and development or redevelopment of five or more acres within a MS4, then certain steps are taken to ensure that the construction does not pollute our waters. The City has its own requirements written in the Land Development Regulations, for construction along the Intracoastal Waterway.

Developing or Re-developing One Acre or More?

A NOI (Notice of Intent) form must be filled out and sent to the FDEP (Florida Department of Environmental Protection) two days prior to construction. Authorization is granted 48 hours after NOI postmark. As additional site operators are identified, they must submit a NOI. The

NOI assigned number (or assigned NPDES permit) must be kept visibly on site at all times throughout the project.

You can now apply online for Interactive Notice of Intent (http://www.dep.state.fl.us/water/stormwater/npdes/index.htm). iNOI (http://www.dep.state.fl.us/water/stormwater/npdes/index.htm) is a web-based application that allows you to complete, edit and submit NOIs, CGP and NOTs online. You can also pay certain NPDES Stormwater permit fees online.

If you prefer, you can submit a completed NOI manually to:

NPDES Stormwater Notices Center, MS#2510
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, FL 32399-2400

A SWPPP (Stormwater Pollution Prevention Plan) is created by the person in charge, such as contractor or owner, and kept on site at all times throughout the project. Each new contractor or subcontractor who joins the project must sign a certification statement, and add it to the SWPPP. The General Permit contains information on creating a SWPPP. The person in charge of the project must inspect the site for BMPs (Best Management Practices) every week or after every 1/2" rain event. This must be documented and available upon request. A SWPPP Inspection and Maintenance Report Form (http://mydelraybeach.com/NR/rdonlyres/ehxu4r773wq3kvsygtxo2smjeo4vzebuce4dgm4/ttnqvzapovydzesxot4ga4i3/mfqwvp3ww/q2a7nkxopqa/Resources%2fDelray%2fDepartments%2fEnvironmental+Services%2fAttachments%2fStormwater/PPP+Inspection+and+Mainten.pdf) is found in the City's Construction Standards (http://mydelraybeach.com/Delray/Departments/Environmental+Services/Standards+and+Details+2011.htm) or downloaded from the Palm Beach County NPDES Program (http://pbco-npdes.org/) web site. A form for the SWPPP for Stormwater Discharges Associated with Small Construction Activities - One to Five Acres (http://mydelraybeach.com/NR/rdonlyres/ovtqpi5y7f4dq34ofbttomlcak4gamsx6xee2eu2pwlcnwcfjvjhbk6mmaedlwb7mlfsyjzcm2f5wcqtnxwmans4/Stormwater/PPP.pdf) may be found in the City's Construction Standards (http://mydelraybeach.com/Delray/Departments/Environmental+Services/Standards+and+Details+2011.htm), or downloaded from the Palm Beach County NPDES Program (http://pbco-npdes.org/) website.

A NOT (Notice of Termination) form must be filled out and sent to the FDEP upon completion of the project. The NOI, NOT, General Permit for Construction Activities and other relevant information may be downloaded from the Palm Beach County NPDES Program (http://pbco-npdes.org/) web site.

Who is SAM?

SAM stands for Stormwater And Me, and he is here to help us to understand where the "me" comes in to stop personal pollution of our waters. There are so many simple, everyday things we can do to stop personal pollution: we can recycle, we can wash our cars away from stormwater inlets, we can fertilize our lawns on days we don't expect rain and we can stop blowing landscape debris into the streets, to name a few. To find out more about what the "me" in "Stormwater And Me" means to each of us, go to Sam's website:

(http://www.stormwaterandme.org/)

Stormwater and Me!
Keep pollution out of our waters

(http://www.stormwaterandme.org/)

Related Links

The Florida Department of Environmental Protection (http://www.dep.state.fl.us/)
The Florida Stormwater Association (http://www.floridastormwater.org/)
The Florida Water and Pollution Control Operator's Association (http://www.fwpcoa.org/)
Florida Yards and Neighborhoods (http://www.pbcgov.com/coopext/fyn/index.htm)
Palm Beach County NPDES Program (http://pbco-npdes.org/)
U.S. Environmental Protection Agency (http://www.epa.gov/)

Delray Beach (city), Florida

People QuickFacts	Delray Beach	Florida
Population, 2013 estimate	64,072	19,552,860
Population, 2012 estimate	62,356	19,320,749
Population, 2010 (April 1) estimates base	60,601	18,802,690
Population, percent change, April 1, 2010 to July 1, 2013	5.7%	4.0%
Population, percent change, April 1, 2010 to July 1, 2012	2.9%	2.8%
Population, 2010	60,522	18,801,310
Persons under 5 years, percent, 2010	4.7%	5.7%
Persons under 18 years, percent, 2010	16.1%	21.3%
Persons 65 years and over, percent, 2010	23.6%	17.3%
Female persons, percent, 2010	51.9%	51.1%
White alone, percent, 2010 (a)	65.7%	75.0%
Black or African American alone, percent, 2010 (a)	28.0%	16.0%
American Indian and Alaska Native alone, percent, 2010 (a)	0.2%	0.4%
Asian alone, percent, 2010 (a)	1.8%	2.4%
Native Hawaiian and Other Pacific Islander alone, percent, 2010 (a)	0.1%	0.1%
Two or More Races, percent, 2010	1.7%	2.5%
Hispanic or Latino, percent, 2010 (b)	9.5%	22.5%
White alone, not Hispanic or Latino, percent, 2010	59.2%	57.9%
Living in same house 1 year & over, percent, 2008-2012	82.9%	83.7%
Foreign born persons, percent, 2008-2012	20.7%	19.3%
Language other than English spoken at home, pct age 5+, 2008-2012	25.2%	27.3%
High school graduate or higher, percent of persons age 25+, 2008-2012	86.2%	85.8%
Bachelor's degree or higher, percent of persons age 25+, 2008-2012	34.8%	26.2%
Veterans, 2008-2012	4,836	1,606,756
Mean travel time to work (minutes), workers age 16+, 2008-2012	22.8	25.8
Housing units, 2010	34,156	8,989,580
Homeownership rate, 2008-2012	65.0%	68.1%
Housing units in multi-unit structures, percent, 2008-2012	50.8%	30.1%
Median value of owner-occupied housing units, 2008-2012	$206,000	$170,800
Households, 2008-2012	26,883	7,147,013
Persons per household, 2008-2012	2.25	2.58
Per capita money income in past 12 months (2012 dollars), 2008-2012	$36,779	$26,451
Median household income, 2008-2012	$50,935	$47,309
Persons below poverty level, percent, 2008-2012	14.7%	15.6%

Business QuickFacts	Delray Beach	Florida
Total number of firms, 2007	9,294	2,009,589
Black-owned firms, percent, 2007	11.0%	9.0%
American Indian- and Alaska Native-owned firms, percent, 2007	F	0.5%
Asian-owned firms, percent, 2007	S	3.2%
Native Hawaiian and Other Pacific Islander-owned firms, percent, 2007	F	0.1%
Hispanic-owned firms, percent, 2007	8.0%	22.4%
Women-owned firms, percent, 2007		

	28.5%	28.9%
Manufacturers shipments, 2007 ($1000)	152,321	104,832,907
Merchant wholesaler sales, 2007 ($1000)	477,911	221,641,518
Retail sales, 2007 ($1000)	1,568,835	262,341,127
Retail sales per capita, 2007	$24,558	$14,353
Accommodation and food services sales, 2007 ($1000)	218,434	41,922,059

Geography QuickFacts	**Delray Beach**	**Florida**
Land area in square miles, 2010	15.81	53,624.76
Persons per square mile, 2010	3,828.3	350.6
FIPS Code	17100	12
Counties		

(a) Includes persons reporting only one race
(b) Hispanics may be of any race, so also are included in applicable race categories

D: Suppressed to avoid disclosure of confidential information
F: Fewer than 25 firms
FN: Footnote on this item for this area in place of data
NA: Not available
S: Suppressed; does not meet publication standards
X: Not applicable
Z: Value greater than zero but less than half unit of measure shown

Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, American Community Survey, Census of Population and Housing, County Business Patterns, Economic Census, Survey of Business Owners, Building Permits, Census of Governments
Last Revised: Tuesday, 08-Jul-2014 06:43:28 EDT

FLORIDA DEPARTMENT OF STATE
DIVISION OF CORPORATIONS

Detail by Entity Name

Florida Limited Partnership

WEST ATLANTIC COMMERCIAL PROPERTIES, LTD.

Filing Information

Document Number	A98000002268
FEI/EIN Number	650867439
Date Filed	09/30/1998
State	FL
Status	ACTIVE

Principal Address

101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Changed: 03/23/2009

Mailing Address

101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Changed: 03/23/2009

Registered Agent Name & Address

REAMER, JOSEPH
101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Name Changed: 04/30/2005

Address Changed: 04/30/2007

General Partner Detail

Name & Address

Document Number P98000084316

WACP, INC.
101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Annual Reports

Report Year	Filed Date

2012	04/17/2012
2013	03/25/2013
2014	04/01/2014

Document Images

04/01/2014 -- ANNUAL REPORT	View image in PDF format
03/25/2013 -- ANNUAL REPORT	View image in PDF format
04/17/2012 -- ANNUAL REPORT	View image in PDF format
02/03/2011 -- ANNUAL REPORT	View image in PDF format
01/06/2010 -- ANNUAL REPORT	View image in PDF format
03/23/2009 -- ANNUAL REPORT	View image in PDF format
03/07/2008 -- ANNUAL REPORT	View image in PDF format
04/30/2007 -- ANNUAL REPORT	View image in PDF format
04/27/2006 -- ANNUAL REPORT	View image in PDF format
04/30/2005 -- ANNUAL REPORT	View image in PDF format
04/20/2004 -- ANNUAL REPORT	View image in PDF format
04/21/2003 -- ANNUAL REPORT	View image in PDF format
04/16/2002 -- ANNUAL REPORT	View image in PDF format
03/07/2001 -- ANNUAL REPORT	View image in PDF format
02/14/2000 -- ANNUAL REPORT	View image in PDF format
02/12/1999 -- ANNUAL REPORT	View image in PDF format
10/01/1998 -- Domestic LP	View image in PDF format

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FLORIDA DEPARTMENT OF STATE
DIVISION OF CORPORATIONS

Detail by Entity Name

Florida Profit Corporation

WACP, INC.

Filing Information

Document Number	P98000084316
FEI/EIN Number	650867440
Date Filed	09/30/1998
State	FL
Status	ACTIVE
Last Event	AMENDMENT
Event Date Filed	11/08/2013
Event Effective Date	NONE

Principal Address

101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Changed: 03/23/2009

Mailing Address

101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Changed: 03/23/2009

Registered Agent Name & Address

REAMER, JOSEPH
101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Name Changed: 04/30/2005

Address Changed: 04/30/2007

Officer/Director Detail

Name & Address

Title P

PUGLIESE, LAURA K
101 PUGLIESE'S WAY
DELRAY BEACH, FL 33444

Annual Reports

Report Year	Filed Date
2012	04/17/2012
2013	03/25/2013
2014	04/01/2014

Document Images

04/01/2014 -- ANNUAL REPORT	View image in PDF format
11/08/2013 -- Amendment	View image in PDF format
03/25/2013 -- ANNUAL REPORT	View image in PDF format
04/17/2012 -- ANNUAL REPORT	View image in PDF format
02/03/2011 -- ANNUAL REPORT	View image in PDF format
01/06/2010 -- ANNUAL REPORT	View image in PDF format
03/23/2009 -- ANNUAL REPORT	View image in PDF format
03/07/2008 -- ANNUAL REPORT	View image in PDF format
04/30/2007 -- ANNUAL REPORT	View image in PDF format
11/13/2006 -- Amendment	View image in PDF format
04/27/2006 -- ANNUAL REPORT	View image in PDF format
04/30/2005 -- ANNUAL REPORT	View image in PDF format
04/19/2004 -- ANNUAL REPORT	View image in PDF format
04/14/2003 -- ANNUAL REPORT	View image in PDF format
04/22/2002 -- ANNUAL REPORT	View image in PDF format
03/05/2001 -- ANNUAL REPORT	View image in PDF format
02/16/2000 -- ANNUAL REPORT	View image in PDF format
03/02/1999 -- ANNUAL REPORT	View image in PDF format
09/30/1998 -- Domestic Profit	View image in PDF format

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State of Florida, Department of State

Gary R. Nikolits, CFA
Property Appraiser
Palm Beach County

Homestead Exemption E-file

Location Address 5283 ATLANTIC AVE
Municipality UNINCORPORATED
Parcel Control Number 00-42-46-14-00-000-5300
Subdivision
Official Records Book 12165 Page 1875
Sale Date NOV-2000
Legal Description 14-46-42, E 1/2 OF SE 1/4 OF NW 1/4 OF SE 1/4 (LESS S 60 FT SR 806 R/W)

Owners
WEST ATLANTIC COMML PROP LTD

Mailing address
THE PUGLIESE CO C/O 101 PINEAPPLE GROVE WAY
DELRAY BEACH FL 33444 3703

Sales Date	Price	OR Book/Page	Sale Type	Owner
NOV-2000	$10	12165 / 1875	DEED OF TRUST	WEST ATLANTIC COMML PROP LTD
SEP-1993	$644,000	07888 / 0534	WARRANTY DEED	
JUN-1987	$1,869,000	05352 / 0684	WARRANTY DEED	
NOV-1982	$1,366,800	03834 / 0956	WARRANTY DEED	
JUN-1981	$1,391,118	03542 / 0563	WARRANTY DEED	

1 2

No Exemption Information Available.

Number of Units 0 *Total Square Feet 34030 Acres 4.4966
Use Code 1300 - DEPARTMENT STORE Zoning CG - General Commercial (00-UNINCORPORATED)

Tax Year	2014	2013	2012
Improvement Value	$956,690	$933,505	$1,033,984
Land Value	$1,421,852	$1,393,974	$1,393,974
Total Market Value	$2,378,542	$2,327,479	$2,427,958

All values are as of January 1st each year

Tax Year	2014	2013	2012
Assessed Value	$2,378,542	$2,327,479	$2,427,958
Exemption Amount	$0	$0	$0
Taxable Value	$2,378,542	$2,327,479	$2,427,958

Tax Year	2014	2013	2012
Ad Valorem	$44,718	$43,905	$46,491
Non Ad Valorem	$8,961	$8,985	$10,968
Total tax	$53,679	$52,890	$57,459

Property Detail

Parcel Control Number: 00424614000005300 Location Address: 5283 ATLANTIC AVE

Owners: WEST ATLANTIC COMML PROP LTD

Mailing Address: THE PUGLIESE CO C/O 101 PINEAPPLE GROVE WAY,DELRAY BEACH FL 33444 3703

Last Sale: NOV-2000 Book/Page#: 12165 / 1875 Price: $10

Legal Description: 14-46-42, E 1/2 OF SE 1/4 OF NW 1/4 OF SE 1/4 (LESS S 60 FT SR 806 R/W)

2014 Values (Current)

Improvement Value	$956,690
Land Value	$1,421,852
Total Market Value	$2,378,542
Assessed Value	$2,378,542
Exemption Amount	$0
Taxable Value	$2,378,542

All values are as of January 1st each year

2014 Taxes

Ad Valorem	$44,718
Non Ad Valorem	$8,961
Total Tax	$53,679

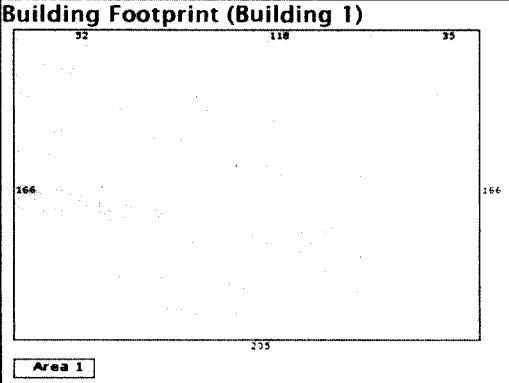
2014 Qualified Exemptions

No Details Found

Applicants

No Details Found

Building Footprint (Building 1)



Subarea and Square Footage (Building 1)

Description	Area	Sq. Footage
DISCOUNT DEPARTMENT STORE	1	34030

Total Square Footage : 34030

Extra Features

Description	Unit
PAVING- ASPHALT	101720
PAVING- ASPHALT	870
FENCE- CHAIN LINK 6FT #11 GAUG	200

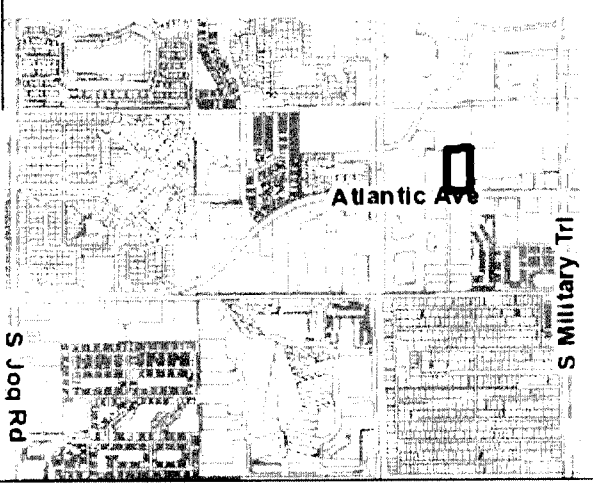
Unit may represent the perimeter, square footage, linear footage, total number or other measurement.

Structural Details (Building 1)

No	Description	
1.	YEAR BUILT	1981
2.	DISCOUNT DEPARTMENT STORE	34030

Acres 4.4966

MAP



Owner: WEST ATLANTIC COMML PROP LTD PCN: 00424614000005300 1 of 1

GARY R. NIKOLITS, CFA PALM BEACH COUNTY PROPERTY APPRAISER www.pbcgov.org/PAPA 12/2/2014

8332

UNITY OF TITLE

In consideration of the issuance of a Permit to DELRAY CHEMICAL CO., INC., a Florida corporation

for the construction of a warehouse for chemical research and storage for chemical company in Palm Beach County, Florida, and for other good and valuable considerations, the undersigned hereby agree to restrict the use of lot/s _____, Block _____, of _____ Subdivision, Plat Book _____, at Page _____ of the Public Records of Palm Beach County, Florida, or property being otherwise described by metes and bounds as: The East half of the Southeast quarter of the Northwest Quarter of the Southeast Quarter of Section 14, Township 46 South, Range 42 East, Palm Beach County, Florida, less that portion Deeded to State Road Department as shown in Official Record Book 1015, page 121, of the Public Records of Palm Beach County, Florida.
in the following manner:

1. That said property shall be considered as one plot and parcel of land, and that no portion of said plot and parcel of land shall be sold, transferred, devised, or assigned separately except in its entirety as one plot or parcel of land.

2. The undersigned further agrees that this condition, restriction and limitation shall be deemed a covenant running with the land, and shall remain in full force and effect, and be binding upon the undersigned, their heirs and assigns until such time as the same may be released in writing by the Palm Beach County Zoning Commission or the Executive Officer of such Commission, or, in the absence of such Commission or Executive Officer, by the Board of County Commissioners.

3. The undersigned further agrees that this instrument may be recorded in the Public Records of Palm Beach County.

Signed, sealed, executed, and acknowledged on this 30th day of December, 1969, at West Palm Beach, Florida.

WITNESSES:

Isabel W. Hall

Margaret C. Kennedy

DELRAY CHEMICAL CO., INC. (SEAL)

by Stanley H. Hesse (SEAL)
Stanley H. Hesse, President

(SEAL)

STATE OF FLORIDA)
:SS)
COUNTY OF PALM BEACH)

I HEREBY CERTIFY that on this _____ day of _____, A.D. 19_____, before me personally appeared Stanley H. Hesse and _____, to me known to be the persons described in and who executed the foregoing instrument, and they acknowledged to me the execution thereof to be their free act and deed for the uses and purposes therein mentioned.

WITNESS my signature and official seal at _____, in the County and State aforesaid, the day and year last aforesaid.

_____
Notary Public

State of FLORIDA
County of PALM BEACH

I Hereby Certify, that on this day, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, personally appeared STANLEY H. HESSE

well known to me to be the President ~~and~~ ~~respectively~~ of DELRAY CHEMICAL CO., INC.

the corporation in whose name the foregoing instrument was executed, and that they severally acknowledged executing the same as such officers of such corporation freely and voluntarily under authority duly vested in them by said corporation; and that the seal affixed thereto is the true corporate seal of said corporation.

Witness my hand and official seal in the County and State last aforesaid this 30th day of December A. D. 1969

Isabel U. Hill
Notary Public

My Commission expires on NOTARY PUBLIC, STATE OF FLORIDA AT LARGE MY COMMISSION EXPIRES OCT. 23, 1971 BONDED THROUGH FREE W. DIESTELHORST.

Recorded in O R Book & Record verified Palm Beach County, Fla., John B. Dunkle Clerk Circuit Court

OFFICIAL RECORDS 1785 PAGE 1515

B.30774

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Locater Map of Palm Beach County, 2008

Florida Center for Instructional Technology, (Tampa, FL: Florida Center for Instructional Technology, 2008)

Downloaded from *Maps ETC*, on the web at http://etc.usf.edu/maps [map #f8610]

Palm Beach County Geology/Hydrogeology Template

(Eastern Coastal Areas)
Please modify bold items to site conditions

This site is located on the ***Atlantic Coastal Ridge/Eastern Valley/Everglades*** geomorphologic feature **[see Copeland. 1991. pg 27]** of the Southern or Distal Geomorphologic Province of Florida. Three hydrostratigraphic units exist in Palm Beach County. These include: the surficial aquifer system, intermediate aquifer system confining unit and the Floridan aquifer system [A,B,C,D,F].

Karst Terrain Evaluation

The western and southwestern parts of Palm Beach County are situated on bare or thinly covered limestone. Sinkholes are few. When present, Solution sinkholes dominate. They are generally shallow and broad. The sinkholes in this area tend to develop gradually. In the northwestern, northeastern and eastern parts of the County, including the West Palm Beach, Lake Worth and Boynton Beach areas, the cover varies between 30 and 200 feet think. The cover consists of incohesive, permeable sand. Sinkholes are generally few, shallow and of small diameter. They also tend to develop gradually. In this area, when present, Cover-subsidence sinkholes prevail [F].

Climate

The climate in Palm Beach County varies from Equatorial Monsoon in the southern part of the county to Equatorial Rainforest in northern Palm Beach County. The climate is characterized by mild winters and long, warm, humid summers. In addition to its low southern latitude, the Atlantic Ocean has a moderating influence on the maximum and minimum temperatures in summer and winter, respectively. However, these effects diminish quickly inland of the coast. Colder temperatures during the winter are closely tied to the advance of cold fronts emanating from the north. However, this cold continental air must pass over water and much of peninsular Florida before reaching Palm Beach County. As such, the cold air is appreciably modified during that journey. During the summer, temperatures are also tempered by the ocean breeze and shade provided by the formation of cumulus clouds and rain showers. Based on weather records from West Palm Beach, the Average Monthly Mean temperature ranges from 65.5°F in January to 82.3°F in August. Rainfall is highly variable from place to place, particularly in an east-west direction. The Mean Annual Rainfall is 62.06 inches. Between 65-70% of the rainfall occurs during the rainy season from June to October. Thunderstorms occur about every other day during the summer, usually in the late afternoon. Thunderstorms also account for the summer rainfall totals. Some of the heavy thunderstorms can account for 2 to 3 inches of rainfall over a 1 to 2 hour period Tropical storms or depressions and Hurricanes occasionally strike the area in September and October. For most of the year, the prevailing winds are generally from the east direction varying from southeast to east-northeast. However, during December and January, they are typically from a northwesterly direction. [Reference M].

Surficial aquifer system-Biscayne aquifer

The surficial aquifer system is the primary source of fresh water in Palm Beach County. The Biscayne aquifer is the most productive unit of this system. Under Section 1424(e) of the Safe Drinking Water Act of 1974, the Biscayne aquifer was designated as a sole-source aquifer. This was based on the fact that it supplies at least 50% of the drinking water in the area and that there are no alternative drinking water sources. This aquifer system is composed of sand, sandstone, shell, silt, calcareous clay (marl) and limestone of Pliocene to Holocene age. Poorly consolidated sand, shell and sandy limestone sediments predominate in the western two-thirds of the County. The sediments of western Palm Beach County may contain trapped seawater. The surficial aquifer system consists of, in ascending order, the upper part of the Tamiami Formation (Fm), Caloosahatchee Fm, Fort Thompson Fm, Anastasia Fm and undifferentiated sediments. The Lake Flint Marl, a fresh water unit of Pleistocene to Holocene age, overlies these deposits in the western portion of the County. The Lake Flint Marl is a low permeability unit of well indurated, cherty limestone that varies in thickness from a few inches to 5 feet. This limestone commonly contains numerous solution holes and is overlain by organic (peat) soils. The aquifer exists under unconfined to semi-confined conditions throughout the County and is recharged primarily by rainfall and seepage from canals. Some recharge may take place from Lake Okeechobee in the northwest part of the County. The aquifer system has two permeable zones in the eastern portion of the County. The most permeable zone is characterized by highly developed secondary porosity and is frequently referred to as the "cavity-riddled zone". This zone ranges in depth from sea level to about 220 feet below sea level. The depth to the water table is generally less than 10 feet below land surface (bls) and the aquifer is approximately ___ **feet** thick in the **West Palm Beach/Lake Worth/Lantana/Pahokee [see Miller, 1987 Figure 1]** area [A,B,C,D,G,H,I]

Intermediate aquifer system/confining unit.

The surficial aquifer system is underlain by the Miocene age impermeable semipermeable marls (calcareous clays) and carbonates (limestone and dolostone) of the Hawthorn Group. The Peace River and Arcadia Formations comprise the Hawthorn Group in South Florida. These sediments are approximately ____ **feet thick [see Copeland, 1991, pg. 35]** in the site area and comprise the intermediate aquifer system confining unit. These sediments isolate the underlying Floridan aquifer system from the surficial aquifer system [A,B,C,D,E,G].

Floridan aquifer system

The Floridan aquifer system consists of carbonates of Oligocene and Eocene age. The Floridan aquifer system is comprised of, in ascending order, the Oldsmar Fm, Avon Park Fm, Ocala Limestone and the Suwannee Limestone. The top of the Floridan aquifer system is found approximately **900/950/1,000 feet** below mean sea level in the **West Palm Beach/Lake Worth/Lantana/Pahokee** area. **[see Copeland, 1991, pg. 70].** The Floridan aquifer system is not a major source of potable water in the area due to high salinity [A,B,C,D].

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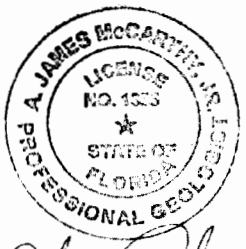
Special Thanks to the Florida Geological Survey and U.S Geological Survey
By A. James McCarthy Jr, Florida PG#1355
Professional Geologist II
FDEP CERCLA Site Screening Section
December 5, 2013



FLORIDA GEOLOGICAL SURVEY

EST. 1907

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Chemical Compounds

The Exotic and Not-So-Exotic

By PAUL PRICE
Post Business Writer

DELRAY BEACH — The brown bottle, no bigger than one in the family medicine cabinet containing mouthwash, contains a chemical compound valued at $2,000.

The 400 grams of Trimethylsilylmethyl Sulfide sitting on the shelf of Delray Chemical Co.'s warehouse is just one of the exotic chemical compounds the little company makes up.

"What happens if someone knocks a bottle like that off the shelf and breaks it?" asks a visitor.

H. S. Allen, general manager of Delray Chemical and a graduate chemist from University of South Carolina, answers straight-faced, "We just take him out back, tie him to a stake and kill him."

It's not quite that bad, but Allen says

"But we also sell a lot of calcium chloride, primarily to concrete companies," Allen says. "We even sell concrete pigment, which is a compound. You know those green sprinkler heads — we sell most of the green pigment for them."

But Stanley H. Hesse, president of Delray Chemical, says the biggest selling item isn't exotic.

"Mil-Kil probably accounts for 25 per cent of our total sales now, and is our biggest seller," Hesse says. "It controls mildew in closed homes. It sure isn't very exotic."

Although Mil-Kil is sold throughout the country, Hesse says the majority of sales are in Palm Beach and Broward counties.

Delray Chemical only occupied its new home on Delray Road West last August, but the firm has been in Delray Beach for a number of years — and

http://news.google.com/newspapers?id=rqg1AAAAIBAJ&sjid=crcFAAAAIBAJ&pg=5123,486414
0&dq=delray-chemical&hl=enhttp://news.google.com/newspapers?id=rqg1AAAAIBAJ&sjid=crcFAAAAIBAJ&pg=5123,4864140&dq=delray-chemical&hl=en

expensive — and there have been no reports of justifible homicide at the plant on the north side of Delray Road West, just west of Military Trail.

Delray Chemical manufactures exotic and not-so-exotic chemical compounds, and also serves as a Florida distributor for Matheson Coleman & Bell compounds.

"We are the principal supplier of chemical compounds for research laboratories, the various state and private college chemical laboratories and to a lot of industries," Ahen says as he conducts a tour through the 75,000-square-foot building, housing manufacturing, warehousing, storage and office space on the five-acre site.

"The company was up for sale," Hesse says. "I'd always liked Florida and buying the company seemed the perfect opportunity to come."

The firm was located on NW 18th Avenue until last August.

Hesse isn't just the owner of a chemical company, he is a chemist with quite a string of credentials.

"I have a B.A. in chemistry, class of '39, from Columbia University," Hesse says. "Then I took a B.S. in education from the University of Minnesota in '41. I hold an M.S. equivalent — and make sure you say 'equivalent' — in organic chemistry from Lehigh University."

Turn to EXOTIC, F4, Col. 1

Exotic and Not-So-Exotic Chemicals

Continued from Page F1

He explains the master's "equivalent."

"I completed all the work on my master's, but I did it over a seven-year period," Hesse says. "The allowable time for completion was five years."

As a chemistry teacher and a "shirt-sleeves chemist," Hesse has devoted his entire life to the science.

"Let's see" he says. "I started out teaching chemistry at Hartwick College, Oneonta, N.Y., then went to Northland College in Ashland, Wis., for two years. From there I went to work for the Pyridium Corp. (now Anahist Corp.) in Yonkers, N.Y., as a chemist. Then I went back to teaching at Lafayette College in Easton, Pa."

From the campus in Easton, Hesse went to work first as a chemist and later research chemist at GAF Corp. in Easton.

"I was with GAF for 10½ years and was awarded five patents while I was with them," he says.

He left to go with Koppers Co. in Pittsburgh as senior research chemist in 1957. Then he served as chief development chemist with Conestoga Chemical Co. in Wilmington, Del., and later was director of research for Columbia Organic Chemical Co. in Columbia, S.C.

"Back in the middle of all that," he says, "I'd started Marstan Laboratories as my own company, making chemical compounds."

When Hesse came to Florida as the owner of Delray Chemical, he moved Marstan from Bethlehem, Pa., and incorporated his inventory into Delray Chemical.

"So you see," he says, "here we have Delray Chemical manufacturing stuff and distributing, but also we have the Marstan label too."

When Hesse took over Delray Chemical 3½ years ago, it was primarily a swimming pool chemical supplier.

"But my idea was, and is, to do a bit more than that," Hesse says.

Gearing for that little bit more, Hesse has staffed accordingly. Five of the company's 10 employes are graduate chemists.

"We're told we have the largest stock of laboratory chemicals in the state," Hesse says. "We stock about 3,000 MCB (Matheson Coleman & Bell) compounds, which we distribute, plus all our own."

Making sure Delray Chemical's own products measure up to specifications, Hesse has an analytical department on the premises. Paul Work, a graduate analytical chemist from Temple University, heads up the operation.

Across the hall from Work's department is what Hesse calls the "heart" of the whole facility — a library.

"The library is a critical necessity," Hesse says. "We have primary and secondary reference sources. The primary sources are original papers by chemists as they have discovered compounds. The secondary sources are books about compounds and their development. We're always in here."

Delray Chemical is always making new compounds.

"Some, as far as we know," Hesse says, "have never been made before. But, now and then, we come up with something entirely new, we think, until a check in the library shows some guy in the 1800s already did it."

The firm now has about 200 regular customers and is grossing sales of $5-$8,000 a month.

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Florida Water Science Center

Water Resources Data, Florida, Water Year 2005

Volume 2B: South Florida Ground Water

By S. Prinos, R. Irvin, M. Byrne

Prepared in cooperation with the State of Florida and with other agencies

This report is available as a pdf.

Abstract

Water resources data for 2005 water year in Florida consists of continuous or daily discharge for 429 streams, periodic discharge for 9 streams, continuous or daily stage for 218 streams, periodic stage for 5 stream, peak discharge for 28 streams, and peak stage for 28 streams, continuous or daily elevations for 15 lakes, periodic elevations for 23 lakes, continuous ground-water levels for 401 wells, periodic ground-water levels for 1,098 wells, quality of water data for 211 surface-water sites, and 208 wells.

The data for South Florida included continuous or daily discharge for 91 streams, continuous or daily stage for 62 streams, no peak stage discharge for streams, 1 continuous elevation for lake, continuous ground-water levels for 248 wells, periodic ground-water levels for 187 wells, water quality for 54 surface-water sites, and 121 wells.

These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State, and Federal agencies in Florida.

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Ground-Water-Quality Data
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Access to USGS Water Data

Definition of Terms

Selected References

Broward County
- Well Descriptions and water-level measurements
- Miscellaneous water-level measurements

Charlotte County
- Well Descriptions and water-level measurements

Collier County
- Well Descriptions and water-level measurements
- Miscellaneous water-level measurements

Glades County

Well Descriptions and water-level measurements
Hendry County
Well Descriptions and water-level measurements
Lee County
Well Descriptions and water-level measurements
Miscellaneous water-level measurements
Martin County
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THE GEO. D. BARNARD COMPANY, ST. LOUIS, MO., 63106

STATE OF FLORIDA

☐ 24

UNIFORM COMMERCIAL CODE – FINANCING STATEMENT – FORM UCC – 1

Any forms used for filing with the Office of Secretary of State pursuant to the Uniform Commercial Code must be approved by Tom Adams, Secretary of State, State of Florida.

INSTRUCTIONS:

1. PLEASE TYPE this form. Fold only along perforation for mailing.
2. Remove Secured Party and Debtor copies and send other 3 copies with interleaved carbon paper to the filing officer. Enclose filing fee of $2.00.
3. If the space provided for any item(s) on the form is inadequate the item(s) should be continued on additional sheets, preferably 5" x 8" or 8" x 10". Only one copy of such additional sheets need be presented to the filing officer with the first three copies of the financing statement. Long schedules of collateral, indentures, etc., may be on any size paper that is convenient for the secured party. Indicate the number of additional sheets attached. Enclose filing fee of $1.00 for each additional sheet.
4. If collateral is crops or goods which are or are to become fixtures, describe generally the real estate and give name of record owner.
5. When a copy of the security agreement is used as a financing statement, it is requested that it be accompanied by a completed but unsigned set of these forms.
6. If acknowledgement of filing is requested indicate so on number-three copy and enclose fee of $1.00.
7. If filing with Clerk of Circuit Court consult Chapter 28, F.S. or local clerk for proper fees.

THIS FINANCING STATEMENT is presented to a filing officer for filing pursuant to the Uniform Commercial Code:

3. Maturity date (if any):

1. Debtor(s) (Last Name First) and address(es)

Delray Chemical Co., Inc.
5065 W. Atlantic Avenue
Delray Beach, Florida

2. Secured Party(ies) and address(es)

BOCA RATON NATIONAL BANK
P.O. Box 400
Boca Raton, Florida 33432

For Filing Officer (Date, Time, Number, and Filing Office)

78 60207

'78 APR 20 PM 12:38

4. This financing statement covers the following types (or items) of property:

1965 Fruehauf Cement Trailer, E-143267-OMF343217

5. Assignee(s) of Secured Party and Address(es)

6. Check if true ☒ The stamps required by Chapter 201, F.S. have been placed on the promissory instruments secured hereby, and will be placed on any additional and similar instrument that may be so secured.

This statement is filed without the debtor's signature to perfect a security interest in collateral. (Check ☒ if so)
☐ Already subject to a security interest in another jurisdiction when it was brought into this state.
☐ which is proceeds of the original collateral described above in which a security interest was perfected.

Check ☒ if covered. ☒ Proceeds of Collateral are also covered. ☐ Products of Collateral are also covered. No. of additional Sheets presented.

Filed with: Clerk of the Curcuit Court

DELRAY CHEMICAL CO., INC.

Eldon M. Armstrong

By: Vincent [illegible]

BOCA RATON NATIONAL BANK

By: Kenneth [illegible], Vice Pres.

(1) Filing Officer Copy – Alphabetical

STANDARD FORM – FORM UCC–1

Approved by TOM ADAMS, Secretary of State, State of Florida

4.00

PALM BEACH REC OFF 2846 PAGE 939

Record Verified
Palm Beach County, Fla.
John B. Dunkle
Clerk Circuit Court

Potable Water System (PWS) Wells

PWS_ID	PWS_STATUS	PWS_NAME	PWS_TYPE	PWS_POP	PWS_PRIMAR	WELL_ID	WELL_NAME	FLUWID	WELL_STA	WELL_YEAR	WELL_DEPTH	OBJECTID	BUFFER RANGE
													.25 Mile
													.5 Mile
													1 Mile
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4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	38238	WELL 12	AAH9750	ACTIVE	2002	170	38238	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10155	WELL # 6	AAH8208	ACTIVE	1980	180	10155	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10158	WELL # 9	AAH8205	ACTIVE	1988	185	10158	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10153	WELL # 4	AAH8210	ACTIVE	1973	150	10153	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10161	WELL # 14	AAH8203	ACTIVE	1990	160	10161	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10150	WELL # 1	AAH8213	ACTIVE	1973	150	10150	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10152	WELL # 3	AAH8211	ACTIVE	1973	155	10152	3 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10156	WELL # 7	AAH8207	ACTIVE	1979	180	10156	3 Miles
PWS_ID	PWS_STATUS	PWS_NAME	PWS_TYPE	PWS_POP	PWS_PRIMAR	WELL_ID	WELL_NAME	FLUWID	WELL_STA	WELL_YEAR	WELL_DEPTH	OBJECTID	4 Miles
4500101	ACTIVE	BEDNER LABOR CAMP	NONCOMMUNITY	28	LABOR CAMP	9423	BEDNER LABOR CAMP	AAG1057	ACTIVE	0	0	9423	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9478	WELL # 36W	AAH1069	ACTIVE	1989	183	9478	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9477	WELL # 35W	AAH1183	ACTIVE	1989	182	9477	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9474	WELL # 27W	AAH1087	ACTIVE	1990	175	9474	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9475	WELL # 30W	AAH1068	ACTIVE	1989	201	9475	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9479	WELL # 37W	AAH8674	ACTIVE	1985	175	9479	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9480	WELL # 39W	AAH1074	ACTIVE	1995	187	9480	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	9476	WELL # 32W	AAH1084	ACTIVE	1990	219	9476	4 Miles
4500130	ACTIVE	BOCA RATON WTP	COMMUNITY	130001	MUNICIPAL/CITY	50923	WELL 29-W	AAH1073	ACTIVE	1984	180	50923	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9551	WELL # 8	AAH8967	ACTIVE	1972	100	9551	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9557	WELL # 16	AAH8965	ACTIVE	1970	90	9557	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9545	WELL # 2	AAH8971	ACTIVE	1958	97	9545	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9546	WELL # 3	AAH8970	ACTIVE	1972	110	9546	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9550	WELL # 6	AAE7604	ACTIVE	1972	100	9550	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9556	WELL # 15	AAE7603	ACTIVE	1953	76	9556	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9547	WELL # 5	AAH7242	ACTIVE	1972	107	9547	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9549	WELL # 4A	AAH8969	ACTIVE	1992	115	9549	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9548	WELL # 6	AAH8968	ACTIVE	1972	100	9548	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9553	WELL # 12	AAE7605	ACTIVE	1947	88	9553	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9555	WELL # 14	AAE7602	ACTIVE	1947	78	9555	4 Miles
4500351	ACTIVE	DELRAY BEACH WATER DEPARTMENT	COMMUNITY	60200	MUNICIPAL/CITY	9558	WELL # 17	AAH8966	ACTIVE	1988	95	9558	4 Miles
4501528	ACTIVE	GOLF, VILLAGE OF	COMMUNITY	3505	MUNICIPAL/CITY	9920	WELL # 7	AAH798	ACTIVE	1978	100	9920	4 Miles
4501528	ACTIVE	GOLF, VILLAGE OF	COMMUNITY	3505	MUNICIPAL/CITY	9921	WELL # 2	AAH797	ACTIVE	1978	100	9921	4 Miles
4501528	ACTIVE	GOLF, VILLAGE OF	COMMUNITY	3505	MUNICIPAL/CITY	9919	WELL # 1	AAD8987	ACTIVE	1971	100	9919	4 Miles
4500609	ACTIVE	HIGHLAND BEACH WATER PLANT	COMMUNITY	4100	MUNICIPAL/CITY	33938	WELL # 7	AAK694	ACTIVE	2002	1250	33938	4 Miles
4500609	ACTIVE	HIGHLAND BEACH WATER PLANT	COMMUNITY	4100	MUNICIPAL/CITY	53504	WELL # 8	AAM7850	ACTIVE	0	1200	53504	4 Miles
4500609	ACTIVE	HIGHLAND BEACH WATER PLANT	COMMUNITY	4100	MUNICIPAL/CITY	38917	WELL # 6	AAK693	ACTIVE	2001	1394	38917	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	38243	WELL # 25	AAH9753	ACTIVE	2002	170	38243	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10165	WELL # 18	AAH9098	ACTIVE	1996	145	10165	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10162	WELL # 15	AAH8201	ACTIVE	1996	145	10162	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10164	WELL # 17	AAH9099	ACTIVE	2003	165	10164	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	50263	SYSTEM 3 WELL 19	AAM7959	ACTIVE	2009	150	50263	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10163	WELL # 16	AAH8200	ACTIVE	1996	145	10163	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	38242	WELL # 26	AAH9752	ACTIVE	2002	165	38242	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	50266	SYSTEM 3 WELL 24	AAM7960	ACTIVE	2009	135	50266	4 Miles
4504393	ACTIVE	PALM BEACH COUNTY WATER UTILITI	COMMUNITY	416303	MUNICIPAL/CITY	10160	WELL # 13	AAH8202	ACTIVE	1990	137	10160	4 Miles

Drycleaning Solvent Program Cleanup Sites

FID	Shape *	SITE	NAME	ADDRESS	CITY	COUNTY	DISTRICT	PROGRAM	STATUS	MANAGER	EPA_PM	OPERATIOI
8	Point	5.1E+08	Family Ass	5044 W At	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
2	Point	5.1E+08	Delray Squ	4751 W At	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
3	Point	5.1E+08	Nova Clear	14743 S M	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
1	Point	5.1E+08	Kristi Klean	4900 Linto	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
6	Point	5.1E+08	Point Clear	6576 W At	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
11	Point	5.1E+08	Hamlet Cle	4051 W At	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
9	Point	5.1E+08	The Rite Pr	7431 W At	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
10	Point	5.1E+08	Lake Ida Cl	600 N Con	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
0	Point	5.1E+08	Swift Clear	251 NE 2nd	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
4	Point	5.1E+08	Pelican Fre	2901 Clint	Boca Rator	Palm Beach	Southeast	Drycleaner	Active	HLADKY, E		Drycleaner
5	Point	5.1E+08	Village Squ	21228 St A	Boca Rator	Palm Beach	Southeast	Drycleaner	Active	PERKINS-D		Drycleaner
7	Point	5.1E+08	Aloha Dry (	501 NE 2nd	Delray Bea	Palm Beach	Southeast	Drycleaner	Unassigned			
12	Point	5.1E+08	Crystal Cle	2316 Dixie	West Palm	Palm Beach	Southeast	Drycleaner	Unassigned			

Drycleaning Solvent Program Cleanup Sites

MOD	EPA_FLD_N	PROG_LEA	METHOD	ACCURACY	DESCRIPTIO	OBJECTID	BUFFER RANGE
		DEP	WGPS	3	FRNTDOOR	5.1E+08	.25 Mile
		DEP	WGPS	3	FRNTDOOR	5.1E+08	.5 Mile
		DEP	WGPS	3	FRNTDOOR	5.1E+08	.5 Mile
							1 Mile
		DEP	WGPS	3	FRNTDOOR	5.1E+08	2 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	2 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	2 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	3 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	3 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	4 Miles
D171	FLR000062	DEP	WGPS	3	FRNTDOOR	5.1E+08	4 Miles
D080	FLR000031	DEP	WGPS	3	FRNTDOOR	5.1E+08	4 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	4 Miles
		DEP	WGPS	3	FRNTDOOR	5.1E+08	4 Miles

Department of Health (DOH) Private Wells from Water Monitoring Section (WMS)

WELL_TYPE	WELL_DRILL	WELL_TOTAL	WELL_CASIN	WELL_CAS_1	WATERBODY_	OBJECTID	BUFFER RANGE
							.25 Mile
PRIVATE DRINKING WATER WELL	<Null>	101	97	GALVANIZED IRON OR GALVANIZED STEEL	SURFICIAL AQUIFER SYSTEM	5621	.5 Mile
PRIVATE DRINKING WATER WELL	4/18/1977	67	60	GALVANIZED IRON OR GALVANIZED STEEL	SURFICIAL AQUIFER SYSTEM	5620	1 Mile
PRIVATE DRINKING WATER WELL	3/16/1979	63	59	GALVANIZED IRON OR GALVANIZED STEEL	SURFICIAL AQUIFER SYSTEM	5623	2 Miles
PRIVATE DRINKING WATER WELL	6/25/1975	84	80	GALVANIZED IRON OR GALVANIZED STEEL	SURFICIAL AQUIFER SYSTEM	5624	3 Miles
PRIVATE DRINKING WATER WELL	<Null>	117	112	GALVANIZED IRON OR GALVANIZED STEEL	SURFICIAL AQUIFER SYSTEM	5622	4 Miles

Element Occurrence

EO_NUMBER	SNAME	SCON	OAT	EORAN	GRANK	SRA	FEDE	SPROT	LASTOBS	DESCRIPTIO	EODATA	BESTS	MANAG	COUNTY	EOSIZE_AC	REP_ACC	LOC	QC	QTR_UPDATE	MAP	SYMBOL	BUFFER RANGE
																						.25 Mile
																						0.5 Mile
																						1 Mile
																						3 Miles
3	Mesic hammock	ZZ	N	BC	G3	S3?	N	N	9/21/2004	2004-09-21: Quercus	2004-09-21: Quercus virginiana, Sabal palmetto dominant han	Tanis	Delray	PALM	8.66	High (>80% ,	Nogi	P	U	MES	C2	3 Miles
246	Aphelocoma coerulescen	Flori	N	NR	G2	S2	LT	FT	5/8/1981	2-3 M OAK SCRUB.	1981-05-08: 3 ADULT, 3 JUVENILE SCRUB JAYS.	COL	No mai	PALM	1125.25	Low (>5%, <4	Area	P	U	APH	A2	3 Miles
246	Scrub	ZZ	N	H	G2	S2	N	N	5/8/1981	2004-09-21: Area dom	2004-09-21: Area of Schinus terebinthifolius; overgrown oaks	COL	No mai	PALM	1125.25	Low (>5%, <4	Area	P	U	SCR	C2	3 Miles
247	Aphelocoma coerulescen	Flori	N	NR	G2	S2	LT	FT	1980-11	2-4 M OAK SCRUB. AB	1980-11: SANDHILL REPORTED 3 SCRUB JAYS.	COL	Delray	PALM	1125.25	Low (>5%, <4	Area	P	U	APH	A2	3 Miles
82	Athene cunicularia florid	Flori	N	NR	G4T3	S3	N	SSC	1990-03	low density suburban	1990-03: M.S. Robson, GFC - 1 burrow observed	Florid	No mai	PALM	1125.25	Low (>5%, <4	Area	P	U	ATH	A2	3 Miles
6	Chamaesyce cumulicola	Sand	N	B?	G2	S2	N	LE	1998	1998: Disturbed, open	1998: More than 20 plants in flower and fruit widely scattered	AUSTI	Yamato	PALM	245.3	Medium (>2	Area	P	U	CHA	P2	4 Miles
298	Crotalus adamanteus	Easte	N	CD	G4	S3	N	N	1986	1986: Low oak scrub	1986: 1 mature adult seen resting in a trash pile; estimated po	Farns	Yamato	PALM	89.09	Medium (>2	Area	P	U	CRO	A2	4 Miles
19	Conradina grandiflora	Large	N	BC	G3	S3	N	LT	1999	1999: Florida scrub-sa	1999: 2000+ plants in flower and fruit over a 1% acre area (1996	Schult	Yamato	PALM	245.3	Medium (>2	Area	P	U	CON	P2	4 Miles
28	Oleonia lappogaea	Burn	N	X?	G3?	S2	N	LE	1993	1993: Growing on dir	1993: This population was possibly introduced to this site. 5 pl	FNAI F	No mai	PALM	7.72	High (>80% ,	Area	P	U	ORE	P2	4 Miles
46	Ophioglossum palmatum	Hand	N	SO	G4	S2	N	LC	2000	2000: growing on cab	2000: 1 plant fruiting, growing on cabbage palm (U00FAR01FL	Farns	Yamato	PALM	6.24	Medium (>2	Area	P	U	OPH	P2	4 Miles
179	Lechea cernua	Nodd	N	B?	G8	S3	N	LT	1998	1998: Old sand jeep tr	1998: 20 plants in various stages of flowering, fruiting and dor	Garn	Yamato	PALM	1.04	Very High (>-	Nogi	P	U	LEC	P1	4 Miles
5	Letrodectus bishopi	Red	N	B?	G2G3	S2S3	N	N	1990	1986: Scrub and scrub	1986: 5 adults with egg cases, population estimated to be 100	Gaby,	Yamato	PALM	245.3	Low (>5%, <4	Nogi	P	U	LAT	A2	4 Miles
349	Sciolopurus woodi	Flori	N	B?	G3	S3	N	N	1991	1985: mostly edges a	1985: 99 young and adults captured; population estimated at 2	Garn	Yamato	PALM	245.3	Medium (>2	Area	P	U	SCE	A2	4 Miles
1380	Gopherus polyphemus	Gopi	N	B?	G3	S3	C	ST	12/17/1998	1998-12-17: dense sa	Need update. 1998-12-17: species rare, 8 active burrows obse	Schult	Yamato	PALM	245.3	Medium (>2	Area	P	U	GOP	A2	4 Miles
1	Passerina ciris	Pain	N	BC	G5	S3	N	N	1990-Wi	1990-Winter: Open Bi	1990-Winter: 1 to 2, up to 6 migrating or overwintering adults	Gaby,	Yamato	PALM	245.3	Low (>5%, <4	Area	P	U	PAS	A2	4 Miles
19	Drymarchon couperi	Easte	N	CO	G3	S2	LT	FT	1984	1984: Sand pine scrul	1984: shed skin of an adult found; population estimated at 2-3	Crisci	Yamato	PALM	245.3	Medium (>2	Area	P	U	DRY	A2	4 Miles
85	Athene cunicularia florid	Flori	N	NR	G4T3	S3	N	SSC	3/29/1990	Institutional develop	1990-03-29: M.S. Robson, GFC - 1 occupied burrow.	Florid	No mai	PALM	1125.25	Low (>5%, <4	Area	P	U	ATH	A2	4 Miles
16	Pandicum abscissum	Cutti	N	NR	G1	S3	N	LE	12/11/1988	No general descriptio	ALMOST "PURE" STAND.	BUCKI	No mai	PALM	7.87	High (>80% ,	Area	P	U	PAN	P1	4 Miles
276	Gopherus polyphemus	Gopi	N	NR	G3	S3	C	ST	1981-07	No general descriptio	1981-07: DEAD ON ROAD (U86DIE01FLUS).	Dierm	No mai	PALM	1125.25	Low (>5%, <4	Area	P	U	GOP	A2	4 Miles
17	Panicum abscissum	Cutti	N	C	G3	S3	N	LE	1996	1996: Mesic flatwood	1996: 5000+ plants over a 12 acre area. Some plants flowerin	Farns	Yamato	PALM	12.87	High (>80% ,	Nogi	P	U	PAN	P2	4 Miles
8	Podomys floridanus	Flori	N	B?	G3	S3	N	SSC	1986	1984: Sand pine scrul	1986: 60 mice trapped on a portion of the site; estimated pop	Richar	Yamato	PALM	245.3	Medium (>2	Area	P	U	POD	A2	4 Miles
91	Athene cunicularia florid	Flori	N	NR	G4T3	S3	N	SSC	3/19/1991	Vacant cleared lots	1991-03-19: M.S. Robson, GFC - 3 marked nests.	Florid	Seacre	PALM	1125.25	Low (>5%, <4	Area	P	U	ATH	A2	4 Miles

Schools Public K-12 within 2-Miles

FID	Shape *	OBJECTID	FACILITY	ADDRESS	CITY	STATE	ZIP	ZIP_4	PHONE	TYPE	DIRLNAME	DIRFNAME	SOURCE	DLAT	DLONG	BUFFER RANGE
																.25 Mile
																.5 Mile
																1 Mile
0	Multipoint	80	South Co. C	16158 S Mi	Delray Bea	FL	33484	0	5.62E+09	10	Iribarren	Raul	DOE			2 Miles
1	Multipoint	784	Carver Mid	101 Barwic	Delray Bea	FL	33445	0	4.07E+09	2			DCA	26.45944	-80.1077778	2 Miles
2	Multipoint	786	Banyon Cre	4243 Sabal	Delray Bea	FL	33445	0	408-243-15	1			DCA	26.48222	-80.1133333	2 Miles
3	Multipoint	2344	Orchard Vi	4050 Old G	Delray Bea	FL	33445	0	4.07E+09	1			DCA	26.4375	-80.1105556	2 Miles
4	Multipoint	2571	Banyan Cre	4243 Sabal	Delray Bea	FL	33445	1236	5.61E+09	1	Fay, Jr.	William	DOE			2 Miles

Schools Private K-12 within 2-Miles

There are no Schools Private K-12 within 2- Miles.

Schools Jr. College within 2- Miles

There are no Schools Jr. College within 2- Miles.

Private University within 2- Miles

There are no Schools Private University within 2- Miles.

Schools Public University within 2-Miles

There are no Schools Public University within 2-Miles.

Schools Vo-Tech within 2-Miles

FID	Shape *	OBJECTID	CODE	NAME	ADDRESS1	ADDRESS2	CITY	ZIP	LONGITUD	LATITUDE	BUFFER RANGE
											.25 Mile
											.5 Mile
											1 Mile
0	Point	356	793	HOME HEA	2192 West		Delray Bea	33444	-80.0937	26.460205	2 Miles

Springs (2011)

There are no Springs within 4-Miles.

Lakes

There are no Lakes within 4-Miles.

PWS Surface Water Intakes

There are no PWS Surface Water Intakes within 4-Miles.

Major Rivers

There are no Major Rivers within 4-Miles.

Ground Water Contamination Areas

There are no Ground Water Contamination Areas within 4-Miles.

Water Bodies

PERIMETER	FCODE	BODYTYPE	SHAPE	OBJECTID *	BASE.WAT	SHAPE_Ler	SHAPE_Are	BUFFER RANGE
								.25 Mile
								.5 Mile
								1 Mile
								2 Miles
1290.483	421	Lake or por	Polygon	14403	84392.21	1290.483	84392.19	3 Miles
776.43	421	Lake or por	Polygon	16854	18813.04	776.4298	18813.05	3 Miles
688.596	421	Lake or por	Polygon	17051	25325.86	688.596	25325.85	3 Miles
2175.417	421	Lake or por	Polygon	17068	94813.2	2175.416	94813.19	3 Miles
612.814	421	Lake or por	Polygon	20582	18203.57	612.814	18203.57	3 Miles
4702.797	421	Lake or por	Polygon	21021	431559.8	4702.797	431559.7	3 Miles
837.333	421	Lake or por	Polygon	14418	31541.56	837.3338	31541.53	4 Miles
626.292	421	Lake or por	Polygon	14579	22553.92	626.2922	22553.91	4 Miles
42138.8	414	Ditch or ca	Polygon	16594	2148895	42138.8	2148895	4 Miles
522.377	421	Lake or por	Polygon	16847	16401.56	522.3765	16401.53	4 Miles
669.95	421	Lake or por	Polygon	16853	31994.38	669.9494	31994.36	4 Miles
776.43	421	Lake or por	Polygon	16854	18813.04	776.4298	18813.05	4 Miles
424.402	421	Lake or por	Polygon	16855	8974.684	424.4017	8974.685	4 Miles
1745.447	421	Lake or por	Polygon	17049	112247.4	1745.447	112247.4	4 Miles
591.372	421	Lake or por	Polygon	20614	17830.69	591.3729	17830.7	4 Miles
4702.797	421	Lake or por	Polygon	21021	431559.8	4702.797	431559.7	4 Miles

Aldrin and Dieldrin- ToxFAQs™

CAS # 309-00-2 and 60-57-1

This fact sheet answers the most frequently asked health questions (FAQs) about aldrin and dieldrin. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to aldrin and dieldrin happens mostly from eating contaminated foods, such as root crops, fish, or seafood. Aldrin and dieldrin build up in the body after years of exposure and can affect the nervous system. Aldrin has been found in at least 207 of the 1,613 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA). Dieldrin has been found in at least 287 of the 1,613 sites.

What are aldrin and dieldrin?

Aldrin and dieldrin are insecticides with similar chemical structures. They are discussed together in this fact sheet because aldrin quickly breaks down to dieldrin in the body and in the environment. Pure aldrin and dieldrin are white powders with a mild chemical odor. The less pure commercial powders have a tan color. Neither substance occurs naturally in the environment.

From the 1950s until 1970, aldrin and dieldrin were widely used pesticides for crops like corn and cotton. Because of concerns about damage to the environment and potentially to human health, EPA banned all uses of aldrin and dieldrin in 1974, except to control termites. In 1987, EPA banned all uses.

What happens to aldrin and dieldrin when they enter the environment?

- Sunlight and bacteria change aldrin to dieldrin so that we mostly find dieldrin in the environment.
- They bind tightly to soil and slowly evaporate to the air.
- Dieldrin in soil and water breaks down very slowly.
- Plants take in and store aldrin and dieldrin from the soil.
- Aldrin rapidly changes to dieldrin in plants and animals.
- Dieldrin is stored in the fat and leaves the body very slowly.

How might I be exposed to aldrin or dieldrin?

- Dieldrin is everywhere in the environment, but at very low levels.
- Eating food like fish or shellfish from lakes or streams contaminated with either chemical, or contaminated root crops, dairy products, or meats.
- Air, surface water, or soil near waste sites may contain higher levels.
- Living in homes that were once treated with aldrin or dieldrin to control termites.

How can aldrin and dieldrin affect my health?

People who have intentionally or accidentally ingested large amounts of aldrin or dieldrin have suffered convulsions and some died. Health effects may also occur after a longer period of exposure to smaller amounts because these chemicals build up in the body.

Some workers exposed to moderate levels in the air for a long time had headaches, dizziness, irritability, vomiting, and uncontrolled muscle movements. Workers removed from the source of exposure rapidly recovered from most of these effects.

Animals exposed to high amounts of aldrin or dieldrin also had nervous system effects. In animals, oral exposure to lower levels for a long period also affected the liver and decreased their ability to fight infections. We do not know whether aldrin or dieldrin affect the ability of people to fight disease.

Studies in animals have given conflicting results about whether aldrin and dieldrin affect reproduction in male animals and whether these chemicals may damage the sperm. We do not know whether aldrin or dieldrin affect reproduction in humans.

Aldrin and Dieldrin

CAS # 309-00-2 and 60-57-1

How likely are aldrin and dieldrin to cause cancer?

There is no conclusive evidence that aldrin or dieldrin cause cancer in humans. Aldrin and dieldrin have shown to cause liver cancer in mice. The International Agency for Research on Cancer (IARC) has determined that aldrin and dieldrin are not classifiable as to human carcinogenicity. The EPA has determined that aldrin and dieldrin are probable human carcinogens.

How can aldrin and dieldrin affect children?

Children can be exposed to aldrin and dieldrin in the same way as adults. There are no known unique exposure pathways for children. Children who swallowed amounts of aldrin or dieldrin much larger than those found in the environment suffered convulsions and some died, as occurred in adults. However, we do not know whether children are more susceptible than adults to the effects of aldrin or dieldrin.

We do not know whether aldrin or dieldrin cause birth defects in humans. Pregnant animals that ingested aldrin or dieldrin had some babies with low birth weight and some with alterations in the skeleton. Dieldrin has been found in human breast milk, therefore, it can be passed to suckling infants.

How can families reduce their risk for exposure to aldrin and dieldrin?

- Since aldrin and dieldrin are no longer produced or used, exposure to these compounds will occur only from past usage.
- Because aldrin and dieldrin were applied to the basement of some homes for termite protection, before buying a home families should investigate what, if any, pesticides have been used within the home.

Is there a medical test to show whether I've been exposed to aldrin and dieldrin?

There are laboratory tests that can measure aldrin and dieldrin in your blood, urine, and body tissues. Because aldrin changes to dieldrin fairly quickly in the body, the test has to be done shortly after you are exposed to aldrin. Since dieldrin can stay in the body for months, measurements of dieldrin can be made much longer after exposure to either aldrin or dieldrin. The tests cannot tell you whether harmful health effects will occur. These tests are not routinely available at the doctor's office because they require special equipment.

Has the federal government made recommendations to protect human health?

The EPA limits the amount of aldrin and dieldrin that may be present in drinking water to 0.001 and 0.002 milligrams per liter (mg/L) of water, respectively, for protection against health effects other than cancer. The EPA has determined that a concentration of aldrin and dieldrin of 0.0002 mg/L in drinking water limits the lifetime risk of developing cancer from exposure to each compound to 1 in 10,000.

The Occupational Safety and Health Administration (OSHA) sets a maximum average of 0.25 milligrams of aldrin and dieldrin per cubic meter of air (0.25 mg/m^3) in the workplace during an 8-hour shift, 40 hour week. The National Institute for Occupational Safety and Health (NIOSH) also recommends a limit of 0.25 mg/m^3 for both compounds for up to a 10-hour work day, 40-hour week.

The Food and Drug Administration (FDA) regulates the residues of aldrin and dieldrin in raw foods. The allowable range is from 0 to 0.1 ppm, depending on the type of food product.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for Aldrin/Dieldrin. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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DIAZINON

CAS # 333-41-5

Division of Toxicology and Environmental Medicine ToxFAQs™ September 2008

This fact sheet answers the most frequently asked health questions (FAQs) about diazinon. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to diazinon is most significant in people involved in the manufacture and professional application of this pesticide. Exposure to diazinon can result in headache, dizziness, weakness, feeling of anxiety, constriction of the pupils, and blurred vision. Diazinon has been found in at least 25 of the 1,699 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is diazinon?

Diazinon is the common name of an organophosphorus pesticide used to control pest insects in soil, on ornamental plants, and on fruit and vegetable field crops. It was formerly used as the active ingredient in household and garden products used to control pests such as flies, fleas, and cockroaches. Diazinon is a synthetic chemical, it does not occur naturally in the environment.

Pure diazinon is a colorless and practically odorless oil. Preparations used in agriculture and by exterminators contain 85–90% diazinon and appear as a pale to dark-brown liquid. Diazinon preparations sold in the past for home and garden use contained 1–5% diazinon in a liquid or as solid granules.

Most diazinon used is in liquid form, but it is possible to be exposed to the solid form. Diazinon does not dissolve easily in water and does not burn easily.

What happens to diazinon when it enters the environment?

- Most environmental diazinon contamination comes from agricultural and household application to control insects, but it may also enter the environment during the manufacturing process.
- After diazinon has been applied, it may be found in the soil, surface waters, and on the surface of plants.
- Diazinon on soil and plant surfaces may be washed into surface waters by rain; diazinon can move through soil and contaminate groundwater.
- In the environment, diazinon is quickly broken down into a variety of other chemicals.
- Diazinon is not likely to build up to high or dangerous levels in animal or plant foods that you might eat.

How might I be exposed to diazinon?

- People who work in the manufacture and professional application of diazinon are likely to have the most significant exposure to this pesticide.
- Exposure may occur by contact with contaminated soils or contaminated runoff water or groundwater.
- Small amounts have been detected in foods, but the levels are far below those that might cause harmful health effects.
- Although sales of home and garden products containing diazinon ceased in the U.S. in 2004, you may be exposed if you still have such products stored at home and use them.

How can diazinon affect my health?

Most diazinon that is ingested will enter the bloodstream, but very little will enter the bloodstream if there is skin contact with it.

Most cases of unintentional diazinon poisoning in people have resulted from short exposures to very high concentrations of the material. These very high levels have occasionally resulted in death.

Diazinon affects mainly the nervous system regardless of the route of exposure. Some mild signs and symptoms of poisoning include headache, dizziness, weakness, feelings of anxiety, constriction of the pupils, and blurred vision. More severe symptoms include nausea and vomiting, abdominal cramps, slow pulse, diarrhea, pinpoint pupils, difficulty breathing, coma, and possibly death. These effects also occur in animals exposed to high doses of diazinon. There is no evidence that long-term exposure to low levels of diazinon causes harmful effects in people.

Diazinon has not been shown to affect fertility in humans.

How likely is diazinon to cause cancer?

Diazinon has not been shown to cause cancer in humans or in animals. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC) and the EPA have not classified diazinon as to its carcinogenicity.

How can diazinon affect children?

Diazinon affects the nervous system in children and adults alike. Therefore, children exposed to diazinon will likely experience the same signs and symptoms observed in exposed adults (see above). However, we do not know whether children are more susceptible than adults to diazinon toxicity.

There is no evidence that environmental exposure to diazinon causes birth defects or other developmental effects in people. In animals, exposure levels that affected the health of the pregnant mothers caused developmental effects in their newborn babies.

How can families reduce the risks of exposure to diazinon?

- ❑ Stay away from agricultural areas that have been treated with diazinon.
- ❑ During spraying operations, remain indoors or leave the area for a short time.
- ❑ Agricultural workers and exterminators who come in contact with diazinon should remove contaminated clothing and wash before coming in contact with family members.
- ❑ Always wash fruits and vegetables before consuming them.
- ❑ Make sure that any person who treats your home with pesticides is properly certified.

Is there a medical test to determine whether I have been exposed to diazinon?

The most common test for exposure to diazinon is to determine the level of an enzyme (cholinesterase) in the blood. However, this test indicates only exposure to a pesticide of this type; it does not specifically show exposure to diazinon. In addition, other chemicals and health conditions may alter the levels of this enzyme.

There are specific tests to determine the presence of diazinon or its break down products in blood, urine, and body tissues.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to diazinon in drinking water at a concentration of 20 micrograms per liter (μg/L) for up to 10 days is not expected to cause any harmful effects in a child.

The EPA has determined that lifetime exposure to 1 μg/L diazinon in drinking water is not expected to cause any harmful effects.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological Profile for Diazinon. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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Guides to Pollution Prevention

The Pesticide Formulating Industry

FOREWORD

Pesticide formulating facilities generate wastes during such operations as decontamination of mixing and storage of equipment, housekeeping, and laboratory testing for quality assurance. The wastes generated are: containers with leftover raw materials; pesticide dust and scrubber water from air pollution control equipment; volatile organic compounds; off-specification products and laboratory analysis wastes; spills; waste sands or clays; waste rinse water and solvent; laundry waste water; and stormwater runoff contaminated with pesticides.

Reducing the generation of these wastes at the source, or recycling the wastes on or off site, will benefit pesticide manufacturers by reducing raw materials needs, reducing disposal costs, and lowering the liabilities associated with hazardous waste disposal. This guide provides an overview of the pesticide formulating processes and operations that generate waste and presents options for minimizing waste generation through source reduction and recycling.

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SECTION 1
INTRODUCTION

This guide is designed to provide pesticide formulators with waste minimization options appropriate for this industry. It also provides worksheets designed to be used for a waste minimization assessment of a pesticide formulating facility, to be used in developing an understanding of the facility's waste generating processes and to suggest ways to reduce the waste.

The guide should be used by pesticide formulating companies, particularly their plant operators and environmental engineers. Others who may find this document useful are regulatory agency representatives and consultants.

The worksheets and the list of waste minimization options for pesticide formulating were developed through assessments of three pesticide formulating firms commissioned by the California Department of Health Services (Calif. DHS, 1987). The three firms' facility operations, manufacturing processes, and waste generation and management practices were surveyed, and their existing and potential waste minimization options were characterized. Economic analyses were performed on selected options.

Waste minimization is a policy specifically mandated by the U.S. Congress in the 1984 Hazardous and Solid Wastes Amendments to the Resource Conservation and Recovery Act (RCRA). As the federal agency responsible for writing regulations under RCRA, the U.S. Environmental Protection Agency (EPA) has an interest in ensuring that new methods and approaches are developed for minimizing hazardous waste and that such information is made available to the industries concerned. This guide is one of the approaches EPA is using to provide industry-specific information about hazardous waste minimization. The options and procedures outlined can also be used in efforts to minimize other wastes generated in a facility.

EPA has also developed a general manual for waste minimization in industry. The *Waste Minimization Opportunity Assessment Manual* (USEPA 1988) tells how to conduct a waste minimization assessment and develop options for reducing hazardous waste generation at a facility. It explains the management strategies needed to incorporate waste minimization into company policies and structure, how to establish a company-wide waste minimization program, conduct assessments, implement options, and make the program an on-going one. The elements of waste minimization assessment are explained in the Overview, next section.

In the following chapters of this manual you will find:

- A profile of the pesticide formulating industry and the processes used by the industry (Section Two);
- Waste minimization options for pesticide formulating firms (Section Three);
- Waste minimization assessment guidelines and worksheets (Section Four)
- An Appendix, containing:
  - Case studies of waste generation and waste minimization practices of pesticide formulating firms;
  - Where to get help: Additional sources of information.

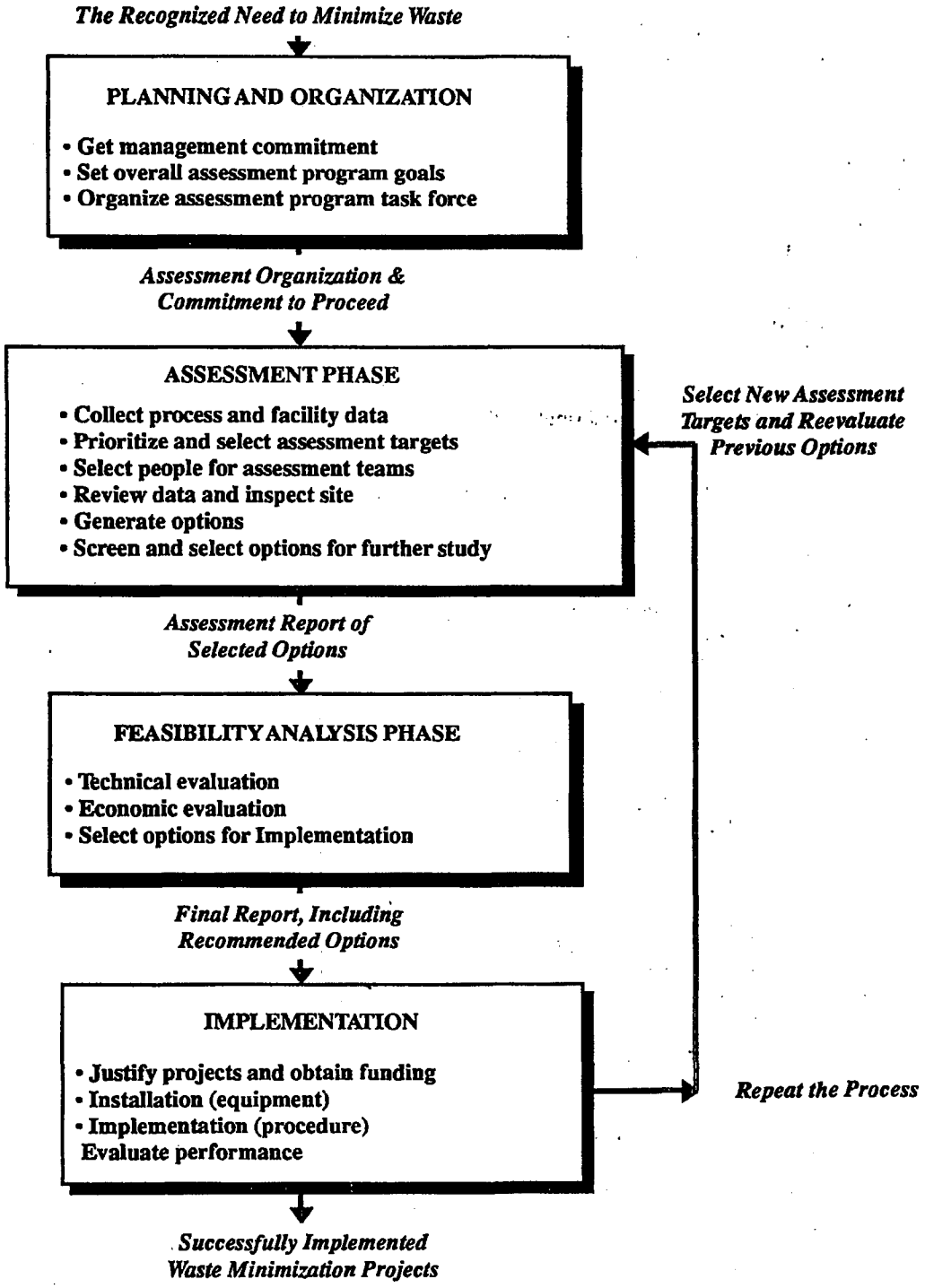
Overview of Waste Minimization Assessment

In the working definition used by EPA, waste minimization consists of *source reduction* and *recycling*. Of the two approaches, source reduction is usually considered preferable to recycling from an environmental perspective. *Treatment* of hazardous waste is considered an approach to waste minimization by some states but not by others, and thus is not addressed in this guide.

A Waste Minimization Opportunity Assessment (WMOA), sometimes called a waste minimization audit, is a systematic procedure for identifying ways to reduce or eliminate waste. The steps involved in conducting a waste minimization assessment are outlined in Figure 1 and presented in more detail in the paragraphs below. Briefly, the assessment consists of a careful review of a plant's operations and waste streams and the selection of specific areas to assess. After a particular waste stream or area is established as the WMOA focus, a number of options with the potential to minimize waste are developed and screened. The technical and economic feasibility of the selected options are then evaluated. Finally, the most promising options are selected for implementation.

To determine whether a WMOA would be useful in your circumstances, you should first read this section

Figure 1. The Waste Minimization Assessment Procedure



describing the aims and essentials of the WMOA process. For more detailed information on conducting a WMOA, consult the *Waste Minimization Opportunity Assessment Manual.*

The four phases of a waste minimization opportunity assessment are:

- Planning and organization
- Assessment phase
- Feasibility analysis phase
- Implementation

PLANNING AND ORGANIZATION

Essential elements of planning and organization for a waste minimization program are: getting management commitment for the program; setting waste minimization goals; and organizing an assessment program task force.

Assessment Phase

The assessment phase involves a number of steps:

- Collect process and facility data
- Prioritize and select assessment targets
- Select assessment team
- Review data and inspect site
- Generate options
- Screen and select options for feasibility study

Collect process and facility data. The waste streams at a facility should be identified and characterized. Information about waste streams may be available on hazardous waste manifests, National Pollutant Discharge Elimination System (NPDES) reports, routine sampling programs and other sources.

Developing a basic understanding of the processes that generate waste at a facility is essential to the WMOA process. Flow diagrams should be prepared to identify the quantity, types and rates of waste generating processes. Also, preparing material balances for various processes can be useful in tracking various process components and identifying losses or emissions that may have been unaccounted for previously.

Prioritize and select assessment targets. Ideally, all waste streams in a facility should be evaluated for potential waste minimization opportunities. With limited resources, however, a plant manager may need to concentrate waste minimization efforts in a specific area. Such considerations as quantity of waste, hazardous properties of the waste, regulations, safety of employees, economics, and other characteristics need to be evaluated in selecting a target stream.

Select assessment team. The team should include people with direct responsibility and knowledge of the particular waste stream or area of the plant. Operators of equipment and the person who sweeps the floor should be included, for example.

Review data and inspect site. The assessment team evaluates process data in advance of the inspection. The inspection should follow the target process from the point where raw materials enter the facility to the points where products and wastes leave. The team should identify the suspected sources of waste. This may include the production process; maintenance operations; and storage areas for raw materials, finished product, and work in progress. The inspection may result in the formation of preliminary conclusions about waste minimization opportunities. Full confirmation of these conclusions may require additional data collection, analysis, and/or site visits.

Generate options. The objective of this step is to generate a comprehensive set of waste minimization options for further consideration. Since technical and economic concerns will be considered in the later feasibility step, no options are ruled out at this time. Information from the site inspection, as well as trade associations, government agencies, technical and trade reports, equipment vendors, consultants, and plant engineers and operators may serve as sources of ideas for waste minimization options.

Both source reduction and recycling options should be considered. Source reduction may be accomplished through:

- Good operating practices
- Technology changes
- Input material changes
- Product changes

Recycling includes:

- Use and reuse of waste
- Reclamation

Screen and select options for further study. This screening process is intended to select the most promising options for full technical and economic feasibility study. Through either an informal review or a quantitative decision-making process, options that appear marginal, impractical or inferior are eliminated from consideration.

FEASIBILITY ANALYSIS

An option must be shown to be technically and economically feasible in order to merit serious consideration for adoption at a facility. A technical evaluation determines whether a proposed option will work in a specific application. Both process and equipment changes need to be assessed for their overall effects on waste quantity and product quality.

An economic evaluation is carried out using standard measures of profitability, such as payback period, return on investment, and net present value. As in any project, the cost elements of a waste minimization project can be broken down into capital costs and economic costs. Savings and changes in revenue also need to be considered.

IMPLEMENTATION

An option that passes both technical and economic feasibility reviews should then be implemented at a facility. It is then up to the WMOA team, with management support, to continue the process of tracking wastes and identifying opportunities for waste minimization, throughout a facility and by way of periodic reassessments. Either such ongoing reassessments or an initial investigation of waste minimization opportunities can be conducted using this manual.

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SECTION 2
PESTICIDE FORMULATING INDUSTRY PROFILE

Industry Description

As defined by Standard Industrial Classification (SIC) 2879, the pesticide formulating industry includes companies which formulate and prepare agricultural pest control chemicals or pesticides. This includes insecticides, herbicides, and fungicides. These products are formulated from pesticide concentrates manufactured elsewhere and are distributed to farmers in ready-to-use form.

The industry is comprised of roughly 330 establishments nationwide. Approximately 59% of the establishments are located in 10 states, although no one state accounts for a major share of the industry. Most of the establishments are located near the agricultural areas which make use of the products.

Products and Their Uses

The agricultural chemicals industry (SIC 2879) produces pesticides and other agricultural chemicals not elsewhere classified, such as soil conditioners. In the U.S., over 600 different pesticides are produced (Kryeger 1983). Most pesticides can be classified as either insecticides, herbicides, or fungicides, although many other minor classifications exist. Table 1 lists the production of the major classes of pesticides. Each division is subdivided to chemical type.

The product formulations that were included in the waste minimization assessments of this Guide were agricultural, industrial, and household pesticide formulations. These include insecticides, herbicides, and rodenticides. Excluded from the study were preservatives, disinfectants, and cleaning agents.

There are three types of pesticide formulations; solvent-based, water-based, and solid-based. In solvent-based formulations, the solvent serves as the carrier solution for the pesticide ingredient. A solvent-water emulsion may also be used as the carrier. Typical solvents are light aromatics such as xylene, chlorinated organics such as 1,1,1-trichloroethane, and mineral spirits. As with solvent-based formulations, water serves as the carrier solution for the active pesticide ingredient in the water-based formulations. Other water-based formulations are in the form of suspensions or emulsions. The solvent- and water-based formulations are applied directly in liquid form or propelled as an aerosol.

There are many types of dry-based pesticide formulations prepared by blending solid active ingredients with inert solids such as clay and sand. Some dry formulations are prepared by absorbing liquid active ingredients with solid carrier materials. Some common dry-based formulations are dusts, wettable powders, granules, treated seed, and bait pellets and cubes.

TABLE 1. 1982 PESTICIDE PRODUCTION IN THE U.S.

Product	Quantity Produced (tons per year)
Insecticidal formulations	
Inorganic compounds	54,300
Organic compounds	206,750
Chlorinated hydrocarbons	18,900
Carbamates	78,400
Organophosphates	73,150
Biological (botanical, bacterial)	11,250
Other organics	25,050
Herbicide formulations	
Inorganic compounds[a]	N/A
Organic compounds	541,750
Phenoxy	101,400
Metal organic	9,450
Triazine	97,250
Urea, amide, benzoic, other organics	333,150
Fungicide formulations	
Inorganic compounds[a]	N/A
Organic compounds	56,250
Other pesticidal formulations	
Fumigants	17,450
Defoliants and desiccants	3,500
All other[a]	N/A

[a]Data not available.

Source: 1982 Census of Manufacturers (USDC 1985).

Roughly 75% of all insecticides and herbicides, and 66% of all pesticides, are used on agricultural cropland. The remainder are used in private homes and gardens and on commercial and industrial property (Dillon 1981). The

majority of pesticides are used on only a few major crops. Currently, cotton, corn, and apples receive 67% of all insecticides used in agriculture. Corn and soybeans receive 60% of the herbicides used, and 84% of the fungicides are applied to fruits and vegetables. Only 48% of the total U.S. cropland is treated with pesticides (Dahlston 1983).

Raw Materials

Pesticide formulation converts highly concentrated pesticide active ingredients into convenient-to-use products at application concentrations packaged for the end-user. As listed below, input raw materials include the pesticide concentrates from pesticide manufacturing plants as well as diluents and other chemical additives used in the formulating process:

Active Agents

Organic/inorganic pesticides: insecticides, herbicides, fungicides, other

Formulations and preparation materials

Dry formulations:
organic flours, sulfur, silicon oxide, lime, gypsum, talc, pyrophyllite, bentonites, kaolins, attapulgite, volcanic ash

Liquid formulations:
Solvents: xylenes, kerosenes, methyl isobutyl ketone, amyl acetate, chlorinated solvents

Propellants: Carbon dioxide, nitrogen

Others: wetting and dispersing agents, masking agents, deodorants, emulsifiers

Process Description

There are two major steps in the production of pesticides for agricultural use. The first step is the manufacturing of the pesticide concentrate from basic chemical feedstocks including petrochemicals, inorganic acids, gases such as chlorine, and other chemicals. This produces the pesticide, but not in a form which is ready for use. The second major step, which is the focus of this report, is the formulation and preparation of the pesticide for final use. Block flow diagrams of the steps involved in formulating liquid-based and dry-based pesticide products are presented in Figures 2 and 3 respectively.

The processes used to formulate pesticides generally consist of blending operations where the active ingredients are mixed with the inert ingredients previously mentioned. Also, particle size reduction operations such as milling and coating operations for granule and treated seed production are used. Generally, chemical reactions do not occur.

Conventional blending equipment is used for pesticide formulation. This equipment includes tanks equipped with mixers for liquid formulations and blending mills for solid formulations. Ancillary equipment includes storage tanks, rotary kilns for curing solid formulations, pumps, hoppers, and conveyors. Mixing tank capacities generally vary from less than 100 gallons to several thousand gallons for liquid formulations. Solids blending mill capacities are usually on the order of several hundred pounds to three tons.

Packaging of the pesticides formulations most commonly occurs at the same plant where the formulating is performed. This avoids the cost of transporting the high volume, dilute formulations. Packaging generally involves pouring liquid formulations into 55-gallon drums or glass bottles for distribution. For solid formulations, the material is usually gravity fed from hoppers into drums or paper bags for distribution.

Waste Description

In order to present a meaningful discussion of source reduction techniques that are applicable to the pesticide formulating industry, the sources of waste generation in this industrial segment must first be described. Pesticide formulating generally involves the blending of concentrated active pesticide ingredients with inert diluents, and the actual formulation process typically does not generate wastes. However, related non-formulating activities do generate hazardous wastes. These include decontamination of mixing and storage equipment, housekeeping operations, and laboratory testing for quality assurance. The wastes and their process origins are listed in Table 2.

Decontamination of liquid pesticide mixing and storage equipment generates pesticide-contaminated wastewater or solvent, depending upon whether the equipment is used to formulate water or solvent-based pesticides. Decontamination of the blending equipment is performed for the same reasons as for the liquid pesticide formulating equipment. The decontamination is commonly performed using high pressure water hoses equipped with spray nozzles, portable steam generators, or by running a batch of solvent through the formulating equipment. Floor washing is typically performed using water hoses equipped with spray nozzles. It may also involve the use of mops and squeegees.

Reuseable active ingredient containers, such as 55-gallon drums, are often decontaminated by triple rinsing. They then can be sold or given to commercial recycling firms. The decontamination is usually performed using a high pressure water hose equipped with a spray nozzle or a portable steam jenny.

Another source of liquid waste, unique to the packaging of aerosol pesticides, is the hot water bath. This is required by the U.S. Department of Transportation to

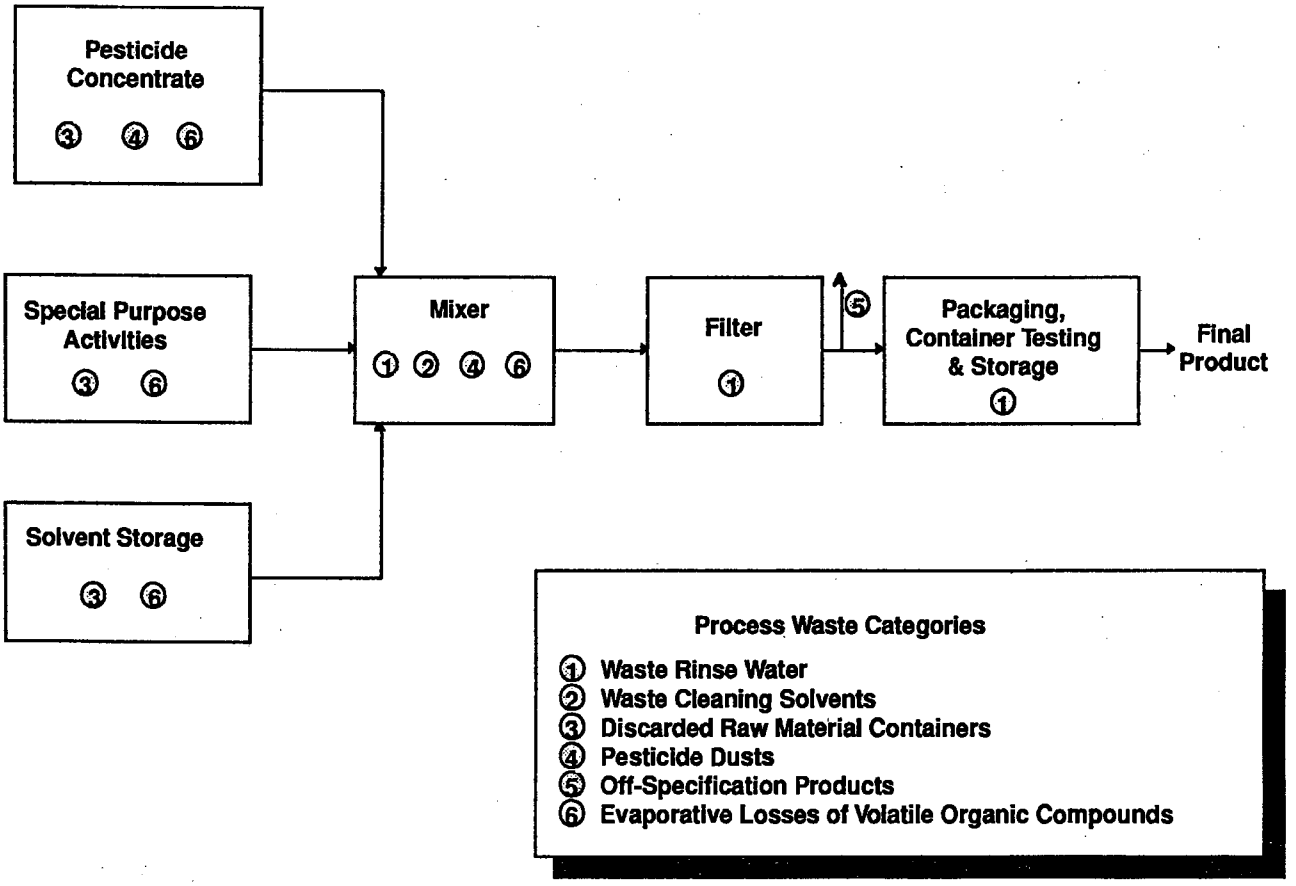

Figure 2. Liquid Pesticide Formulation Process

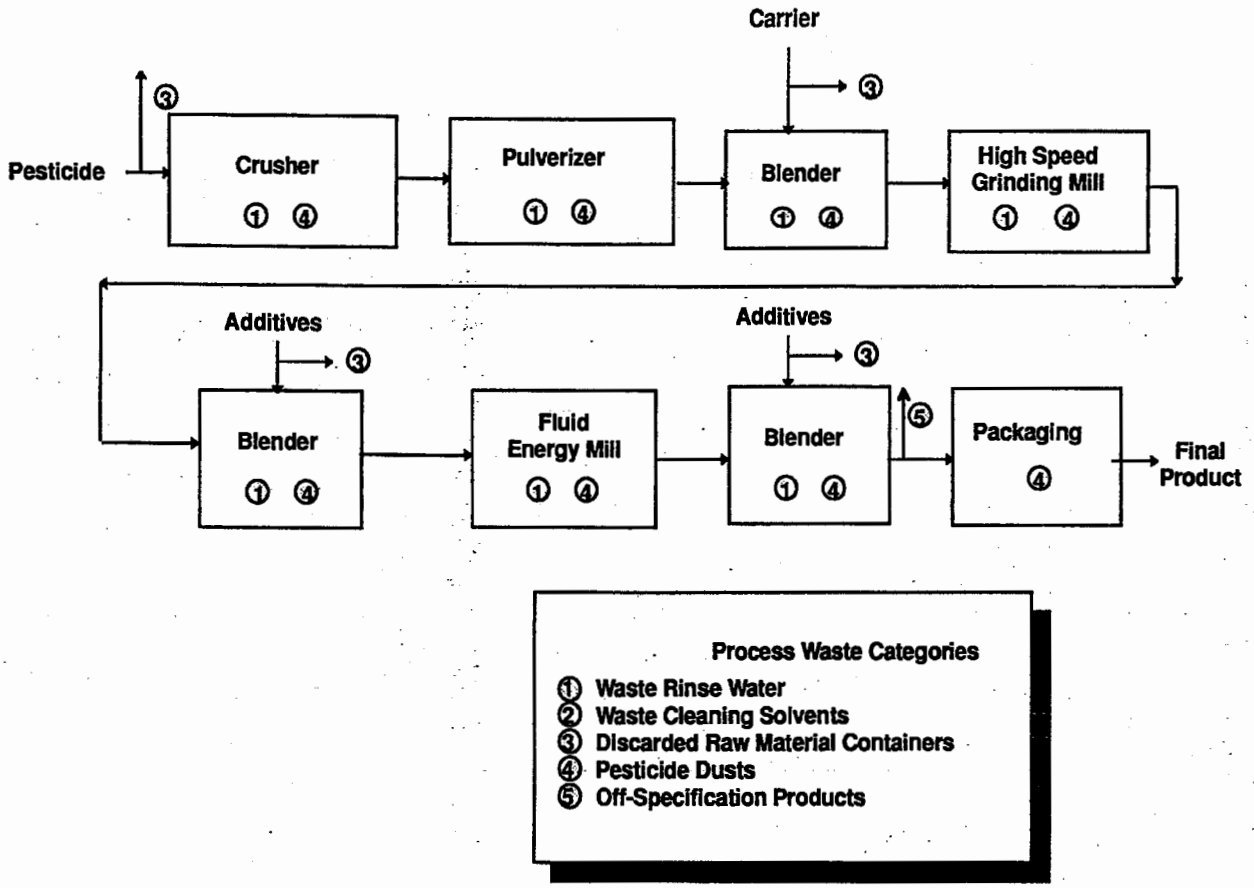

Figure 3. Dry Pesticide Formulation Process

Table 2. Pesticide Formulating Process Wastes

No.	Waste Description	Process Origin	Composition
1.	Leftover raw materials containers.	Unloading of materials into blending tanks.	Bags, fiber drums, steel drums with small amounts of residual raw material.
2.	Pesticide dust from air pollution equipment.	Unloading of dry pesticides into blending tanks.	Pesticide dust, inert carrier dust.
3.	Scrubber water from air pollution equipment.	Unloading of dry pesticides into blending tanks.	Pesticide-contaminated wastewater and solvents.
4.	Volatile organic compounds.	Air emissions from storage tanks and open processing equipment.	Solvents.
5.	Off-specification products and laboratory analysis wastes.	Formulating and testing.	Waste pesticide formulations.
6.	Spills.	Accidental discharge.	Waste pesticide formulations.
7.	Waste sands or clays.	Equipment cleaning.	Pesticide-contaminated sands or clays.
8.	Waste rinse water.	Equipment cleaning, area washdown, hot water bath for leak checking.	Pesticide-contaminatedwastewater.
9.	Waste solvent.	Equipment cleaning.	Pesticide-contaminated solvents.[1]
10.	Laundry waste water.	Laundering of protective clothing.	Pesticide-contaminated wastewaters.
11.	Stormwater runoff.	Pesticide spillage and fallout of pesticide dust in open process areas.	Pesticide-contaminated wastewaters.

[1]RCRA Codes F002 and F003.

check for leaking cans (49B CFR Part 178). Each filled aerosol can is immersed in the bath where bubbles can be seen if a container has not been sealed. Water from the hot water baths is discharged routinely to prevent turbidity.

Decontamination of the solid-based pesticide blending mills generates solid diluent contaminated with pesticides. The diluent typically consists of clay for dust mills and sand for granule mills.

Decontamination is performed in between batches of different types of formulations to prevent cross contamination of the subsequent batch. Decontamination is also performed prior to taking the equipment out of service for maintenance.

Most dust/granule blending mills are equipped with vacuum systems to collect fugitive dust. This provides for worker safety, for control of product loss, and for housekeeping in the process area. Some vacuum systems are dedicated to certain mills to facilitate reuse of the dust. Other systems are used to collect dust from a number of areas.

Conventional process technology unit operations are commonly used to treat wastewater from pesticide and related industries. Table 3 below presents a list of the unit operations commonly used to treat pesticide industry wastewaters. However, this list does not include all the applicable treatment unit operations for the many varied waste streams in the pestticide formulating industry. An appropriate combination of unit operations can remove or destroy pesticides and other toxic pollutants to levels which allow reuse of the treated wastewater, discharge to publicly owned treatment works (POTW), or direct discharge to surface waters.

Table 3. Unit Operations for Treatment of Pesticide Formulating Wastewaters

Filtration
Precipitation
Incineration
Coagulation/flocculation
Oil/water separation
Biological treatment
Flotation
Activated carbon adsorption
Evaporation
Hydrolysis
Stabilization
Chemical oxidation
Equalization
Resin adsorption
Decantation
Steam/air stripping

Source: ESE and TRW, 1983.

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Regulating Pesticides Home

Reregistration Home

About Reregistration

Public Participation

Reregistration Status

Progress & Status Reports

Organic Arsenicals

Current as of April 2013

The organic arsenical pesticides consist of monosodium methanearsonate (MSMA), disodium methanearsonate (DSMA), calcium acid methanearsonate (CAMA), and cacodylic acid and its sodium salt. They are used or have been used as herbicides on cotton and other agricultural crops, in forestry, on residential and other lawns and turf, and in non-crop areas such as rights of way, drainage ditch banks, fence rows, and storage yards.

On this page you will find:

- Voluntary Cancellations and Amendments
- Agreement in Principle
- Changes since the 2006 RED
- MSMA Cotton Use is Eligible for Reregistration with Mitigation
- All Other Uses will be Phased Out and Canceled
- Scientific Peer Review
- How Organic Arsenical Herbicides Are Used
- Exposure through Drinking Water
- Exposure from Treated Residential Lawns
- Safe Use and Disposal of Homeowner Products
- Alternatives to Organic Arsenicals for Homeowner Use

MSMA Registration Review

- FR Notice, March 27, 2013
- Preliminary Work Plan (March 2013)
- Docket EPA-HQ-OPP-2013-0107
- MSMA Chemical Page

Quick Resources

- RED Amendment - April 2009
- MSMA, DSMA, CAMA, and Cacodylic Acid RED - July 2006 (70 pp, 742 KB, About PDF)
- Agreement in Principle:
  - January 16, 2009
- Guidance for Products Containing the Organic Arsenicals(PDF) (8p., 351K, About PDF) (February 18, 2009)
- Organic Arsenicals Dockets:
  - EPA-OPP-HQ-2006-0201
  - EPA-OPP-HQ-2009-0191

Voluntary Cancellations and Amendments

EPA's order, Organic Arsenicals; Product Cancellation Order and Amendments to Terminate Uses – FR Notice, September 30, 2009 terminates the last products containing DSMA, CAMA, and cacodylic acid and its sodium salt registered for use in the U.S. It terminates certain MSMA product registrations and amends others to phase out all uses except cotton. All uses of DSMA, CAMA, and cacodylic acid and its sodium salt, and all uses of MSMA except cotton, sod farms, golf courses, and highway rights-of-way, were canceled as of September 30, 2009. Use of MSMA on sod farms, golf courses, and highway rights-of-way was to have been prohibited after December 31, 2013. Because EPA has modified the 2009 Agreement in Principle with registrants to include a National Academy of Sciences review, presently these uses remain registered. See Organic Arsenicals; Amendments to Terminate Uses; Amendment to Existing Stocks Provisions – FR Notice, March 27, 2013.

The sod farm, golf course, and highway rights-of-way uses, in addition to the cotton use, will be considered during the registration review of MSMA that began in March 2013. For further details on these uses and related mitigation measures see MSMA Cotton Use is Eligible for Reregistration with Mitigation and All Other Uses will be Phased Out and Canceled.

Agreement in Principle

In January and February 2009, EPA reached agreement with the technical registrants of all existing organic arsenicals manufacturing-use products to eliminate, phase out, and modify certain uses.

- Agreement in Principle, January 16, 2009
- Agreement in Principle, February 5, 2009

The voluntary agreements steadily remove all organic arsenical pesticide product uses, except the use of MSMA on cotton, from the market and implement new restrictions to better protect drinking water resources. Phasing out these uses is expected to accelerate the transition to new, lower risk herbicides.

Under the agreements, many uses, including use on residential lawns, were canceled by the end of 2009, and mitigation measures to protect water resources are being implemented through revised product labeling.

- In mid-March 2009, the registrants submitted voluntary cancellation requests for all uses, other than the use of MSMA on cotton.
- By the end of 2009, many uses were cancelled including use on residential lawns, forestry, non-bearing fruit and nut trees, and citrus orchards.
- A subset of uses (golf courses, sod farms, and highway rights of way) will be phased out, promoting transition to alternatives.

For products used on cotton and products phased out after 2009, new use restrictions and mitigation measures have been added to increase protections to water resources.

The agreements also provided for scientific review of any new toxicity or benefits data prior to the final cancellation of major uses, if the data were provided by the date set forth in the agreements.

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Changes since the 2006 RED

In the Agency's 2006 Reregistration Eligibility Decision (RED) for MSMA, DSMA, CAMA, and cacodylic acid and its sodium salt, EPA concluded that all uses of the organic arsenical herbicides were ineligible for reregistration. Following application, these pesticides convert over time to a more toxic form in soil, inorganic arsenic, and potentially contaminate drinking water through soil runoff.

Since MSMA is used on cotton, EPA also believed at that time that residues of inorganic arsenic could enter the human food supply through the meat and milk of animals fed cotton by-products (seeds, hulls, and gin by-products) that have been treated with MSMA. In completing the RED, EPA found that the aggregate dietary risks from exposure to inorganic arsenic in food and drinking water combined did not meet the reasonable certainty of no harm standard under the Federal Food, Drug, and Cosmetic Act (FFDCA).

In 2007 and 2008, stakeholders submitted to the Agency additional data on organic arsenicals that previously were not available. These data indicate that no residues of inorganic arsenic are likely to remain in the meat and milk of animals fed cotton by-products that have been grown in fields treated with MSMA, or in food crops that are rotated with cotton that has been treated with MSMA.

Cotton growers also have documented the increasing spread of Palmer amaranth or pigweed, a glyphosate-resistant weed that can significantly reduce cotton yields and could have a negative effect on conservation tillage efforts. Currently, no alternative herbicides to MSMA are registered on cotton to control this pest.

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MSMA Cotton Use is Eligible for Reregistration with Mitigation

In light of the new information, the agreements allow for the reregistration of MSMA use on cotton only, contingent on the development and acceptance of confirmatory data demonstrating that no residues of inorganic arsenic are likely to remain in the meat and milk of animals fed cotton by-products. These data were provided and are under review.

EPA also rescheduled the MSMA registration review to begin in March 2013. During this ongoing review, the risks and benefits of MSMA will be reevaluated considering any new toxicity information as well as the availability of new, lower-risk herbicides that should be entering the market.

The agreements require certain mitigation measures for MSMA use on cotton to protect water resources. Pre-plant cotton use has been deleted. The cotton use is limited to two post-emergent applications per year of two pounds active ingredient per acre each. Cotton growers also must maintain a 50-foot buffer zone around permanent water bodies.

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All Other Uses will be Phased Out and Canceled

All use of the organic arsenical herbicides, except MSMA use on cotton, will be canceled in two phases. In addition to products used on cotton, MSMA products with uses phasing out over several years will include new restrictions, summarized below, to protect water resources.
Phase 1 – Many existing uses were canceled as of September 30, 2009. These uses include among others: residential turf, forestry, non-bearing fruit and nuts, citrus (bearing and non-bearing), various grasses, and drainage ditch banks, certain rights-of-way, fence rows, storage yards and similar non-crop areas.
Phase 2 – MSMA use on golf courses, sod farms, and highway rights-of-way was to be canceled as of December 31, 2012, with use of existing stocks permitted through 2013. If any person submitted benefits information concerning these uses to EPA on or before December 31, 2011, EPA would review such information, along with peer review recommendations (see below), and could amend its position on the continued registration of these uses. EPA received and is considering benefits information regarding these three MSMA uses.

As discussed further below, peer review recommendations from the National Academy of Sciences (NAS) would inform EPA's final decision regarding the use of MSMA on golf courses, sod farms, and highway rights-of-way. Because EPA did not provide a written determination by December 31, 2012, these three uses were not deleted at that time and will be extended until the Agency provides the required written determination.

The following new use restrictions currently apply.

For golf courses:
- Spot treatments only (100 sq feet per spot), not to exceed 25 percent of the total golf course acreage per year
- One broadcast treatment for newly constructed courses only

For sod farms:
- 1-2 broadcast applications
- 25 foot buffer around permanent water bodies

For highway rights-of-way:
- Two broadcast applications ONLY on highway rights-of-way
- 100 foot buffer around permanent water bodies

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Scientific Peer Review

The agreement also provides for scientific peer review related to the mode of action for cancer effects for inorganic arsenic prior to the final cancellation of MSMA use on golf courses, sod farms and highway rights-of-way. OPP was to seek concurrence from other EPA offices engaged in the regulation of inorganic arsenic to convene a joint review by the EPA Science Advisory Board (SAB) and the FIFRA Science Advisory Panel (SAP) in the first half of 2012.

In light of a Congressional directive to have the National Academy of Sciences (NAS) review the mode of action for carcinogenic effects by inorganic arsenic, EPA and the registrants have agreed to modify the agreement to include the NAS as a third potential peer review body, one of which must hold a public meeting on the mode of action before the cancellations can be finalized. EPA currently intends to undertake the peer review specified in the agreement by relying upon the NAS review. See EPA's March 27, 2013, FR Notice. The Agency plans to consider recommendations of the NAS peer review and make a written determination as to whether the science has changed sufficiently to warrant continuation of any of the Phase 2 uses. Additional information on the NAS review of inorganic arsenic is available at:
http://www8.nationalacademies.org/cp/projectview.aspx?key=49483

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How Organic Arsenical Herbicides Are Used

MSMA, DSMA, and CAMA are herbicides that are used or have been used for applications to cotton, bearing and non-bearing fruit and nut trees, commercial turf, golf courses, athletic fields, parks, and residential lawns, among other sites. MSMA, DSMA, and CAMA are selective, post-emergent herbicides that kill weeds without damaging grass and can be applied after weeds are visible.

Common trade names for MSMA, DSMA, or CAMA include *Scotts Post Emergent Crabgrass Control*, *Gordon's Crabgrass* and *Nutgrass Killer*, and *Ferti-Lome Crabgrass* and *Dallis Grass Killer*.

Cacodylic acid is a defoliant used to edge and renovate lawns. Unlike MSMA, DSMA, and CAMA, cacodylic acid is non-selective, meaning that it kills weeds and surrounding grass. Common trade names for cacodylic acid include *Scotts Spot Grass & Weed Control, Liquid Edger*, and *Liquid Fence & Grass Edger*.

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Exposure through Drinking Water

For the cotton use and all uses being phased out, EPA is immediately requiring new restrictions that are designed to prevent exposure to inorganic arsenic in drinking water. These include limiting use in areas of particularly vulnerable ground water, implementing buffer zones around surface water bodies, limiting the number of applications, and restricting golf course use to spot treatment only.

For residential areas, it is important to follow label instructions and minimize runoff (e.g., do not apply to sidewalks and other impermeable surfaces; do not apply near storm drains or water bodies).

Exposure from Treated Residential Lawns

Short-term use of organic arsenical products used according to label directions does not present an imminent risk. The Agency's primary concern is for these products to transform over time to the more toxic inorganic form of arsenic in soil and subsequently be transported to sources of drinking water. This issue is being addressed through new label restrictions. Because this transformation occurs beneath the soil surface, long-term residential exposure to inorganic arsenic in soil is unlikely. To further minimize potential exposure on lawns, keep children and pets off treated areas.

Safe Use and Disposal of Homeowner Products

It remains legal to purchase and use organic arsenical herbicides according to label directions and precautions. Use of these products according to label directions does not pose an imminent hazard. EPA has initiated action to address the potential for these chemicals to transform over time and contaminate sources of drinking water. Consumers who choose to use these products should take special care to always read and follow the label precautions and directions.

If you choose to discontinue use, contact your state or local hazardous waste disposal programs or your local solid waste collection service for information on proper disposal. See also Safe Disposal of Pesticides.

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Alternatives to Organic Arsenicals for Homeowner Use

The primary manner in which grass weeds such as crabgrass and dallisgrass can be effectively controlled is through the maintenance of a high quality turf. This includes developing healthy soil, using types of grass that thrive in your climate, and correcting thatch build-up. See additional information about Lawn and Garden pest control using integrated pest management and other environmentally friendly practices.

URS

Supplemental Groundwater Quality Report and Request for No Further Action for Second Discharge
Marketplace of Delray – Outlot D
aka Majestic/Royal Mart Gasoline Station
14683 South Military Trail
Delray Beach, Florida
FDEP Facility Identification: 508943661

Prepared for:
RLV Marketplace, LP
c/o Ramco-Gershenson, Inc.

Prepared by:
URS Corporation

URS Job No. 15262831
February 8, 2012

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APPENDICES

Appendix A Palm Beach County Department of Environmental Resources Management dated September 15, 2011
Appendix B Groundwater Sampling Logs
Appendix C Groundwater Laboratory Analytical Report and Chain-of-Custody Record

URS

February 8, 2012

Mr. David C. Gibson, P.G.
Senior Hydrogeologist
Palm Beach County
Department of Environmental Resources Management
2300 North Jog Road – Fourth Floor
West Palm Beach, Florida 33411

Re: Supplemental Groundwater Quality Monitoring Report and Request for No Further Action for Second Discharge Marketplace of Delray – Outlot D aka Majestic/Royal Mart Gasoline Station 14683 South Military Trail Delray Beach, Florida FDEP Facility Identification: 508943661

Dear Mr. Gibson:

1.0 INTRODUCTION

On behalf of RLV Marketplace, LP, URS Corporation (URS) is pleased to present this Supplemental Groundwater Quality Monitoring Report and Request for North Further Action for Second Discharge for the Marketplace of Delray – Outlot D facility (subject property) located at 14683 South Military Trail in Delray Beach, Florida. The scope of work was performed in accordance with the Palm Beach County Department of Environmental Resources Management's (PBCDERM) *Document Review Letter for Market Place of Delray – Outlot D* dated September 15, 2011 (see attached in Appendix A) for URS' Underground Storage Tank Closure – Soil Source Removal Report dated September 8, 2011. This report documents the groundwater quality sampling activities performed at the subject property on November 4, 2011.

2.0 BACKGROUND

The Marketplace of Delray – Outlot D facility is the former Majestic/Royal Mart convenience store/gasoline station. On May 16, 1995, a Discharge Reporting Form (DRF) was submitted based on the detection of water in one of the three previous USTs situated on the west side of the subject property. Subsequently in September 1998, the three USTs were removed and two new 10,000 gallon USTs were installed on the western side of the subject property. Petroleum impacts were reportedly not detected in the UST pit area as reported in the UST closure

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assessment. However, soil screening from soil borings adjacent to the eastern dispenser islands detected petroleum impacted soil with Organic Vapor Analyzer (OVA) readings in excess of 1,000 parts per million. Consequently, another DRF form was submitted to the FDEP as well as a claim for cleanup reimbursement under the Florida Petroleum Restoration Insurance Program (FPLRIP). The Majestic/Royal Mart facility has a current score of 31 related to the DRF dated September 28, 1998 for the eastern pump island area. The Majestic/Royal Mart outlet closed in 2009 and the USTs were registered as "Out of Service" with the FDEP.

In April 2011, the two existing 10,000-gallon USTs, associated piping, and dispensers were removed from the western area of the subject property. Based on the excavation activities for the western section of the product lines, URS submitted a Discharge Reporting Form (DRF) to the PBERM on May 9, 2011.

URS submitted a UST Closure and Soil Source Removal Report for the subject property dated September 8, 2011. For the UST closure, approximately 200 tons of impacted soil was excavated and disposed from the UST and western pump island areas. Confirmatory soil sampling from the UST excavation indicated that the soil source area above the water table had been removed to below the FDEP Soil Cleanup Target Levels (SCTLs). Open-hole sparging was conducted from May 12 through May 23, 2011. Groundwater quality samples (May 26, 2011 and June 13, 2011) from monitor well MW-100 (within the former UST pit area) and monitor wells MW-101 and MW-102 (adjacent to the western pump islands) did not detect groundwater concentrations of BTEX, MTBE, PAHs or TPH that exceeded the FDEP Groundwater Cleanup Target Levels (GCTLs). A site plan map is presented as **Figure 1**.

PBCDERM' *Document Review Letter* dated September 15, 2011 indicated that additional groundwater assessment would be required with respect to the eastern area of the subject property due to the impacts detected in monitor wells MW-6 and MW-12 (off site), which is related to the September 28, 1998 discharge.

However, soil and groundwater quality related to the UST Closure on the west side of the subject property, which resulted in the May 11, 2011 discharge, meets the soil SCTLs and groundwater GCTLs. Therefore the objective of the this report is to request No Further Action status for the May 11, 2011 discharge based on the previous soil and groundwater quality and current groundwater quality confirmation data for the subject property as described below.

3.0 FIELD ACTIVITIES

Groundwater Table Elevations

On November 4, 2011, URS personnel measured the depth to groundwater in monitor wells MW-1, MW-2, MW-4, MW-6, MW-100, MW-101, MW-102 and MW-103 to determine the current direction of groundwater flow. **Figure 2** illustrates the observed direction of groundwater flow and **Table 1** shows the groundwater elevation data. Based upon the groundwater table measurements, the observed direction of groundwater flow appears to be the east.

Groundwater Quality Sampling

On November 4, 2011, URS collected groundwater samples from shallow monitor wells MW-100, MW-102, and MW-103. Each well was purged a minimum of three well volumes with new polyethylene (PE) tubing using a peristaltic pump. Groundwater samples were collected after the filed parameters of dissolved oxygen, pH, conductivity, temperature and turbidity reached static equilibrium, defined by predetermined variance intervals. All procedures followed DEP-SOP-001/01 sampling protocol. The groundwater samples were placed in laboratory supplied containers, stored on ice and delivered to Palm Beach Environmental Laboratories in West Palm Beach, Florida for analysis of BTEX and MTBE using EPA Method 8206B, PAHs using EPA Method 8270, and total petroleum hydrocarbons (TPH) using the FL-PRO Method. Copies of the groundwater sampling logs are attached in Appendix B.

4.0 GROUNDWATER ANALYTICAL RESULTS

A summary of the groundwater analytical results are presented in the attached **Tables 2 and 3**. The groundwater analytical tests indicated that the BTEX, MTBE and PAH groundwater concentrations were below the laboratory detection levels of all monitor wells. TPH groundwater concentrations from each of the three monitor wells were reported at less than 1 milligram per liter (mg/L) compared to the TPH GCTL of 5 mg/L.

The groundwater laboratory analytical report and chain of custody record are provided in Appendix C. The groundwater concentrations are shown on **Figure 3**.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the November 4, 2011 groundwater quality data, URS has concluded the following for the May 11, 2011 discharge area:

- Based on the current groundwater quality test results, BTEX, MTBE, PAH and TPH

groundwater concentrations do not exceed their respective GCTLs in the three shallow monitor wells situated within the former UST pit area and western pump island area.

- Based upon the groundwater elevations shown in **Table 1** and **Figure 2**, the observed direction of groundwater flow appears to be to the east-southeast.

- The eastern area of the subject property will remain in the FPLRIP program and wait for funding for supplemental groundwater assessment related to the September 28, 1998 discharge.

URS recommends no further action status be issued for the former Majestic/Royal Mart (Marketplace of Delray – Outlot D) property and the monitor wells properly abandoned.

Please call us if you have any questions or comments regarding the above report.

Sincerely,
URS CORPORATION

David Schulte

David Schulte, P.G.
Senior Project Geologist

cc: Ramco, Inc.

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Table 1
Monitor Well Construction Details
Groundwater Elevations - November 4, 2011
Majestic / Royal Mart Gasoline Station
14683 Military Trail
Delray Beach, Florida

WELL NO.	DATE INSTALLED	INSTALLATION METHOD	TOP OF CASING ELEVATION	DEPTH TO WATER (feet)	GROUND WATER ELEVATION	TOTAL WELL DEPTH (fbls)	SCREENED LENGTH (feet)	WELL DIAMETER (inches)
MW-1	9/20/01	Hollow Stem Auger	13.94	4.83	9.11	17.03	10	2
MW-2	9/20/01	Hollow Stem Auger	13.52	4.79	8.73	16.77	10	2
MW-3	Destroyed	NA	NA	NA	NA	NA	NA	NA
MW-4	9/20/01	Hollow Stem Auger	13.46	4.89	8.57	17.40	10	2
MW-5	Destroyed	NA	NA	NA	NA	NA	NA	NA
MW-6	9/20/01	Hollow Stem Auger	13.40	4.93	8.47	17.40	10	2
MW-7D	Destroyed	NA	NA	NA	NA	NA	NA	NA
MW-8	Destroyed	NA	NA	NA	NA	NA	NA	NA
MW-9	9/20/01	Hollow Stem Auger	14.01	NM	NA	16.90	10	2
MW-10	Destroyed	NA	NA	NA	NA	NA	NA	NA
MW-11	9/20/01	Hollow Stem Auger	14.21	NM	NA	17.31	10	2
MW-12	10/16/01	Hollow Stem Auger	14.02	NM	NA	17.61	10	2
MW-13	10/16/01	Hollow Stem Auger	13.98	NM	NA	17.63	10	2
MW-14	10/29/01	Hollow Stem Auger	15.17	NM	NA	17.56	10	2
MW-100	6/9/11	Direct Push	13.68	4.25	9.43	15.92	10	1.5
MW-101	6/9/11	Direct Push	13.54	4.22	9.32	16.80	10	1.5
MW-102	6/9/11	Direct Push	13.55	4.30	9.25	16.28	10	1.5
MW-103	6/9/11	Direct Push	13.52	4.37	9.15	16.55	10	1.5

Notes:
fbls - feet below land surface
Monitoring well installations performed by Centerline Drilling
Top of Casing data from Envirospec Supplemental Site Assessment Report, Table 6, dated February 12, 2002
Top of Casing data transferred from old monitor wells to new using MW-1 as benchmark
Depth to water levels collected on June 13, 2011

TABLE 2
GROUNDWATER ANALYTICAL SUMMARY - VOAs
Majestic / Royal Mart Gasoline Station
14683 South Military Trail
Delray Beach, Florida 33484
FDEP Facility Identification: 508943661

Sample		Benzene	Toluene	Ethyl-benzene	Total Xylenes	Total VOAs	MTBE
Well	Date	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
MW-100	6/13/2011	0.54 U	0.60 U	0.52 U	1.2 I	1.2	0.48 U
	11/4/2011	0.64 U	0.66 U	0.73 U	1.63 U	NA	0.53 U
MW-101	6/13/2011	0.54 U	0.60 U	0.52 U	1.0 U	NA	0.48 U
	11/4/2011	0.64 U	0.66 U	0.73 U	1.63 U	NA	0.53 U
MW-102	6/13/2011	0.54 U	0.60 U	0.52 U	1.0 U	NA	0.48 U
	11/4/2011	0.64 U	0.66 U	0.73 U	1.63 U	NA	0.53 U
MW-2	6/13/2011	0.54 U	0.60 U	0.52 U	1.0 U	NA	0.48 U
MW-4	6/13/2011	0.54 U	0.60 U	0.58 I	1.0 U	0.58	0.48 U
MW-6	6/13/2011	1.4	27	68	710	804	1.2 U
MW-103	6/13/2011	0.54 U	0.60 U	0.52 U	1.0 U	NA	0.48 U
GCTLs		1**	40**	30**	20**	NA	20
NADCs		100	400	300	200	NA	200

Notes: NA = Not Available.

NS = Not Sampled.

GCTLs = Groundwater Cleanup Target Levels specified in Table I of Chapter 62-777, F.A.C.

NADCs = Natural Attenuation Default Source Concentrations specified in Table V of Chapter 62-777, F.A.C.

** = As provided in Chapter 62-550, F.A.C.

I = Result > = MDL but < RL MDL = Minimum Detection Level

Bold = Values exceeding GCTLs as defined in Table 1 of FAC 62-770

TABLE 3
GROUNDWATER ANALYTICAL SUMMARY - PAHs and TPH
Majestic / Royal Mart Gasoline Station
14683 South Military Trail
Delray Beach, Florida 33484
FDEP Facility Identification: 508943661

Sample Well	Sample Date	TPHs (µg/L)	Naphthalene (µg/L)	1-Methylnaphthalene (µg/L)	2-Methylnaphthalene (µg/L)	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Anthracene (µg/L)	Benzo (g,h,i) perylene (µg/L)	Fluoranthene (µg/L)	Fluorene (µg/L)	Phenanthrene (µg/L)	Pyrene (µg/L)	Benzo (a) pyrene (µg/L)	Benzo (a) anthracene (µg/L)	Benzo (b) fluoranthene (µg/L)	Benzo (k) fluoranthene (µg/L)	Chrysene (µg/L)	Dibenz (a,h) anthracene (µg/L)	Indeno (1,2,3-cd) pyrene (µg/L)
MW-100	6/13/2011	27 U	0.049 U	0.033 U	0.048 U	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.016 U	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
	11/4/2011	432 I	0.1 U	0.3 U	0.3 U	0.2 U	0.4 U	0.3 U	0.3 U	0.4 U	0.2 U	0.2 U	0.4 U	0.2 U	0.05 U	0.05 U	0.5 U	0.2 U	0.005 U	0.05 U
MW-101	6/13/2011	27 U	0.049 U	0.033 U	0.048 U	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.016 U	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
	11/4/2011	478 I	0.1 U	0.3 U	0.3 U	0.2 U	0.4 U	0.3 U	0.3 U	0.4 U	0.2 U	0.2 U	0.4 U	0.2 U	0.05 U	0.05 U	0.5 U	0.2 U	0.005 U	0.05 U
MW-102	6/13/2011	27 U	0.049 U	0.033 U	0.048 U	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.020 I	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
	11/4/2011	327 I	0.1 U	0.3 U	0.3 U	0.2 U	0.4 U	0.3 U	0.3 U	0.4 U	0.2 U	0.2 U	0.4 U	0.2 U	0.05 U	0.05 U	0.5 U	0.2 U	0.005 U	0.05 U
MW-2	6/13/2011	62 U	0.050 I	0.033 U	0.048 U	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.016 U	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
MW-4	6/13/2011	170	0.10	0.033 U	0.060 I	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.016 U	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
MW-6	6/13/2011	4100	0.050 I	0.033 U	0.048 U	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.016 U	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
MW-103	6/13/2011	32 I	0.049 U	0.033 U	0.048 U	0.016 U	0.009 U	0.015 U	0.012 U	0.012 U	0.020 I	0.015 U	0.012 U	0.015 U	0.009 U	0.012 U	0.012 U	0.011 U	0.012 U	0.014 U
GCTLs		5,000	14	28	28	20	210	2,100	210	280	280	210	210	0.2**	0.05*	0.05*	0.5	4.8	0.005*	0.05*
NADCs		50,000	140	280	280	200	2,100	21,000	2,100	2,800	2,800	2,100	2,100	20	5	5	50	480	0.5	5

Notes: NA = Not Available.

NS = Not Sampled.

GCTLs = Groundwater Cleanup Target Levels specified in Table I of Chapter 62-777, F.A.C.

NADCs = Natural Attenuation Default Source Concentrations specified in Table V of Chapter 62-777, F.A.C.

** = As provided in Chapter 62-550, F.A.C.

* = See the October 12, 2004 "Guidance for the Selection of Analytical Methods and for the Evaluation of Practical Quantitation Limits" to determine how to evaluate data when the CTL is lower than the PQL.

I = Result > = MDL but < RL MDL = Minimum Detection Level

Bold = Values exceeding GCTLs as defined in Table 1 of FAC 62-770

APPENDIX A

Department of Environmental Resources Management
2300 North Jog Road, 4th Floor
West Palm Beach, FL 33411-2743
(561) 233-2400
FAX: (561) 233-2414
www.pbcgov.com/erm

Palm Beach County Board of County Commissioners

Karen T. Marcus, Chair
Shelley Vana, Vice Chair
Paulette Burdick
Steven L. Abrams
Burt Aaronson
Jess R. Santamaria
Priscilla A. Taylor

County Administrator
Robert Weisman

"An Equal Opportunity Affirmative Action Employer"

September 15, 2011

Mr. David P. Hayman
URS Corporation
7800 Congress Ave., Suite 200
Boca Raton, Florida 33487

Dear Mr. Hayman:

SUBJECT: **DOCUMENT REVIEW**
MARKETPLACE OF DELRAY - OUTLOT D,
14683 MILITARY TRAIL, DELRAY BEACH,
FDEP FACILITY #508943661

The Palm Beach County Department of Environmental Resources Management (ERM) has reviewed the Underground Storage Tank Closure – Soil Source Removal Report dated September 8, 2011 (received September 12, 2011), prepared and submitted by URS Corporation, for the subject site. The following comments are provided concerning ERM staff's review of the above referenced report.

1. Based on the data provided in the above referenced report, it appears site conditions may meet the criteria for continued remediation by natural attenuation. However, the current extent of groundwater contamination was not fully identified. According to data provided in the Supplemental Site Assessment Report dated February 12, 2002, petroleum contamination was detected in groundwater samples collected from monitor well MW-12. The perimeter wells downgradient from well MW-6 were not sampled during the supplemental assessment conducted following source removal. The full extent of groundwater contamination must be identified before post remediation monitoring can be approved.

2. Although the discharge reported on September 28, 1998 is eligible for state funding through the Florida Petroleum Liability Restoration Insurance Program (FPLRIP), the discharge dated May 5, 2011 is not eligible for state funding. No discussion was provided in the above referenced report concerning the source of the groundwater contamination with respect to these reported discharges. If the responsible party intends to pursue state funding through the FPLRIP, an application for a Site Rehabilitation Funding Allocation Agreement must be submitted to the Florida Department of Environmental Protection. Otherwise, contamination cleanup must proceed in accordance with the guidelines established in Chapter 62-770, Florida Administrative Code.

If you have any questions concerning this review, please contact me at (561) 233-2483.

Sincerely,

David C. Gibson, P.G.
Senior Hydrogeologist
Resources Protection

dcg:kle
cc: Grace Rivera, Environmental Manager
Bureau of Petroleum Storage Systems, FDEP
Tim Comer, RLV Marketplace, LP
31500 Northwestern Hwy., Suite 300, Farmington Hills, MI 48334

APPENDIX B

Form FD 9000-24

GROUNDWATER SAMPLING LOG

SITE NAME: Majestic Royal Mart Gasoline	SITE LOCATION: 14683 S. Military Trail - Delray Bch, FL	
WELL NO: MW100	SAMPLE ID: MW100	DATE: 11/4/11

PURGING DATA

WELL DIAMETER (inches): 1 1/2"	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL DEPTH: 5.9 feet to 15.9 feet	STATIC DEPTH TO WATER (feet): 4.25	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (15.90 feet – 4.25 feet) X 0.10 gallons/foot = 1.165 gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= gallons + (gallons/foot X feet) + gallons = gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 8'	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 8'	PURGING INITIATED AT: 0840	PURGING ENDED AT: 0858	TOTAL VOLUME PURGED (gallons): 3.00

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet)	pH (standard units)	TEMP. (°C)	COND. (circle units) µmhos/cm or µS/cm	DISSOLVED OXYGEN (circle units) mg/L or % saturation	TURBIDITY (NTUs)	COLOR (describe)	ODOR (describe)
0849	1.60	1.60	0.20	4.35	7.62	28.5	1467	0.03	4.96	Brown	Organic
0852	.60	2.00	0.20	4.35	7.54	28.5	1454	0.06	4.99	"	"
0855	.60	2.60	0.20	4.35	7.31	28.5	1429	0.05	4.52	"	"
0858	.60	3.00	0.20	4.35	7.27	28.5	1416	0.03	3.74	"	"

WELL CAPACITY (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: David Warner/ERS	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 0900	SAMPLING ENDED AT: 0905
PUMP OR TUBING DEPTH IN WELL (feet):	TUBING MATERIAL CODE: PE	FIELD-FILTERED: Y (N) Filtration Equipment Type:	FILTER SIZE: ____ µm
FIELD DECONTAMINATION: PUMP Y (N)	TUBING Y (N (replaced)	DUPLICATE: Y (N)	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW100	2	CG	40ml	None		7.27	VOA's	RFPP	<100ml
MW100	1	AG	1L	None		7.27	PAH's	APP	100ml
MW100	1	AG	1L	HCL		7.27	EC PRO	APP	100ml

REMARKS:

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RFPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

NOTES: 1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
pH: ± 0.2 units Temperature: ± 0.2 °C Specific Conductance: ± 5% Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater) Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009

Form FD 9000-24

GROUNDWATER SAMPLING LOG

SITE NAME: Majestic/Royal Mart Gasolines Ft.	SITE LOCATION: 14683 S. Military Trail - Delray Bch, Fl	
WELL NO: MW101	SAMPLE ID: MW101	DATE: 11/4/11

PURGING DATA

WELL DIAMETER (inches): 1 1/2"	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL DEPTH: 6.57 feet to 16.57 feet	STATIC DEPTH TO WATER (feet): 4.22	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (16.72 feet – 4.22 feet) x 0.10 gallons/foot = 1.25 gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= gallons + (gallons/foot X feet) + gallons = gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 8'	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 8'	PURGING INITIATED AT: 0920	PURGING ENDED AT: 0938	TOTAL VOLUME PURGED (gallons): 3.00

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet)	pH (standard units)	TEMP. (°C)	COND. (circle units) µmhos/cm mS/cm	DISSOLVED OXYGEN (circle units) mg/L or % saturation	TURBIDITY (NTUs)	COLOR (describe)	ODOR (describe)
0929	1.60	1.60	0.2	4.30	7.26	28.0	577	0.00	10.46	Brown	Organic
0932	.60	2.60	0.2	4.30	7.24	28.0	577	0.00	10.99	"	"
0935	.60	2.60	0.2	4.30	7.22	28.0	578	0.00	6.21	"	"
0938	.60	3.00	0.2	4.30	7.20	28.0	578	0.00	6.19	"	"

WELL CAPACITY (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016
PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: David Warner/ERS	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 0940	SAMPLING ENDED AT: 0945
PUMP OR TUBING DEPTH IN WELL (feet): 8'	TUBING MATERIAL CODE: PE	FIELD-FILTERED: Y (N) Filtration Equipment Type:	FILTER SIZE: ___ µm
FIELD DECONTAMINATION: PUMP Y (N)	TUBING Y (N) (replaced)	DUPLICATE: Y (N)	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW101	2	CG	40ml	None		7.20	VOA's	RFPP	<100 ml
MW101	1	AG	1L	NaOH		7.20	PAH's	APP	100 ml
MW101	1	AG	1L	HCL		7.20	FL PRO	APP	100 ml

REMARKS:

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RFPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

NOTES: 1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
pH: ± 0.2 units Temperature: ± 0.2 °C Specific Conductance: ± 5% Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater) Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009

Form FD 9000-24

GROUNDWATER SAMPLING LOG

SITE NAME: Majestic Royal Mart Gasoline Site		SITE LOCATION: 4683 S. Military Trail - Delray Bch, FL	
WELL NO: MW102	SAMPLE ID: MW102		DATE: 11/4/11

PURGING DATA

WELL DIAMETER (inches): 1 1/2"	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL DEPTH: 6.31 feet to 16.31	STATIC DEPTH TO WATER (feet): 4.30	PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
(only fill out if applicable)
= (16.31 feet – 4.30 feet) x 0.10 gallons/foot = 1.201 gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= gallons + (gallons/foot X feet) + gallons = gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 8'	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 8'	PURGING INITIATED AT: 1145	PURGING ENDED AT: 1203	TOTAL VOLUME PURGED (gallons): 3.60

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet)	pH (standard units)	TEMP. (°C)	COND. (circle units) µmhos/cm or µS/cm	DISSOLVED OXYGEN (circle units) mg/L or % saturation	TURBIDITY (NTUs)	COLOR (describe)	ODOR (describe)
1154	1.60	1.60	0.20	4.35	7.51	28.5	692	0.07	2.96	Brown	Organic
1157	.60	2.00	0.20	4.35	7.50	28.5	688	0.05	1.50	"	"
1200	.60	2.60	0.20	4.35	7.48	28.5	680	0.03	0.00	"	"
1203	.60	3.60	0.20	4.35	7.45	28.6	658	0.02	0.00	"	"

WELL CAPACITY (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION: David Warine/ERS	SAMPLER(S) SIGNATURE(S):	SAMPLING INITIATED AT: 1205	SAMPLING ENDED AT: 1210
PUMP OR TUBING DEPTH IN WELL (feet): 8'	TUBING MATERIAL CODE: PE	FIELD-FILTERED: Y (N) Filtration Equipment Type:	FILTER SIZE: ____ µm
FIELD DECONTAMINATION: PUMP Y (N)	TUBING Y (N) (replaced)	DUPLICATE: Y (N)	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE	SAMPLE PUMP FLOW RATE (mL per minute)
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH			
MW102	2	CG	40ml	None		7.45	VOA's	RPP	<100ml
MW102	1	AG	1L	None		7.45	SVOA's	RPP	100ml
MW102	1	AG	1L	HCL		7.45	TCL PRO	RPP	100ml

REMARKS:

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RFPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

NOTES: 1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
pH: ± 0.2 units Temperature: ± 0.2 °C Specific Conductance: ± 5% Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater) Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009

APPENDIX C

R Majestic

Palm Beach Environmental
Laboratories Inc.

David Schulte
URS Corporation
Boca Raton, FL 33487
(561) 994-6500
LOG #: 0009320

November 11, 2011

Enclosed is the laboratory report for your project. All results meet the requirements of the NELAC standards.

Please note the following:

(1) The samples were received as stated on the chain of custody, correctly labeled and at the proper temperature unless otherwise noted. The results contained in this report relate only to the items tested or to the samples as received by the laboratory.

(2) This report may not be reproduced except in full, without the written approval of the laboratory. Any anomalies are noted in the case narrative.

(3) Results for all solid matrices are reported in dry weight unless otherwise noted.

(4) Results for all liquid matrices are analyzed as received in the laboratory unless otherwise noted.

(5) Samples are disposed of within 30 days of their receipt by the laboratory.

(6) A statement of Qualifiers is available upon request.

(7) Certain analyses are subcontracted to outside NELAC certified laboratories and are designated on your report.

(8) Precision & Accuracy will be provided when clients require a measure of estimated uncertainty.

(9) The issuance of the final Certificate of Analysis takes precedence over any previous Preliminary Report Preliminary Data should not be used for regular purposes. Authorized signature(s) is provided on final report only

Please contact me if you have any questions or concerns regarding this report.

Sincerely,

Pamela Shore
QA Officer

Palm Beach Environmental Laboratories Inc.

CERTIFICATE OF ANALYSIS

URS Corporation
7800 Congress Ave Suite 200
Boca Raton, FL 33487
ATTN: David Schulte
PHONE: (561) 994-6500 FAX: (561) 994-6524

LOG #: 0009320
COC#: 13901
REPORTED: 11/11/2011 8:45:03AM
PROJECT #: [none]
PROJECT: Majestic/Royal Mart

Description: MW-100 | Lab ID: 0009320-01 | Sampled: 11/04/11 00:00
Matrix: Water | Sampled By: David Waring | Received: 11/04/11 13:30

EPA 8020 List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	POL	Extraction Date	Analysis Date	Analyst
71-43-2	Benzene	0.64	U	ug/L	EPA 8260C	1	0.64	1.00	11/07/11	11/11/11	PLS
108-88-3	Toluene	0.66	U	ug/L	EPA 8260C	1	0.66	1.00	11/07/11	11/11/11	PLS
108-90-7	Chlorobenzene	0.67	U	ug/L	EPA 8260C	1	0.67	1.00	11/07/11	11/11/11	PLS
100-41-4	Ethylbenzene	0.73	U	ug/L	EPA 8260C	1	0.73	1.00	11/07/11	11/11/11	PLS
108-38-3/106-42-3	m,p-Xylene	0.76	U	ug/L	EPA 8260C	1	0.76	1.00	11/07/11	11/11/11	PLS
95-47-6	o-Xylene	0.87	U	ug/L	EPA 8260C	1	0.87	1.00	11/07/11	11/11/11	PLS
541-73-1	1,3-Dichlorobenzene	0.31	U	ug/L	EPA 8260C	1	0.31	1.00	11/07/11	11/11/11	PLS
106-46-7	1,4-Dichlorobenzene	0.51	U	ug/L	EPA 8260C	1	0.51	1.00	11/07/11	11/11/11	PLS
95-50-1	1,2-Dichlorobenzene	0.51	U	ug/L	EPA 8260C	1	0.51	1.00	11/07/11	11/11/11	PLS
1634-04-4	MTBE	0.53	U	ug/L	EPA 8260C	1	0.53	1.00	11/07/11	11/11/11	PLS

		% Recovery	Q	% Recovery Limits
1868-53-7	Surrogate: Dibromofluoromethane	129 %		Limit 62-200
2037-26-5	Surrogate: Toluene-d8	92.7 %		Limit 63-144
460-00-4	Surrogate: 4-Bromofluorobenzene	108 %		Limit 50-131

EPA 8100 PAH List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	POL	Extraction Date	Analysis Date	Analyst
91-20-3	Naphthalene	0.1	U	ug/L	EPA 3510C / 8270	1	0.1	10.0	11/08/11	11/11/11	MH
91-57-6	2-Methylnaphthalene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH
90-12-0	1-Methylnaphthalene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH
208-96-8	Acenaphthylene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/08/11	11/11/11	MH
83-32-9	Acenaphthene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/08/11	11/11/11	MH
86-73-7	Fluorene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/08/11	11/11/11	MH
85-01-8	Phenanthrene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/08/11	11/11/11	MH
120-12-7	Anthracene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH
206-44-0	Fluoranthene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/08/11	11/11/11	MH
129-00-0	Pyrene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/08/11	11/11/11	MH
56-55-3	Benzo(a)anthracene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/08/11	11/11/11	MH
218-01-9	Chrysene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	0.2	11/08/11	11/11/11	MH
205-99-2	Benzo(b)fluoranthene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/08/11	11/11/11	MH
207-08-9	Benzo(k)fluoranthene	0.5	U	ug/L	EPA 3510C / 8270	1	0.5	0.5	11/08/11	11/11/11	MH
50-32-8	Benzo(a)pyrene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	0.2	11/08/11	11/11/11	MH
53-70-3	Dibenz(a,h)anthracene	0.005	U	ug/L	EPA 3510C / 8270	1	0.005	0.05	11/08/11	11/11/11	MH
193-39-5	Indeno(1,2,3-cd)pyrene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/08/11	11/11/11	MH

Palm Beach Environmental Laboratories Inc.

CERTIFICATE OF ANALYSIS

URS Corporation
7800 Congress Ave Suite 200
Boca Raton, FL 33487
ATTN: David Schulte
PHONE: (561) 994-6500 **FAX:** (561) 994-6524

LOG #: 0009320
COC#: 13901
REPORTED: 11/11/2011 8:45:03AM
PROJECT #: [none]
PROJECT: Majestic/Royal Mart

Description: MW-100 **Lab ID:** 0009320-01 **Sampled:** 11/04/11 00:00
Matrix: Water **Sampled By:** David Waring **Received:** 11/04/11 13:30

EPA 8100 PAH List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
191-24-2	Benzo(g,h,i)perylene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH

		% Recovery	Q	% Recovery Limits
NA	Surrogate: Nitrobenzene-d5	121 %		Limit 40-142
321-60-8	Surrogate: 2-Fluorobiphenyl	114 %		Limit 47-150
NA	Surrogate: p-Terphenyl-d14	130 %		Limit 55-165

FLPRO

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
NA	FLPRO Total	0.432	I	mg/L	EPA 3510C /RO	1	0.040	0.500	11/07/11	11/11/11	MH

		% Recovery	Q	% Recovery Limits
84-15-1	Surrogate: o-Terphenyl	113 %		Limit 37-142

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Boca Raton, FL 33487
ATTN: David Schulte
PHONE: (561) 994-6500 FAX: (561) 994-6524

LOG #: 0009320
COC#: 13901
REPORTED: 11/11/2011 8:45:03AM
PROJECT #: [none]
PROJECT: Majestic/Royal Mart

Description: MW-101 | Lab ID: 0009320-02 | Sampled: 11/04/11 00:00
Matrix: Water | Sampled By: David Waring | Received: 11/04/11 13:30

EPA 8020 List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
71-43-2	Benzene	0.64	U	ug/L	EPA 8260C	1	0.64	1.00	11/07/11	11/11/11	PLS
108-88-3	Toluene	0.66	U	ug/L	EPA 8260C	1	0.66	1.00	11/07/11	11/11/11	PLS
108-90-7	Chlorobenzene	0.67	U	ug/L	EPA 8260C	1	0.67	1.00	11/07/11	11/11/11	PLS
100-41-4	Ethylbenzene	0.73	U	ug/L	EPA 8260C	1	0.73	1.00	11/07/11	11/11/11	PLS
108-38-3/106-42-3	m,p-Xylene	0.76	U	ug/L	EPA 8260C	1	0.76	1.00	11/07/11	11/11/11	PLS
95-47-6	o-Xylene	0.87	U	ug/L	EPA 8260C	1	0.87	1.00	11/07/11	11/11/11	PLS
541-73-1	1,3-Dichlorobenzene	0.31	U	ug/L	EPA 8260C	1	0.31	1.00	11/07/11	11/11/11	PLS
106-46-7	1,4-Dichlorobenzene	0.51	U	ug/L	EPA 8260C	1	0.51	1.00	11/07/11	11/11/11	PLS
95-50-1	1,2-Dichlorobenzene	0.51	U	ug/L	EPA 8260C	1	0.51	1.00	11/07/11	11/11/11	PLS
1634-04-4	MTBE	0.53	U	ug/L	EPA 8260C	1	0.53	1.00	11/07/11	11/11/11	PLS

		% Recovery	Q	% Recovery Limits
1868-53-7	Surrogate: Dibromofluoromethane	133 %		Limit 62-200
2037-26-5	Surrogate: Toluene-d8	92.9 %		Limit 63-144
460-00-4	Surrogate: 4-Bromofluorobenzene	120 %		Limit 50-131

EPA 8100 PAH List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
91-20-3	Naphthalene	0.1	U	ug/L	EPA 3510C / 8270	1	0.1	10.0	11/07/11	11/11/11	MH
91-57-6	2-Methylnaphthalene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/07/11	11/11/11	MH
90-12-0	1-Methylnaphthalene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/07/11	11/11/11	MH
208-96-8	Acenaphthylene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/07/11	11/11/11	MH
83-32-9	Acenaphthene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/07/11	11/11/11	MH
86-73-7	Fluorene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/07/11	11/11/11	MH
85-01-8	Phenanthrene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/07/11	11/11/11	MH
120-12-7	Anthracene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/07/11	11/11/11	MH
206-44-0	Fluoranthene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/07/11	11/11/11	MH
129-00-0	Pyrene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/07/11	11/11/11	MH
56-55-3	Benzo[a]anthracene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/07/11	11/11/11	MH
218-01-9	Chrysene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	0.2	11/07/11	11/11/11	MH
205-99-2	Benzo[b]fluoranthene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/07/11	11/11/11	MH
207-08-9	Benzo[k]fluoranthene	0.5	U	ug/L	EPA 3510C / 8270	1	0.5	0.5	11/07/11	11/11/11	MH
50-32-8	Benzo[a]pyrene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	0.2	11/07/11	11/11/11	MH
53-70-3	Dibenz[a,h]anthracene	0.005	U	ug/L	EPA 3510C / 8270	1	0.005	0.05	11/07/11	11/11/11	MH
193-39-5	Indeno[1,2,3-cd]pyrene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/07/11	11/11/11	MH

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ATTN: David Schulte
PHONE: (561) 994-6500 FAX: (561) 994-6524

LOG #: 0009320
COC#: 13901
REPORTED: 11/11/2011 8:45:03AM
PROJECT #: [none]
PROJECT: Majestic/Royal Mart

Description: MW-101 Lab ID: 0009320-02 Sampled: 11/04/11 00:00
Matrix: Water Sampled By: David Waring Received: 11/04/11 13:30

EPA 8100 PAH List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
191-24-2	Benzo[g,h,i]perylene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/07/11	11/11/11	MH

		% Recovery	Q	% Recovery Limits
NA	Surrogate: Nitrobenzene-d5	123 %		Limit 40-142
321-60-8	Surrogate: 2-Fluorobiphenyl	107 %		Limit 47-150
NA	Surrogate: p-Terphenyl-d14	122 %		Limit 55-165

FLPRO

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
NA	FLPRO Total	0.476	I	mg/L	EPA 3510C /RO	1	0.040	0.500	11/07/11	11/11/11	MH

		% Recovery	Q	% Recovery Limits
84-15-1	Surrogate: o-Terphenyl	108 %		Limit 37-142

Palm Beach Environmental Laboratories Inc.

CERTIFICATE OF ANALYSIS

URS Corporation
7800 Congress Ave Suite 200
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ATTN: David Schulte
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LOG #: 0009320
COC#: 13901
REPORTED: 11/11/2011 8:45:03AM
PROJECT #: [none]
PROJECT: Majestic/Royal Mart

Description: MW-102 Lab ID: 0009320-03 Sampled: 11/04/11 00:00
Matrix: Water Sampled By: David Waring Received: 11/04/11 13:30

EPA 8020 List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
71-43-2	Benzene	0.64	U	ug/L	EPA 8260C	1	0.64	1.00	11/07/11	11/11/11	PLS
108-88-3	Toluene	0.66	U	ug/L	EPA 8260C	1	0.66	1.00	11/07/11	11/11/11	PLS
108-90-7	Chlorobenzene	0.67	U	ug/L	EPA 8260C	1	0.67	1.00	11/07/11	11/11/11	PLS
100-41-4	Ethylbenzene	0.73	U	ug/L	EPA 8260C	1	0.73	1.00	11/07/11	11/11/11	PLS
108-38-3/106-42-3	m,p-Xylene	0.76	U	ug/L	EPA 8260C	1	0.76	1.00	11/07/11	11/11/11	PLS
95-47-6	o-Xylene	0.87	U	ug/L	EPA 8260C	1	0.87	1.00	11/07/11	11/11/11	PLS
541-73-1	1,3-Dichlorobenzene	0.31	U	ug/L	EPA 8260C	1	0.31	1.00	11/07/11	11/11/11	PLS
106-46-7	1,4-Dichlorobenzene	0.51	U	ug/L	EPA 8260C	1	0.51	1.00	11/07/11	11/11/11	PLS
95-50-1	1,2-Dichlorobenzene	0.51	U	ug/L	EPA 8260C	1	0.51	1.00	11/07/11	11/11/11	PLS
1634-04-4	MTBE	0.53	U	ug/L	EPA 8260C	1	0.53	1.00	11/07/11	11/11/11	PLS

		% Recovery	Q	% Recovery Limits
1868-53-7	Surrogate: Dibromofluoromethane	136 %		Limit 62-200
2037-26-5	Surrogate: Toluene-d8	93.2 %		Limit 63-144
460-00-4	Surrogate: 4-Bromofluorobenzene	113 %		Limit 50-131

EPA 8100 PAH List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
91-20-3	Naphthalene	0.1	U	ug/L	EPA 3510C / 8270	1	0.1	10.0	11/08/11	11/11/11	MH
91-57-6	2-Methylnaphthalene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH
90-12-0	1-Methylnaphthalene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH
208-96-8	Acenaphthylene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/08/11	11/11/11	MH
83-32-9	Acenaphthene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/08/11	11/11/11	MH
86-73-7	Fluorene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/08/11	11/11/11	MH
85-01-8	Phenanthrene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	10.0	11/08/11	11/11/11	MH
120-12-7	Anthracene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH
206-44-0	Fluoranthene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/08/11	11/11/11	MH
129-00-0	Pyrene	0.4	U	ug/L	EPA 3510C / 8270	1	0.4	10.0	11/08/11	11/11/11	MH
56-55-3	Benzo[a]anthracene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/08/11	11/11/11	MH
218-01-9	Chrysene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	0.2	11/08/11	11/11/11	MH
205-99-2	Benzo[b]fluoranthene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/08/11	11/11/11	MH
207-08-9	Benzo[k]fluoranthene	0.5	U	ug/L	EPA 3510C / 8270	1	0.5	0.5	11/08/11	11/11/11	MH
50-32-8	Benzo[a]pyrene	0.2	U	ug/L	EPA 3510C / 8270	1	0.2	0.2	11/08/11	11/11/11	MH
53-70-3	Dibenz[a,h]anthracene	0.005	U	ug/L	EPA 3510C / 8270	1	0.005	0.05	11/08/11	11/11/11	MH
193-39-5	Indeno[1,2,3-cd]pyrene	0.05	U	ug/L	EPA 3510C / 8270	1	0.05	0.05	11/08/11	11/11/11	MH

Palm Beach Environmental Laboratories Inc.

CERTIFICATE OF ANALYSIS

URS Corporation
7800 Congress Ave Suite 200
Boca Raton, FL 33487
ATTN: David Schulte
PHONE: (561) 994-6500 FAX: (561) 994-6524

LOG #: 0009320
COC#: 13901
REPORTED: 11/11/2011 8:45:03AM
PROJECT #: [none]
PROJECT: Majestic/Royal Mart

Description: MW-102 Lab ID: 0009320-03 Sampled: 11/04/11 00:00
Matrix: Water Sampled By: David Waring Received: 11/04/11 13:30

EPA 8100 PAH List

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
191-24-2	Benzo(g,h,i)perylene	0.3	U	ug/L	EPA 3510C / 8270	1	0.3	10.0	11/08/11	11/11/11	MH

		% Recovery	Q	% Recovery Limits
NA	Surrogate: Nitrobenzene-d5	124 %		Limit 40-142
321-60-8	Surrogate: 2-Fluorobiphenyl	99.4 %		Limit 47-150
NA	Surrogate: p-Terphenyl-d14	122 %		Limit 55-165

FLPRO

CAS #	Parameter	Results	Q	Units	Method	DF	MDL	PQL	Extraction Date	Analysis Date	Analyst
NA	FLPRO Total	0.327	I	mg/L	EPA 3510C /RO	1	0.040	0.500	11/07/11	11/11/11	MH

		% Recovery	Q	% Recovery Limits
84-15-1	Surrogate: o-Terphenyl	119 %		Limit 37-142

Palm Beach Environmental Laboratories Inc.

Notes and Definitions

U	Analyte included in the analysis, but not detected
I	The reported value is between the laboratory Method Detection Limit & the laboratory Practical Quantation Limit

Palm Beach Environmental Laboratories, Inc.

Log #: 9320 ✓
PO #:
Quote #: 577
FDEP :

CHAIN OF CUSTODY RECORD

Company Name: URS Corp
Address: 7800 Congress Ave # 200
City: Boca Raton State: FL Zip: 33487
Attn: Dave Schulte Phone#: (561) 862-1027
email: Fax#: (561) 994-6524
Project Name: Majestic/Royal Market Proj#:
Sampler Signature / Name: David Waring

LAB ANALYSIS

#	Sample Label (Client ID)	Collect Date	Collect Time	Matrix	Field Filtered	Integrity OK	Total # of containers	Parameters	VOA's 8260C	PAH's 8270C	FL PRO	11/4/11 PS pH FLPRO
								pH				
								PRES CODE	I	I	I E	
1	MW 100	11/4/11	9:05	GW			4		X	X	X	<2
2	MW 101	11/4/11	9:45	GW			4		X	X	X	<2
3	MW 102	11/4/11	12:10	GW			4		X	X	X	<2
4												
5												
6												
7												
8												
9												
0												

Matrix Codes

SD	Solid Waste	OL	Oil
GW	Ground Water	SL	Sludge
EFF	Effluent	SO	Soil Sediment
AFW	Analyte Free H2O	AQ	Aqueous
WW	Waste Water	NA	Nonaqueous
DW	Drinking Water		
SW	Surface Water	O	Other (Please Specify)

Press Codes

A. None	E. HCL	O. Other
B. HNO3	F. MeOH	
C. H2SO4	G. Na2S2O3	
D. NaOH	I. Ice	

T.A.T. Request

Standard	RUSH
Y/N	24 Hour / 48 Hour Date Due:

QA/QC Report Level: None___ 1___ 2___ 3___ Other___

COC OK: (Y) N

Initials: PS.

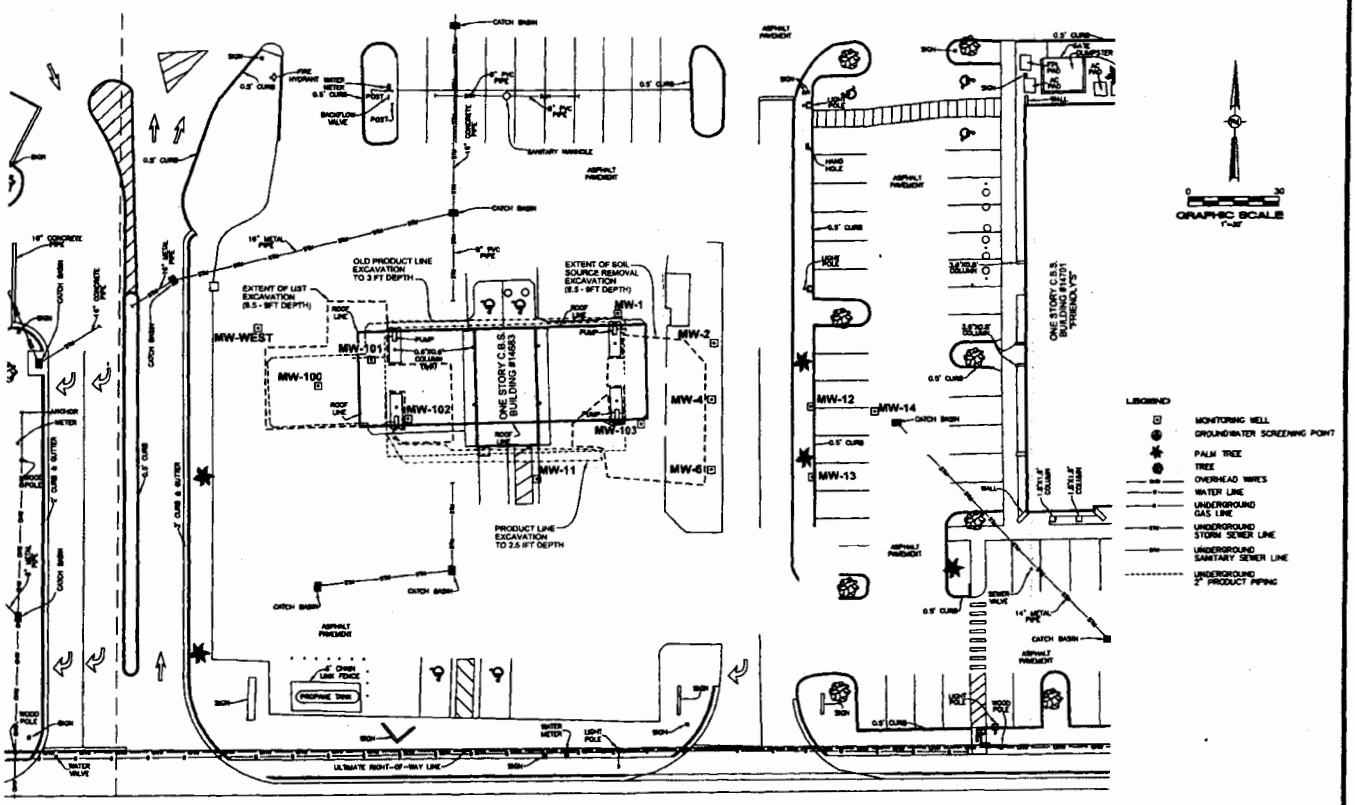
Item	Relinquished by	Affiliation	Date	Time	Received By	Affiliation	Date	Time
3	[signature]	URS	11/4/11	1330	[signature]	PBEL	11/4/11	1330

Lab Use Only

	Yes	No	N/A
Sample INTACT upon arrival?	✓		
Received on Wet Ice? Temp. 4 °C	✓		
Proper Preservatives Indicated?	✓		
Received within holding time?	✓		
Custody seals intact?	✓		
Volatile rec'd without headspace?	✓		
Proper Containers Used?	✓		

1550 Latham Road, Suite 2 • West Palm Beach, FL 33409 • Tel: (561) 689-6701 • Fax: (561) 689-6702

COC# 13901



DRAWN BY: BC
CHECKED BY: DS
DATE: Dec 2011

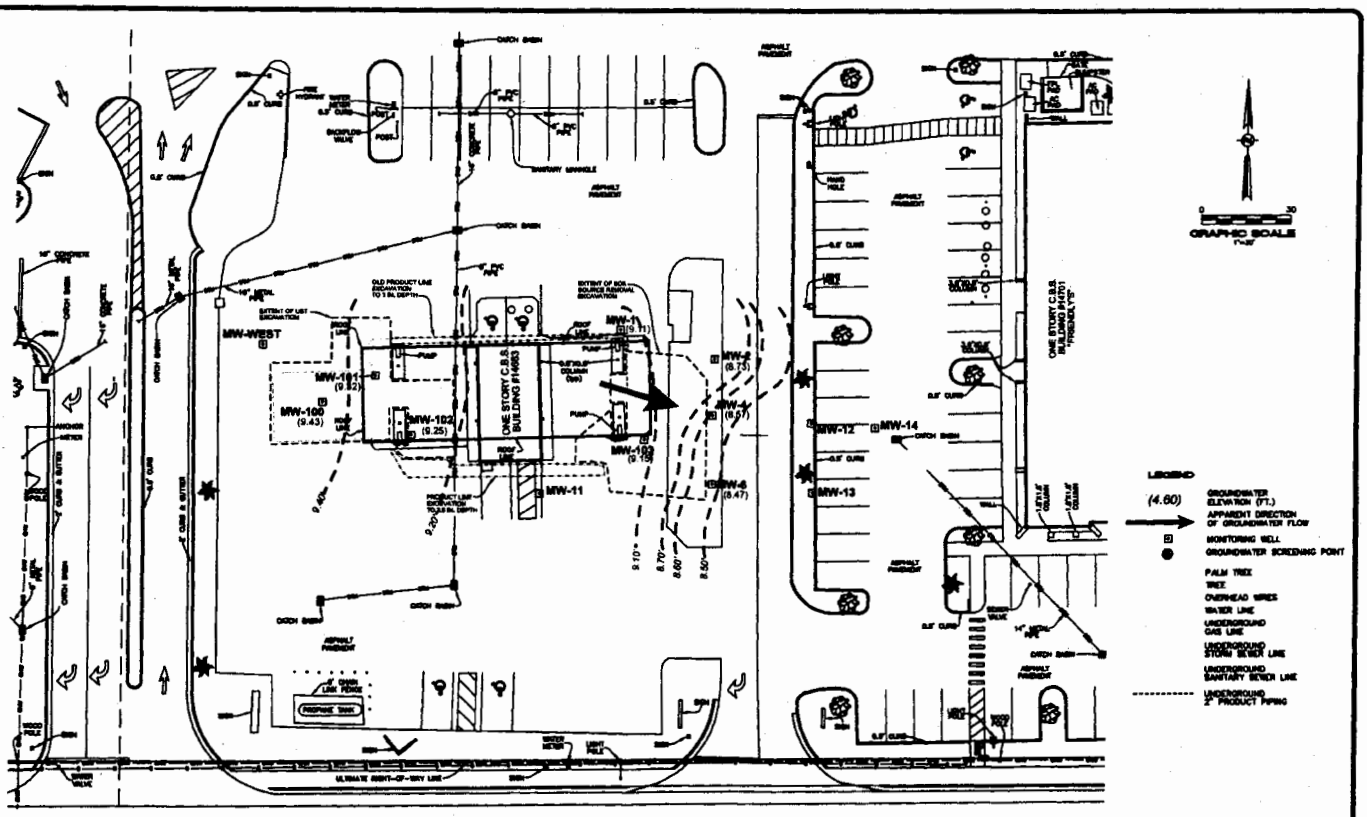
URS

7800 CONGRESS AVENUE, SUITE 200
BOCA RATON, FLORIDA 33487
PHONE: (561) 994-6500
FAX: (561) 994-6524

MAJESTIC / ROYAL MART GASOLINE STATION
14683 SOUTH MILITARY TRAIL
DELRAY BEACH, FLORIDA 33484

SITE PLAN MAP SHOWING MONITOR WELL LOCATIONS

FIGURE 1



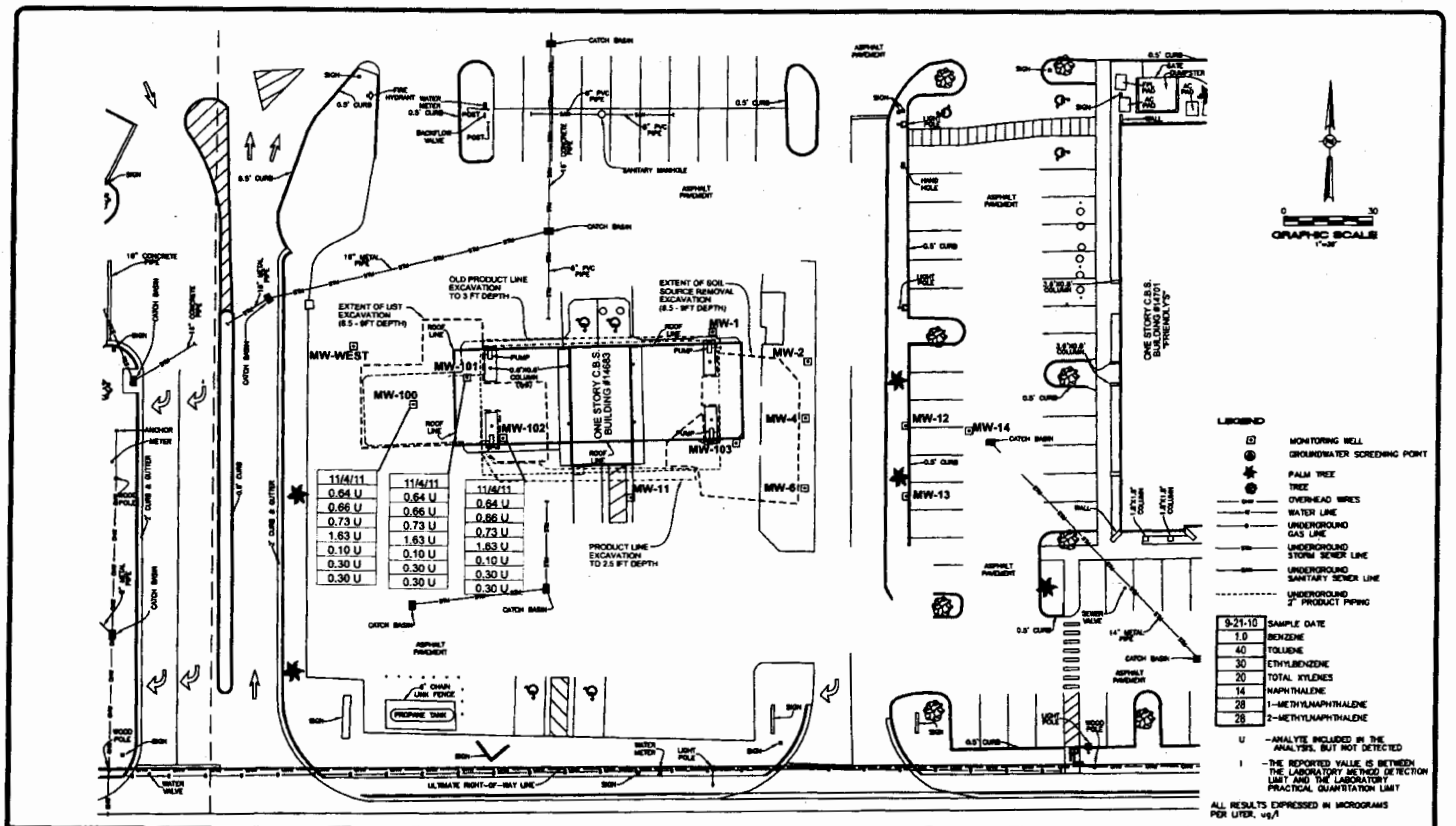
URS

7800 CONGRESS AVENUE, SUITE 200
BOCA RATON, FLORIDA 33487
PHONE: (561) 994-9500
FAX: (561) 994-9524

MAJESTIC / ROYAL MART GASOLINE STATION
14683 SOUTH MILITARY TRAIL
DELRAY BEACH, FLORIDA 33484

GROUNDWATER ELEVATION MAP

Figure 2



11/4/11
0.64 U
0.66 U
0.73 U
1.63 U
0.10 U
0.30 U
0.30 U

11/4/11
0.64 U
0.66 U
0.73 U
1.63 U
0.10 U
0.30 U
0.30 U

11/4/11
0.64 U
0.66 U
0.73 U
1.63 U
0.10 U
0.30 U
0.30 U

DRAWN BY: RC
CHECKED BY: DS
DATE: Dec 2011

URS

7800 CONGRESS AVENUE, SUITE 200
BOCA RATON, FLORIDA 33487
PHONE: (561) 994-6500
FAX: (561) 994-6524

MAJESTIC / ROYAL MART GASOLINE STATION
14683 SOUTH MILITARY TRAIL
DELRAY BEACH, FLORIDA 33484

GROUNDWATER QUALITY MAP

Figure 3

LITHOLOGIC WELL LOG PRINTOUT SOURCE - FGS

WELL NUMBER: W-17630 COUNTY - PALM BEACH
TOTAL DEPTH: 270 FT. LOCATION: T.46S R.42E
S.16 NW
SAMPLES - NONE LAT = 26D 28M
05S
LON = 80D 10M
16S
COMPLETION DATE: 12 08 86 ELEVATION: 19 FT
OTHER TYPES OF LOGS AVAILABLE - NONE

OWNER DRILLER:USGS WELL #4 SFWMD ID #009-38

WORKED BY:DESCRIBED BY JOY GRIFFIN 1 20 98

0. - 100. 121PCPC PLIOCENE-PLEISTOCENE

0 - 4 SAND; GRAYISH BROWN TO DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: ORGANICS-05

4 - 7 SAND; MODERATE YELLOWISH BROWN TO DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX
ACCESSORY MINERALS: PLANT REMAINS-05

7 - 10 SAND; DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: PLANT REMAINS-01 , HEAVY MINERALS-01
ORGANICS-05

10 - 17 SAND; GRAYISH BROWN TO DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01 , ORGANICS-05
VARIES TO POORLY INDURATED

17 - 20 SAND; MODERATE YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED

20 - 24 SAND; GRAYISH BROWN TO DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED

24 - 30 SAND; VERY LIGHT GRAY TO DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01
VARIES TO POORLY INDURATED CEMENTED WITH ORGANICS

30 - 40 SAND; DARK YELLOWISH BROWN
30 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX

40 - 44 SAND; VERY LIGHT GRAY TO DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
ROUNDNESS: ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX
VARIES TO UNCONSOLIDATED

44 - 50 SAND; DARK YELLOWISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; MEDIUM SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX

50 - 57 SAND; GRAYISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): ORGANIC MATRIX

57 - 67 SAND; WHITE TO GRAYISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO COARSE
ROUNDNESS: ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01

67 - 70 SAND; VERY LIGHT ORANGE TO GRAYISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE

ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
VARIES TO UNCONSOLIDATED

70 - 74 SAND; GRAYISH BROWN TO DARK GRAY
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO VERY COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
SAMPLE CONTAINS FRAGMENTS OF GRAYISH BLACK, POORLY INDURATED QUARTZ SAND CEMENTED WITH ORGANICS

74 - 87 SAND; VERY LIGHT ORANGE TO GRAYISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01

87 - 94 SAND; GRAYISH BROWN
35 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO COARSE
ROUNDNESS: ANGULAR TO ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: HEAVY MINERALS-01
VARIES TO POORLY INDURATED

94 - 100 SAND; LIGHT OLIVE GRAY
30 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: FINE; RANGE: FINE TO MEDIUM
ROUNDNESS: ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CLAY MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01
VARIES TO UNCONSOLIDATED

100 - 110 LIMESTONE; LIGHT GRAY TO MODERATE LIGHT GRAY
20 POROSITY: INTRAGRANULAR, INTERCRYSTALLINE
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
25 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MICROCRYSTALLINE
RANGE: MICROCRYSTALLINE TO GRANULE; MODERATE INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-05 , QUARTZ SAND-15
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, ECHINOID, FOSSIL MOLDS
SAMPLE CONTAINS UNCONSOLIDATED QUARTZ SAND AND PHOSPHATIC SAND

110 - 117 LIMESTONE; GRAYISH BROWN TO LIGHT GRAY
20 POROSITY: INTRAGRANULAR, INTERCRYSTALLINE

POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
30 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MICROCRYSTALLINE
RANGE: MICROCRYSTALLINE TO GRANULE; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-01
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: MOLLUSKS, BARNACLES, FOSSIL FRAGMENTS, ALGAE
25 OF LIMESTONE IS COVERED IN A PALE BROWN ALGAE

117 - 160 LIMESTONE; LIGHT GRAY TO MODERATE LIGHT GRAY
20 POROSITY: INTRAGRANULAR, INTERCRYSTALLINE
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
60 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MICROCRYSTALLINE
RANGE: MICROCRYSTALLINE TO VERY COARSE; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-05
OTHER FEATURES: FOSSILIFEROUS
FOSSILS: FOSSIL FRAGMENTS, BARNACLES, MOLLUSKS, ECHINOID
THE SAMPLE INTERVAL 130-134FT AND 137-140FT HAS AN ALGAL
COATING ON 15 OF THE LIMESTONE GRAINS, SAMPLE 137-140
FT
ALSO HAS A DARK YELLOWISH ORANGE, EUHEDRAL CALCITE
GROWING
RADIALLY ON THE LIMESTONE

160 - 174 LIMESTONE; YELLOWISH GRAY TO LIGHT GRAY
20 POROSITY: INTRAGRANULAR, INTERCRYSTALLINE
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
85 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MICROCRYSTALLINE
RANGE: MICROCRYSTALLINE TO VERY COARSE; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-03 , QUARTZ SAND-05
FOSSILS: BARNACLES, CORAL, FOSSIL FRAGMENTS

174 - 177 LIMESTONE; YELLOWISH GRAY TO LIGHT GRAY
25 POROSITY: INTRAGRANULAR, INTERCRYSTALLINE
POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL, CRYSTALS
50 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: MICROCRYSTALLINE
RANGE: MICROCRYSTALLINE TO VERY COARSE; GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-02 , QUARTZ SAND-05
FOSSILS: FOSSIL FRAGMENTS, BARNACLES, ECHINOID, MOLLUSKS

177 - 194 GRAINSTONE; YELLOWISH GRAY
25 POROSITY: INTRAGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL

85 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: VERY COARSE; RANGE: COARSE TO GRANULE
GOOD INDURATION
CEMENT TYPE(S): SPARRY CALCITE CEMENT
ACCESSORY MINERALS: PHOSPHATIC SAND-01 , QUARTZ SAND-10
FOSSILS: FOSSIL FRAGMENTS, MOLLUSKS, BARNACLES, SPICULES
BENTHIC FORAMINIFERA
VARIES TO UNCONSOLIDATED FOSSIL FRAGMENTS

194 - 197 GRAINSTONE; YELLOWISH GRAY TO DARK YELLOWISH BROWN
20 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
70 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: VERY COARSE; RANGE: VERY FINE TO GRANULE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-03 , QUARTZ SAND-05
FOSSILS: ALGAE, FOSSIL FRAGMENTS, BENTHIC FORAMINIFERA

197 - 210 GRAINSTONE; YELLOWISH GRAY
25 POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
GRAIN TYPE: BIOGENIC, SKELETAL
75 ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO GRANULE
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-01 , QUARTZ SAND-10
FOSSILS: FOSSIL FRAGMENTS, BARNACLES, BENTHIC
FORAMINIFERA
MOLLUSKS
VARIES TO UNCONSOLIDATED QUARTZ SAND AND FOSSIL FRAGMENTS

210 - 247 SAND; YELLOWISH GRAY TO VERY LIGHT GRAY
30 POROSITY: INTERGRANULAR, INTRAGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: MEDIUM TO COARSE
ROUNDNESS: SUB-ANGULAR TO ROUNDED; LOW SPHERICITY
UNCONSOLIDATED
ACCESSORY MINERALS: SHELL-40 , LIMESTONE-05
PHOSPHATIC SAND-02
OTHER FEATURES: CALCAREOUS
FOSSILS: FOSSIL FRAGMENTS, BARNACLES, MOLLUSKS, ECHINOID
BENTHIC FORAMINIFERA
SHELL CONTENT IN SAMPLE VARIES FROM 40-20

247 - 250 SAND; YELLOWISH GRAY TO VERY LIGHT GRAY
30 POROSITY: INTERGRANULAR, INTRAGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM
ROUNDNESS: SUB-ANGULAR TO ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-03 , SHELL-20
OTHER FEATURES: CALCAREOUS

FOSSILS: MOLLUSKS, BARNACLES, ECHINOID

250 - 270 SAND; YELLOWISH GRAY TO LIGHT OLIVE GRAY
25 POROSITY: INTERGRANULAR, INTRAGRANULAR
POSSIBLY HIGH PERMEABILITY
GRAIN SIZE: MEDIUM; RANGE: FINE TO MEDIUM
ROUNDNESS: SUB-ANGULAR TO SUB-ROUNDED; LOW SPHERICITY
POOR INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX, CLAY MATRIX
ACCESSORY MINERALS: PHOSPHATIC SAND-05 , SHELL-20
OTHER FEATURES: CALCAREOUS
FOSSILS: FOSSIL FRAGMENTS, BENTHIC FORAMINIFERA,
BARNACLES

270 TOTAL DEPTH

http://pi.ace.orst.edu/mapl/regTab.jsp#/mapl/showProduct.s?r=014797&p=00003

Reg. Number: 14797-3
Name: DIAZINON
Registrant: DELRAY CHEMICAL COMPANY, INC. Get contact info
Formulation: Ready-to-Use Solution
Signal Word: CAUTION
Appr. Date: 05/19/1982
Status: Canceled 01/22/1991 — Maint Fee Non-Payment - Registrant Req
Ingredient(s): + Show
Pest(s): + Show
Use Site(s): + Show

Reg. Number: 14797-1
Name: MIL-KIL
Registrant: DELRAY CHEMICAL COMPANY, INC. Get contact info
Formulation: Crystalline
Signal Word: DANGER
Appr. Date: 02/01/1973
Status: Canceled 11/30/1992 — Maint. Fee Non-Payment - No Response
Ingredient(s): + Show
Pest(s): + Show
Use Site(s): + Show

http://pi.ace.orst.edu/mapl/regTab.jsp#/mapl/showProduct.s?r=014797&p=00001

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

May 19, 2003

BUREAU OF WASTE CLEANUP

MAY 21 2003

TECHNICAL REVIEW SECTION

4WD-SSMB

Teresa Kinner-Booeshaghi
Bureau of Waste Cleanup
Florida Department of Environmental Protection
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Re: Prescreening/Discovery Sites for FY 2004
Inactive Pesticide Formulators

Dear Ms. Kinner-Booeshaghi:

Enclosed is provided a listing of pesticide formulators that were identified by the Pesticides and Toxic Substance Branch as being inactive. Winston Smith, our Division Director of the Waste Management Division, has recommended to the Superfund Site Management Branch that these facilities be screened for potential entry in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). I would like to request that the Florida Department of Environmental Protection include reviewing these reports as a task in its FY 2004 Pre-Remedial Cooperative Agreement Work Plan. This list should be reviewed to determine likely candidates for Prescreening Evaluations.

A report for the inactive pesticide formulators is provided for each county in Florida. The SSMB thought it might be best to start with those counties in South Florida because of the shallow depth to the Biscayne Aquifer. Many of the facilities you will notice are pool suppliers or other pool related businesses. These appear on the list because of their use of algae-killing compounds and would not be likely potential Superfund candidates. However, others on the list may yield potential discovery possibilities. I was told that you may want to check with Florida's Department of Agriculture, because they are the regulators for these types of facilities and thus may have further site-specific information. The dates shown on the reports are the dates that they were identified as being inactive.

Please feel free to call, 404-562-8923, or email dick.barbara@epa.gov, to discuss this further.

Sincerely,

Barbara S. Dick

Barbara S. Dick

MAY 2 1 2003

TECHNICAL REVIEW SECTION

Project Manager
South Site Management Branch
Waste Management Division

cc: Joseph K. McGarrity, DEP✓

MAPL

Reg. Number: 14797-4055
Name: SODIUM HYPOCHLORITE
Registrant: DELRAY CHEMICAL COMPANY, INC.

Get contact info

Formulation: Ready-to-Use Solution
Signal Word: WARNING
Appr. Date: 09/02/1975
Status: Canceled 08/25/1987 — Other Agency Action
Ingredient(s): Show
Pest(s): Show
Use Site(s): Show

Species Profiles

- **Birds**
  - Cranes
  - Game Birds
  - Owls
  - Raptors and Vultures
  - Shorebirds/Seabirds
  - Songbirds
  - Waterbirds
  - Waterfowl
  - Woodpeckers
- **Mammals**
- **Invertebrates**
- **Reptiles and Amphibians**
- **Fish**
- **Sharks**
- **Rays**
- **Relocating Wildlife**

Managed Species

Imperiled Species

Nonnative Species

Invasive Plants

Captive Wildlife

Wildlife Assistance

Living with Wildlife

Habitat Information

Health & Disease

Florida Scrub-Jay: *Aphelocoma coerulescens*

Appearance:

The Florida scrub-jay is a 12-inch-long, blue and gray crestless jay that lacks the white wing spots and tail feather tips of the more common and widespread blue jay. A necklace of blue feathers separates the whiter throat from the gray whitish forehead. The tail is long and loose in appearance, and the back is gray.

Scrub-jays that are less than about 5 months old can be identified by their dusky brown head and neck, but there are no such physical traits that distinguish males from females.

Habitat:

Scrub-jays range over much of the western United States and Mexico, but the physically and behaviorally unique Florida scrub-jay is restricted to scattered, often small and isolated patches of sand pine scrub, xeric oak scrub, and scrubby flatwoods in peninsular Florida. They have very specific habitat requirements. Scrub-jays prefer these various forms of scrub habitat which burn frequently enough to maintain a tree height of 3-10 feet tall. They actively avoid other forest types, wetlands, and large, open areas such as agricultural lands. While scrub-jays can be found in areas where scrub has been recently converted to other uses such as residential developments or farmland, their survival and reproductive success are generally very poor in these areas

Behavior:

Florida scrub-jays eat a variety of animal and plant items. Insects comprise a major food source during spring and summer. These birds also prey on other terrestrial invertebrates, and on small vertebrates including frogs, toads, lizards, snakes, birds' eggs, and even mice. Acorns are consumed year-round and are the birds' staple diet, especially during the winter when drupes, greenbrier berries, and tread-softly fruits are not available.

Florida scrub-jays mate for life. Breeding rarely occurs before 2 years of age, and often not until the birds are 3 or 4 years old. Their breeding season is short compared with other Florida perching birds; nests with eggs or young occur from early March through June. Scrub-jays build a new nest each year. The nest, a shallow basket of twigs lined with palmetto fibers, is typically built about 3-10 feet above ground in one of the shrubby oaks. Scrub-jays usually raise only one brood per year, but in case of nest failures, they may lay two, three, or even four clutches a season, each in a new nest. Clutch size is usually three or four eggs, but may vary from two to five eggs. Incubation requires 17 days, and the nestlings fledge about 17 days after hatching.

Florida scrub-jays live in family groups composed of a breeding pair, their offspring from years past and present, and sometimes even birds "adopted" from other families. In contrast to other Florida songbirds, nonbreeding scrub-jays (especially males) may remain in their parents' territory as helpers for several years before dispersing to establish their own territory or join another family. A well-defined hierarchy exists within these extended family groups.

Cooperation among family members is a complex and fascinating aspect of scrub-jay family life. Each family maintains a permanent territory ranging from about 5 to 50 acres (averaging about 25 acres), which it defends from adjacent families. Scrub-jays exhibit a well-established sentinel system in which each bird, in turn, will watch for predators while other family members go about their daily activities. The helpers assist in defending the breeding territory, nest, and young from neighboring scrub-jays and predators. They also help feed the nestlings and fledglings. They do not, however, assist in nest-building, incubating, or brooding activities. Long-term studies have established that helpers contribute to the reproductive effort: Breeding pairs with helpers successfully raise more young than do lone pairs.

The original range of the jay, estimated at 7,000 square miles, has been reduced considerably by suburban development and conversion of scrub habitats to agricultural uses. Many isolated populations have been eliminated, and the historically almost continuous population along the Atlantic coast has been radically fragmented by urban development. Due to extensive habitat loss and elimination of scrub-jays from much of their former range, they are now legally protected as a Threatened Species by the United States Fish and Wildlife Service and the Florida Fish and Wildlife Conservation Commission. Preservation of existing populations is of paramount importance, as is habitat management within designated sanctuaries.

Habitat management for scrub-jays essentially consists of periodically burning scrub tracts to maintain the desired shrub height, canopy closure, and percentage of bare ground. Optimal fire frequency for scrub-jay management is about once every 5 to 20 years. Mechanical site renovation may also prove satisfactory for scrub-jay habit management where prescribed burning is inadvisable.

Because of the territoriality of this species and the requirement for maintaining specific habitat conditions, it is unlikely that a "viable" population can be supported on any but the very largest scrub preserves. It is likely, however, that even small populations scattered throughout a region actually function as a metapopulation, or "population of populations." It is important, therefore, that scrub jays be preserved wherever they occur, with each isolated population being recognized as an integral part of a larger, regional scrub-jay population. As little as 5-10 acres of suitable habitat may support a mated pair, but a minimum of 25 acres per family is recommended as a general guideline for establishing scrub-jay preserves.

Biologists in several regions of the state are currently studying scrub-jays, both in undisturbed, natural habitats, and in areas undergoing rapid development. Because it is often difficult to determine a jay's sex or age in the field, marking each bird being studied with a unique set of colored plastic and aluminum leg bands is required. These banding techniques have been used on scrub-jays for over 20 years, and do not harm or distress the birds in any way.

By identifying families and individual birds, banding studies provide information on territory size and stability, kinship of birds within and between families, nesting success, survival and dispersal of jays, and many other aspects of scrub-jays and their environment. In many cases, interested citizens can assist the biologists by reporting observations of banded birds to the appropriate agency.

Predators are the number one cause of mortality for scrub-jays, but disease also plays a role in scrub-jay population dynamics.

Translocation often is used as a conservation tool to boost small populations or to move species back to places where they used to live.

What You Can Do To Help:

1. Support establishment of regional and local scrub-jay preserves. Protection of scrub-jay populations on managed tracts of optimal habitat is the best means of protecting this species.
2. Provide habitat for scrub-jays. Plant, protect, and cultivate patches of shrubby scrub live oak, Chapman's oak, myrtle oak, and scrub oak on your property. Maintain all of your landscaping at a maximum of 10 feet in height if you live on or near scrub-jay habitat.
3. Protect scrub-jays from your pets. Encourage passage and strict enforcement of leash lows for cats and dogs in your community. Protect areas being used by nesting scrub-jays from domestic animals, especially cats.
4. Restrict use of pesticides. Scrub-jays feed on insects usually considered pests around golf courses and homes. Pesticides may limit or contaminate food used by the jays. Reduce use of pesticides if possible; if you must use them, please do so with caution.
5. Report malicious destruction or harassment of scrub-jays or their nests. 888-404-FWCC (3922)

Additional Information:

Scrub-Jay Festival

Image Credit:

FWC Facts:
Spring and summer are the best times to listen for the elusive 5-inch Bachman's sparrow. Their song begins with a loud, clear whistle followed by an extended trill.

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- Aquifers
- Public Water Systems
- Assessment
- Potential Contaminants
- Susceptibility
- Prevention

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EPA Source Water Protection website

Public Water Systems Search Results

Public Water Systems for PALM BEACH county

A. DUDA & SONS,INC(M.HOWELLER)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
A.G. HOLLEY STATE HOSPITAL	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	
AAA WHEELCHAIR WAGON,INC	(2004)	(2008)					
ABC MONTESSORI OF JUPITER FARMS	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ACTS 2 WORSHIP CENTER	(2004)	(2008)	(2009)	(2010)			
ACTS 2 WORSHIP CENTER A/K/A ACTS II ASMB	(2004)	(2008)	(2009)	(2010)			
ACTS II ASSEMBLY OF GOD	(2004)	(2008)	(2009)	(2010)			
AGAPE TEMPLE CHURCH OF GOD	(2004)						
AIRPORT PLAZA	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
AL BOYD&DENNIS CARUSO OFF.BLDG	(2004)						
ALL STAR KIDS EARLY LEARN.CTR.	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
AMERIGROW RECYCLING				(2010)	(2011)	(2012)	(2013)
AMOCO OIL STATION #5213	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ATLANTIC SUGAR ASSOCIATION	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ATLANTIC SUGAR ASSOCIATION INC.	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ATLANTIS CITY OF		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ATLANTIS UTILITIES COMPANY		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ATLANTIS, CITY OF		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ATLAS PEAT AND SOIL, INC			(2009)	(2010)	(2011)	(2012)	(2013)
AUTO LIQUIDATION CENTER, INC	(2004)						
BANYAN GOLF CLUB	(2004)						
BAYHILL ESTATES GOLF CLUB/PGA NATIONAL				(2010)	(2011)	(2012)	(2013)
BEACON BAPTIST TABERNACLE				(2010)	(2011)	(2012)	(2013)
BEDNER LABOR CAMP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
BEELINE COMMUNITY DEVELOPMENT DISTRICT	(2004)	(2008)	(2009)				
BEELINE UTILITY LLC	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
BELLE GLADE WATERWORKS	(2004)		(2009)				
BIO TOOLS F/K/A AAA WHEELCHAIR WAGON	(2004)	(2008)					
BOBB'S PIANOS & ORGANS	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
BOCA RATON WTP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
BOYLAN SALES(JETTINGHOFF)	(2004)						
BOYNTON BEACH WTP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
CANDLELIGHT MOTOR LODGE	(2004)						
CARIDAD HEALTH CAMPUS	(2004)	(2008)					
CASA LOMA MHP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	
CASA LOMA TRAILER PARK	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	
CEMEX CONSTRUCTION MATERIALS OF FLORIDA,	(2004)	(2008)	(2009)	(2010)	(2011)		
CENTURY VILLAGE UTILITIES			(2009)				
CHURCH IN THE FARMS, THE		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
CITY OF LAKE WORTH UTILITIES	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
COLLEGE BP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
COLONIAL ESTATES MHP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
CORNER STONE CHURCH OF GOD	(2004)						
CORNERSTONE FELLOWSHIP AKA LOX BAPTIST		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
DELL'S STOP & SHOP	(2004)	(2008)					
DELRAY AUTOMOTIVE& MARINE INC.	(2004)						
DELRAY BEACH WATER DEPARTMENT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
DRY DOCK CAFE	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
DUBOIS FARMS- CENTRAL OFFICE	(2004)	(2008)	(2009)				

EVERGLADES YOUTH CAMP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
FAITH FARMS MINISTRIES	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
FIRST PARK SOUTH FLORIDA	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
FLORIDA RESEARCH PARK (PB PARK COMMERCE)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
FLORIDA SPACE CENTER	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
FOUR POINTS MARKET	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
FPL-DELRAY WEST SERVICE CENTER	(2004)						
GLADES UTILITIES AUTHORITY			(2009)	(2010)	(2011)	(2012)	(2013)
GOLD COAST CHRISTIAN CAMP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
GOLF, VILLAGE OF	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
GRACE PRESBYTERIAN CHURCH	(2004)						
GULFSTREAM TOWN OF		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
GULFSTREAM WATER DEPARTMENT		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
GULFSTREAM, TOWN OF		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
HAITIAN BETHEL BAPTIST CHURCH	(2004)						
HIGHLAND BEACH WATER PLANT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
HORIZON BAPTIST CHURCH				(2010)	(2011)	(2012)	(2013)
HYPOLUXO VILLAGE			(2009)	(2010)	(2011)	(2012)	(2013)
IGLESIA DE ADORACION FAMILIAR	(2004)			(2010)	(2011)	(2012)	(2013)
IN THE PINES MLC.	(2004)						
INDIAN TRAIL WATER CONTROL DISTRICT			(2009)	(2010)	(2011)	(2012)	(2013)
J & N FARMS #3(THOMAS BROTHERS	(2004)						
JOURNEY CHURCH A/K/A JUP. FARMS COMMUNI	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
JUPITER FARMS COM.SHOP.CENTER	(2004)	(2008)	(2009)	(2010)	(2011)		
JUPITER FARMS COMMU.ELEM.SCHL.	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
JUPITER FARMS COMMUNITY CHURCH	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
JUPITER FARMS COMMUNITY ELEMENTARY SCHOO	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
JUPITER FARMS COMMUNITY SHOPPING CENTER	(2004)	(2008)	(2009)	(2010)	(2011)		
JUPITER SEVENTH DAY ADVENTIST CHURCH							(2013)
JUPITER WATER SYSTEM,TOWN OF	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
KID WORKS OF WEST JUPITER, INC.	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
KINGDOM HALL OF JEHOVAH'S WIT.	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LAKE CLARKE SHORES		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LAKE OSBORNE		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LAKE OSBORNE (AQUA UTILITIES)		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LAKE OSBORNE ESTATES		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LAKE REGION WTP			(2009)	(2010)	(2011)	(2012)	(2013)
LAKE WORTH UTILITIES	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LAKE WORTH VILLAGE MHP. WTP	(2004)						
LANDING STRIP	(2004)						
LANTANA CASCADE MHP		(2008)	(2009)				
LANTANA HESS EXPRESS	(2004)						
LANTANA WATER TREATMENT PLANT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LOXAHATCHEE A.G. CENTER	(2004)	(2008)					
LOXAHATCHEE BAPTIST MISSION CHURCH		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
LOXAHATCHEE COUNTRY PRESCHOOL, INC.	(2004)						
LOXAHATCHEE GROVES ELEMENTARY SCHOOL	(2004)						
LOXAHATCHEE NATIONAL WILDLIFE REFUGE	(2004)	(2008)	(2009)	(2010)	(2011)		(2013)
LOXAHATCHEE SHELL A/K/A WELLNGTN HS MRT	(2004)	(2008)					
MANALAPAN WTP (LEROY C.PASLAY)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MANALAPAN WTP(LEROY C.PASLAY)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MANGONIA PARK UTILITY COMPANY	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MANGONIA PARK, TOWN OF	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MANY'S FOOD MARKET	(2004)						
MARALAGO CAY	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MARALAGO CAY MHP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)

MARATHON GAS STATION	(2004)						
MECCA FARMS MIGRANT LABOR CAMP	(2004)						
MELROSE PARK	(2004)						
MENORAH GARDENS&FUNERALCHAPELS	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MENORAH GARDENS&FUNERALCHAPLES	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
MOROSO MOTORSPORTS PARK	(2004)	(2008)			(2011)	(2012)	(2013)
NEW HOPE SOUTH INC (SUGAR FARMS)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
NEW PINES CHILD DEVELOP.CENTER	(2004)	(2008)	(2009)	(2010)	(2011)		
NOAH'S ARK ACADEMY	(2004)						
NORTH COUNTY GEN. AVIATION A/P	(2004)	(2008)	(2009)	(2010)	(2011)		
OKEELANTA SUGAR MILL	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
OKEELANTA SUGAR MILL & MLC	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
OSCEOLA/VERMILLON SUGAR MILL	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
P.B.C. SCHOOL DIS (FORMER BURT REYNOLDS)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PAHOKEE CITY OF	(2004)		(2009)				
PALM BCH CO FIRE STATION #21	(2004)						
PALM BEACH COUNTY #8 WTP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PALM BEACH COUNTY WATER UTILITIES	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PALM BEACH COUNTY WATER UTILITIES ITID			(2009)	(2010)	(2011)	(2012)	(2013)
PALM BEACH EQUESTRIAN CENTER	(2004)	(2008)					
PALM BEACH INTERNATIONAL RACEWAY	(2004)	(2008)			(2011)	(2012)	(2013)
PALM LAKES ESTATES NORTH		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PALM LAKES ESTATES SOUTH		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PALM SPRINGS, VILLAGE OF	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PALMS WEST ALLIANCE CHURCH	(2004)	(2008)					
PALMS WEST CHAMBER OF COMMERCE	(2004)						
PALMS WEST PLAZA	(2004)	(2008)					
PALMS WEST PRESBYTERIAN CHURCH	(2004)						
PARRY TRAILER VILLAGE	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PBC GENERAL AVIATION AIRPORT	(2004)	(2008)	(2009)	(2010)	(2011)		
PBCWUD - INDIAN TRAILS			(2009)	(2010)	(2011)	(2012)	(2013)
PBCWUD - LAKE REGION WTP - SYSTEM 11			(2009)	(2010)	(2011)	(2012)	(2013)
PBG MUNICIPAL GOLF COURSE	(2004)						
PBSO SHOOTING RANGE	(2004)	(2008)	(2009)				
PEANUTS COUNTRY STORE	(2004)	(2008)					
PELICAN LAKE VILLAGE		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PELICAN WATER CORPORATION		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PERO BROTHERS PACKING & SALES	(2004)						
PINE GROVE VILLAGE	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PLANET KIDS	(2004)						
PLANET KIDS V (OVER THE RAINBOW PRE-SCH)	(2004)						
PONDEROSA INDUSTRIAL PARK #1	(2004)	(2008)					
PONDEROSA INDUSTRIAL PARK #2	(2004)	(2008)					
PONDEROSA INDUSTRIAL PARK EAST #2	(2004)	(2008)					
PORTUGESE-AMERICAN CULTURAL SOCIETY	(2004)	(2008)	(2009)				
PRATT & WHITNEY AIRCRAFT INC.	(2004)	(2008)	(2009)				
PREWITT TRACTOR SHED (US SUGAR)		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
PUBLIC STORAGE WAREHOUSE	(2004)	(2008)	(2009)	(2010)	(2011)		
RANCHO GRANDE-EL CUBANOGROCERY	(2004)						
RANGELINE GRILL	(2004)	(2008)					
RINKER MATERIALS-LAKE PARK FAC	(2004)	(2008)	(2009)	(2010)	(2011)		
RIVIERA BEACH UTILITY DISTRICT, CITY OF	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
RIVIERA BEACH WTR. & SWR. DEPT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
RIVIERA BEACH, CITY OF SPECIAL DISTRICT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ROYAL MANOR MOBILE HOME ESTATE	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
ROYAL PALM BCH MOOSE LODGE	(2004)						
ROYAL PALM BEACH UTILITIES	(2004)						

ROYAL PALM MOBILE HOME PARK	(2004)						
SADISCO OF FLORIDA	(2004)			(2010)	(2011)		
SAND & SEA VILLAGE MHP							
SEACOAST UTILITIES AUTHORITY	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SEACOAST UTILITY(HOOD RD.WTP)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SEMINOLE MANOR SUBDIVISION		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SEMINOLE MANOR(TOWN OF L.C.SH)		(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SEMINOLE WATER TREATMENT PLANT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SETA CORPORATION	(2004)						
SHERIFF'S PISTOL RANGE	(2004)	(2008)	(2009)				
SIERRA SQUARE	(2004)	(2008)	(2009)	(2010)	(2011)		
SONFEST CHAPEL OF JUPITER	(2004)			(2010)	(2011)	(2012)	(2013)
SOUTH BAY WTP	(2004)		(2009)				
SOUTH FLORIDA TROTTING - EAST	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SOUTH FLORIDA TROTTING - NORTH	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SOUTH FLORIDA TROTTING - WEST	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SOUTH SHORE WATER ASSOCIATION			(2009)	(2010)	(2011)		
SOUTHERN PINES GOLF CENTER	(2004)	(2008)					
SOUTHERN TRUSS	(2004)						
STAR OF DAVID A/K/A MENORAH GARDENS	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SUGAR CANE GROWERS COOP OF FLORIDA			(2009)	(2010)	(2011)	(2012)	(2013)
SUNSHINE MEADOWS	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
SUNSHINE TREE SCHOOL	(2004)	(2008)					
SUNSPORT GARDENS NUDIST CAMP	(2004)						
TEQUESTA WATER TREATMENT PLANT	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
TEQUESTA WTP	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
THE FAMILY. F/K/A PATHWAYS TO RECOVERY	(2004)						
THE GOLF LEARNING CENTER / FKA SOUTHER P	(2004)	(2008)					
THE VALMARON CENTER (EQUESTRAIN GRILL)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
THE VALMARON CENTER (EQUESTRIAN GRILL)	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
THREE AMIGOS FOOD & DELI STORE	(2004)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)
TIRE KINGDOM	(2004)						
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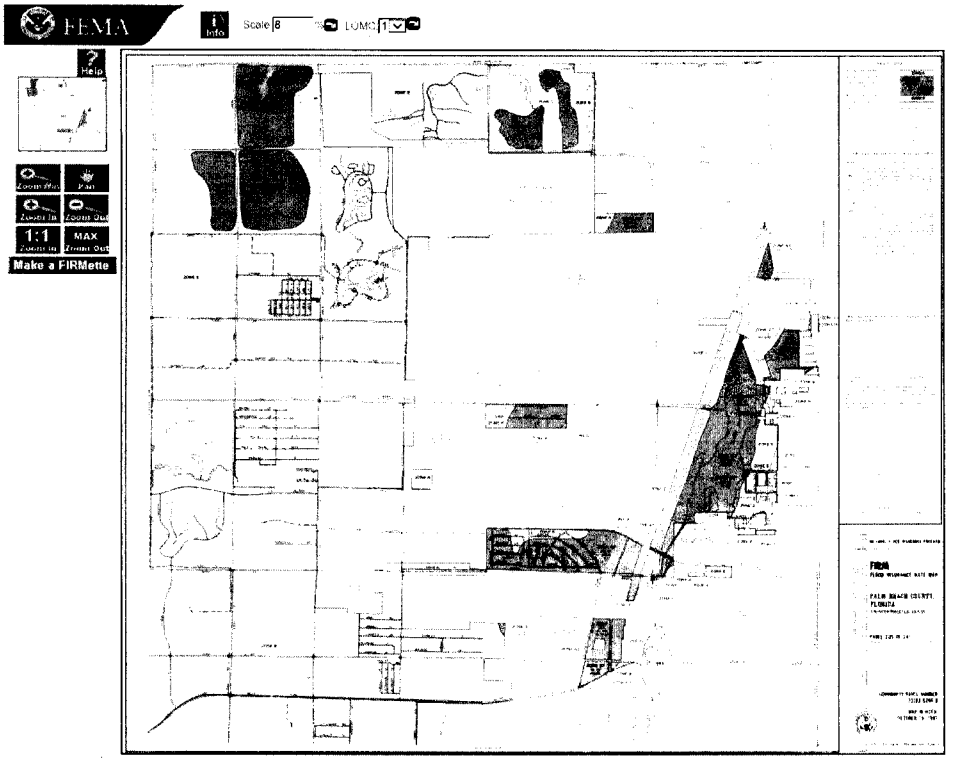
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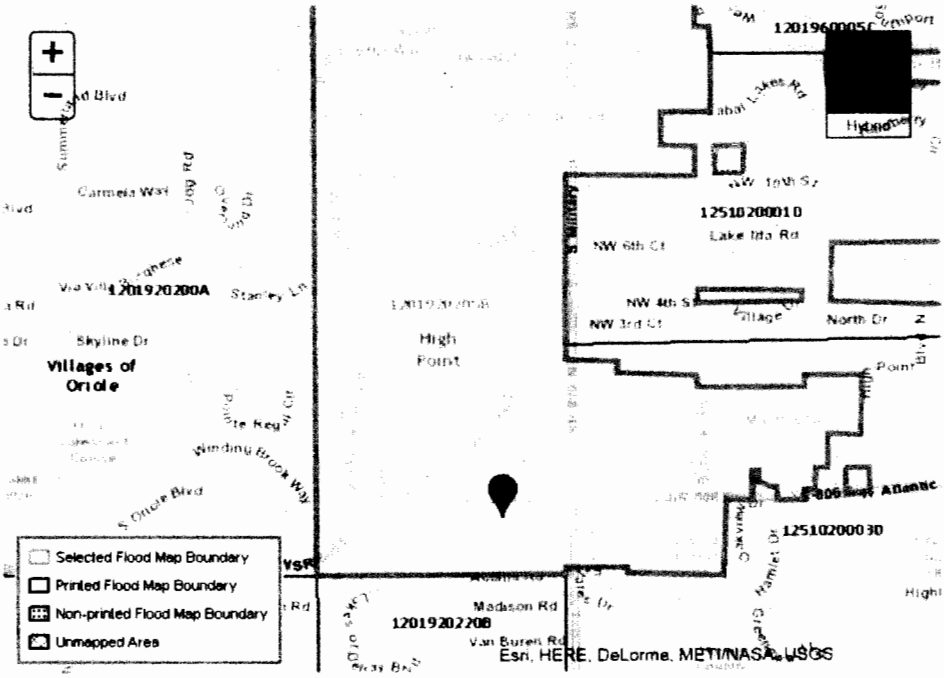

Metropolitan Southeast Florida Canals

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Saltwater Fishing

Sport Fish Restoration

Persons with Disabilities

Outfitters & Guides

Accessing Florida's Butterfly Peacock Bass and other fisheries

Palm Beach, Broward, and Miami-Dade counties:

The man-made canals of coastal southeast Florida are part of an extensive, interconnecting network of canals that were primarily constructed in the early 1900's for drainage, flood protection, and water storage purposes. The freshwater canals in the southern section (Cypress Creek Canal and south) are mostly box-cut into a coral rock substrate, more than 10 feet deep with little littoral zone, and have much subsurface water flowing into them. The amount of groundwater flowing into some canals is sufficient enough to dramatically increase water clarity. Canals in the northern section (Hillsboro Canal and north) tend to be shallower, more bowl-shaped, have sugar-sand substrate, and little water groundwater intrusion. Fortunately, many of these man-made canals offer boat or shoreline access; a **Canal Overview Map** of the major canals is available. A series of **Angler's Guides** for the canals listed below provide boat ramp locations, directions, and fishing information for each site:

Angler Guides

Black Creek (C-1) Canal	Cutler Drain (C-100) Canal
Snapper Creek (C-2) Canal	Aerojet (C-111) Canal
Tamiami (C-4) Canal	North E-4 Canal
Snake Creek (C-9) Canal	Central E-4 Canal
South New River (C-11) Canal	South E-4 Canal
Cypress Creek (C-14) Canal	Hillsboro (G-08) Canal
Earman River (C-17) Canal	North New River (G-15) Canal
Loxahatchee Slough (C-18) Canal	**Canal Overview Map**

Local Fishing Guides include:

- Burke, John: 954-971-1915
- Fettes, Clark: 954-426-2094
- Harris, Doub: 954-435-0486
- Norling, Gregg: 954-979-4933
- Zaremba, Allen: 954-961-7512

Local Bait and Tackle Shops include:

- Perk's Bait & Tackle: 561-582-3133
- X Generation Custom Rods + Tackle: 561-296-7637
- Boynton Fisherman Supply: 561-736-0568
- Sandy Hook Bait & Tackle: 561-274-9300
- Everglades Pro-Bass Center: 954-434-4495
- Lloyd's Bait and Tackle: 954-401-5681
- Kendall Bait & Tackle Inc.: 305-670-3474
- The Fishing Line: 305-598-2444

Taxidermists include:

- Marine Taxidermy of the Palm Beaches: 561-585-0830
- Steve's Marine Designs: 954-752-4360
- Don Winge: 941-353-9359

Current Forecast:

Miami-Dade County:

April is a peak month for butterfly peacock spawning and this should be a great time for anglers trying to catch one in shallow water areas. Depending on water clarity, angers can often sight-fish for spawning butterfly peacock. The spawning season provides anglers one of their best opportunities for catching a large butterfly peacock as they are highly aggressive when guarding their nests. Weedless bucktail jigs in bright colors such as orange head, chartreuse body are a good bet for a big peacock on a nest. Free-lining live shiners, or small, minnow imitating lures by Matzuo, YoZuri, and Rapala as good choices for anglers targeting south Florida's premier sportfish. The fire tiger and chartreuse color patterns are a dependable color whatever your choice of lure. The Fish and Wildlife Commission strongly encourages the catch and release of butterfly peacock year around but more so during the spawning season to ensure the continued success of this very popular south Florida sportfish.

Weedless Texas rigged plastic worms in colors including pumpkinseed and watermelon are an effective tactic for catching largemouth bass in Miami-Dade waters. Live shiners are very effective bait for butterfly peacock and largemouth bass, and are also the bait of choice for snook and tarpon in urban canals. Wigglers, crickets or a piece of night crawler fished under a bobber, or with only a sinker 3 feet above the hook are excellent ways to catch bluegill, redear sunfish, Mayan cichlid, and oscar. Mayan cichlid are often seen bedding in shallow water next to the canal banks, and are easily caught on a variety of baits including wigglers and red worms, bread, small poppers, and beetle spins. Cutler Drain Canal, Tamiami, and Parkline canals are good angling destinations for this time of year.

Broward County:

Fishing for butterfly peacock in south Broward waterbodies should really pick up as water temperatures in urban canals rise and they begin to spawn. Bedding peacocks can often be sight-fished and anglers may want to try 1/8-1/4 oz Roostertails in green/yellow and green/orange or the ¼ oz Bomber Fat A in green with black and yellow spots for some fast action. Small, live shiners are always a top butterfly peacock bait. The FWC strongly encourages the catch and release of butterfly peacock to help them rebound from the effects of this historically cold winter.

Largemouth bass should be coming off the beds ready to feed and anglers are encouraged to try minnow imitating lures made by Rapala and Rebel in color patterns like black/gold, or silver/black for some fast action. Bream will be spawning during this time and anglers should have great fun catching them on light spinning gear. A long shank hook baited with a wiggler, red worm, piece of a night crawler, or cricket often results in some fast bream action. Good catches of bream can also be made using 1/32-1/16 oz crappie jigs with single or multiple tails, small Beetlespins, or Roostertails. These types of lures in white, green, and patterns with chartreuse are great bream bait colors.

The Griffin Road Canal or local parks such as Plantation Heritage, Markham, Brian Piccolo, and Quiet Waters are good areas to try for bass, peacock, and bream.

Palm Beach County: A live shiner is always a good choice for largemouth bass, particularly while the water temperatures stay cool. As the water temperatures rise, the bass will go deeper and plastic worms in the go-to colors such as red shad, black shad, watermelon seed, and June bug are excellent choices. Also crank baits such as YoZuri's Rattlin Vibe and Rattle Traps in natural colors such as blue and black chrome, or shad colored fished deep around culverts with moving water are good bets for some fast action. Plastic lizards in natural colors and rigged weedless can also be effective this time of year, particularly if fished in the early morning or late afternoon. Cast them out, keep the rod tip up, and retrieve just fast enough to keep the lizard on the surface and hold on! Reports are coming in of butterfly peacock being caught in the Ida-Osborne chain of lakes and associated canals. They will be spawning and weedless bucktail jigs are good baits to use when sight fishing butterfly peacock on beds. They are starting to make a comeback after the 2010 winterkill so FWC strongly encourages catch and release during the spawning season to allow their population to increase. Native and exotic bream (particularly Mayan cichlid) are caught on a variety of baits such as pieces of night crawler, crickets or small tube jigs, crappie jigs, grub tails or Roostertail spinners. Fish these baits along rocky shorelines for some great freshwater action. For flyfishers, try a 4 or 5 weight rod and tie on a bumble bee popper. The Delray Canal (C-15) and the E-4 Canal system are two places anglers should give a try.

FWC's most recent sampling data remains a good way to pick among the many canals to be found in southeast Florida:

Between October and November 2012, fish in 9 southeast Florida canals were stunned with electricity, netted, weighed, measured, and released unharmed back into the waterway from which they were collected. The overall electrofishing catch rate of **largemouth bass** was 48 fish over ten-inches-long every hour, 50% higher than the 1997-2011 average of

32 fish/hour. This increase is due in large part to exceptionally good catches of bass in the West Palm Beach (C-51; 130 fish/hr), Hillsboro (G-08; 106 fish/hr) and Boynton Beach (C-16; 97 fish/hr) canals. A total of 635 largemouth bass >10 inches were counted from 9 canals.

The populations of **butterfly peacock** in several well-known-to-angler Miami-Dade canals are doing extremely well despite cold water temperatures in January 2010 and a great deal of fishing pressure, a testament to the good conservation ethic of catch and release practiced by many urban canal anglers for butterfly peacock and largemouth bass. The electrofishing catch rates of butterfly peacock larger than ten-inches-long in six Miami-Dade and Broward counties continue to increase from the 2010 winterkill, and in 2012 they averaged 28 fish every hour, up from 25 fish/hr in 2011 and 22 fish/hr in 2010. A total of 208 butterfly peacock >10 inches were counted and released from these canals.

The electrofishing catch rate of **bream** (bluegill, redear sunfish, Mayan cichlid, and jaguar guapote) was 27 fish over six-inches-long every hour which is lower than the 1997-2011 average of 37 fish/hr. This catch rate is expected to increase as Mayan cichlid continues to recover from cold water temperatures in 2010.

These results are from an annual electrofishing survey designed to monitor sportfish populations in urban canals in Miami-Dade, Broward, and Palm Beach counties. Each canal is sampled for approximately eight hours and based on these findings, fisheries biologists at the Non-Native Fish Laboratory in Boca Raton predict that anglers will enjoy excellent catches of largemouth bass and butterfly peacock, and good catches of bream this quarter.

The recent survey produced some interesting facts:

--Southeast Florida urban canals produce good numbers of quality largemouth bass but have few "lunkers" over 6 pounds.

--Some of the best canals for **largemouth bass** were the Tamiami (C-4) and Parkline (L-31W) canals in Miami-Dade County, Hillsboro and Cypress Creek (C-14) canals in Broward County, and West Palm Beach, and Boynton canals in Palm Beach County.

--Some of the best canals for **butterfly peacock** were the Tamiami, Cutler Drain (C-100), Black Creek (C-1) and Parkline canals.

--The best canals for **largemouth bass and butterfly peacock combined** were Snake Creek (C-9), and Parkline canals in Miami-Dade County. Low catches of butterfly peacock in north Broward and Palm Beach counties were likely the result of low water temperature related kills experienced early in January 2010. These periodic kills were predicted and expected when butterfly peacock were originally stocked and a few consecutive mild winters will likely enable them to bounce back to historic levels.

--One canal yielded largemouth bass over six pounds, two canals yielded largemouth bass over five pounds, and six canals yielded bass over four pounds. The largest largemouth bass collected this year weighed 8.2 pounds and measured 22.1 inches.

--The highest number of largemouth bass were shocked in the West Palm Beach Canal, and the Tamiami Canal had the most butterfly peacock.

--Three canals yielded butterfly peacock over five pounds, and three canals yielded four pound butterfly peacock. The largest butterfly peacock collected this year weighed 5.2 pounds and measured 20.0 inches.

--Some of the best **bream** canals were Snake Creek and Tamiami canals in Miami-Dade County, Cypress Creek and Hillsboro canals in Broward Canal, and West Palm Beach and Boynton canals in Palm Beach County.

--**Snook and tarpon** are found in many southeast Florida canals and the highest numbers of these sportfish were observed in the Tamiami, Snake Creek, and Black Creek canals, all in Miami-Dade County.

FWC Facts:
A group of bass is called a shoal.

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West Indian manatee

Trichechus manatus

(Photo by FWC)

Taxonomic Classification

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Sirenia
Family: Trichechidae
Genus/Species: *Trichechus manatus*
Common Name: West Indian manatee

The subspecies of the West Indian manatee (*Trichechus manatus*) that occurs in Florida is also known as the Florida manatee (*Trichechus manatus latirostris*).

Listing Status

Federal Status: Endangered
FL Status: Federally-designated Endangered
FNAI Ranks: G2 S2 (Imperiled)
IUCN Status: VU (Vulnerable)

Physical Description

The West Indian manatee is a large gray aquatic mammal that commonly reaches a body length of nine to ten feet (2.7-3 meters) and a weight of 1,000 pounds (453.6.6 kilograms); however, it can grow to more than 13 feet (four meters) and weight up to 3,500 pounds (1587.6 kilograms). Manatees feature a wide rounded tail and two flipper-like fore limbs that have three to four nails. Flippers are used to maneuver in the water and to grasp vegetation while feeding. The nostrils

are located above the snout and have valves that tightly close when the manatee is under water. Their small eyes have a membrane that can cover the eyes for protection. The ear openings are small and external lobes are lacking. Manatees have a flexible lip pad that is used to move food into their mouth. Manatees have back teeth (molars) for chewing but no frontal teeth. Teeth are continuously lost and re-grown throughout the manatee's life. Molars form at the back of the jaw and slowly progress to the front of the jaw where they will fall out. This is seen as an adaptation trait for feeding on vegetation with sand mixed in. Manatees can hold their breath up to 20 minutes when resting, but when active they surface to breath every three to five minutes.

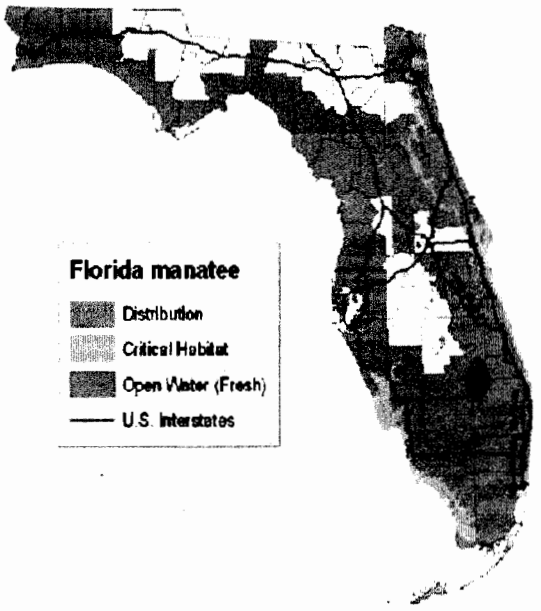
Life History

The diet of the manatee primarily consists of marine and freshwater vegetation (ex. *Syringodium filaforme*) (Bester, n.d.). This species feeds between six and eight hours a day, eating up to ten percent of its body weight in vegetation.

Manatees can breed and give birth throughout the year; however, birthing usually peaks in the spring. During the breeding season, males gather and pursue a female to form a mating group and breed at different times (Bester, n.d.). The gestation time for the manatee is 13 months. Manatees have a low reproductive rate, only giving birth to an average of one calf every three to five years. Females give birth to their first calf between the ages of four and seven years old (Marmontel 1995; O'Shea and Hartley 1995; Rathbun *et al.*, 1995). The calf will stay with the mother for up to two years.

Habitat & Distribution

The West Indian manatee can be found along coasts and inland waters of the southeastern United States, eastern Mexico, the Greater Antilles (Hispaniola, Cuba, Puerto Rico, Jamaica), and Central America down to as far as northern Brazil.



Threats

The main threats to manatees are boat collisions and the loss of warm water habitat. Manatees feed in shallow waters making them susceptible to interactions with boats. Boat related deaths can be caused by propeller cuts, impacts from the hull or lower unit of the motor, or a combination of the two. Large ships can crush manatees on the bottom of waterways or between the vessel and the wharf. Impact related and crushing injuries cause various lethal internal injuries. Due to the inability to

regulate their body temperature (thermoregulate) in cold water, cold stress is a serious threat to the manatee (Irvine 1983). The loss of warm water refuges is seen as a serious long-term threat to the continued existence of the manatee (U.S. Fish & Wildlife Service 2001). Habitat loss is also an issue as coastal development and pollution can destroy seagrass beds and freshwater aquatic vegetation, which is the main food source of manatees. Manatees are also at risk of becoming entangled in monofilament line (fishing line) and crab trap lines which lead to injury, rescues, and death in extreme cases. Periodically, manatees will get crushed in flood gates and canal locks, or trapped in culverts where they drown or starve. Other threats include diseases, natural disasters, and red tide. Red tide is a dramatic increase of the *Karenia brevis* algae, which can be a danger to many marine species.

Conservation & Management

The West Indian manatee is protected as an Endangered species by the Federal Endangered Species Act and as a Federally-designated Endangered species by Florida's Endangered and Threatened Species Rule. It is also protected by the U.S. Marine Mammal Protection Act and the Florida Manatee Sanctuary Act (FMSA). The FMSA allows the State to set restrictions on boat speed and access in important manatee habitats. FWC enforces these boating restrictions along with Federal and local government partners.

-State Management Plan
-Federal Recovery Plan

Other Informative Links

FWC Manatee Research
FWC Petitions and Listing Actions
FWC Species Profile
International Union for Conservation of Nature
U.S. Fish and Wildlife Service Species Information
U.S. Geological Survey

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Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

To show bookmarks which navigate through the document. Click the show/hide navigation pane button , and then click the bookmarks tab. It will navigate you to the contents, chapters, rainfall maps, and printable forms.

Preface

Technical Release 55 (TR-55) presents simplified procedures to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs. These procedures are applicable in small watersheds, especially urbanizing watersheds, in the United States. First issued by the Soil Conservation Service (SCS) in January 1975, TR-55 incorporates current SCS procedures. This revision includes results of recent research and other changes based on experience with use of the original edition.

The major revisions and additions are.

- A flow chart for selecting the appropriate procedure,
- Three additional rain distributions,
- Expansion of the chapter on runoff curve numbers,
- A procedure for calculating travel times of sheet flow,
- Deletion of a chapter on peak discharges,
- Modifications to the Graphical Peak Discharge method and Tabular Hydrograph method,
- A new storage routing procedure,
- Features of the TR-55 computer program, and
- Worksheets.

This revision was prepared by Roger Cronshey, hydraulic engineer, Hydrology Unit, SCS, Washington, DC, Dr. Richard H. McCuen, professor of Civil Engineering, University of Maryland, College Park, MD, Norman Miller, head, Hydrology Unit, SCS, Washington, DC, Dr.Walter Rawls, hydrologist, Agricultural Research Service, Beltsville, MD, Sam Robbins (deceased), formerly hydraulic engineer, SCS, South National Technical Center (NTC), Fort Worth, TX, and Don Woodward, hydraulic engineer, SCS, Northeast NTC, Chester, PA. Valuable contributions were made by John Chenoweth, Stan Hamilton, William Merkel, Robert Rallison (ret.), Harvey Richardson, Wendell Styner, other SCS hydraulic engineers, and Teresa Seeman.

Revised June 1986
Update of Appendix A January 1999

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Appendix B Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

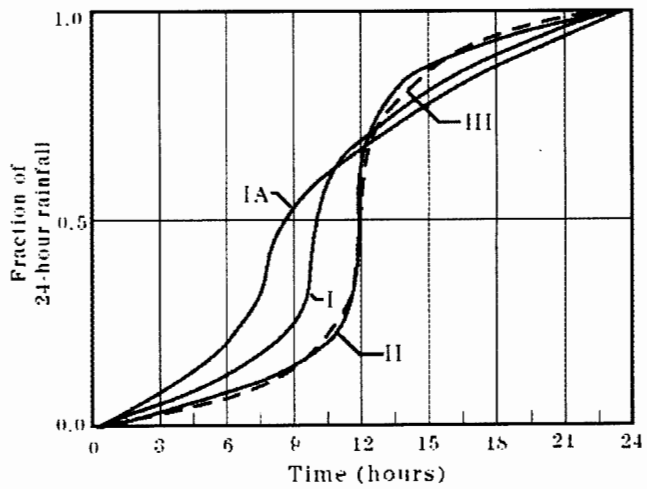
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c. For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c.

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having "nested" rainfall intensities was developed. The set "maximizes" the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

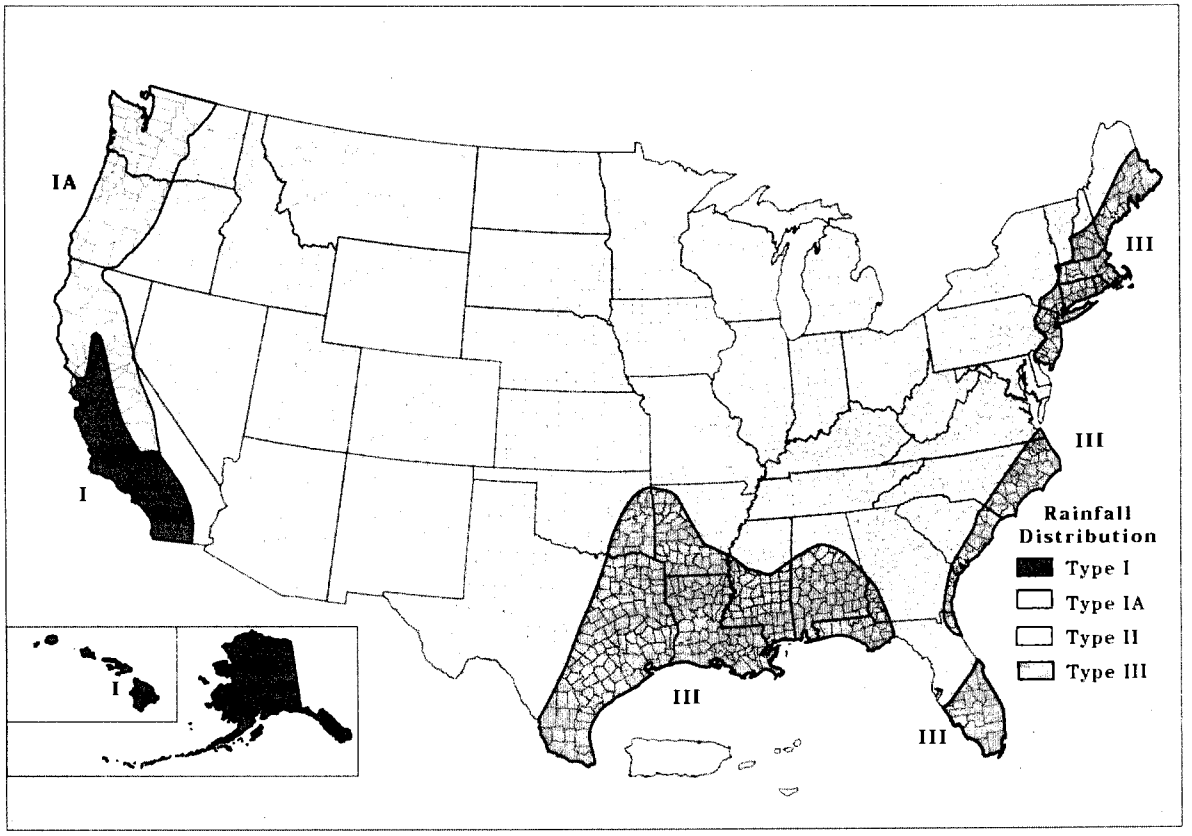
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061, Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Figure B-3 2-year, 24-hr rainfall

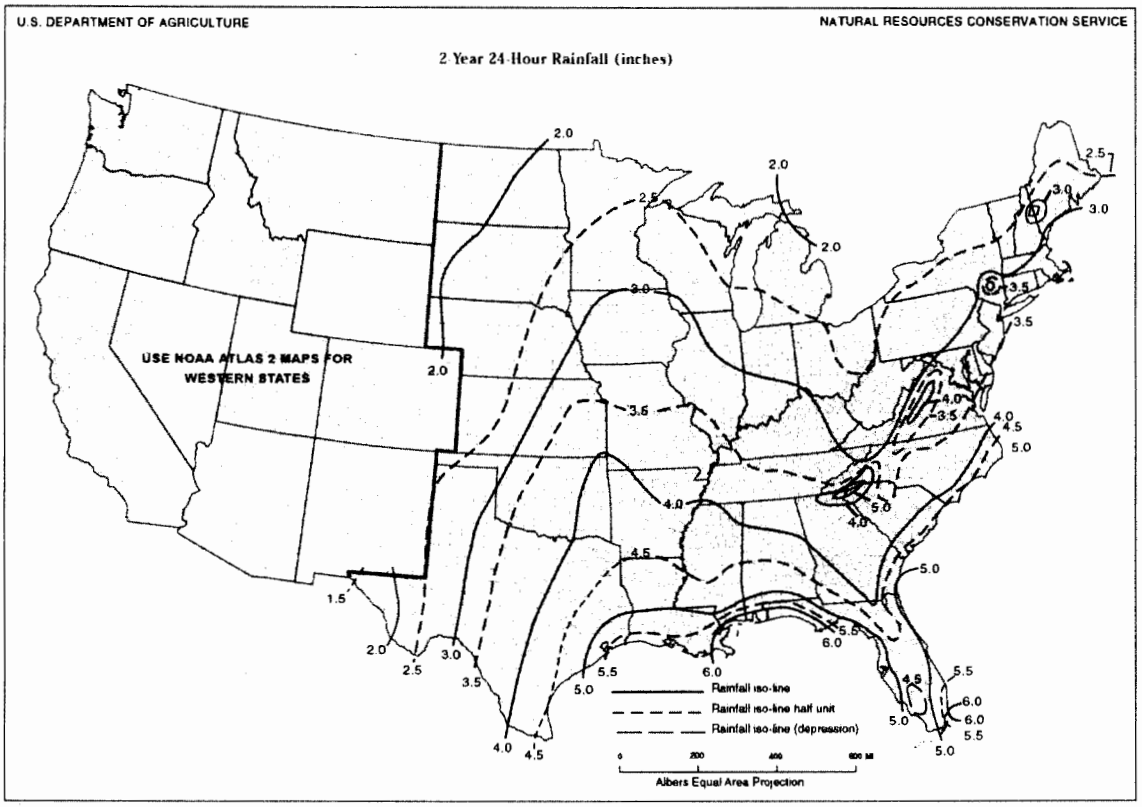


Figure B-4 5-year, 24-hour rainfall

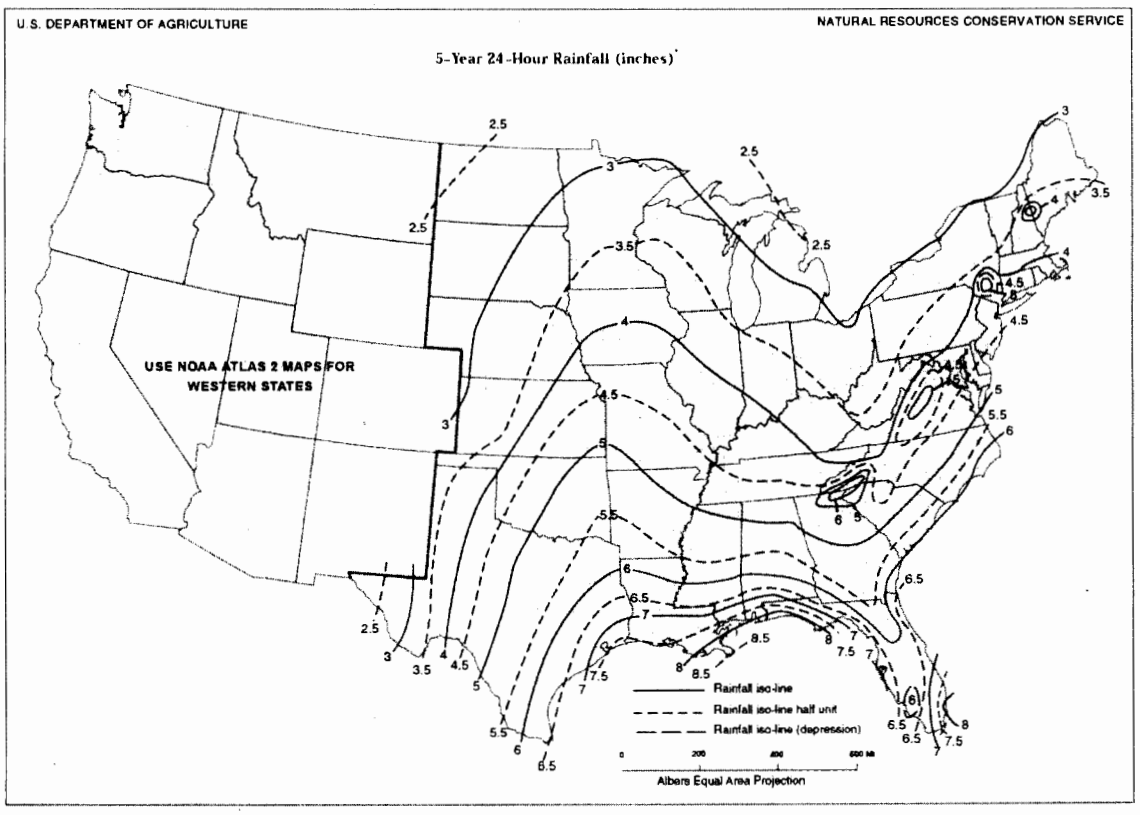


Figure B-5 10-year, 24-hour rainfall

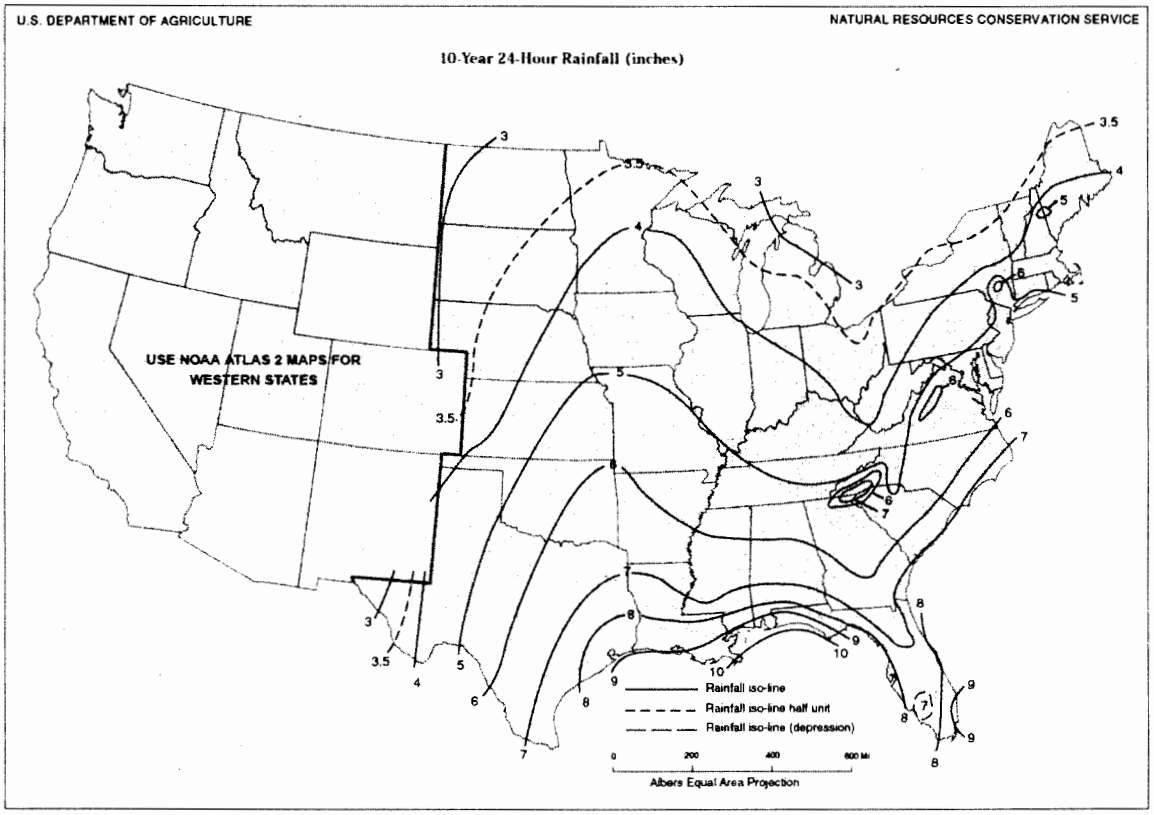


Figure B-6 25-year, 24-hour rainfall

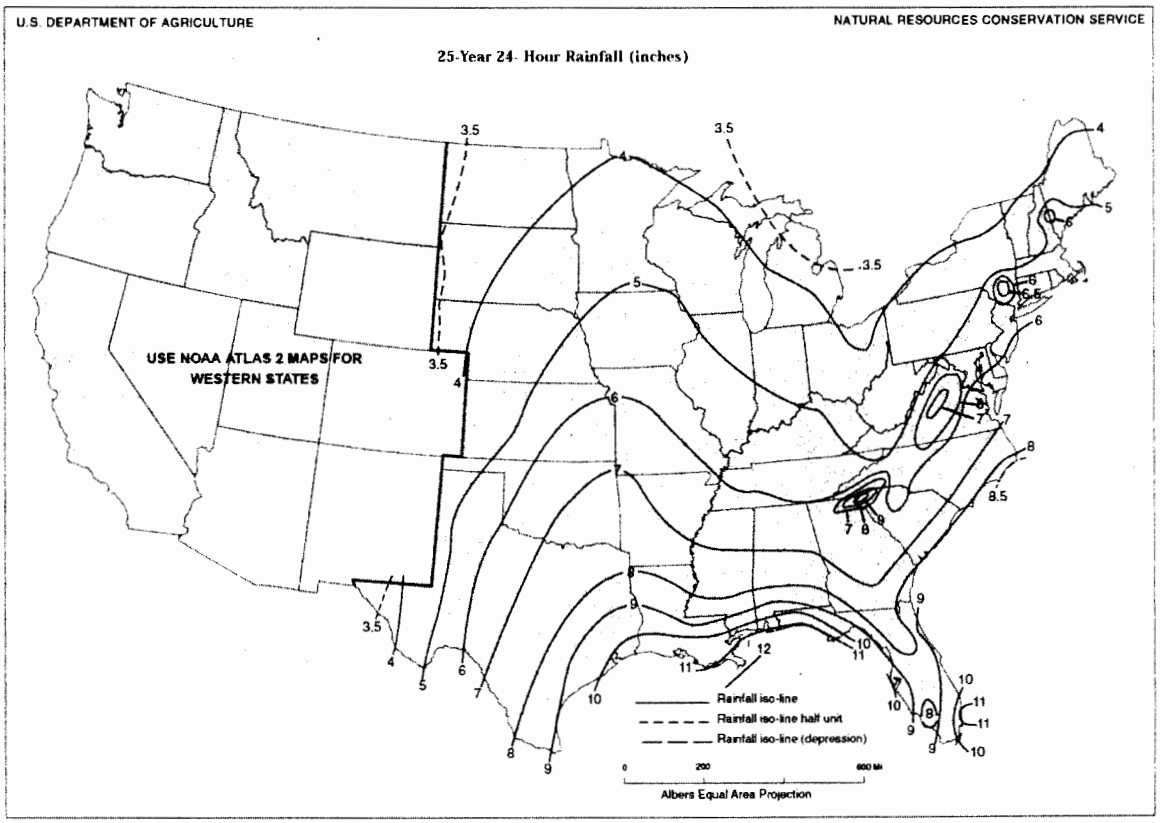


Figure B-7 50-year, 24-hour rainfall

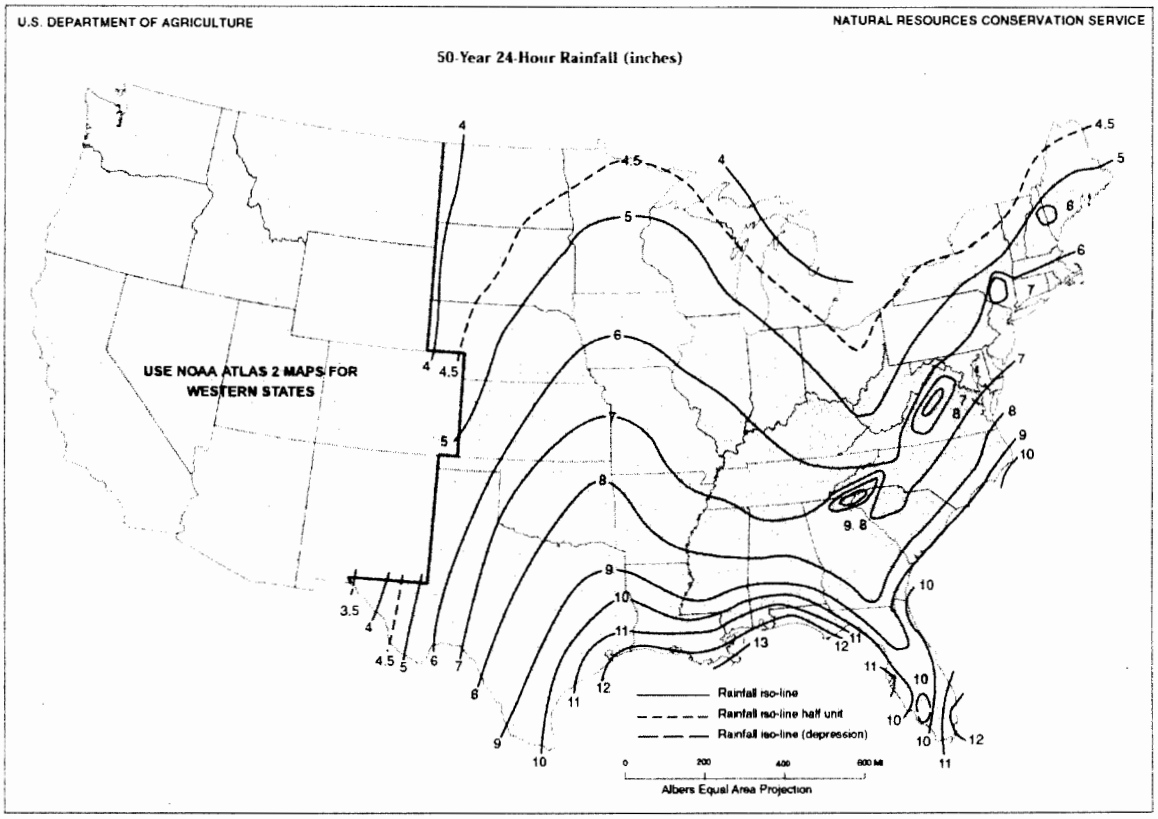
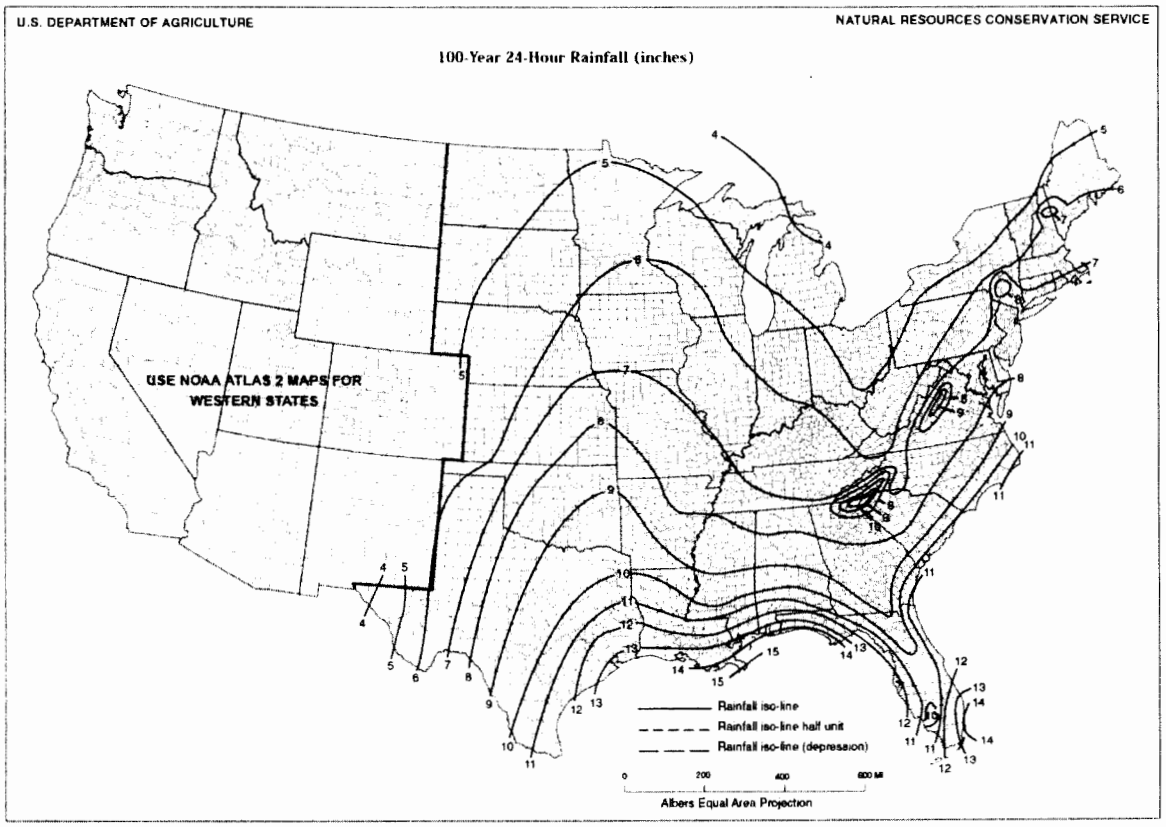


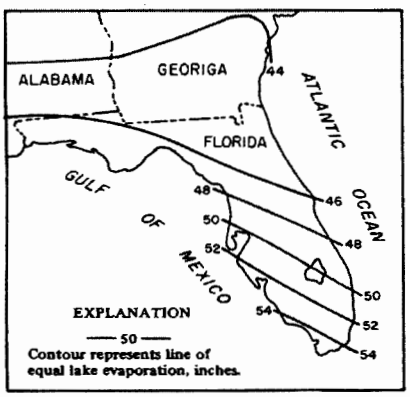
Figure B-8 100-year, 24-hour rainfall



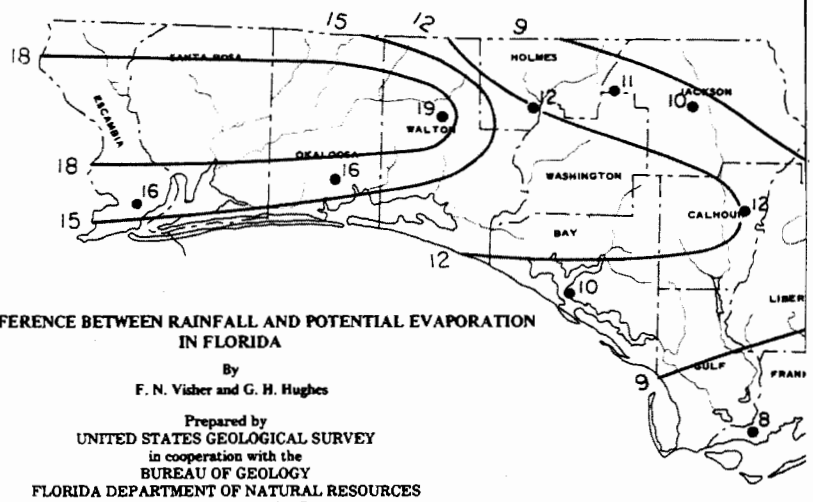
McCarty

MAP SERIES NO. 32 SECOND EDITION

UNITED STATES DEPA
GEOLOGI



AVERAGE ANNUAL LAKE EVAPORATION



THE DIFFERENCE BETWEEN RAINFALL AND POTENTIAL EVAPORATION IN FLORIDA

By
F. N. Visher and G. H. Hughes

Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BUREAU OF GEOLOGY
FLORIDA DEPARTMENT OF NATURAL RESOURCES
TALLAHASSEE, FLORIDA
1969
SECOND EDITION 1975

Rainfall in Florida is generally abundant, but man presently has little opportunity to control or direct the use of a large part of the total rainfall. Evaporation from land, water and plant surfaces has first call on much of the rainfall. Evaluation of the amount and areal variation of rainfall in excess of all evaporative losses is a necessary factor in appraising the outflow of water from an area. Outflow is the total surface and ground water flow from an area, and is equal to the difference between rainfall on an area and actual evaporation from an area.

Present technology does not permit accurate determination of evaporation from large areas of diversified soils and vegetative cover where the availability of water may differ and vary both in time and in space. Thus, outflow is not determined directly, but is evaluated by determining the incremental outflow that results from the excess rainfall in the area. Such an approach usually is practicable in areas where the total outflow occurs in well-defined surface channels. In Florida, however, many areas are underlain by permeable limestone aquifers which transcend surficial drainage divides and which transmit large quantities of water underground. Even though part of the water transmitted through aquifers may reappear in seeps or springs at some downstream point, the areas or points of recharge of all the underground water cannot be determined, nor can all of the

The values shown by the evaporation map depend on meteorological factors such as solar radiation, wind movement, air temperature, and humidity, all of which are importantly related to lake evaporation. Thus, the values are applicable to individual lakes as long as the lakes are openly exposed to wind movement, a requirement met by most large lakes in Florida. The same requirement may not be met by some small lakes covering only a few acres that may lie at the bottom of deep sinkhole depressions or that may be entirely rimmed by tall and dense vegetation.

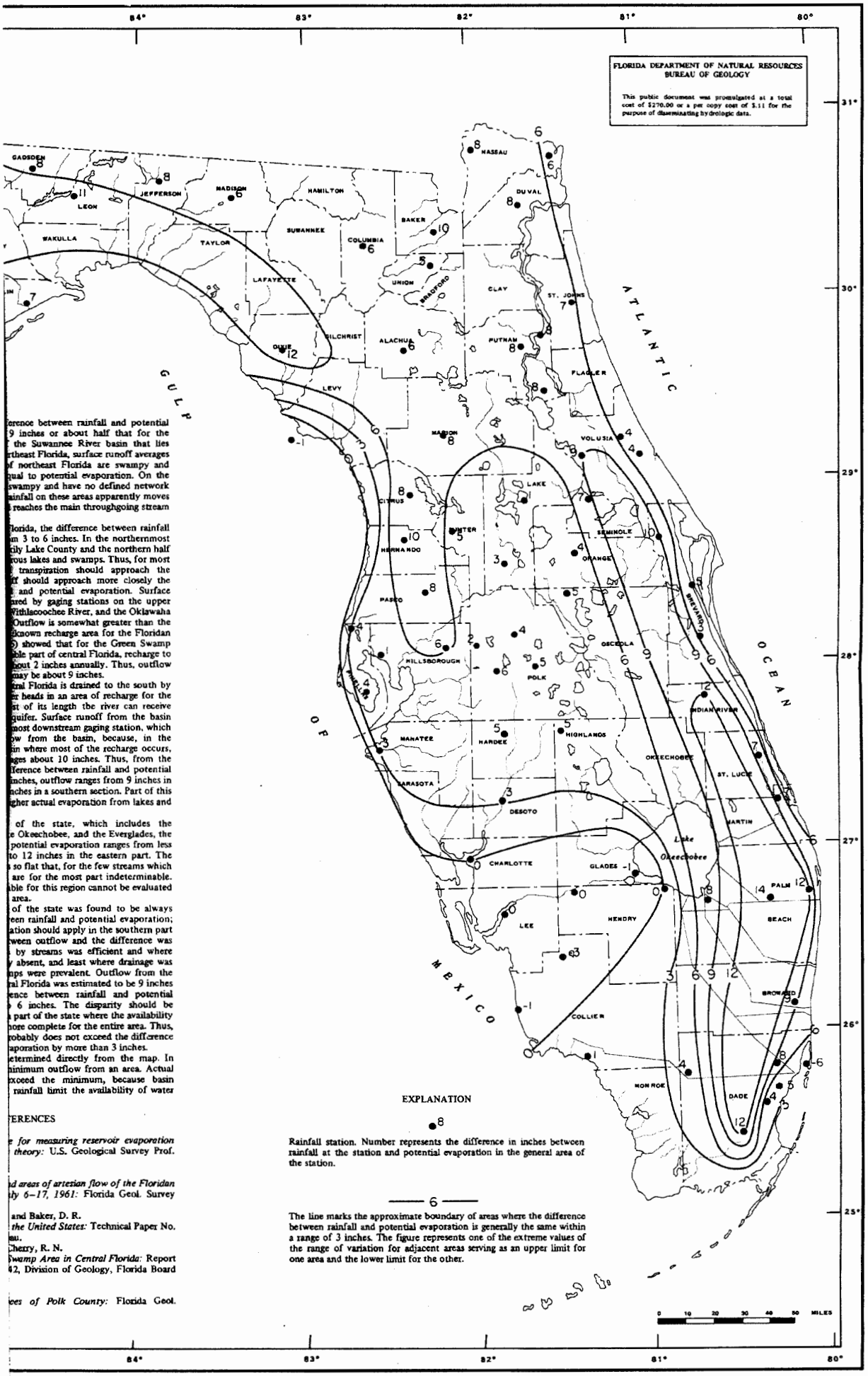
Yearly potential evaporation varies only slightly compared to yearly rainfall, which in many areas of Florida ranges from about 50 percent greater than normal to about 50 percent less than normal. Although some of the excess rainfall of wet years may be carried over as soil moisture or stored in lakes or in a shallow water table, much of the excess rainfall flows out of the area and does not remain available for evaporation in subsequent years. Similarly, but in a somewhat opposite sense, the energy represented by potential evaporation that cannot be used because of a lack of water during a dry year is not stored for later use but rather is dissipated. Because the yearly and seasonal irregularities between the supply and demand of water for evaporation are not smoothed by storage, the average outflow of water tends to be greater than the difference between average rainfall and average

In northeast Florida, the di
evaporation ranges from 6 to
panhandle area. In the part
entirely or almost entirely in n
about 14 inches. Large areas
evaporation losses are almost
other hand, larger areas are no
of surface streams. Much of the
downward to the water table ar
without large evaporation losses

Over a large part of central
and potential evaporation is fr
part of this area, including prim
of Polk County, there are num
of this area, evaporation an
evaporation potential and run
difference between the rainfa
runoff from the area, as mea
Withlacoochee River, the Little
River, averages about 7 inches
surface runoff because this is
Aquifer. Pride and others (19

FLORIDA DEPARTMENT OF NATURAL RESOURCES
BUREAU OF GEOLOGY

This public document was promulgated at a total cost of $270.00 or a per copy cost of $.11 for the purpose of disseminating hydrologic data.



ference between rainfall and potential
9 inches or about half that for the
the Suwannee River basin that lies
rtheast Florida, surface runoff averages
f northeast Florida are swampy and
qual to potential evaporation. On the
swampy and have no defined network
ainfall on these areas apparently moves
reaches the main throughgoing stream

lorida, the difference between rainfall
m 3 to 6 inches. In the northernmost
ily Lake County and the northern half
rous lakes and swamps. Thus, for most
transpiration should approach the
ff should approach more closely the
and potential evaporation. Surface
red by gaging stations on the upper
Withlacoochee River, and the Oklawaha
Outflow is somewhat greater than the
known recharge area for the Floridan
) showed that for the Green Swamp
ble part of central Florida, recharge to
bout 2 inches annually. Thus, outflow
may be about 9 inches.
ral Florida is drained to the south by
r heads in an area of recharge for the
t of its length the river can receive
quifer. Surface runoff from the basin
most downstream gaging station, which
w from the basin, because, in the
in where most of the recharge occurs,
ges about 10 inches. Thus, from the
ference between rainfall and potential
inches, outflow ranges from 9 inches in
nches in a southern section. Part of this
gher actual evaporation from lakes and

of the state, which includes the
e Okeechobee, and the Everglades, the
potential evaporation ranges from less
to 12 inches in the eastern part. The
so flat that, for the few streams which
are for the most part indeterminable.
able for this region cannot be evaluated
area.
of the state was found to be always
een rainfall and potential evaporation;
ation should apply in the southern part
ween outflow and the difference was
by streams was efficient and where
absent, and least where drainage was
nps were prevalent. Outflow from the
ral Florida was estimated to be 9 inches
ence between rainfall and potential
6 inches. The disparity should be
part of the state where the availability
ore complete for the entire area. Thus,
robably does not exceed the difference
aporation by more than 3 inches.
etermined directly from the map. In
inimum outflow from an area. Actual
xceed the minimum, because basin
rainfall limit the availability of water

ERENCES

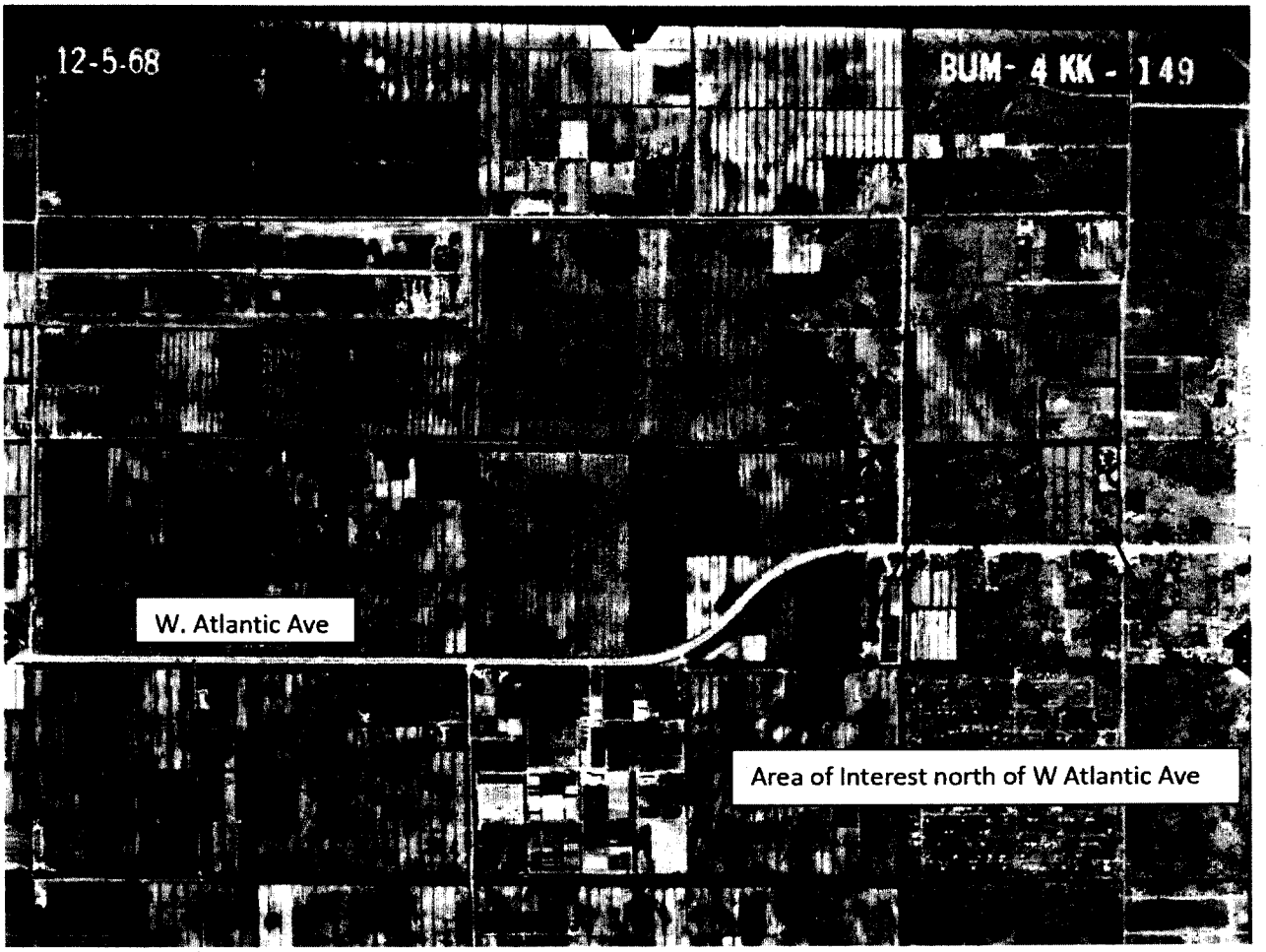
e for measuring reservoir evaporation
theory: U.S. Geological Survey Prof.

d areas of artesian flow of the Floridan
ty 6–17, 1961: Florida Geol. Survey

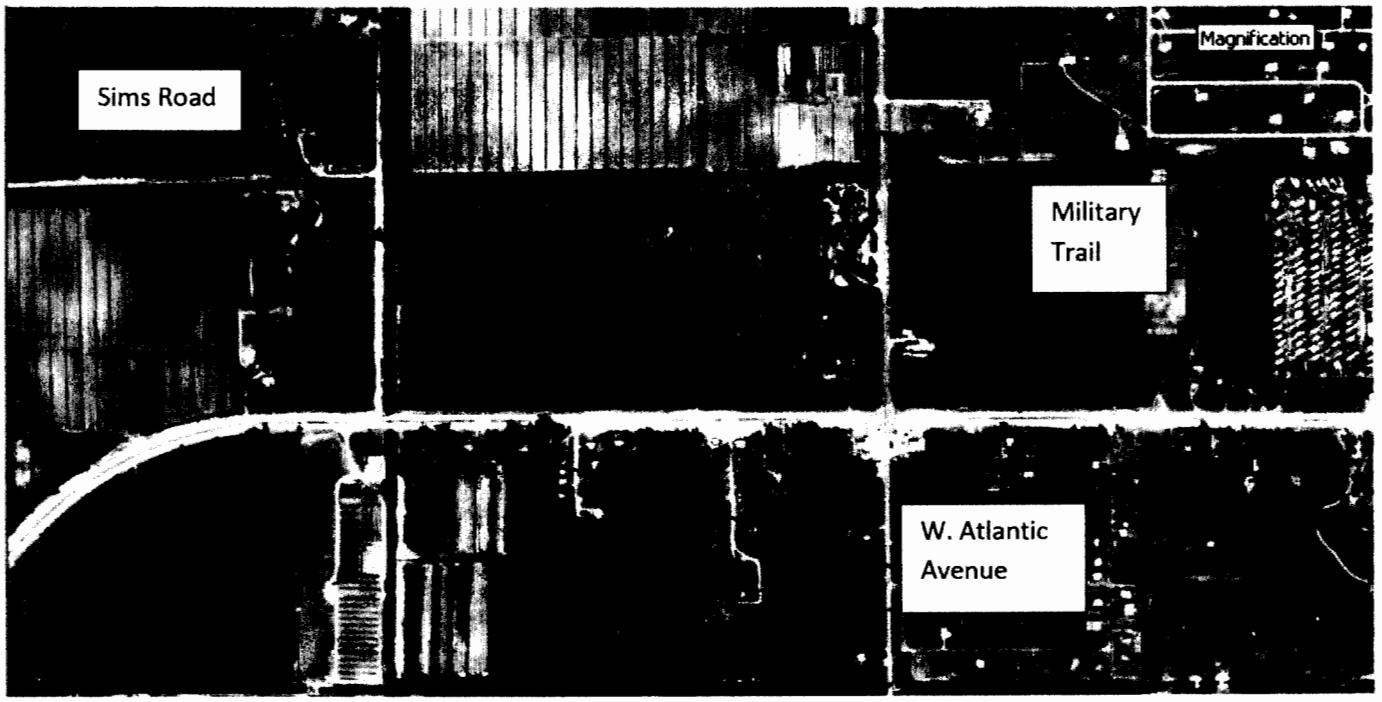
and Baker, D. R.
the United States: Technical Paper No.
au.
Cherry, R. N.
Swamp Area in Central Florida: Report
42, Division of Geology, Florida Board

ees of Polk County: Florida Geol.

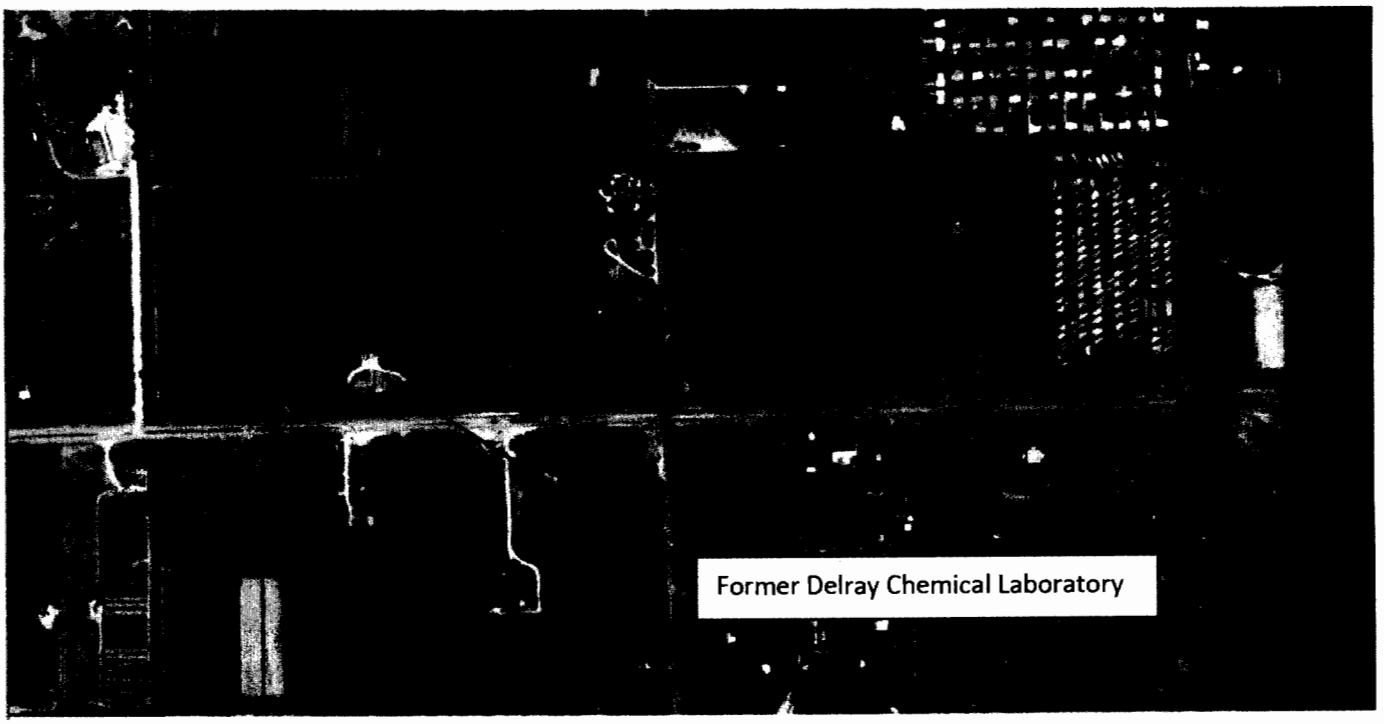
12-5-68 Photo



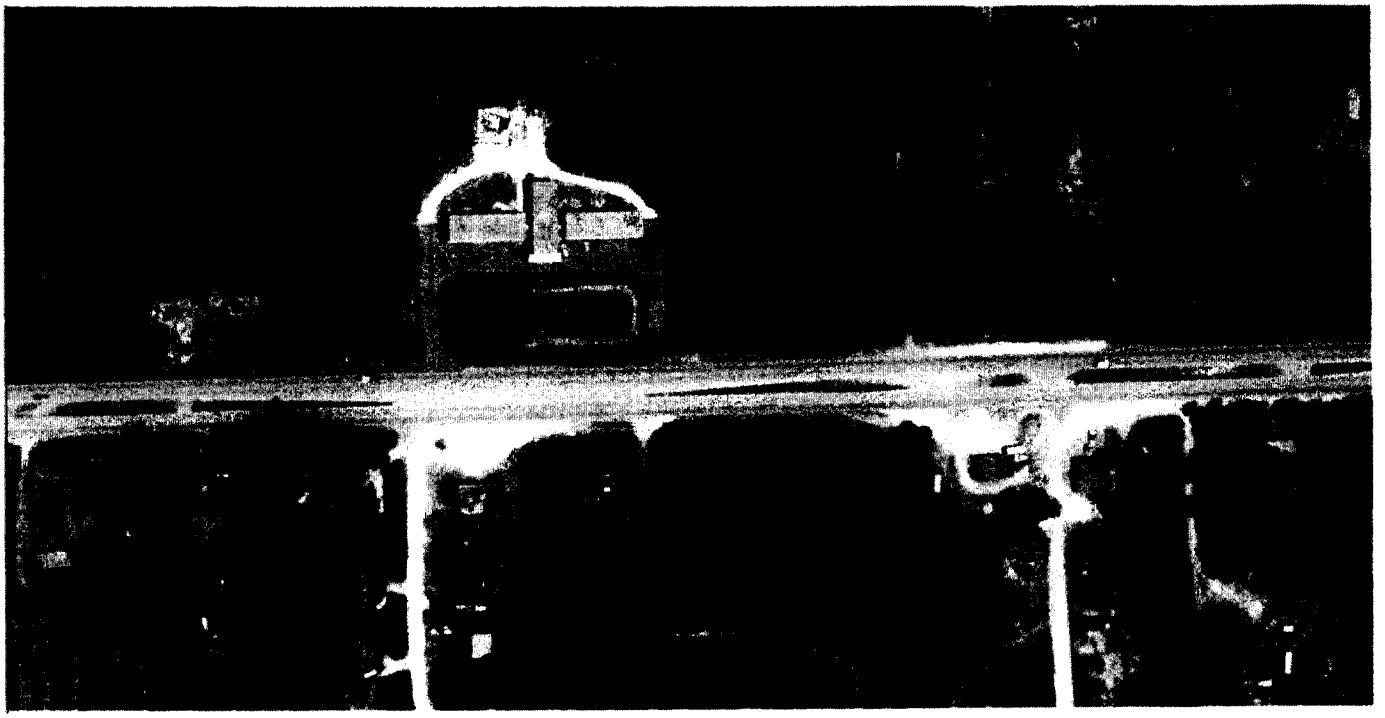
11-6-69 Photo


Sims Road
Magnification
Military
Trail
W. Atlantic
Avenue

4-17-73 Photo


Former Delray Chemical Laboratory

Blowup of 73 Photo



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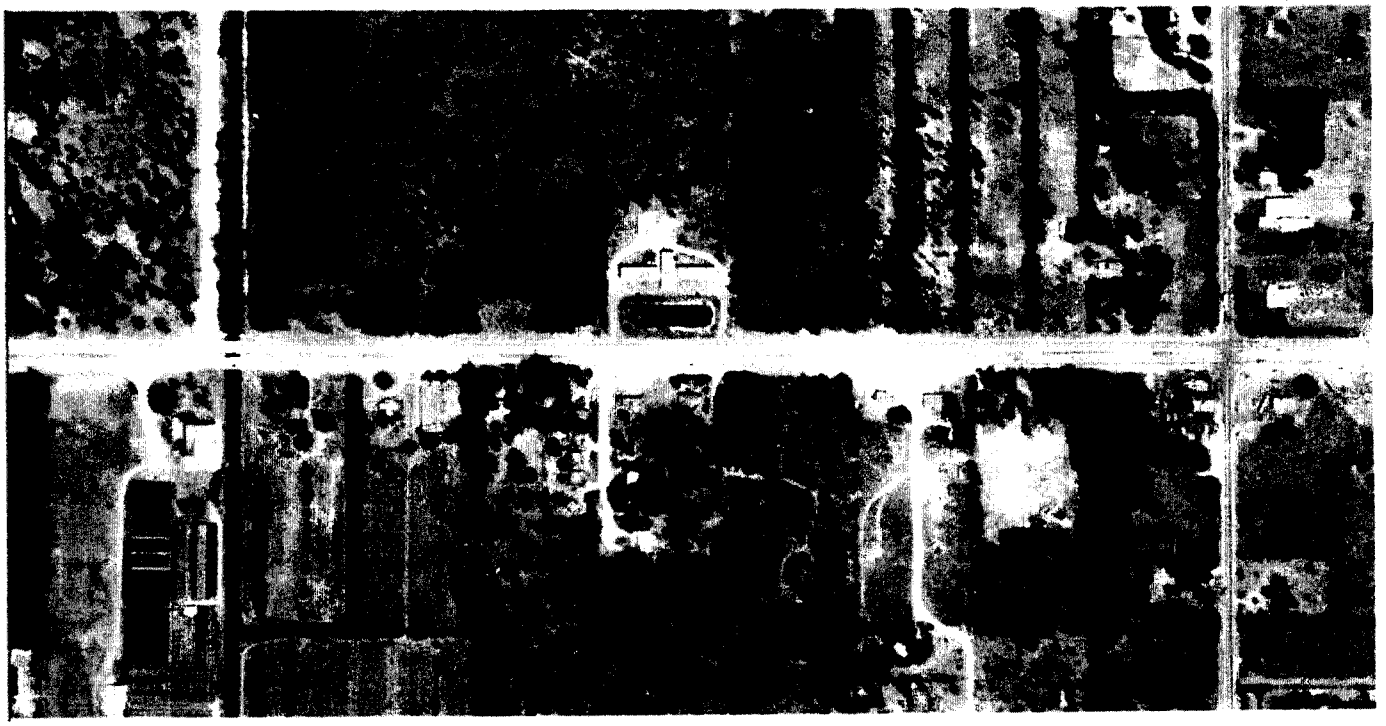

4-23-86 Photo

The Miami Herald
Found on Miami.com
The Miami Herald

April 17, 1983 Sunday
FINAL EDITION

BYLINE: HERALD STAFF

SECTION: FRONT; A; Pg. 27

LENGTH: 880 words

I'm 73, sick, deaf and afraid to go to sleep. My bedroom window faces a very dark back yard because Florida Power and Light hasn't fixed the light that went out over two months ago. Three calls have been made to FPL and that light is still out. Please don't print my name. I'm frightened enough already without everybody finding out about my situation. -- L. D.

You're sleeping better now. The street light in the alley behind your house is working just fine now. We called Florida Power and Light and the wiring problem that was keeping you in the dark was fixed pronto. FPL told us there was no record of any phone calls reporting the problem.

I sure hope you can back me up. I was having lunch with some colleagues when I happened to mention that Southeast Asia has snakes that fly. Needless to say, they don't believe me. -- Telesforo Pernetti, Miami Springs

They should. No less than three species of an arboreal constrictor known as Chrysopelea are liable to go gliding through the treetops in Southeastern Asia and the East Indies. The flying snakes aren't adorned with wings, they simply straighten out their 40-inch bodies, draw up their ventral (bottom) scales, make their undersides concave and soar down from the treetops to lower elevations. Snakes aren't the only unlikely critters to take to the air in that neck of the woods. The area is also home to an 8-inch long lizard that goes by the name of the flying dragon. It glides by means of folds of skin stretched over an extension of its ribs.

When I got married, I needed to have my name changed on my Social Security card. I sent my marriage certificate to the North Miami Beach Social Security office so the name change could be made. I got the card three weeks ago but my marriage certificate has never been returned. I've called Social Security several times and all I get is a runaround. Where's my marriage certificate? -- Cathy Layow Allen, North Miami Beach

It's lost. Normally, marriage certificates and other proof of identification are

returned the same day they're received, says Dee Dee Cobb of Miami's Social Security office. No one could find your certificate, and Cobb says she apologizes for the loss. Replacing the certificate isn't difficult. To get a certified copy, write the Marriage License Bureau, Room 610, 44 W. Flagler St., Miami 33130. Enclose a $3 check and a letter giving the date of your marriage, your husband's name, your maiden name and a self-addressed, stamped envelope. You should get a duplicate in seven days. If you stop by the Marriage License Bureau, you can get one the same day.

A few of us down here in the Republic of Panama were having a discussion over some cervezas the other night. The topic was the word "gringo" and everyone had a different view on the origin of the word. What can Action Line tell us? -- Sue Casillas, Panama, Republic of Panama

You're in the same boat with the experts. They all agree that it has become a Mexican term for North Americans, but that's as far as agreement goes. The most picturesque explanation of the word says it dates back to the 1850s when American cowboys who frequented Mexican cantinas would get maudlin after too many beers and sing their favorite tune "Green Grow The Rushes." Ear-weary Mexicans began referring to the cowboys as "gringos." But other word sleuths say gringo first appeared in a Madrid publication in 1787 and was used to refer to any person with a peculiar accent who didn't speak proper Spanish. They say gringo came from the Spanish word griego, which meant Greek. However, Spanish dictionaries we checked say griego means Greek and gringo is an Italian word for foreigner. Action Line checked three Italian dictionaries and the word gringo doesn't appear in any of them.

On April 2, you published an Action reaction from a West Palm Beach reader who said she hadn't had a mildew problem for 12 years. When she closes her apartment for the summer, she puts Mil-Kil powder in aluminum pie plates and places them around the rooms just before she leaves. I've been looking all over Miami for Mil-Kil powder for two weeks and I can't find it anywhere. I want to buy some. -- O. Lefkowitz

So do a lot of other readers. Mil-Kil is available only from **Delray Chemical** Co. Inc., 15711 Tangelo Ter., Delray Beach, Fla. 33444. The company's been manufacturing the product for 20 years and ships it everywhere, but it has no dealers or distributors, says the firm's Joyce Perez. Mil-Kil comes in five-pound bags. If you go to the company and pick it up, it costs $9.52 plus tax. If you order it sent to you, it costs $12.84 and will be sent via UPS. After May 1, the cost will be $12.85 because UPS's rates are going up, says Perez. A five- pound bag of Mil-Kil will take care of 1,000 square feet.

Sound off

Free gifts -- phooey. When a time share promotional mailing promised us a 1983 Cadillac, a three-day cruise, a color TV or $100 in cash, we succumbed to the temptation. We wasted five hours of our precious week-end time. Our "free" gift was a cruise to Mexico for two. However, it was out of Los Angeles. To top it off, a $500 nonrefundable deposit was required. Keep on reminding your readers to read between the lines when it comes to offers like this one. What you get for nothing is nothing. -- J. R. and J. G.

LOAD-DATE: October 23, 2009

The Miami Herald April 17, 1983 Sunday

LANGUAGE: ENGLISH

PUBLICATION-TYPE: Newspaper

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CAS

Search GO

MSDS : MIL-KIL, MIKI101792
CAS : 20018-09-1
NAME : benzene,1-((diiodomethyl)sulfonyl)-4-methyl-;

========== Product Identification ==========

MSDS NAME:MIL-KIL, MIKI101792
NIIN:00N068662
MSDS Number: CBJFN
=== Responsible Party ===
Company:PRO POWER MARKETING INC
Address:11205 WEST HILLSBOROUGH AVE
City:TAMPA
State:FL
ZIP:33635
Country:US
Info Phone Num:800-848-7792
Emergency Phone Num:800-255-3924
CAGE:PRPWR
=== Contractor Identification ===
Company:PRO POWER MARKETING INC
Address:11205 WEST HILLSBOROUGH AVE
Box:City:TAMPA
State:FL
ZIP:33635
Country:US
Phone:800-848-7792
CAGE:PRPWR

========== Composition/Information on Ingredients ==========

Name:BENZENE,1-((DIIODOMETHYL)SULFONYL)-4-METHYL-;
(DIIODOMETHYL-P-TOLYLSULFONE)
CAS:20018-09-1
RTECS #:CZ6000000
OSHA PEL:N/K
ACGIH TLV:N/K

========== Hazards Identification ==========

LD50 LC50 Mixture:NONE SPECIFIED BY MANUFACTURER.
Routes of Entry: Inhalation:YES Skin:YES Ingestion:YES
Reports of Carcinogenicity:NTP:NO IARC:NO OSHA:NO
Health Hazards Acute and Chronic:ACUTE EFFECTS ARE POSSIBLE IRRITATION AND DISCOMFORT. INHALATION: NONE EXPECTED, HOWEVER CERTAIN INDIVIDUALS MAY BE SENSITIZED AND EXPERIENCE MINOR NAUSEA OR HEADACHES. SKIN: NONE EXPECTED, HOWEVER, P ROLONGED CONTACT MAY CAUSE IRRITATION. EYES: THIS PRODUCT IS CONSIDERED TO BE AN EYE IRRITANT. CONTACT (EFTS OF OVEREXP)
Explanation of Carcinogenicity:NOT RELEVANT
Effects of Overexposure:HLTH HAZ: WITH THE EYES WILL CAUSE IRRITATION. INGESTION: MAY CAUSE GASTRIC DISTRESS, VOMITING AND DIARRHEA. CHRONIC: NO KNOWN CHRONIC EFFECTS HAVE BEEN ESTABLISHED.
Medical Cond Aggravated by Exposure:PREEXISTING SKIN, EYE OR RESPIRATORY DISORDERS MAY BECOME AGGRAVATED THROUGH PROLONGED EXPOSURE.

========== First Aid Measures ==========

First Aid:INHAL: REMOVE TO FRESH AIR. IF SYMPS PERSIST, SEEK MED ATTN. SKIN: REMOVE CONTAMD CLTHG; WASH AFFECTED AREA W/SOAP & WATER; LAUNDER CONTAMD CLTHG BEFORE REUSE; IF IRRIT PERSISTS, SEEK MED ATTN. EYES: FLUSH W/CLEAR RUNNING WATER FOR AT LEAST 15 MIN WHILE HOLDING EYELIDS OPEN; SEEK MED ATTN. INGEST: GIVE 2 GLASSES OF WATER FOR DILUTION; INDUCE VOMIT BY HAVING VICTIM PLACE HIS/HER FINGER (SUPDAT)

========== Fire Fighting Measures ==========

Flash Point:NON-FLAMMABLE
Extinguishing Media:CARBON DIOXIDE, WATER, WATER FOG, DRY CHEMICAL, CHEMICAL FOAM.
Fire Fighting Procedures:USE NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT . KEEP DRUMS COOL WITH WATER SPRAY TO PREVENT DRUM RUPTURE DUE TO STEAM BUILDUP.
Unusual Fire/Explosion Hazard:NONE.

========== Accidental Release Measures ==========

Spill Release Procedures:SMALL SPILLS - WASH TO SANITARY SEWER WITH PLENTY OF WATER. LARGE SPILLS - CONFINE SPILLS, SOAK UP WITH APPROVED ABSORBENT, SHOVEL PRODUCT INTO APPROVED CONTAINER FOR DISPOSAL. WASH AREA WITH PLENTY O F WATER.
Neutralizing Agent:NONE SPECIFIED BY MANUFACTURER.

========== Handling and Storage ==========

Handling and Storage Precautions:KEEP CONTAINER CLOSED WHEN NOT USE; PROTECT CONTAINERS FROM ABUSE; PROTECT FROM EXTREME TEMPERATURES.
Other Precautions:KEEP THIS AND OTHER CHEMICALS OUT OF REACH OF CHILDREN; MINIMIZE BODY CONTACT WITH THIS PRODUCT AS WELL AS ALL CHEMICALS IN GENERAL.

========== Exposure Controls/Personal Protection ==========

Respiratory Protection:NONE REQUIRED; IF MISTING OCCURS, NIOSH/MSHA APPROVED RESPIRATOR CAPABLE OF REMOVING PARTICULATE FROM AIR MUST BE WORN.
Ventilation:MECHANICAL (GENERAL) VENTILATION. LOCAL EXHAUST NOT NECESSARY.
Protective Gloves:NEOPRENE OR RUBBER GLOVES.
Eye Protection:ANSI APPRVD CHEM WORKERS GOGGLES .
Other Protective Equipment:ANSI APPROVED EYE WASH & DELUGE SHOWER .
Work Hygienic Practices:PRACTICE SAFE WORKPLACE HABITS. MINIMIZE BODY CONTACT WITH THIS AS WELL AS ALL CHEMICALS IN GENERAL.
Supplemental Safety and Health
SPEC GRAV: 1.320-1.330 (H*2O=1). SOL IN H*2O: MATL FORMS SUSPENSION IN WATER. FIRST AID PROC: DOWN THROAT; SEEK MED ATTN. NEVER GIVE ANYTHING BY MOUTH TO AN UNCON PERSON.

========== Physical/Chemical Properties ==========

Boiling Pt:B.P. Text:212F,100C
Vapor Pres:17 @ 20C
Vapor Density:<1
Spec Gravity:SUPDAT
Evaporation Rate & Reference:<1 (WATER =1)
Solubility in Water:SUPDAT
Appearance and Odor:LIGHT GRAY, FINELY DIVIDED SUSPENSION.
Percent Volatiles by Volume:60 WT

========== Stability and Reactivity Data ==========

Stability Indicator/Materials to Avoid:YES
STRONG ALKALIES, KETONES.
Stability Condition to Avoid:EXTREME TEMPERATURES; KEEP FROM FREEZING.
Hazardous Decomposition Products:THERMAL DECOMPOSITION MAY YIELD CARBON MONOXIDE, CARBON DIOXIDE, SO*2; POSSIBLE IODINE VAPORS.

========== Disposal Considerations ==========

Waste Disposal Methods:DISPOSE OF IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL REGULATIONS. THIS PRODUCT IS TOXIC TO FISH; DO NOT DISCHARGE INTO LAKES, PONDS, STREAMS OR PUBLIC WATERWAYS.

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ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

March 26, 2008

MEMORANDUM

SUBJECT: Environmental Fate Assessment of Di-iodomethyl p-tolyl sulfone for RED

Case No.: 4009 **DP Barcode:** 344849

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Risk Assessment and Science Support Branch (RASSB)
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Chemical Name	PC Code	CAS#	Common Name
(p-tolyl diiodomethyl sulfone	101002	20018-09-1	AMICAL™ 48

Environmental Fate Science Chapter and Fate Assessment on Diiodomethyl p-tolyl sulfone technical is submitted for Reregistration.

Diiodomethyl p-tolyl sulfone Technical
ENVIRONMENTAL FATE SCIENCE CHAPTER

EXECUTIVE SUMMARY

AMICAL™ 48 is an anti-fouling preservative that contains 95% of the active ingredient (p-tolyl diiodomethyl sulfone). It is used for **Materials Preservatives** [Paints (in-can), coatings, fire retardant, adhesives, caulks, sealants, slurries, dispersions emulsions solutions suspensions, rubber products, plastic PVC vinyl products, hides leathers leather products, textiles, papermaking, paper and paperboard, melamine formaldehyde thermosetting resins, and **Wood Preservatives** (mildew, sapstain, and wood-rotting organisms for wood above ground, no pressure treatment).

Diiodomethyl p-tolyl sulfone is a wettable powder that is slightly soluble in water. The chemical structure of diiodomethyl p-tolyl sulfone is as follows:

Figure 1. Structure of Diiodomethyl p-tolyl sulfone

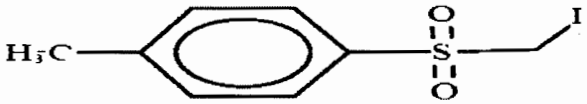


Figure 2. Structure of MIMPTS (monoiodomethyl-p-tolylsulfone)

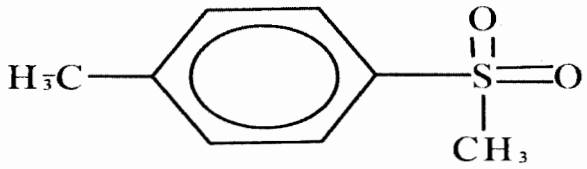
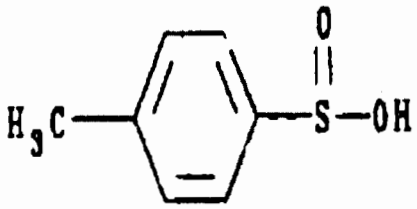
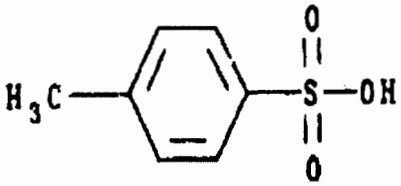


Figure 3. Structure of MPTS (methyl-p-tolylsulfone)



p-toluene sulfinic acid

Figure 4. Structure of PTSA (p-toluene sulfinic acid)



p-toluene sulfonic acid

Figure 5. Structure of PTS-O-A (p-toluene sulfonic acid)

Diiodomethyl p-tolyl sulfone (Figure 1) is stable to hydrolysis at pH 5, but degraded with half-lives of 2-4 days at pH 7 and 9. MIMPTS (Figure 2, Monoiodomethyl-p-tolylsulfone, parent minus one iodo group) was the major degradate, and increased until the end of the study (30 days). MPTS (Figure 3, methyl-p-tolylsulfone, parent minus both iodo groups) and PTSA (Figure 4, p-toluene sulfinic acid, parent minus methyl group) reached minor concentrations. Soil photolysis half-lives of 13 days (linear) and 5.3 (non-linear) were observed for parent

compound. MIMPTS was stable in the dark control but degraded with a half-life of 12.5 day in irradiated sample. Volatiles and non-extractables were negligible.

Degradation by microorganisms will reduce diiodomethyl p-tolyl sulfone concentrations in the environment, but residues are expected to partition to water in the presence of soil or sediment. In aerobic soil (the top layer of non-flooded soil), the non-linear parent, MIMPTS, and MPTS half-lives were 1.5, 32, and 53 days, respectively. The linear half-life of MPTS was 173 days. PTS-O-A (p-toluene sulfonic acid, parent minus methyl plus added oxygen, Figure 5) did not exceed 0.7 % in the study. In the anaerobic soil metabolism study (the second layer of soil), the half-lives of parent diiodomethyl p-tolyl sulfone were 1.7 and 4.2 days in aerobic (non-flooded) and anaerobic (flooded soil) portions of the study, respectively. Diiodomethyl p-tolyl sulfone was found in equal portions in water and sediment. MIMPTS was a major degradate with a half-life of 21 days and was found predominantly in water. MPTS reached 81 % by the end of the study and was primarily found in water. Anaerobic aquatic metabolism (representing bottom sediment) degrades parent and MIMPTS with total system half-lives of 9.6 and 11 days, respectively. MPTS was the terminal metabolite and increased to 95 % by 4-6 months. Aqueous residues were greater than sediment residues for parent, MIMPTS, and MPTS for 7, 180, and 60 days, respectively.

Diiodomethyl p-tolyl sulfone was mobile in columns of soil that were leached with water. The amounts of parent compound that leached through 12-inch columns were 73, 84, 34, and 8 % in sand, silt loam, sandy loam, and clay soils. An average of 2, 1.5, 5, and 8 % of applied compound was present in each inch of the columns, respectively.

The Log Kow (Log P) for parent diiodomethyl p-tolyl sulfone is 2.66, and the estimated (EPI-SUITE) Log Kow values for MIMPTS, MPTS, and PTSA were 2.2, 1.1, and 0.56, respectively. None of these compounds are expected to bioconcentrate significantly because the Log Kow values are below 3.0.

An average of 43 % of diiodomethyl p-tolyl sulfone from wooden tongue depressors leached into pH 5, 7, 9 unfiltered buffers over a 30-day study (median of 42 %). Maximum residues in water were observed at day zero, followed by a decrease to the minimum values at day 7 and a general increase. In filtered samples, the aqueous residues averaged 4.3 %, indicating that some sorption to organic materials may occur in the environment.

There was no inhibition of microorganisms in sewage sludge treated at 9 mg L.

I. Environmental Fate Assessment

A. Abiotic

Diiodomethyl p-tolyl sulfone (Figure 1) forms sequential metabolites MIMPTS (parent minus one iodo group, Figure 2), MPTS (parent minus both iodo groups, Figure 3), PTSA (parent minus methyl group, Figure 4), and PTS-O-A (MPTS minus methyl plus oxygen, Figure 5). The degree of formation of metabolites depends on the level of oxidation potential present in the test system. Diiodomethyl p-tolyl sulfone and its metabolites are largely present in water in the presence of soil sediment and degradation forms compounds that are more polar and water soluble than parent compound.

Diiodomethyl p-tolyl sulfone is stable to hydrolysis at pH 5, but degrades rapidly in pH 7 and 9 buffered solutions with linear half-lives of 2.1-3.6 days. The dark-control adjusted half-life was 8.5 days. The major degradate was MIMPTS, whose concentrations did not decline in the study and reached 90-100 % of applied by the end of the study. The minor degradates MPTS and PTSA were formed in the study. Soil photolysis half-lives of 13 days (linear) and 5.3 (non-linear) were observed for parent compound. MIMPTS was stable in the dark control but degraded with a half-life of 12.5 day in irradiated sample. For parent DIMTS, Dow calculated half-lives of 7.7 and 19.9 days in light and dark, studies, respectively. Volatiles and non-extractables were negligible.

B. Biotic

Under aerobic soil conditions, parent Diiodomethyl p-tolyl sulfone and MIMPTS degraded with non-linear half-lives of 1.5 and 32 days in sandy loam soil, respectively. The next sequential metabolite was MPTS which degraded with calculated non-linear and linear half-lives of 53 (poor fit) and 173 (better fit) days, respectively. Dow calculated half-lives of 2 days (initial decay) and 94 days (all data points) for parent compound. For MIMPTS and MPTS, the calculated half-lives were 58 and 173 days, respectively. The metabolite PTS-O-A (MPTS minus methyl plus oxygen) did not exceed 0.7 % in the study. Based on the increase in non-extractable

residues, the decrease in extractable residues, and the formation of CO_2, complete mineralization of some of the product in aerobic soil was occurring.

In sandy loam soil, diiodomethyl p-tolyl sulfone degraded with calculated half-lives of 1.7 and 4.2 days in aerobic and anaerobic conditions, respectively. Diiodomethyl p-tolyl sulfone was found in equal portions in water and soil in the anaerobic portion of the study. MIMPTS degraded with a non-linear half-life of 21 days in the anaerobic portion of the study and was found primarily in the water phase. Dow calculated half-lives of 2 and 7.7 days for the aerobic and anerobic phases, respectively. No half-lives were reported for MIMPTS. MPTS increased to 81 % by the end of the study (60 days) and was found in the water instead of the sediment. PTS-O-A was not formed in significant quantities. Extractable residues declined in the study, non-extractables were not in significant quantities, and water soluble residues increased to 84 % by 60 days. The lack of non-extractables and the increase in water soluble residues is consistent with the formation of metabolites with increasing water solubility. Volatiles did not exceed 0.05 % indicating that complete mineralization or volatility of organic compounds did not occur.

Under anaerobic aquatic conditions (sandy loam sediment, water, and nitrogen atmosphere), the total system, non-linear half-lives of diiodomethyl p-tolyl sulfone and MIMPTS were 9.6 and 11 days, respectively. Parent compound was associated more with water than sediment through 7 days and more in sediment afterwards. MIMPTS reached 16.2 % by 7 days, and then declined to 1 % by 3-6 months. MIMPTS was associated more in water than sediment for 60 days and then in equal portions thereafter. MPTS increased to 94.5 by 4-6 months, and was associated with water rather than sediment over the duration of the study. PTS-O-A did not reach significant levels in the study. Extractable residues were 23-31 % (0-14 days) and 16-18 % by 30-180 days, and non-extractable residues never exceeded 2 %. Water soluble residues ranged from 68 to 85 % and volatiles did not exceed 0.8 %.

In columns of sand, silt loam, sandy loam, and clay soils, 73, 84, 34, and 8 % of radioactivity passed through the columns into the leachate, respectively. An average of 2, 1.5, 5, and 8 % of applied diiodomethyl p-tolyl sulfone was detected in each inch of the 12-inch columns. These results indicate that diiodomethyl p-tolyl sulfone residues will eventually leach through the columns.

An average of 43 % of diiodomethyl p-tolyl sulfone from wooden tongue depressors leached into pH 5, 7, 9 unfiltered buffers over a 30-day study (median of 42 %). Maximum residues in water were observed at day zero, followed by a decrease to the minimum values at day 7 and a general increase. The wood extract accounted for 2.1-6 % of applied for pH 5, 7, and 9. In filtered samples, the aqueous residues averaged 4.3 %, indicating that some sorption to organic materials may occur in the environment.

There was no inhibition of microorganisms in sewage sludge treated at 9 mg l.

APPENDIX

Environmental Fate Data for Diiodomethyl p-tolyl sulfone Technical

A. Environmental Fate Guideline Studies

1. Hydrolysis (Guideline Number OPPTS 161-1, MRID No. 43008701)

This hydrolysis study, submitted under MRID No. 43008701, was reviewed by the Agency and found to be acceptable for the active ingredient, di-iodomethyl-p-tolylsulfone. The hydrolysis data requirement for diiodomethyl p-tolyl sulfone technical has been fulfilled.

Di-iodomethyl-p-tolylsulfone, Figure 1 is stable to hydrolysis at pH 5, but degrades rapidly in pH 7 and 9 buffered solutions with linear half-lives of 2.1-3.6 days. The major degradate was MIMPTS (Monoiodomethyl-p-tolylsulfone, parent minus 1 iodo group, Figure 2). MIMPTS concentrations did not decline in the study and reached 90-100 % of applied by the end of the study (14-30 days). However, some MIMPTS did degrade to the minor degradates MPTS (methyl-p-tolylsulfone, parent minus both iodo group, Figure 3) and PTSA (p-toluene sulfinic acid, parent minus methyl group, Figure 4). MPTS and PTSA were formed at 2.8 and 4.4 % of applied, respectively (MRID 43008701).

2. Photodegradation in Water and on Soil (Guideline Nos. OPPTS 161-2 and 161-3, not required for use pattern, but studies submitted)

The Agency is waiving the data requirement for the photodegradation of diiodomethyl p-tolyl sulfone in water. However, the studies submitted will be reviewed at a later date and made part of the file. The active ingredient is hydrolytically unstable (2-4 days) and rapidly degrades. However, Dow apparently submitted a photodegradation in water study (MRID not assigned) (Williams, M. (1991) *Determination of the Photolysis Rate of ^{14}C-AMICAL 48 in pH 5 Buffered Solution at 25C;* Guideline 161-2; ABC Laboratories; ANGUS Chemical Company; 45 pages) that was not reviewed. However, the environmental fate assessment is essentially complete. The aerobic soil metabolism study also demonstrates a half-life of 1.5 days. The registrant submitted a soil photolysis study (Madsen, S. and M.D. Williams. ABC Report No. 38727. MRID 47323601). Soil photolysis half-lives of 13 days (linear) and 5.3 (non-linear) were observed for parent compound. MIMPTS was stable in the dark control but degraded with a half-life of 12.5 day in irradiated sample. Volatiles and non-extractables were negligible.

3. Aerobic Soil Metabolism (Guideline No. OPPTS 162-1, MRID No. 41765405)

This aerobic soil metabolism study, submitted under MRID No. 41765405, was reviewed by the Agency and found to be supplemental for the active ingredient, di-iodomethyl-p-tolylsulfone.

Under aerobic soil conditions, parent diiodomethyl p-tolyl sulfone degraded with a non-linear half-life of 1.5 days in sandy loam soil. Parent compound declined from 87 % of applied

at time zero to 1.3-3 % by 60-366 days (end of study). The first sequential metabolite was MIMPTS (Figure 2), which reached a maximum of 65 % by day five and declined to 1.2-2.1 % by 182-366 days. It declined with a calculated non-linear (formation decline) half-life of 32 days. The next sequential metabolite was MPTS (Figure 3), which reached about 56 % of applied by 121 days and declined to about 20 % of applied by 366 days. The calculated non-linear and linear half-lives were 53 and 173 days, respectively. The 173-day linear half-life more closely represents the MPTS data. The metabolite PTS-O-A (parent minus methyl plus oxygen, Figure 5) did not exceed 0.7 % in the study. Non-extractable residues reached consistent levels of 18-27 % by 21-366 days, and extractable residues declined from 77 % (21 days) to 25 % (366 days). Volatiles (virtually all CO_2) increased to 53 % of applied by 366 days, indicating complete mineralization of some residues (MRID 41765405).

4. Anaerobic Soil Metabolism (Guideline No. OPPTS 162-2, MRID No. 41765406)

This anaerobic soil metabolism study, submitted under MRID No. 41765406, was reviewed by the Agency and found to be supplemental for the active ingredient, di-iodomethyl-p-tolylsulfone.

Under aerobic soil and anaerobic conditions, diiodomethyl p-tolyl sulfone degraded with half-lives of 1.7 and 4.2 days, respectively. Parent compound was found in equal portions in water and soil in the anaerobic portion of the study. MIMPTS (Figure 2) was the first major metabolite, and degraded under anaerobic conditions with a non-linear half-life of 21 days. Aqueous residues were about 4.6 times higher than those in sediment. MPTS (Figure 3) increased to 81 % by the end of the study (60 days) and was found in the water over the sediment (4X). PTS-O-A (Figure 5) was formed at 1.4 % of applied in the study. Extractable residues declined from 99 % at day zero to 15 % at 60 days and non-extractables did not exceed 5 % in the study. Water soluble residues increased from 56 % at the start of the anaerobic period (15 days) and increased to 84 % by 60 days. The lack of non-extractables and the increase in water soluble residues is consistent with the formation of metabolites with increasing water solubility. Volatiles did not exceed 0.05 % (MRID 41765406).

5. Anaerobic Aquatic Metabolism (Guideline No. OPPTS 162-3, MRID No. 42177201)

This anaerobic aquatic metabolism study was reviewed by the Agency and found to be supplemental for the active ingredient di-iodomethyl-p-tolylsulfone.

Under anaerobic aquatic conditions (sandy loam sediment, water, and nitrogen atmosphere), the total system, non-linear half-lives of diiodomethyl p-tolyl sulfone and MIMPTS were 9.6 and 11 days, respectively. Dow calculated a half-life of 8.1 days for parent compound, but did not calculate one for MIMPTS. Parent compound was associated more with water than sediment through 7 days and more in sediment afterwards. MIMPTS reached 16.2 % by 7 days, and then declined to 1 % by 3-6 months. MIMPTS was associated more in water than sediment for 60 days and then in equal portions thereafter. MPTS increased to 94.5 by 4-6 months, and

was associated with water rather than sediment over the duration of the study. PTS-O-A did not reach significant levels in the study. Extractable residues were 23-31 % (0-14 days) and 16-18 % by 30-180 days, and non-extractable residues never exceeded 2 %. Water soluble residues ranged from 68 to 85 % and volatiles did not exceed 0.8 % (MRID 42177201).

6. Aerobic Aquatic Metabolism (Guideline No. OPPTS 162-4, No data)

No data have been submitted.

7. Adsorption/Desorption (Guideline No. OPPTS 163-1, MRID No. 41765407)

This soil column leaching study was reviewed by the Agency and found to be supplemental for the active ingredient di-iodomethyl-p-tolylsulfone. Batch equilibrium studies using parent compound are not possible because of hydrolytic instability.

In columns of sand, silt loam, sandy loam, and clay soils, 73, 84, 34, and 8 % of radioactivity passed through the columns into the leachate, respectively. An average of 2, 1.5, 5, and 8 % of applied parent compound was detected in each inch of the 12-inch columns. These results indicate that diiodomethyl p-tolyl sulfone residues will eventually leach through the columns (MRID 41765407).

8 Bioaccumulation in Fish (Guideline No. OPPTS 165-4, Agency Estimated BCF) (No MRID Number))

Based on the Log P (Log Kow) of 2.66 (3), significant bioconcentration in fish is not likely. Based on the Log P (assuming stability of parent), the maximum bioconcentration factor is 11X, which is far less the level of concern of 1,000X. Also, the lack of persistence in hydrolysis (2-4 days) and the formation of metabolites with higher polarity and water solubility than parent will prevent significant bioconcentration.

9. Special Leaching Study (American Wood Preservers' Association Standards-1998, Standard Method E11-97, MRID No. 43997001)

This leaching study was reviewed by the Agency and was rejected because non-standard wood (tongue depressors) was used in the study. The wood leaching data requirement for diiodomethyl p-tolyl sulfone may be satisfied using the AWPA E11-97 protocol as followed in the newest study. However, it has not been formally reviewed, and a summary is contained below. AD will conduct a more comprehensive review at a later date because the study was recently submitted.

Puritan® tongue depressors were treated with diiodomethyl p-tolyl sulfone stock solution to achieve a 1 % concentration in the wood (weight basis). The treated wood sticks were placed into pH 5 (acetate buffer), pH 7 (HEPES buffer), pH 9 (Borate buffer), 0.1 N HCl, and into deionized water. In unfiltered buffers, the aqueous residues within each buffer averaged 46, 42, 43, 42, and 40 % of the applied, respectively. Within each test interval, the averages of aqueous

residues were 53, 33, 40, 42, and 46 % for day 0, 7, 14, 21, and 30, respectively. Maximum residues in water were observed at day zero, followed by a decrease to the minimum values at day 7 and a general increase. The wood extract accounted for 2.1-6 % of applied for pH 5, 7, 9, HCl, and water, respectively. In filtered samples, the aqueous residues generally declined from day zero (mean of 8 %), declined to about 1 % at day 7, and increased to 6 % by 30 days. The average percent aqueous recovery in each buffer was 3-7 %. Apparently, wood fragments sorbed the compound in the water. MIMPTS (Figure 2) was only major (10 %) degradate, and minor amounts of PTSA (Figure 4), PTS-O-A (Figure 5) and MPTS (Figure 3) were formed. The median ratio of unfiltered:filtered concentrations was 11, which could have occurred either from suspended wood particles or the filter itself (MRID 43997001).

In a later study, the aqueous leaching rate for di-iodomethyl-p-tolylsulfone (DIMTS), the active ingredient in AMICAL™ 48, was determined from Southern Pine wood following a simulated pressure treatment. The test followed the procedures of Standard E11-06 from the American Wood-Preservers Association in which DIMTS loadings in wood of 5.6, 11.2, and 16 mg cm3 were evaluated. The calculated aqueous leaching rates based on wood surface area for all three wood loadings were similar, ranging from 0.021 to 0.026 mg DIMTS cm2 day. Corresponding quantities of DIMTS that leached from the wood blocks over the entire 14-day study were 0.31 mg DIMTS cm2, 0.35 mg DIMTS cm2 and 0.41 mg DIMTS cm2 for the 5.6, 11.2,16 mg cm3 loadings, respectively. These results indicate that the leaching rate of DIMTS from the wood blocks may have been limited by the aqueous solubility of DIMTS, particularly at the two higher loadings. Thus, these calculated leaching rates represent minimum values.

10. Inhibition of Sewage Sludge Respiration (OECD Test Method 209), Gonsior, 2002.

The potential for diiodomethyl-p-tolylsulfone to inhibit the respiration of municipal activated sludge was evaluated using the test method OECD 209 "Activated Sludge, Respiration Inhibition Test." This test method assesses the effect of a test chemical on microorganisms by measuring the respiration rate under defined conditions in the presence of different concentrations of the test chemical following a 3-hour contact period. Diiodomethyl p-tolyl sulfone at a nominal concentration of 9 mg L, did not inhibit the respiration rate of the activated sludge compared to control mixtures (no test chemical added).

Data Gap: See Table below.

Environmental Fate Data Requirements for Diiodomethyl p-tolyl sulfone Technical			
OPP Guideline	**Data Requirement**	**MRID No.**	**Data Requirement Status**
161-1	Hydrolysis	41765404 43008701	Satisfied
161-2	Photodegradation in Water	None	Not required
161-3	Photodegradation on Soil	Madsen and Williams. ABC Report No. 38727. no MRID)	Acceptable but not required
162-1	Aerobic Soil Metabolism	41765405	Acceptable but not required
162-2	Anaerobic Soil Metabolism	41765406	Acceptable but not required
162-3	Anaerobic Aquatic Metabolism	42177201	Acceptable but not required
162-4	Aerobic Aquatic Metabolism	None	Not required
163-1	Adsorption Desorption	41765407	Acceptable but not required
OECD 305	Bioaccumulation in Fish	None	Not required
AWPA E11-06 protocol study required	Special Leaching Study	43997001 Gonsior and Hales. 2008	Rejected because of non-standard wood used in test Newer Study may be acceptable but has not been formally reviewed to date

OECD 209	Inhibition of Sewage Sludge Respiration	Gonsior, 2002, no MRID	Acceptable but not required

BIBLIOGRAPHY

MRID **CITATION**

161-1 Hydrolysis

MRID	Citation Reference
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161-3 Photodegradation on Soil

MRID 47323601 Madsen, S. and M.D. Williams. 1991. Determination of the Photolysis Rate of ^{14}C-AMICAL 48 on the Surface of Soil. ABC Laboratories Final Report No. 38727.

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162-1 Aerobic soil metabolism

MRID	Citation Reference
41765405	Cranor, W. (1990) Aerobic Soil Metabolism of carbon 14|-Abbott- 9248 (AMICAL 48): Lab Project Number: 36608. Unpublished study prepared by Analytical Bio-Chemistry Labs., Inc. 955 p.

162-2 Anaerobic soil metabolism

MRID	Citation Reference
41765406	Madsen, S.; Williams, M. (1990) Anaerobic Soil Metabolism of carbon 14|-AMICAL 48: Lab Project Number: 38730. Unpublished study prepared by Analytical Bio-Chemistry Labs., Inc. 461 p.

162-3 Anaerobic aquatic metabolism

MRID **Citation Reference**

42177201	Madsen, S.; Williams, M. (1991) Anaerobic Aquatic Metabolism of carbon 14| AMICAL 48: Final Report: Lab Project Number: 38729. Unpublished study prepared by ABC Labs, Inc. 532 p.

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MRID	Citation Reference
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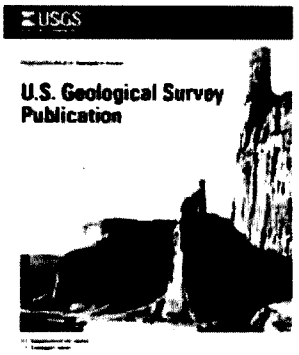

Lithology and base of the surficial aquifer system, Palm Beach County, Florida

Water-Resources Investigations Report 86-4067

By: Wesley L. Miller

Tweet

Links

- Plate: **Plate 1** (pdf)

Abstract

The surficial aquifer system is a major source of freshwater in Palm Beach County. In 1982, public supply withdrawals from the aquifer system totaled 33,543 million gallons, 77.5% of total public supply withdrawals. To evaluate the aquifer system and its geologic framework, a cooperative study with Palm Beach County was begun in 1982 by the U.S. Geological Survey. The surficial aquifer system in Palm Beach County is composed primarily of sand, sandstone, shell, silt, calcareous clay (marl), and limestone deposited during the Pleistocene and Pliocene epochs. In the western two-thirds of Palm Beach County, sediments in the aquifer system are poorly consolidated sand, shell, and sandy limestone. Owing to interspersed calcareous clays and silt and very poorly sorted materials, permeabilities in this zone of the aquifer system are relatively low. Two other zones of the aquifer system are found in the eastern one-third of the county where the sediments are appreciably more permeable than in the west due to better sorting and less silt and clay content. The location of more detailed lithologic logs for wells in these sections, along with data from nearby wells, allowed enhanced interpretation and depiction of the lithology which had previously been generalized. The most permeable zone of the aquifer system in this area is characterized by highly developed secondary porosity where infiltrating rainwater and solution by groundwater have removed calcitic-cementing materials from the sediments to produce interconnected cavities. Increased permeability in the aquifer system is generally coincident with the eastern boundary of the overlying organic soils and Lake Flirt Marl. Lithologic logs of wells in Palm Beach County indicate that sediments forming the aquifer system were deposited directly on the erosional surface of the Hawthorn Formation in some areas. In other locations in the county, lithologic logs indicate that the base of the aquifer system was formed by fluvial deposits containing erosional materials from the Tamiami and Hawthorn Formations and Caloosahatchee Marl. (Lantz-PTT)

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FLORIDA'S GROUND WATER QUALITY MONITORING PROGRAM

HYDROGEOLOGIC FRAMEWORK

much of the Floridan aquifer system in the central and western panhandle. The extensive development of secondary porosity by dissolution has greatly enhanced the permeability, especially in those areas where the confining beds are breached or absent. The Ocala Limestone forms the lower portion of the Floridan in the western panhandle (Wagner, 1982). In much of the peninsular area, it comprises all or part of the upper Floridan.

By Late Eocene, carbonate sediments were deposited significantly further to the north and west than had previously occurred during the Cenozoic. The Ocala Limestone is present throughout much of the State except where the unit has been erosionally removed. This occurs in outcrop on the crest of the Ocala Platform and in the subsurface on the Sanford High, a limited area in central Florida and a relatively large area in southernmost Florida (Miller, 1986). Chen (1965) suggests that the Ocala Limestone is also absent in a portion of Palm Beach County in eastern southern Florida. The surface and thickness of the Ocala Limestone are highly irregular due to dissolution of the limestones as karst topography developed.

Oligocene Series

The carbonate sediments of the Oligocene Series form much of the upper portion of the Floridan aquifer system in Florida. The depositional pattern of the Oligocene sediments shows that carbonate sediments were deposited well updip to the north of the Florida Platform (Miller, 1986). In the central panhandle and to the west, siliciclastic sediments began to be mixed with the carbonates.

The Oligocene sediments in peninsular Florida and part of the panhandle are characteristically assigned to the Suwannee Limestone. The Oligocene sediments in the central and western panhandle are placed in the Marianna, Bucatunna and Chickasawhay Formations (Miller, 1986). In the westernmost panhandle, the lower carbonates of the Suwannee Limestone grade into the siliciclastic Byram Formation (Braunstein et al., 1988).

Suwannee Limestone

The Suwannee Limestone consists primarily of variably vuggy and muddy (carbonate) limestone (grainstone to packstone). The occurrence of a vuggy, porous dolostone is recognized in the type area, the eastern to central panhandle and in southwest Florida. The dolostone often occurs interbedded between limestone beds.

The Suwannee Limestone is absent throughout a large area of the northern and central peninsula probably due to erosion. Scattered outliers of Suwannee Limestone are present within this area. Where it is present, the Suwannee Limestone forms much of the upper portion of the Floridan aquifer system. The reader is referred to Miller (1986) for a map of the occurrence of the Suwannee Limestone in the peninsula.

Marianna Limestone

The Marianna Limestone is a fossiliferous, variably argillaceous limestone (packstone to wackestone) that occurs in the central panhandle. It is laterally equivalent to the lower portion of the Suwannee Limestone. The Marianna Limestone forms a portion of the uppermost Floridan aquifer system in the central panhandle region.

Bucatunna Clay Member of the Byram Formation

The Bucatunna Clay Member is silty to finely sandy clay. Fossils are generally scarce in the Bucatunna (Marsh, 1966). The sand content of the Bucatunna ranges from very minor percentages to as much as 40 percent (Marsh, 1966).

The Bucatunna Clay Member has a limited distribution in the western panhandle. It occurs from the western end of the state eastward to approximately the Okaloosa-Walton County line where it pinches out (Marsh, 1966). The Bucatunna Clay Member provides an effective intra-aquifer confining unit in the middle of the Floridan aquifer system in the western panhandle.

Chickasawhay Formation

Marsh (1966) describes the Chickasawhay Formation as being composed of highly porous limestone and dolomitic limestone. This is often interbedded with porous to compact dolomitic limestone to dolostone. The Chickasawhay Formation grades into the upper Suwannee Limestone eastward. Due to difficulty in separating the Chickasawhay from the Lower Miocene limestones in the western panhandle, both Marsh (1966) and Miller (1986) included thin beds of possible Lower Miocene carbonate in the upper portion of the Chickasawhay Formation. The permeable sediments of the Chickasawhay Formation form part of the upper Floridan in the western panhandle (Wagner, 1982).

Miocene Series

The Miocene Epoch was a time of significant change in the depositional sequence on the Florida Platform and the adjacent Gulf and Atlantic Coastal Plains. During the early part of the Miocene, carbonate sediments continued to be deposited over most of the State. Intermixed with the carbonates were increasing percentages of siliciclastic sediments. By the end of the Early Miocene, the deposition of carbonate sediments was occurring only in southern peninsular Florida. Siliciclastic deposition dominated the Middle Miocene statewide with this trend continuing into the Late Miocene.

The basal Miocene carbonate sediments often form the uppermost portion of the Floridan aquifer system. The remainder of the Miocene sediments form much of the intermediate aquifer system and intermediate confining system. In some instances, these sediments may also be included in the surficial aquifer system.

Unusual depositional conditions existed during the Miocene as is evident from the occurrence of abundant phosphate, palygorskite, opaline cherts and other uncommon minerals plus an abundance of dolomite within the Hawthorn Group (Scott, 1988a). The presence of these minerals may influence ground-water quality in areas where the Miocene sediments are being weathered. Ground-water quality may also be affected where these sediments form the upper portion of the Floridan aquifer system or portions of the intermediate aquifer system.

Current geologic thought holds that in the peninsula the Miocene section is composed of the Hawthorn Group. The Tampa Formation is included as a member in the basal Hawthorn Group. In the panhandle, the Lower Miocene remains the Chattahoochee and St. Marks Formations, the Middle Miocene Alum Bluff Group and the Upper Miocene Choctawhatchee Formation and equivalents. Formations previously mentioned in the literature as being Miocene in age include the Tamiami, which is Pliocene in age, and the Miccosukee Formation which is now recognized as being Late Pliocene to possibly early Pleistocene in age.

The Miocene sediments are absent from the Ocala Platform and the Sanford High (Scott, 1988a). These sediments are as much as 800 feet thick in southwest Florida (Miller, 1986; Scott, 1988a), 500 feet thick in the northeastern peninsula (Scott, 1988a) and 900 to 1000 feet thick in the westernmost panhandle (Miller, 1986).

Chattahoochee Formation

The Chattahoochee Formation is predominantly a fine-grained, often fossiliferous, silty to sandy dolostone which is variable to a limestone (Huddlestun, 1988). Fine-grained sand and silt may also form beds with various admixtures of dolomite and clay minerals. Clay beds may also be common in some areas (Puri and Vernon, 1964).

The Chattahoochee Formation occurs in a limited area of the central panhandle from the axis of the Gulf Trough westward. It appears that the Chattahoochee grades to the west into a carbonate unit alternately referred to as Tampa Limestone (Marsh, 1966; Miller, 1986) or St. Marks (Puri and Vernon, 1964; NWFWMD Staff, 1975). Northward into Georgia, this unit grades

into the basal Hawthorn Group (Huddlestun, 1988). To the east of the axis of the Gulf Trough, the Chattahoochee Formation grades into the St. Marks Formation (Puri and Vernon, 1964; Scott, 1986). The gradational change between the Chattahoochee and St. Marks Formations occurs over a broad area of Leon and Gadsden Counties (Scott, 1986). The sediments of the Chattahoochee Formation comprise the upper zone of the Floridan aquifer system in the central panhandle.

St. Marks Formation

The St. Marks Formation is a fossiliferous limestone (packstone to wackestone). Sand grains occur scattered in an often very moldic limestone. The lithology of the St. Marks and the associated units in the Apalachicola Embayment and to the west are often difficult to separate (Schmidt, 1984). The St. Marks Formation lithology can be traced in cores grading into the Chattahoochee Formation (Scott, 1986). This formation forms the upper part of the Floridan aquifer system in portions of the eastern and central panhandle.

Hawthorn Group

The Hawthorn Group is a complex series of the phosphate-bearing Miocene sediments in peninsular and eastern panhandle Florida. The carbonate sediments of the Hawthorn Group are primarily fine-grained and contain varying admixtures of clay, silt, sand and phosphate. Dolostone is the dominant carbonate sediment type in the northern two-thirds of the peninsula while limestone predominates in the southern peninsula and in the eastern panhandle area.

The siliciclastic sediment component consists of fine- to coarse-grained quartz sand, quartz silt and clay minerals in widely varying proportions. The clay minerals present include palygorskite, smectite and illite with kaolinite occurring in the weathered sediments.

The top of the Hawthorn Group is a highly irregular erosional and karstic surface. This unconformable surface can exhibit dramatic local relief especially in outcrop along the flanks of the Ocala Platform. **Figures 12 through 19** show the top and thickness of the Hawthorn Group sediments which comprise the intermediate aquifer system/confining unit.

In the peninsula, the Hawthorn Group can be broken into a northern section and a southern section. The northern section consists of interbedded phosphatic carbonates and siliciclastics with a trend of increasing siliciclastics in the younger sediments. In ascending order, the formations in northern Florida are the Penney Farms, Marks Head and Coosawhatchee and its lateral equivalent Statenville (Scott, 1988a). The sediments comprising these formations characteristically have low permeabilities and form an effective aquiclude, the intermediate confining unit. In a few areas, permeabilities within the Hawthorn sediments are locally high enough to allow the limited development of an intermediate aquifer system.

The southern section consists of a lower dominantly phosphatic carbonate section and an upper phosphatic siliciclastic section. In the southern area, in addition to increasing siliciclastics upsection, there is also a trend of increasing siliciclastics from west to east in the lower carbonate section. The Hawthorn Group in southern Florida has been subdivided into, in ascending order: the Arcadia Formation with the former Tampa Formation as a basal member; and the Peace River Formation (Scott, 1988a). Throughout much of south Florida these sediments have limited or low permeabilities and form an effective intermediate confining unit. However, where the Tampa Member is present and permeable enough, it may form the upper portion of the Floridan aquifer system. In portions of southwestern Florida the Hawthorn sediments are permeable enough to form several important producing zones in the intermediate aquifer system (Knapp et al.l 1986; Smith and Adams 1988).

The Hawthorn Group, Torreya Formation sediments in the eastern panhandle are predominantly siliciclastics with limited amounts of carbonates (Scott) 1988a). In this area, carbonates become increasingly important in the Gulf Trough where the basal Hawthorn sediments are fine-grained carbonates. The siliciclastic sediments are very clayey and form an effective intermediate confining unit. The carbonate sediments may locally be permeable enough to form the upper portion of the Floridan aquifer system.

Bruce Creek Limestone

Huddlestun (1976) applied the name Bruce Creek Limestone to late Middle Miocene limestones occurring in the Apalachicola Embayment and coastal areas of the central and western panhandle. The Bruce Creek Limestone is a fossiliferous variably sandy limestone (Schmidt, 1984). This lithology becomes indistinguishable, to the east, from lithologies found in the St. Marks Formation (Schmidt, 1984). The Bruce Creek Limestone is laterally equivalent to and grades into the lower portion of the Alum Bluff Group (Schmidt, 1984). The Bruce Creek Limestone forms part of the upper Floridan aquifer system in the central and western panhandle.

Alum Bluff Group

West of the Apalachicola River in the Florida panhandle, the Hawthorn Group is replaced by the Alum Bluff Group. The Alum Bluff Group includes the Chipola Formation, Oak Grove Sand, Shoal River Formation and the Choctawhatchee Formation (Braunstein et al.l 1988). The formations included in this group are generally defined on the basis of their molluskan faunas and are of variable area, extents. These sediments can be distinguished as a lithologic entity at the group level and will be referred to as such in this text.

The Alum Bluff Group consists of clays, sands and shell beds which may vary from a fossiliferous, sandy clay to a pure sand or clay and occasional carbonate beds or lenses. The Jackson Bluff Formation is currently thought to be Late Pliocene in age; and, even though Huddlestun (1976) included it in the Alum Bluff Group, it was not included in the Alum Bluff Group on the latest correlation charts (Braunstein et al.l 1988). Sediments comprising the Jackson Bluff Formation are very similar to those making up the Alum Bluff Group.

The sediments comprising the Alum Bluff Group are generally impermeable due to the abundance of clay-sized particles. These sediments form an important part of the intermediate confining unit in the central panhandle.

Pensacola Clay

The Pensacola Clay consists of three members: lower and upper clay members and a middle sand member; the Escambia Sand (Marsh, 1966). Lithologically, the clay members consist of silty, sandy clays with carbonized plant remains (Marsh, 1966). The sand member is fine to coarse, quartz sand. Marine fossils are rarely present in the Pensacola Clay with the exception of a fossiliferous layer near the base (Clark and Schmidt, 1982). The Pensacola Clay grades laterally into the lower portion of the (Miocene Coarse Clastics) to the north and the Alum Bluff Group and the lower Intracoastal Formation to the east (Clark and Schmidt, 1982).

The Pensacola Clay forms the intermediate confining unit for the Floridan in the western panhandle. It lies immediately supradjacent to the limestones of the upper Floridan aquifer system.

Intracoastal Formation

Schmidt (1984) describes the Intracoastal Formation as a very sandy, highly microfossiliferous, poorly consolidated, argillaceous, calcarenitic limestone." Phosphate is generally present in amounts greater than one percent. This unit is laterally gradational with the Pensacola Clay and Mio-Pliocene "Coarse Clastics" (Schmidt, 1984). The lower Intracoastal Formation is Middle Miocene while the upper portion is Late Pliocene. Wagner (1982) indicates that the Intracoastal Formation forms part of the intermediate confining unit in the central to western panhandle.

Pliocene-Pleistocene Series

The sediments of the Pliocene-Pleistocene Series occur over most of the State. These sediments range from nonfossiliferous, clean sands to very fossiliferous, sandy clays and carbonates.

Lithologic units comprising this series include the 'Coarse Clastics, Tamiami Formation Citronelle Formation, Miccosukee Formation Cypresshead Formation, Nashua Formation, Caloosahatchee formation, Fort Thompson Formation, Key Largo Limestone, Miami Limestone, Anastasia Formation and Undifferentiated Pleistocene-Holocene sediments. The upper portion of the Intracoastal Formation is Pliocene and is discussed with the lower Intracoastal Formation under the Miocene Series.

"Coarse Clastics"

The name "Coarse Clastics" has been applied to sequences of quartz sands and gravels in a number of areas around Florida. These sediments are often referred to in the literature as "Miocene Coarse Clastics" (for example) Puri and Vernon 1964)

In northern Florida, these sediments are referred to as the Cypresshead Formation of Late Pliocene to Early Pleistocene age (Scott, 1988b). In southern Florida Knapp et al. (1986) referred to these sediments as the (Miocene Coarse Clastics) and placed them in the Hawthorn Group. In the panhandle, Marsh (1966) mentions the"Miocene Coarse Clastics" as sands and gravel with some clay which underlie the Citronelle Formation.

In the panhandle, the "Coarse Clastics" are variably clayey sands with gravel and some shell material (Clark and Schmidt, 1982). These siliciclastics occur in Escambia, Santa Rosa and western Okaloosa Counties in the western panhandle. They equate in part to the upper part of the Pensacola Clay, part of the Intracoastal Formation and part of the Alum Bluff Group.

In southern peninsular Florida the coarse siliciclastics are fine to very coarse quartz sands with quartz gravel and variable amounts of clay, carbonate and phosphate. These sediments may equate with the Cypresshead Formation sediments in central and northern Florida.

These siliciclastic sediments form important aquifer systems in portions of southern and panhandle Florida. In the western panhandle, the "Coarse Clastics" form a portion of the Sand-and-Gravel aquifer, part of the surficial aquifer system. These sediments also comprise a portion of the surficial aquifer system in the peninsular area, especially in southern Florida.

Tamiami Formation

The Tamiami Formation consists of the Pinecrest Sand Member; the Ochopee Limestone Member; and the Buckingham Limestone Member (Hunter, 1968). The various facies of the Tamiami occur over a wide area of southern Florida. The relationships of the facies are not well known due to: 1- the complex set of depositional environments that were involved in the formation of the sediments and 2- the Tamiami Formation most often occurs as a shallow subsurface unit throughout much of its extent. Many of the facies are important from a hydrogeologic perspective in an area of ground-water problems.

The limestone in the Tamiami Formation occurs as two types: 1- a moderately to well- indurated, slightly phosphatic, variably sandy, fossiliferous limestone (Ochopee) and 2- a poorly indurated to unindurated, slightly phosphatic, variably sandy, fossiliferous limestone (Buckingham). The sand facies is often composed of a variably phosphatic and sandy, fossiliferous, calcareous, quartz sand often containing abundant, well-preserved mollusk shells (Pinecrest). The sand varies from a well-sorted, clean sand with abundant well-preserved shells and traces of silt- sized phosphate in the type Pinecrest Sand Member (Hunter, 1968) to a clayey sand with sand-sized phosphate, clay-sized carbonate in the matrix and abundant, well preserved mollusk shells. Siliciclastic sediments (undifferentiated) of this age appear to occur along the eastern side of the peninsula but have not been assigned to the Tamiami Formation.

Sediments of the Tamiami Formation exhibit variable permeabilities and form the lower Tamiami aquifer and Tamiami confining beds of the surficial aquifer system (Knapp et al., 1986). Smith and Adams (1988) indicate that the upper Tamiami sediments form the basal portion of the water table aquifer overlying the Tamiami confining beds.

Citronelle Formation

The Citronelle Formation is composed of fine to very coarse siliciclastics. The name was extended to include the siliciclastics comprising the central ridge system in the Florida peninsula by Cooke (1945). As it is currently recognized, the Citronelle Formation occurs only in the panhandle. The unit is recognized from central Gadsden County on the east to the western boundary of the State. The Citronelle Formation is composed of very fine to very coarse, poorly sorted, angular to subangular quartz sand. The unit contains significant amounts of clay, silt and gravel which may occur as beds, lenses or stringers and may vary rapidly over short distances. Limonite nodules and limonitic cemented zones are common .

The Citronelle Formation extends over much of the central and western panhandle. Previous investigators encountered problems in the separation of the Citronelle and the overlying terrace deposits and generally considered the thickness of the Citronelle including these younger sediments (Marsh, 1966; Coe, 1979). The Citronelle Formation grades laterally into the Miccosukee Formation through a broad transition zone in Gadsden County. The Citronelle Formation forms an important part of the Sand-and-Gravel aquifer in the western panhandle and produces up to 2,000 gallons of water per minute (Wagner, 1982).

Miccosukee Formation

Hendry and Yon (1967) describe the Miccosukee Formation as consisting of interbedded and cross-bedded clay, silt, sand and gravel of varying coarseness and admixtures. Limonite pebbles are common in the unit. The Miccosukee Formation occurs in the eastern panhandle from central Gadsden County on the west to eastern Madison County on the east. Due to its clayey naturel the Miccosukee Formation does not produce significant amounts of water. It is generally considered to be part of the surficial aquifer system (Southeastern Geological Society 1986) .

Cypresshead Formation

The name Cypresshead Formation was first used by Huddlestun (1988). It was extended into Florida by Scott (1988b). The Cypresshead Formation is composed entirely of siliciclastics; predominantly quartz and clay minerals. The unit is characteristically a mottled, fine- to coarse-grained, often gravelly, variably clayey quartz sand. As a result of weathering, the clay component of these sediments has characteristically been altered to kaolinite. Clay serves as a binding matrix for the sands and gravels. Clay content may vary from absent to more than fifty percent in sandy clay lithologies although the average clay content is 10 to 20 percent. These sediments are often thinly bedded with zones of cross bedding. The Cypresshead Formation appears to occur in the Central Highlands of the peninsula south to northern Highlands County, although the extent of the Cypresshead Formation has not been accurately mapped in this area. This unit may locally comprise the surficial aquifer system where clay content is low.

Nashua Formation

The Nashua is a fossiliferous, variably calcareous, sometimes clayey, quartz sand. The fossil content is variable from a shelly sand to a shell hash. The dominant fossils are mollusks.

The extent of the Nashua in northern Florida is not currently known. It extends some distance into Georgia and appears to grade laterally into the Cypresshead Formation (Huddlestun, 1988). The Nashua Formation may produce limited amounts of water in localized areas where it forms part of the surficial aquifer system.

Caloosahatchee Formation

The Caloosahatchee Formation consists of fossiliferous quartz sand with variable amounts of carbonate matrix interbedded with variably sandy, shelly limestones. The sediments vary from non-indurated to well indurated. The fauna associated with these sediments are varied and often well preserved. Fresh water limestones are commonly present within this unit.

Sediments identified as part of the Caloosahatchee Formation by various investigators occur from north of Tampa on the west coast south to Lee County, eastward to the East Coast then northward into northern Florida (DuBar, 1974). The Caloosahatchee Formation as used here includes those sediments informally referred to as the Bermont Formation (DuBar 1974).

In most hydrogeologic investigations of southern Florida the Caloosahatchee Formation is not differentiated from the Fort Thompson Formation and other faunal units. The undifferentiated sediments form much of the surficial aquifer system.

Fort Thompson Formation

The Fort Thompson Formation consists of interbedded shell beds and limestones. The shell beds are characteristically variably sandy and slightly indurated to unindurated. The sandy limestones present in the Fort Thompson Formation were deposited under both freshwater and marine conditions. The sand present in these sediments is fine- to medium-grained. The sediments of Fort Thompson age in central Florida along the east coast, consist of fine to medium quartz sand with abundant mollusk shells and a minor but variable clay content.

The Fort Thompson Formation, as the Caloosahatchee Formation, is part of the undifferentiated sediments in southern Florida. It forms a portion of the surficial aquifer system.

Key Largo Limestone

The Key Largo Limestone is a coralline limestone composed of coral heads encased in a matrix of calcarenite (Stanley, 1966). Hoffmeister and Multer (1968) indicate that the Key Largo Limestone occurs in the subsurface from as far north as Miami Beach to as far south as the Lower Keys. The fossil reef tract represented by the Key Largo sediments may be as much as 8 miles wide (DuBar, 1974). Near the northern and southern limits of the Key Largo Limestone, it is overlain conformably by the Miami Limestone with which the Key Largo is, in part, laterally equivalent.

The Key Largo Limestone forms a part of the Biscayne aquifer of the surficial aquifer system. The Biscayne aquifer provides water for areas of Dade, Broward and Monroe Counties.

Miami Limestone

The Miami Limestone includes an oolitic facies and a bryozoan facies. The bryozoan facies underlies and extends west of the western boundary of the oolitic facies. The bryozoan facies consists of calcareous bryozoan colonies imbedded in a matrix of ooids, pellets and skeletal sand. It generally occurs as a variably sandy, recrystallized, fossiliferous limestone (Hoffmeister et al.l 1967). The oolitic facies consists of variably sandy limestone composed primarily of oolites with scattered concentrations of fossils.

Hoffmeister et al. (1967) indicate that the Miami Limestone covers Dade County, much of Monroe County and the southern part of Broward County. It grades laterally to the south into the Key Largo Limestone and to the north into the Anastasia Formation. The oolitic facies underlies the Atlantic Coastal Ridge southward from southern Palm Beach County to southern Dade County.

The Miami Limestone forms a portion of the Biscayne aquifer of the surficial aquifer system. It is very porous and permeable due to the dissolution of carbonate by ground water as it recharges the aquifer system.

Anastasia Formation

The Anastasia Formation consists of interbedded quartz sands and coquinoid limestones. The sand beds consist of fine to medium- grained, variably fossiliferous, calcareous, quartz sand. The contained fossils are primarily broken and abraided mollusk shells. The limestone beds, commonly called coquina, are composed of shell fragments, scattered whole shells and quartz sand enclosed in a calcareous matrix, usually sparry calcite cement.

The Anastasia Formation forms the Atlantic Coastal Ridge through most of its length (White, 1970). Natural exposures of this unit occur scattered along the east coast from St. Augustine south to southern Palm Beach County near Boca Raton. South of this area the Anastasia Formation grades into the Miami Limestone. Cooke (1945) felt that the Anastasia Formation extended no more than three miles inland from the Intracoastal Waterway. Field work by this author (Scott) suggests that the Anastasia may extend as much as 10 miles inland; although, Schroeder (1954) suggests that this unit may occur more than 20 miles inland.

The Anastasia Formation forms a portion of the surficial aquifer system along the eastern coast of the state. Ground water is withdrawn from the Anastasia Formation in many areas along the Atlantic Coastal Ridge where, locally, it may be the major source of ground water. Near the southern extent of the Anastasia Formation, it forms a portion of the Biscayne aquifer (Hoffmeister, 1974).

Undifferentiated Pleistocene-Holocene Sediments

The sediments referred to as the undifferentiated Pleistocene-Holocene sediments" cover much of Florida effectively hiding most older sediments. Included in this category are marine "terrace" sediments, eolian sand dunes, fluvial deposits, fresh water carbonates, peats and a wide variety of sediment mixtures. These sediments often occur as thin layers overlying older formations and are not definable as formations. As such, these sediments have been referred to by many different names including Pliocene to Recent sands, Pleistocene sands, Pleistocene Terrace Deposits.

The sediments incorporated in this category are most often quartz sands. The sands range from fine- to coarse-grained, nonindurated to poorly indurated and nonclayey to slightly clayey. Gravel may be present in these sediments in the panhandle area. Other sediments included in this group include peat deposits, some clay beds, and freshwater carbonates. The freshwater carbonates occur in many freshwater springs and in large areas of the Everglades.

Locally, these sediments may form a portion of the surficial aquifer system. The greatest thicknesses of these sediments occurs infilling paleokarst features where more than 300 feet of undifferentiated Pleistocene-Holocene sediments have been recorded (Florida Geological Survey, unpublished well data).

HYDROSTRATIGRAPHY

The hydrostratigraphy of the Florida Platform has been the focus of numerous investigations by the various water management districts, the USGS and the FGS. The hydrostratigraphic framework recognized in Florida consists of a thick sequence of Cenozoic sediments which comprise the Floridan aquifer system, the intermediate aquifer system/confining unit and the surficial aquifer system **(Figure 4)** (Southeastern Geological Society Ad Hoc Committee, 1986). The Floridan aquifer system underlies much of the State, providing abundant potable water for a rapidly expanding population **(Figure 20)**. In limited areas throughout the State, the intermediate aquifer system is utilized. Water is also withdrawn from the surficial aquifer system in many areas particularly in the western panhandle and southern Florida. As an example, **Figure 21** illustrates the extent and occurrence of ground-water systems in the NWFWMD area of the panhandle.

The hydrologic parameters of each aquifer system vary widely from one area of the state to another as do the lithologies of the sediments. Hydrologic subdivisions do not have to conform to the lithostratigraphic framework.

Each water management district has identified surface-water basins and ground- water areas. The surface-water basins **(Figures 22 through 26)** delineate the areas influenced by the tributaries of the major drainage features. The ground-water areas **(Figures 27 through 31)** were delineated as convenient study areas. Maps representing the potentiometric surface of the Floridan aquifer system were constructed for each district **(Figures 32 through 36)**.

Surficial aquifer system

The surficial aquifer system is defined by the Southeastern Geological Society (SEGS) Ad Hoc Committee on Florida Hydro-stratigraphic Unit Definition (1986) as "the permeable hydrologic unit contiguous with the land surface that is comprised principally of unconsolidated to poorly indurated, siliciclastic deposits. It also includes well-indurated carbonate rocks, other than those of the Floridan aquifer system where the Floridan is at or near land surface. Rocks making up the surficial aquifer system belong to all or part of the Upper Miocene to Holocene Series. It contains the water table, and the water within it is under mainly unconfined conditions; but beds of low permeability may cause semi- confined or locally confined conditions to prevail in its deeper parts. The lower limit of the surficial aquifer system coincides with the top of the laterally extensive and vertically persistent beds of much lower permeability".

Some areas of the state rely heavily upon the surficial aquifer system for potable water in areas where the water quality of the Floridan aquifer system is poor. The two main aquifers of the surficial aquifer system to which names have been applied are the Sand and Gravel Aquifer of northwestern panhandle Florida and the Biscayne Aquifer in southeastern Florida. The distribution of these aquifers is limited **(Figure 20)**. Maps delineating the thickness of the surficial aquifer system were provided by the Northwest Florida Water Management District (NWFWMD) **(Figure 37)** and the Southwest Florida Water Management District (SWFWMD) **(Figure 38)**. The South Florida Water Management District provided a map of the base of the surficial aquifer system **(Figure 39)**. Figure 40 depicts those areas of the SJRWMD where the surficial aquifer system is a primary groundwater supplier.

The surficial aquifer system is composed of Pliocene to Holocene quartz sands, shell beds and carbonates **(Figure 4)**. In the Florida panhandle, these units include the Citronelle and Miccosukee Formations and undifferentiated sediments. In the northern portion of the peninsula, sediments belonging to the Anastasia Formation, Cypresshead Formation and Undifferentiated Sediments, which include shell beds and limestones that are time equivalent to the Caloosahatchee and Fort Thompson Formations, comprise the surficial aquifer system. In southern Florida, the surficial aquifer system consists of the Tamiami, Caloosahatchee, Fort Thompson, and Anastasia Formations, the Key Largo and Miami Limestones and the undifferentiated sediments. Following the definition of the Tamiami as proposed by Hunter and Wise (1980), the portion of the Tamiami previously considered to be the lower Tamiami confining unit now forms the upper part of the Hawthorn Group of the intermediate confining unit. Where a clay bed separates the upper and lower limestones of the Tamiami, as in Hendry County (Smith and Adams, 1988), the clay bed is recognized as a thin confining unit within the surficial aquifer system.

Intermediate aquifer system/confining unit

The SEGS (1986) defines the intermediate aquifer system/confining unit as "all rocks that lie between and collectively retard the exchange of water between the overlying surficial aquifer system and the underlying Floridan aquifer system. These rocks in general consist of fine-grained siliciclastic deposits interlayered with carbonate strata belonging to all or parts of the Miocene and younger series. In places, poorly-yielding to non-water-yielding strata mainly occur and there the term "intermediate confining unit" applies. In other places, one or more low- to moderate-yielding aquifers may be interlayered with relatively impermeable confining beds; there the term "intermediate aquifer system" applies. The aquifers within this system contain water under confined conditions.

The top of the intermediate aquifer system/confining unit "coincides with the base of the surficial aquifer system. The base of the intermediate aquifer or confining unit, is at the top of the vertically persistent, permeable, carbonate section that comprises the Floridan aquifer system, or, in other words, that place in the section where siliciclastic layers of significant thickness are absent and permeable carbonate rocks are dominant. Where the upper layers of the persistent carbonate section are of low permeability, they are part of either the intermediate aquifer system or intermediate confining unit, as applicable to the area."

The sediments comprising the intermediate aquifer system/confining unit exhibit wide variability over the state. In the central and western panhandle, this section acts principally as an intermediate confining unit for the Floridan aquifer system. The formations belonging to the intermediate confining unit include the Alum Bluff Group, Pensacola Clay, Intracoastal Formation, and the Chipola Formation (SEGS, 1986). In the eastern panhandle, the confining unit includes primarily the Hawthorn Group sediments. **Figures 41 and 42** show the top and thickness of the intermediate confining unit in the NWFWMD area while **Figures 12 and 13** show the top and thickness of the Hawthorn Group sediments in the eastern part of the District. In the northern peninsula, the Hawthorn Group sediments form the intermediate confining unit with minor occurrences of aquifer zones **(Figures 14 through 17)**. In the southern peninsula, the Hawthorn Group sediments form both an intermediate confining unit and an intermediate aquifer system. The top and thickness of the intermediate aquifer system/confining unit in the SWFWMD area is shown in **Figures 43 and 44**. The top and isopach of the Hawthorn Group sediments in southern Florida (SWFWMD and SFWMD) are shown on **Figures 18 and 19**. In many areas of the state, impermeable carbonates of Eocene and Oligocene age may form the base of the intermediate confining unit. Conversely, permeable carbonates occurring at the base of the Hawthorn Group may be hydraulically connected to the Floridan aquifer system and locally form the top of the Floridan.

The intermediate aquifer system plays a very important role in the ground-water resources of southwestern peninsular Florida. In the Lee County and surrounding areas, the intermediate aquifer system provides relatively large quantities of potable water. The Hawthorn Group may contain two producing zones (Wedderburn et al., 1982) referred to as the mid-Hawthorn aquifer and the sandstone aquifer. **Figure 45** illustrates the top of the mid-Hawthorn confining zone in Lee County. **Figure 46** delineates the base of the sandstone aquifer while **Figure 47** shows the top of the mid-Hawthorn aquifer.

The intermediate confining unit occurs widespread in the state providing an effective aquiclude for the Floridan aquifer system. On the crests of the Ocala Platform, Sanford High, St. Johns Platform, Brevard Platform and the Chattahoochee Anticline (Figure 4) these beds are absent due to erosion. In these areas, surface water has a direct avenue to recharge the Floridan aquifer system. Immediately surrounding these areas, the intermediate confining unit is present but is breached by karst features which also allow surface water and water from the surficial and intermediate aquifer systems direct access to the Floridan. In the west-central portion of the peninsula and along the west coast from Hillsborough County into the eastern panhandle, the intermediate confining unit is generally absent and the Floridan aquifer system occurs unconfined. In the east-central peninsula, the intermediate confining unit is thin and provides only limited confinement for the underlying Floridan aquifer system. Miller (1986) mapped a maximum thickness of the intermediate confining unit as being greater than 1000 feet thick in the western-most panhandle and in southwestern Florida.

Floridan aquifer system

The Floridan aquifer system is one of the world's most productive aquifers. The sediments that comprise the aquifer system underlie the entire state although potable water is not present everywhere (Figure 20).

The Floridan aquifer system may occur as a continuous series of vertically connected carbonate sediments or may be separated by sub-regional to regional confining beds (Miller, 1986). Often the confining beds consist of low permeability carbonates. In the western panhandle, the intra-aquifer confining unit is the Bucatunna Clay. Elsewhere, the confining beds are carbonate sediments belonging to the Ocala Limestone, Avon Park Formation or the Oldsmar Formation. When intra~aquifer confining beds are present, the Floridan aquifer system can be subdivided into an upper and lower Floridan. **Figures 48 through 51**

indicate the configuration of the top and the thickness of the upper and lower limestones of the Floridan aquifer system. **Figures 52 and 53** reveal the top and thickness of the Bucatunna Clay, the intra-aquifer confining unit in the western panhandle. **Figure 54** shows the top of the lower Floridan aquifer system in the SJRWMD area.

The Floridan aquifer system in peninsular Florida and the eastern panhandle is composed of all or parts of the Cedar Keys Formation, Oldsmar Formation, Avon Park Formation, Ocala Limestone, Suwannee Limestone, St. Marks Formation and, possibly, the basal carbonates of the Hawthorn Group in limited areas of the state **(Figure 4)**. The Floridan aquifer system encompasses the Ocala Limestone, Marianna Limestone, Suwannee Limestone, Chickasawhay Limestone, Chattahoochee Formation, St. Marks Formation and Bruce Creek Limestone (Figure 4) in the central and western panhandle.

The elevation of the upper surface of the Floridan aquifer system is directly related to the positioning on the major structural features **(Figure 5)**. The top of the Floridan aquifer system ranges in elevation from greater than +100 feet NGVD on the Ocala Platform and Chattahoochee Arch to more than -1400 feet NGVD in the western-most panhandle and more than -1100 feet NGVD in the Okeechobee Basin of southern Florida **(Figures 55 through 59)**. The thickness of the Floridan aquifer system (including those areas where water from the Floridan aquifer system may not be potable) varies from less than 100 feet along the state line in north-central panhandle to more than 3000 feet in the Apalachicola Embayment and 3400 feet in southern peninsular Florida **(Figures 60 through 64)**. The base of the Floridan aquifer system in the NWFWMD area is shown in **Figure 65**.

The degree of confinement of the Floridan aquifer system also varies in relation to the position of the major structural features. The Floridan may be unconfined or semiconfined on the major features including the Ocala Platform and the Chattahoochee Anticline **(Figures 66 through 68)**. In the negative areas such as the Jacksonville Basin, Okeechobee Basin and the Gulf Coast Basin, the Floridan aquifer system is well confined. Many areas of central peninsular Florida and in the eastern panhandle exhibit the development of karst features that breach the confining unit allowing localized recharge to occur. **Figure 69** illustrates the NWFWMD area karst development. Throughout most of southern Florida, particularly the SFWMD area, the Floridan aquifer system occurs under confined conditions. The thickness of the beds confining the Floridan aquifer system in the SWFWMD area is shown in **Figure 70**.

Recharge to the Floridan aquifer system is directly related to the confinement of the system. The highest recharge rates occur where the Floridan is unconfined or poorly confined as in those areas where the Floridan aquifer system is at or near land surface **(Figure 71)**. Recharge may also be high in areas where the confining layers are breached by karst features as shown for the NWFWMD area **(Figure 69)**. **Figures 72 through 76** indicate the relative recharge rates around the state.

The potentiometric surface of the Floridan aquifer system varies widely throughout the state. In localized areas, the potentiometric surface may be affected by intensive pumpage of ground water. **Figures 32 through 36** indicate the elevation of this surface relative to NGVD. In those areas where the potentiometric surface is higher than the ground elevation, artesian conditions occur. **Figures 77 through 82** delineate the areas where artesian flow is expected based on current data.

The intrusion of saline waters into fresh water producing zones is a major concern for Florida's coastal, and some inland, communities. Excessive pumpage of fresh water may draw the saline waters laterally or may cause an upconing of underlying nonpotable water. The salt water that can affect the potable water supply may be connate water trapped during the deposition of the sediments forming the aquifer system. It may represent saline waters that entered the aquifer system during previous high sea level stands which have not been flushed from the aquifer.

The limits of salt water intrusion are shown on **Figures 83 through 86**.

The Claiborne aquifer occurs in a limited area of the central-northern panhandle. It is a permeable portion of the sub-Floridan Confining Unit in that area. It is poorly defined and rarely used at this time (Allen, 1987).

CONCLUSION

This volume presents a review of the current knowledge of the Cenozoic lithostratigraphy and hydrostratigraphy as it relates to ground water in Florida. This publication represents the efforts of the five water management districts, the Department of Environmental Regulation and the Florida Geological Survey, Department of Natural Resources to provide a geologic framework of the state's ground-water resources. Recognition of the geologic framework of the aquifer systems and confining units is imperative for determining and understanding the ambient ground-water quality in Florida. Through recognizing the geologic frame-work, areas that are particularly sensitive to pollution may be defined and proper ground-water management techniques can be applied to protect these resources.

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		PANHANDLE FLORIDA		NORTH FLORIDA		SOUTH FLORIDA	
SYSTEM	SERIES	LITHOSTATIGRAPHIC UNIT	HYDROSTRATI-GRAPHIC UNIT	LITHOSTATIGRAPHIC UNIT	HYDROSTRATI-GRAPHIC UNIT	LITHOSTATIGRAPHIC UNIT	HYDROSTRATI-GRAPHIC UNIT
QUATERNARY	HOLOCENE	UNDIFFERENTIATED PLEISTOCENE-HOLOCENE SEDIMENTS	SURFICIAL AQUIFER SYSTEM	UNDIFFERENTIATED PLEISTOCENE-HOLOCENE SEDIMENTS	SURFICIAL AQUIFER SYSTEM	UNDIFFERENTIATED PLEISTOCENE-HOLOCENE SEDIMENTS	SURFICIAL AQUIFER SYSTEM
	PLEISTOCENE					MIAMI LIMESTONE KEY LARGO LIMESTONE ANASTASIA FORMATION FORT THOMPSON FORMATION	
TERTIARY	PLIOCENE	CITRONELLE FORMATION MICCOSUKEE FORMATION COARSE CLASTICS		MICCOSUKEE FORMATION CYPRESSHEAD FORMATION NASHUA FORMATION		TAMIAMI FORMATION	
	MIOCENE	ALUM BLUFF GROUP PENSACOLA CLAY INTRACOASTAL FORMATION HAWTHORN GROUP BRUCE CREEK LIMESTONE ST. MARKS FORMATION CHATTAHOOCHEE FORMATION	INTERMEDIATE CONFINING UNIT	HAWTHORN GROUP STATENVILLE FORMATION COOSAWHATCHIE FM. MARKSHEAD FORMATION PENNEY FARMS FORMATION ST. MARKS FORMATION	INTERMEDIATE AQUIFER SYSTEM OR CONFINING UNIT	HAWTHORN GROUP PEACE RIVER FORMATION BONE VALLEY MEMBER ARCADIA FORMATION TAMPA-NOCATEE MEMBERS	INTERMEDIATE AQUIFER SYSTEM OR CONFINING UNIT
	OLIGOCENE	CHICKASAWHAY LIMESTONE SUWANNEE LIMESTONE MARIANNA LIMESTONE BUCATUNNA CLAY	FLORIDAN AQUIFER SYSTEM	SUWANNEE LIMESTONE	FLORIDAN AQUIFER SYSTEM	SUWANNEE LIMESTONE	FLORIDAN AQUIFER SYSTEM
	EOCENE	OCALA LIMESTONE CLAIBORNE GROUP UNDIFFERENTIATED SEDIMENTS	SUB-FLORIDAN CONFINING UNIT	OCALA LIMESTONE AVON PARK FORMATION OLDSMAR FORMATION		OCALA LIMESTONE AVON PARK FORMATION OLDSMAR FORMATION	
	PALEOCENE	UNDIFFERENTIATED PALEOCENE ROCKS		CEDAR KEYS FORMATION	SUB-FLORIDAN CONFINING UNIT	CEDAR KEYS FORMATION	SUB-FLORIDAN CONFINING UNIT
CRETACEOUS AND OLDER		UNDIFFERENTIATED		UNDIFFERENTIATED		UNDIFFERENTIATED	

Figure 4. Hydrostratigraphic Nomenclature (modified from Southeastern Geological Society Ad Hoc Committee on Florida Hydorstratigraphic Unit Definition, 1986)

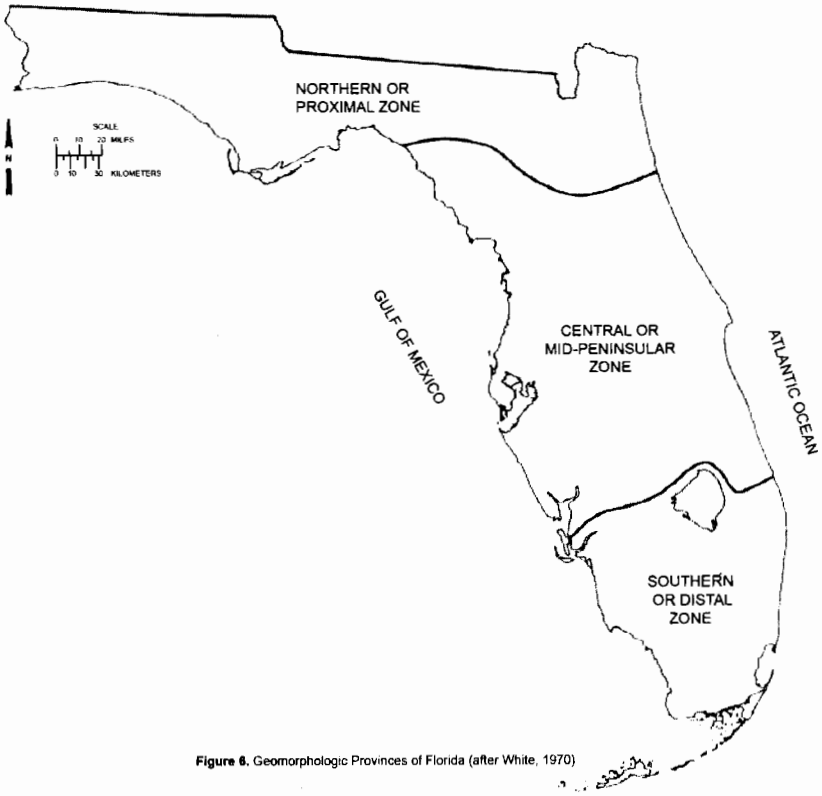


Figure 6. Geomorphologic Provinces of Florida (after White, 1970)

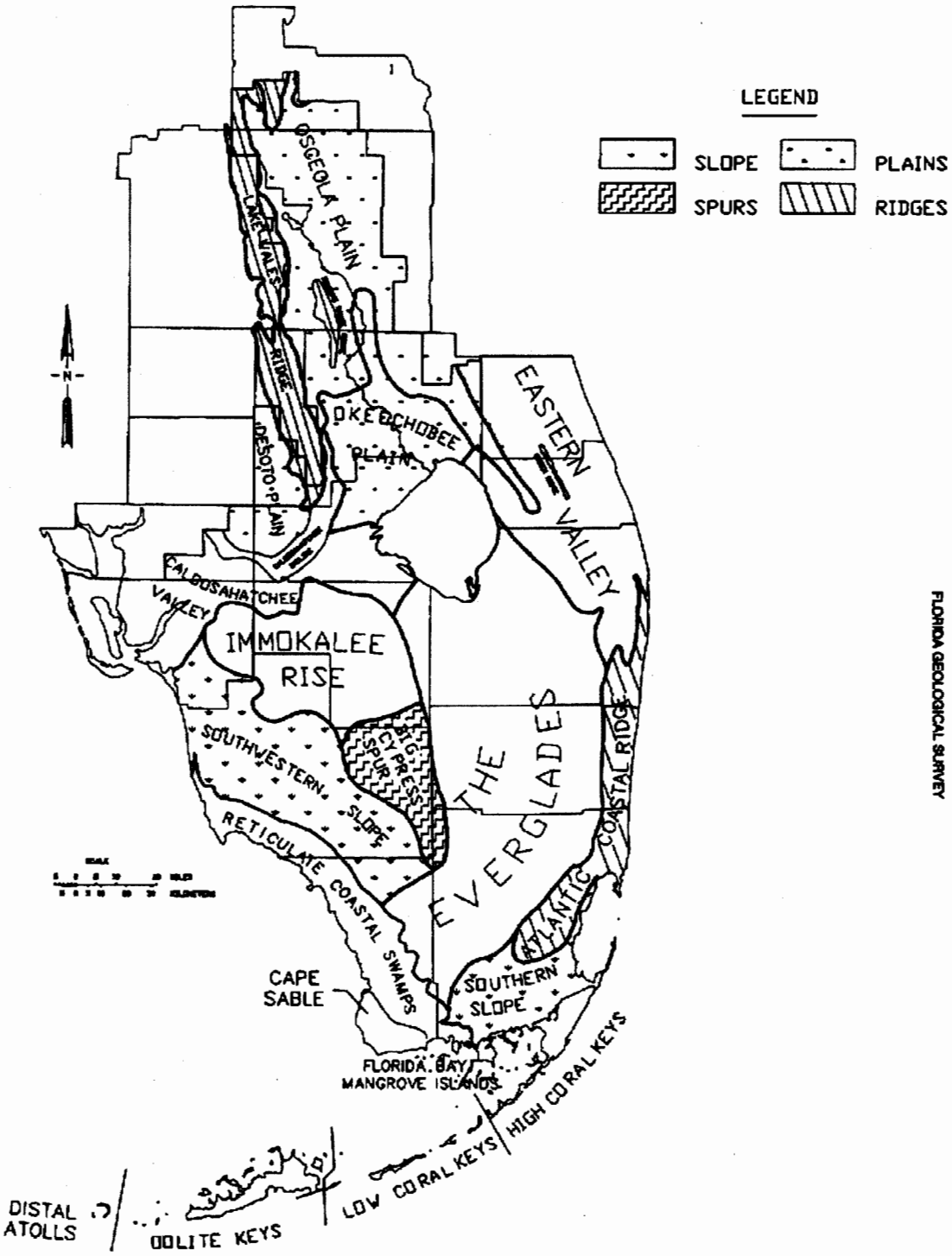


Figure 11. Geomorphologic Features of South Florida Water Management District (SFWMD) (after White, 1970)

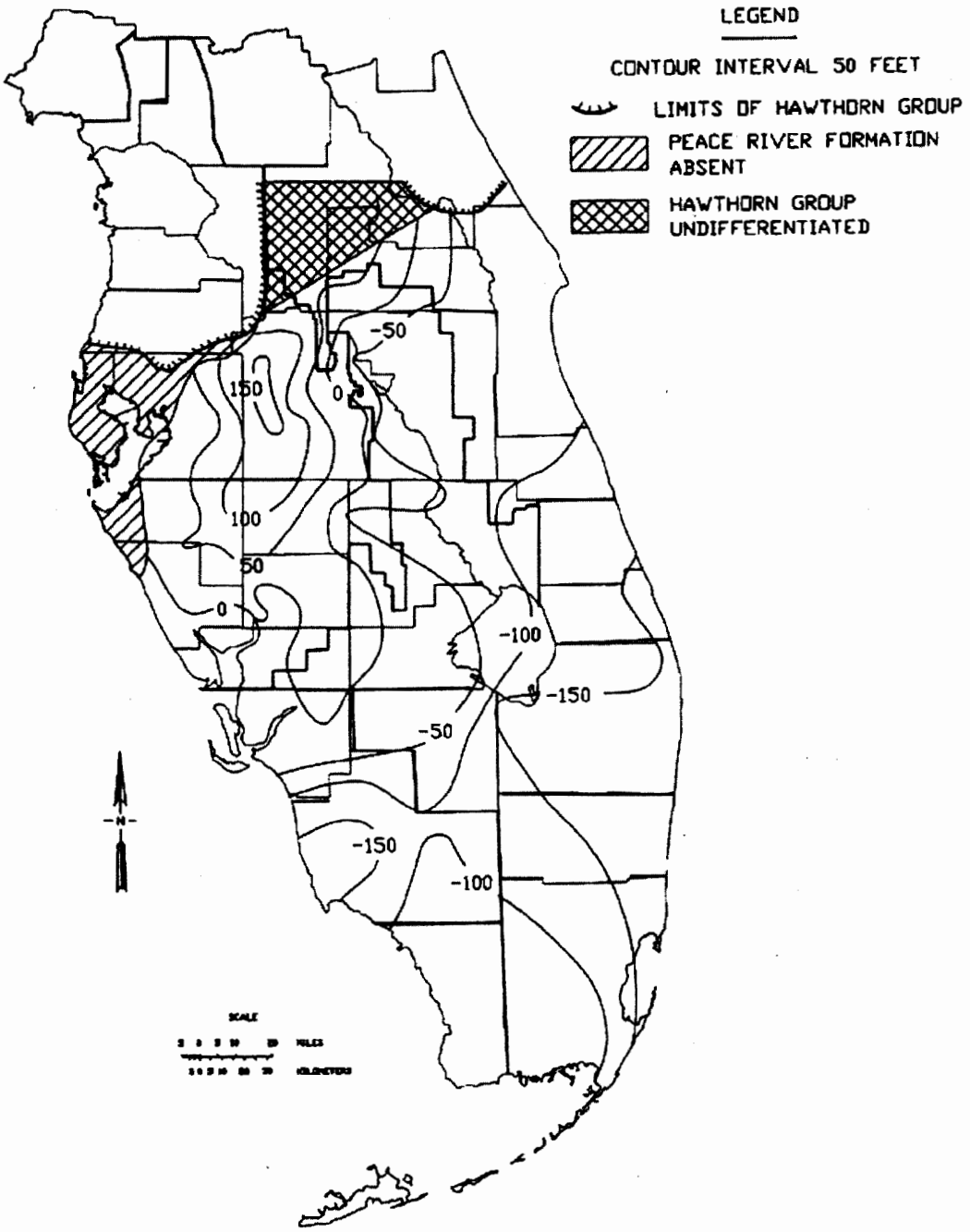


Figure 18. Top of Hawthorn Group, SWFWMD and SFWMD (after Scott, 1988a)

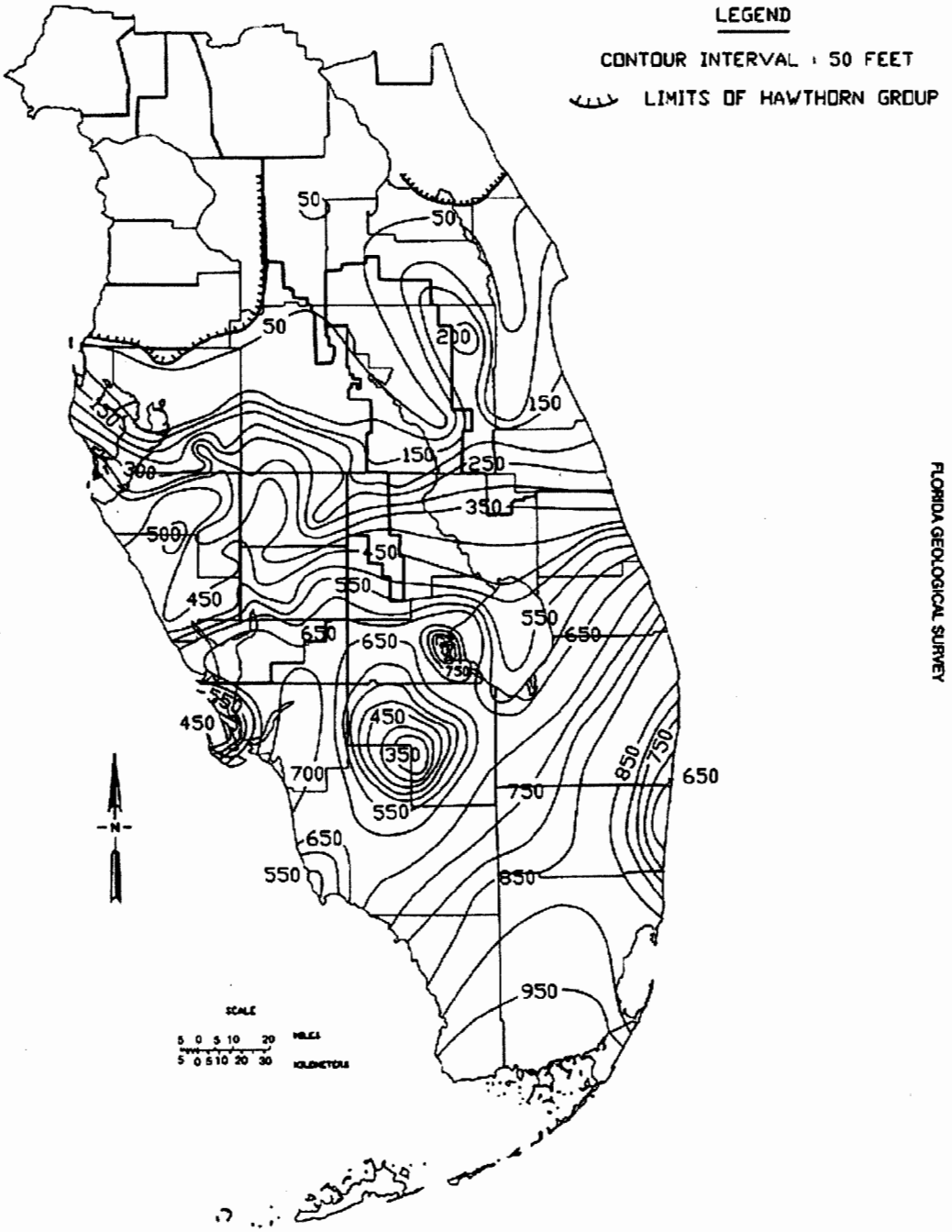


Figure 19. Isopach of Hawthorn Group, SWFWMD and SFWMD (after Scott, 1988a)

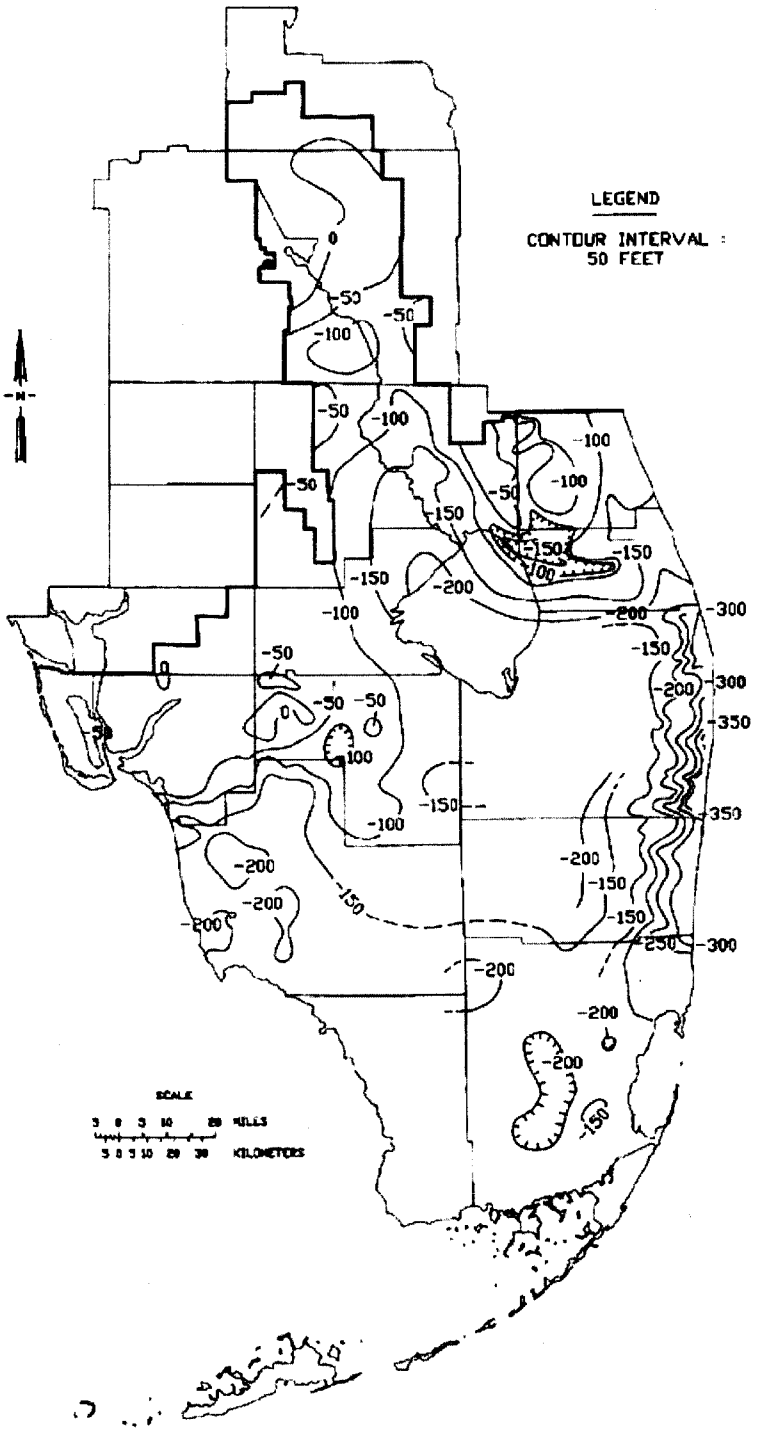


Figure 39. Surficial aquifer system base, SFWMD

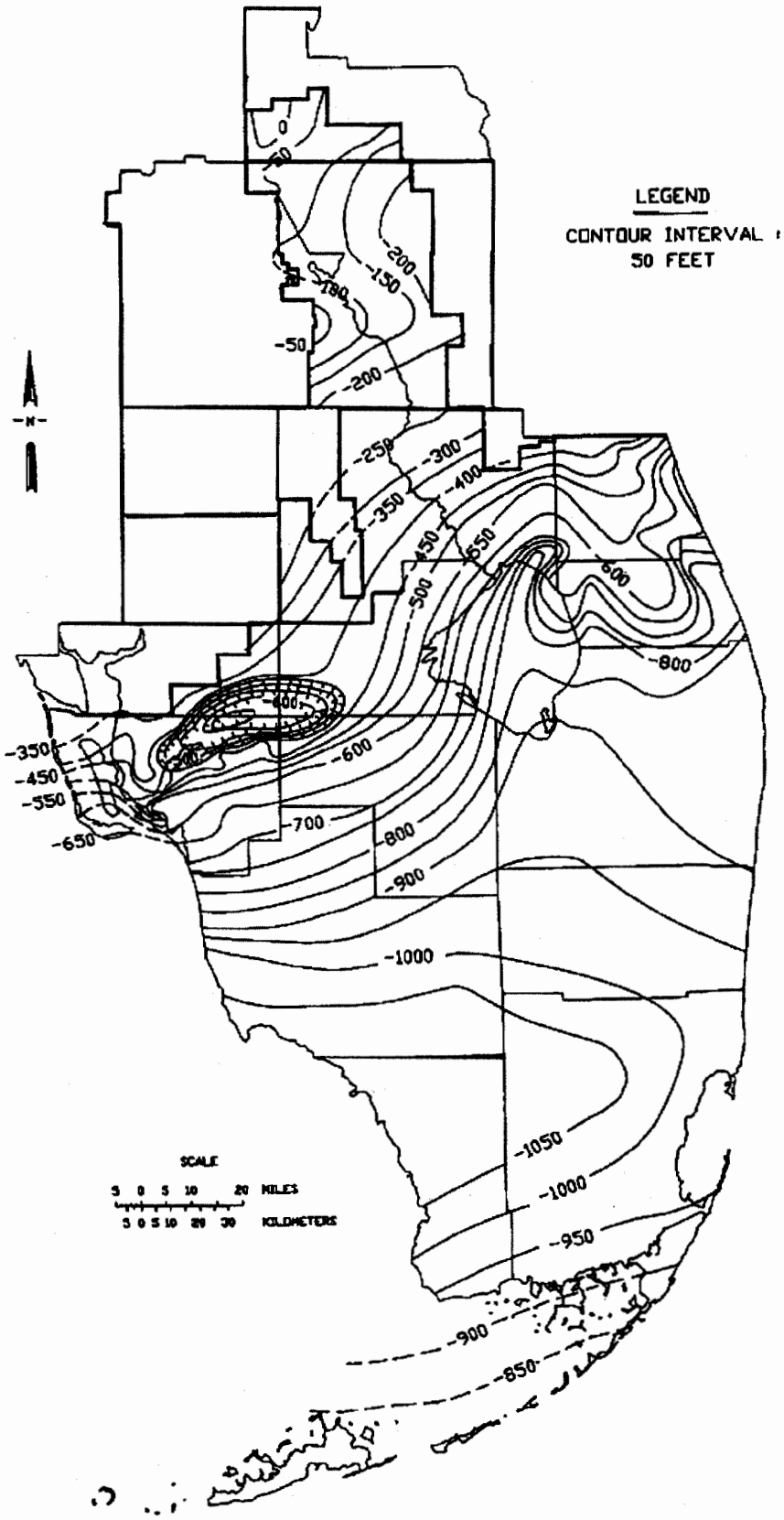
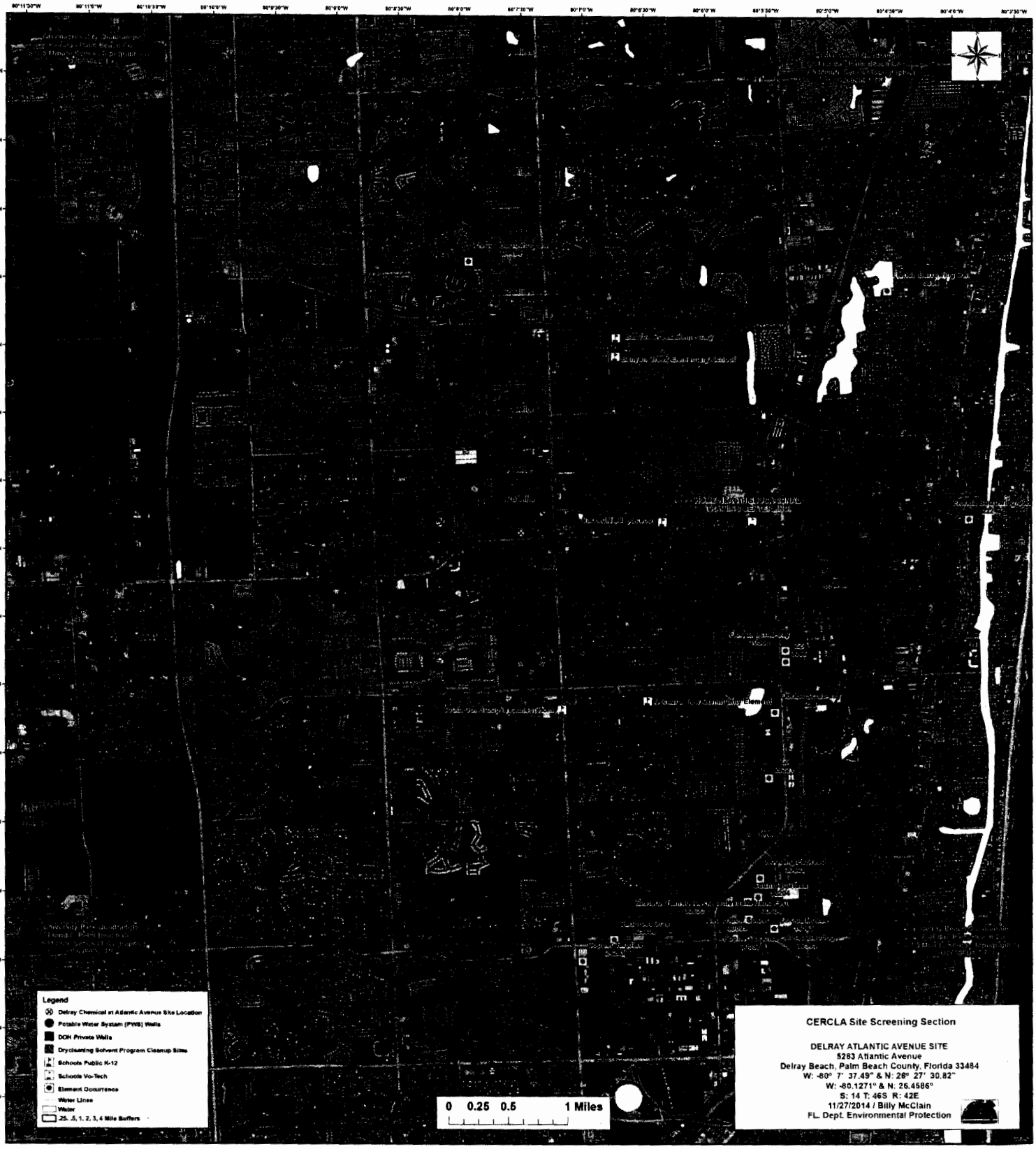


Figure 59. Top of the Floridan aquifer system, SFWMD


Legend
Delray Chemical at Atlantic Avenue Site Location
Potable Water System (PWS) Wells
DOH Private Wells
Drycleaning Solvent Program Cleanup Sites
Schools Public K-12
Schools Vo-Tech
Element Occurrence
Water Lines
Water
.25, .5, 1, 2, 3, 4 Mile Buffers
0 0.25 0.5 1 Miles
CERCLA Site Screening Section
DELRAY ATLANTIC AVENUE SITE
5283 Atlantic Avenue
Delray Beach, Palm Beach County, Florida 33484
W: -80° 7' 37.49" & N: 26° 27' 30.82"
W: -80.1271° & N: 26.4586°
S: 14 T: 46S R: 42E
11/27/2014 / Billy McClain
FL. Dept. Environmental Protection

Toxaphene - ToxFAQs™

CAS # 8001-35-2

This fact sheet answers the most frequently asked health questions (FAQs) about toxaphene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Toxaphene is a pesticide which is currently banned for all uses in the United States. Breathing, eating, or drinking high levels of toxaphene could damage the nervous system, the liver, and kidneys, and even cause death. Toxaphene has been found in at least 68 of the 1,699 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is toxaphene?

Toxaphene is a mixture of hundreds of different chlorinated compounds. It was one of the most heavily used pesticides in the Unites States until 1982, when it was canceled for most uses. All registered uses were banned by 1990. Toxaphene was used primarily in the southern United States to control insect pests on cotton and other crops.

Toxaphene is usually found as a solid or a gas. In its original form, toxaphene is a yellow to amber waxy solid that has a piney odor.

What happens to toxaphene when it enters the environment?

- When released to the environment, it can enter the air, the soil, and the water.
- It does not dissolve well in water and evaporates easily.
- Toxaphene is more likely found in air, soil, and sediment at the bottom of lakes or streams, than in surface water.
- Toxaphene can stay in the environment for a long time because it breaks down very slowly.
- The composition of toxaphene in the environment changes over time because congeners of toxaphene degrade at different rates; such toxaphene is called "weathered toxaphene."
- Toxaphene can be carried long distances in the air.
- Toxaphene accumulates in fatty tissues of fish and mammals.

How might I be exposed to toxaphene?

- People living near a location with heavy toxaphene contamination, such as a hazardous waste site, may be exposed to higher levels through breathing contaminated air or through direct skin contact with contaminated soil or water.
- People who eat large quantities of fish, shellfish, or wild game animals from areas contaminated with toxaphene may have higher exposure to this substance since these animals tend to accumulate toxaphene in fatty tissues.
- Individuals may be exposed to toxaphene through drinking water contaminated with toxaphene runoff from contaminated soils.

How can toxaphene affect my health?

Breathing, eating, or drinking high amounts of toxaphene could damage the nervous system, liver, and kidneys, and even cause death. However, since toxaphene is no longer used in the United States, most people would not be exposed to high levels of it.

Studies showed that animals which ate food or drank water containing toxaphene had effects on the liver, kidneys, and immune system.

It is not known whether toxaphene can affect reproduction in humans.

How likely is toxaphene to cause cancer?

It is not known whether toxaphene would cause cancer in people. Toxaphene caused liver cancer in mice and possible thyroid cancer in rats that were given large amounts of toxaphene by mouth.

Toxaphene

CAS # 8001-35-2

The Department of Health and Human Services (DHHS) has determined that toxaphene is reasonably anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that toxaphene is possibly carcinogenic to humans. The EPA has determined that toxaphene is a probable human carcinogen.

How can toxaphene affect children?

Toxaphene would be expected to affect children in the same manner as adults. It is not known whether children are more susceptible than adults to the effects of toxaphene.

A few studies in animals have shown minor changes in fetal development. We do not know if toxaphene would cause developmental effects in humans.

How can families reduce the risk of exposure to toxaphene?

- For people who live in areas where surface waters (for example lakes) have been contaminated with toxaphene, consumption of toxaphene-contaminated foods such as fish may need to be reduced.
- Avoid drinking water contaminated with toxaphene.

Is there a medical test to show whether I've been exposed to toxaphene?

Toxaphene and some of its breakdown products can be detected in blood, urine, breast milk, and body tissues. Urine and blood tests are the most common tests used.

These tests are not available at most doctor's offices, but can be done at special laboratories that have the right equipment.

These tests cannot determine how much toxaphene you have been exposed to, or whether you will experience any health effects.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to toxaphene in drinking water at concentrations of 0.004 milligrams per liter (mg/L) for up to 10 days is not expected to cause any adverse effects in a 10 kg child.

The EPA has determined that lifetime exposure to 0.01 mg/L toxaphene in the drinking water is not expected to cause any adverse noncancer effects if the only source of exposure to toxaphene is the drinking water.

The Food and Drug Administration (FDA) has determined that the concentration of toxaphene in bottled drinking water should not exceed 0.003 mg/L.

The Occupational Safety and Health Administration (OSHA) set a legal limit of 0.5 mg/m3 for toxaphene in air averaged over an 8-hour work day.

References

This ToxFAQs™ information is taken from the 2014 Toxicological Profile for Toxaphene produced by the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636

ToxFAQs™ on the web: www.atsdr.cdc.gov/toxFAQs.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Toxaphene - ToxFAQs™

CAS # 8001-35-2

This fact sheet answers the most frequently asked health questions (FAQs) about toxaphene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Toxaphene is a pesticide which is currently banned for all uses in the United States. Breathing, eating, or drinking high levels of toxaphene could damage the nervous system, the liver, and kidneys, and even cause death. Toxaphene has been found in at least 68 of the 1,699 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is toxaphene?

Toxaphene is a mixture of hundreds of different chlorinated compounds. It was one of the most heavily used pesticides in the Unites States until 1982, when it was canceled for most uses. All registered uses were banned by 1990. Toxaphene was used primarily in the southern United States to control insect pests on cotton and other crops.

Toxaphene is usually found as a solid or a gas. In its original form, toxaphene is a yellow to amber waxy solid that has a piney odor.

What happens to toxaphene when it enters the environment?

- When released to the environment, it can enter the air, the soil, and the water.
- It does not dissolve well in water and evaporates easily.
- Toxaphene is more likely found in air, soil, and sediment at the bottom of lakes or streams, than in surface water.
- Toxaphene can stay in the environment for a long time because it breaks down very slowly.
- The composition of toxaphene in the environment changes over time because congeners of toxaphene degrade at different rates; such toxaphene is called "weathered toxaphene."
- Toxaphene can be carried long distances in the air.
- Toxaphene accumulates in fatty tissues of fish and mammals.

How might I be exposed to toxaphene?

- People living near a location with heavy toxaphene contamination, such as a hazardous waste site, may be exposed to higher levels through breathing contaminated air or through direct skin contact with contaminated soil or water.
- People who eat large quantities of fish, shellfish, or wild game animals from areas contaminated with toxaphene may have higher exposure to this substance since these animals tend to accumulate toxaphene in fatty tissues.
- Individuals may be exposed to toxaphene through drinking water contaminated with toxaphene runoff from contaminated soils.

How can toxaphene affect my health?

Breathing, eating, or drinking high amounts of toxaphene could damage the nervous system, liver, and kidneys, and even cause death. However, since toxaphene is no longer used in the United States, most people would not be exposed to high levels of it.

Studies showed that animals which ate food or drank water containing toxaphene had effects on the liver, kidneys, and immune system.

It is not known whether toxaphene can affect reproduction in humans.

How likely is toxaphene to cause cancer?

It is not known whether toxaphene would cause cancer in people. Toxaphene caused liver cancer in mice and possible thyroid cancer in rats that were given large amounts of toxaphene by mouth.

Toxaphene

CAS # 8001-35-2

The Department of Health and Human Services (DHHS) has determined that toxaphene is reasonably anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that toxaphene is possibly carcinogenic to humans. The EPA has determined that toxaphene is a probable human carcinogen.

How can toxaphene affect children?

Toxaphene would be expected to affect children in the same manner as adults. It is not known whether children are more susceptible than adults to the effects of toxaphene.

A few studies in animals have shown minor changes in fetal development. We do not know if toxaphene would cause developmental effects in humans.

How can families reduce the risk of exposure to toxaphene?

- For people who live in areas where surface waters (for example lakes) have been contaminated with toxaphene, consumption of toxaphene-contaminated foods such as fish may need to be reduced.
- Avoid drinking water contaminated with toxaphene.

Is there a medical test to show whether I've been exposed to toxaphene?

Toxaphene and some of its breakdown products can be detected in blood, urine, breast milk, and body tissues. Urine and blood tests are the most common tests used.

These tests are not available at most doctor's offices, but can be done at special laboratories that have the right equipment.

These tests cannot determine how much toxaphene you have been exposed to, or whether you will experience any health effects.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to toxaphene in drinking water at concentrations of 0.004 milligrams per liter (mg/L) for up to 10 days is not expected to cause any adverse effects in a 10 kg child.

The EPA has determined that lifetime exposure to 0.01 mg/L toxaphene in the drinking water is not expected to cause any adverse noncancer effects if the only source of exposure to toxaphene is the drinking water.

The Food and Drug Administration (FDA) has determined that the concentration of toxaphene in bottled drinking water should not exceed 0.003 mg/L.

The Occupational Safety and Health Administration (OSHA) set a legal limit of 0.5 mg/m3 for toxaphene in air averaged over an 8-hour work day.

References

This ToxFAQs™ information is taken from the 2014 Toxicological Profile for Toxaphene produced by the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333

Phone: 1-800-232-4636.

ToxFAQs™ on the web: www.atsdr.cdc.gov/toxFAQs.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

EPA-R3-73-035
April 1973

Ecological Research Series

Environmental Effects on Toxaphene Toxicity to Selected Fishes and Crustaceans

Office of Research and Monitoring
U.S. Environmental Protection Agency
Washington, D.C. 20460

EPA-R3-73-035
April 1973

ENVIRONMENTAL EFFECTS ON TOXAPHENE TOXICITY TO SELECTED FISHES AND CRUSTACEANS

By

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Project 18080 DLR

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ABSTRACT

Laboratory studies were conducted to determine lethal limits (96 hr TL_{50}) for Toxaphene, salinity, temperature, and dissolved oxygen and their interaction effects on developmental stages of selected warm-temperate and subtropical fishes and crustaceans. Species tested were *Micropterus salmoides* (largemouth bass), *Mugil cephalus* (striped mullet), *Mugil curema* (silver mullet), *Trachinotus carolinus* (pompano), *Callinectes sapidus* (blue crab), *Penaeus duorarum* (pink shrimp), *Sesarma cinereum* (drift line crab), and *Rhithropanopeus harrisii* (mud crab). Histopathological and gross morphological studies were conducted on all early life history stages of the species included.

Earliest developmental stages of the fish species treated are more resistant to high levels of salinity, and to low levels of dissolved oxygen, but more sensitive to high temperatures than are later stages. Decapod larvae showed increasing tolerance to Toxaphene with increasing developmental age. Synergistic effects between Toxaphene and the three environmental factors were suggested in the species tested. Some histopathology was noted in fry of bass and mullet, and in larvae of *S. cinereum*, *C. sapidus*, and *R. harrisii*.

This report was submitted in fulfillment of Project Number 18080DLR, Contract 14-12-532, under the sponsorship of the Office of Research and Monitoring (formerly Water Quality Office), Environmental Protection Agency.

In requesting information about this report from Aquatic Sciences, Inc. refer to the identification number ASI 216-02.

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CONCLUSIONS

1. Synergistic effects were suggested between temperature-reduced dissolved oxygen and salinity-reduced dissolved oxygen for eggs, larvae and juveniles of fish and in some cases for larvae of decapod crustaceans but were not statistically demonstrable.

2. Synergistic effects have been statistically demonstrated between Toxaphene and all three environmental parameters for some stages of decapod species studied. In other cases, the data suggests synergistic effects.

3. The earliest stages (embryos) in the life history of fishes were most tolerant to extremes of salinity. Sac-fry larvae were more tolerant to this factor than juveniles.

4. Decapod larvae became more tolerant to Toxaphene at later developmental stages than at earlier stages. In some cases a 10-fold increase in tolerance was noted from one stage to the next.

5. Decapod larvae became increasingly tolerant of salinity extremes in advanced stages but the increase was not as striking as the increased tolerance of Toxaphene.

6. Sac-fry of the striped mullet showed enlargement of cells and increased numbers of cells in glandular tissue in the head region when exposed to high concentrations of Toxaphene.

7. Sac-fry of largemouth bass exposed to extreme salinities exhibited deformation of the yolk sac and the notochord. The latter caused a humpbacked condition.

8. Larvae of *S. cinereum*, *C. sapidus*, and *R. harrisii* exposed to extreme concentrations of Toxaphene ($<$96 hr TL_{50}) showed destruction of the hepatopancreas and constriction of the intestine.

9. Plastic containers should not be used in pesticide bioassays because of the rate and degree of sorption by the plastic. This phenomenon led to gross overestimates of 96 hr TL_{50} values for all fish studies in these tests.

10. Glass containers also exhibit some degree of sorption to pesticide so that the 96 hr TL_{50} is overestimated (10 to 25%). Chemical assays for the pesticide should be made during all bioassay tests.

RECOMMENDATIONS

1. Continued research is recommended on these species to elucidate the effects of Toxaphene and environmental parameters on stages not covered in this report.

2. It is believed that the 96 hr TL_{50} is higher than the TL_{50} ultimate. In the case of fishes, sensitivity seems to be related to development of gills, not included in the test period. In the case of crustaceans, the most sensitive phase in development is the molt between stages. The contract did not call for study at these points in the life history. Further study is recommended to elucidate these points.

3. Since significant synergistic effects of Toxaphene with environmental parameters were noted, consideration must be given to the environmental parameters of receiving waters in determining maximum permissible concentrations of Toxaphene.

4. Exposure to extreme conditions has a marked effect on behavior and feeding of both fish and decapods. Further study is recommended to elucidate the role of starvation as a possible cause of death.

5. The synergistic effect between Toxaphene and salinity suggests that Toxaphene interferes with osmoregulation and perhaps ionic regulation. Studies are recommended to examine this hypothesis.

INTRODUCTION

For several decades there has been increasing concern among scientists and fishermen (sport and commercial) that aquatic organisms and their population dynamics are being affected adversely through the addition of various chemicals to the aquatic ecosystem. Pesticides, particularly the persistent chlorinated hydrocarbons, have been implicated in many "fish kills" in the United States and elsewhere. These chemical pollutants, along with many others, can be passed through the food chain and may be accumulated to lethal levels in those organisms at the top of the chain through the process of biological magnification (Egler, 1964).

The chlorinated hydrocarbon insecticides generally enter aquatic ecosystems by runoff during periods of rain or may be directly introduced through carelessness during applications. Highest concentrations occur in and near agricultural areas where these pesticides are most often used. Once these chemicals are in aquatic situations, they are distributed downstream into lakes, estuaries, and eventually into marine waters (Nicholson, Grzenda, Laver, Cox, and Teasley, 1964).

Dilution occurs from the site of entry of pesticides into the aquatic ecosystem and continues throughout the downstream drift of these chemicals. High concentrations at the source of entry may produce a fish kill. Similar effects may not occur downstream as the chemicals undergo dilution to sublethal levels. Pesticides typically enter the lower portions of inland waterways, estuaries, and marine waters in sublethal concentrations.

The coastal regions of streams, rivers, canals, and inshore marine waters are generally shallow, often associated with marshes and swamps, and undergo wide fluctuations in hydrographic conditions with tidal, climatic, and seasonal changes. Variations in such characteristics as salinity and temperature are often dramatic in these areas. Variations in temperature are now being produced by man as new electrical power plants are constructed. Many of these are thermonuclear and require vast quantities of water to cool the reactors, and return the heated effluent to the environment.

Coastal regions are very productive in terms of aquatic organisms. Shallow areas of fresh waters, estuaries, and inshore marine habitats provide vast breeding and spawning grounds for the species present. Moreover, these same factors are of economic and recreational importance to man because large commercial and sport fisheries depend upon these areas of stock renewal for the fisheries.

Fishery biologists have long recognized the importance of water quality in these areas to renewal of fishery stocks although until recently relatively few biologists have investigated water quality with respect to chemical pollutants (Holden, 1966; Johnson, 1968; Butler, 1966). While they cite declining stocks of animals to support a fishery, and pollution

caused fish kills, no one has investigated the less apparent but perhaps more significant effects of sublethal levels of pesticides on the important early life history stages of these organisms. Similarly, there have been few studies on interaction effects of these pesticides and fluctuations in environmental factors for these same life history stages. These problems form the basis of the study reported herein.

Behind the urbanized coastal regions of Florida lies a large agricultural complex. The climate of Florida, particularly that of central and southern regions, provides a twelve month growing period for many fruit and vegetable crops. Citrus fruit is the largest agricultural crop. Around and south of Lake Okeechobee are thousands of square miles which are utilized for vegetable and fruit production. Florida ranks as the third largest cattle-producing state.

It has been estimated that 25 thousand tons of pesticides are used annually in Florida, mostly by agriculture, with only a small amount used for domestic pest control. Prior to 1969, DDT was the most commonly used insecticide for agricultural crops in central and south Florida. During 1969 the use of DDT was restricted and farmers began using Toxaphene instead (James E. Brogden, Department of Entomology, University of Florida, personal communication). Exact figures on the amounts of specific pesticide useage in Florida are not available from any source.

Toxaphene is administered to crops in the same formulations as was DDT. One of the most popular is a mixture of this chlorinated hydrocarbon with an organophosphate insecticide, typically Parathion. It was used in this manner on potatoes until the registry for use of Toxaphene on this crop was cancelled (James E. Brogden, personal communication). This formulation remains in use on corn, beans, cabbage, and for control of caterpillars on domestic lawns. Toxaphene is also used by itself or with Parathion on peanuts, soybeans, southern peas, cabbage, peppers, eggplant, tomatoes (south Florida's major vegetable crop), and early season celery. Toxaphene is the active ingredient of many livestock sprays for beef cattle and is also used for treatment of pastures (James E. Brogden, personal communication).

Toxaphene, therefore, has been one of the most likely chemical pollutants to be found in south Florida waters since 1969, although this was not tested in this study. The U. S. Geological Survey has found DDT in south Florida waters and soils (Benjamin McPherson, personal communication) and this indicates that its replacement, Toxaphene, is probably now present in these same areas. Few data are available on the effects of Toxaphene on aquatic animals. It is for these reasons that Aquatic Sciences, Inc. chose Toxaphene as the insecticide to be tested.

The aquatic animals utilized in this study were chosen because (1) they are distributed in the waters described above, (2) they are important as commercial, sport, or forage organisms, (3) knowledge of their physiology and/or life history is available in the scientific literature, and

(4) these species could be cultured at Aquatic Sciences, Inc. Information on these organisms is provided in the introduction for the fish and crustacean sections of this report.

FISHES

INTRODUCTION

Four species of fishes were chosen for this study. The largemouth bass, Micropterus salmoides (Lacepede), was included because (1) it is the most important freshwater sport fish in the southeastern United States, and particularly Florida, where millions of dollars are expended annually by sportsmen (J. Walter Dineen, personal communication), (2) the species inhabits waters which adjoin or flow through agricultural areas, and (3) largemouth bass spawn and live in fresh waters in the coastal plain and in the upper reaches of estuaries where fluctuations of temperature and salinity and, on occasion, dissolved oxygen (when eutrophication is advanced) occur. With or without the presence of pesticides, these fluctuations can cause stress.

Two species of mullet, Mugil cephalus Linnaeus, the striped mullet, and Mugil curema Valenciennes, the white mullet, were chosen as being representative of estuarine fishes. They provide an important commercial fishery in Florida with an annual value exceeding $2.4 million (Anon., 1970). Both species spawn at sea, the late larvae and early juveniles returning to inshore waters at a standard length of between 14 and 20 mm. This life history stage coincides with a major change in the feeding mechanism and a departure from a zooplankton - harpacticoid copepod diet to filter feeding on detrital material, primarily of plant origin, in bottom sediments (Cowart, 1971). At this point, however, the two species diverge in their habitat preferences. Mugil cephalus juveniles enter intracoastal waterways, canals, and rivers, into fresh waters such as Lake Okeechobee inhabited by largemouth bass and other freshwater fishes. Juveniles of M. curema migrate into low salinity waters of intracoastal waterways, canals, and estuaries but typically do not invade waters of less than 15 $^{o}/oo$ salinity.

Trachinotus carolinus (Linnaeus), the Florida pompano, was chosen as a representative marine species for this study. From an economic standpoint, T. carolinus is the most valuable commercial food fish along the Atlantic coast of the United States and represents a $1 million annual fishery in Florida alone. Mariculture interests have placed Florida pompano as the high priority species for commercial culture.

Although the entire life history of T. carolinus has not been thoroughly studied, adults apparently spawn at sea. Early juveniles return to inshore waters at a standard length of 10 to 20 mm where they are often found in the surf zone along beaches (Cowart, 1971).

Three early life history stages of each species were studied, gastrula, 10-12 day post hatch larva, and juveniles of 20-30 mm standard length. Gastrulae hatched during the 96 hour exposure period, and reached a late sac-fry stage by the end of the test period. These stages were chosen

because of the relative differences in developmental complexity and organogenesis. These stages are less able to move from one area to another during periods of environmental stresses than are their parent stocks.

The early life history stages of all four species share several further important considerations for inclusion in this study: (1) they are particularly critical stages in development, (2) at least one or more of these stages occur in areas where interaction effects between environmental factor fluctuation and man-induced environmental pollutants, such as Toxaphene, can occur (3) methods for laboratory culture of these fishes for use in research have been and continue to be developed and improved at Aquatic Sciences, Inc., and (4) all four species are of great economic value in Florida.

MATERIALS AND METHODS

Micropterus salmoides eggs are demersal and were collected attached to rocks from Conservation Area II, Broward County, Florida. Eggs at the late gastrula - neurula stage marked by the first appearance of melanophores were selected for testing. Other eggs were allowed to develop and hatch to produce the sac-fry used in testing. Some additional sac-fry were obtained from the Federal Fish Hatchery, Welaka, Florida. Juveniles were obtained from two sources; Federal Fish Hatchery, Welaka, Florida, and Florida Game and Freshwater Fish Commission Hatchery, Richloam, Florida. Additional juveniles used only for screening tests were derived from Federal Fish Hatcheries in Georgia, West Virginia and South Dakota.

Adult Mugil cephalus were collected by cast net at Boynton Beach Inlet, Palm Beach County, Florida. These adults were then spawned in the laboratory to produce a limited number of eggs. Juvenile M. cephalus were collected by seining in Indian River, St. Lucie County, Florida and Tampa Bay, Hillsborough County, Florida.

Mugil curema juveniles were collected from the same locations as M. cephalus, the majority at Indian River, Florida.

Trachinotus carolinus juveniles were collected at Cocoa Beach, Brevard County with limited numbers being derived from Daytona Beach, Volusia County, Florida and St. Augustine, St. Johns County, Florida.

Aquatic Sciences, Inc. has conducted considerable supportive research directed toward manipulation of unripe fishes into prespawning condition, spawning and rearing. This is the only procedure available for obtaining adequate numbers of eggs and larvae of M. cephalus, M. curema, and T. carolinus for experimentation.

The original proposal (ASI Document Number 103-02) and the Schedule for Contract 14-12-532 both specify that tests with eggs will begin at the onset of gastrulation (embryonic shield to primitive streak). Several problems were encountered in attempting to test eggs at this stage. First, there is great variability in the number of unfertilized or dead eggs either collected from the field or produced in Federal hatcheries or our own laboratory. For M. salmoides, from less than 1% to 60% of the eggs in a nest were dead or unfertilized. These eggs must be removed prior to testing. Second, embryos are encountered which, regardless of source, terminate development because of processes not fully understood. Arrested development usually occurs during early cleavage to blastula stages and to a lesser extent in later stages. The proportion of eggs in a given batch which exhibit this phenomenon is highly variable. These eggs cannot be identified and removed at the early gastrula stage. These biological anomalies could lead to large errors in experimental results.

It was therefore necessary to select embryos of each species for testing at a slightly later stage of development than specified in the contract. When embryos are selected at the late gastrula - neurula stage after melanophores become visible, nearly 100 percent of the selected embryos hatch when maintained under suitable conditions. This stage can be readily distinguished from unfertilized eggs, arrested embryos, and other developmental stages. Therefore embryos were selected at this stage for all tests.

Acquisition of larvae from field or hatchery operations does not present the same problems as are inherent with the eggs, at least with regard to M. salmoides. Our experience has been excellent in obtaining healthy fishes from both sources. Only two minor problems were encountered and only one of these could probably be reduced through laboratory culture of this species. The first problem is that certain larvae from a given spawning could be referred to as the "runts of the litter"; i.e., they do not grow as rapidly as the majority, and therefore are subject to heavier pressures of competition by their siblings leading to death by starvation or cannibalism. The second problem is a correlary of the first. Whenever possible, hatchery personnel attempt to select larvae of the same size. In doing this larvae of different ages may be selected, and occasionally "runts" from an older group of larvae may be selected along with the average of a younger group because of their similar size. In some cases it appears that these "runts", in spite of their equality in size, are still unable to compete with the younger individuals and may starve to death or become victims of cannibalism.

Juveniles are subject to injury during collection and transport from field to laboratory. In addition they may be diseased when collected. Therefore all juvenile fishes were quarantined for 24 to 48 hours prior to experimentation. Only juveniles from collections exhibiting low mortality during this period were used in experiments.

With one exception, all acute and interaction determinations were conducted utilizing styrofoam fish shipping boxes manufactured by Plasti-Kraft of Ozona, Florida and lined with a 15 x 15 x 22 inch 0.004 mil polyethylene bag. This apparatus was selected after considerable testing based on the following criteria: (1) containers should provide adequate and uniform life support for experimental fishes without filtration for a period of 96 hours and with filtration (i.e., corner filter) for long term exposures; (2) containers should be of convenient size for handling, maintenance, and storage; (3) containers should have better insulation qualities than glass aquaria; (4) containers should be readily sealed for reduced oxygen experiments; (5) containers should be inexpensive and disposable. Few of these criteria are met by the glass containers (glass pickle jars) routinely used in bioassay experiments or glass aquaria. It is widely recognized that many, if not all, of the chlorinated hydrocarbon pesticides will adhere to glass and, in some cases, will chemically bind to the glass. The use of a polyethylene liner in a styrofoam "frame" does not reduce chlorinated hydrocarbon adsorption to the container surface but it does provide for a low cost,

disposable liners which is destroyed after each test with Toxaphene. Each apparatus contained twenty liters of water. Water circulation and oxygen saturation were maintained with a single 1 inch air stone in a corner of the unit.

The experimental apparatus utilized for juvenile T. carolinus was different than that described above. Two containers were tested with T. carolinus: (1) styrofoam fish shipping boxes with plastic liners containing 20 liters of water and (2) large cylindrical polyethylene vessels with plastic liners containing 80 liters of water. Survival rates were examined in these containers with and without filtration for 5, 10, 15, 20, and 25 fish per tank and several different feeding regimes including live adult Artemia and Tetramin® flake food. Juvenile pompano prefer live adult Artemia although they readily accept Tetramin®. They feed selectively on the latter diet, rejecting the green flakes altogether. Water samples were tested for pH and ammonia content at the end of 96 hours (Table 1). Based on these tests, the large plastic lined polyethylene container without filtration, but with an airlift device for aeration and water circulation, was selected.

TABLE 1.

WATER QUALITY DATA FOR TWO EXPERIMENTS DESIGNED TO SELECT CULTURE CONDITIONS FOR TESTS INVOLVING JUVENILE Trachinotus carolinus

A - 20 liters volume

				July 2		July 3		July 6	
Tank	Food	Filtration	Animals/Tank	pH	NH_3	pH	NH_3	pH	NH_3
1	Tetramin®	with	25	7.1	9.37	7.3	14.3	7.8	30.3
2	Artemia	with	25	7.3	7.40	7.5	10.6	7.8	20.5
3	Tetramin®	without	25	7.3	9.37	7.4	12.1	---	----
4	Artemia	without	25	7.5	6.25	7.6	10.5	7.9	19.8
5	Tetramin®	without	0	7.1	0.75	7.8	1.94	7.9	8.1

B - 20 liter versus 80 liter

				13 April		19 April	
Tank	Volume	Animals/Tank	Filtration	pH	NH_3	pH	NH_3
1	80	25	without	7.6	1.62	7.4	2.42
2	80	20	without	8.0	1.21	7.4	1.54
3	80	15	without	7.9	0.90	7.5	0.82
4	80	10	without	7.8	0.59	7.4	0.57
5	80	5	without	7.9	0.45	7.3	0.53
6	80	25	with	7.9	0.57	7.5	0.38
7	80	20	with	7.9	0.49	7.4	0.45
8	20	15	without	7.6	6.25	7.2	9.37
9	20	10	without	7.7	2.21	7.6	6.25
10	20	15	with	7.7	6.70	7.3	7.85
11	20	10	with	7.7	5.16	7.6	8.10

Fertilized eggs and sac-fry were placed in specially designed "protectors" during exposure for ease of handling, examination, feeding, and removal of dead individuals. The "protectors" consist of cylindrical baskets of fine mesh netting supported by cylindrical PVC frames and floated from a styrofoam collar. The collar is inexpensive and disposable.

In standard bioassay tests, experimental animals are not fed during exposure. Food deprivation is suggested to reduce the number of deaths resulting from breakdown products of non-ingested food materials and from increases in metabolites from experimental animals (Anon. 1960). While these factors may be real problems in bioassays, food deprivation is an unnatural situation and in itself becomes a stress factor. Furthermore, larval and juvenile fishes of the sizes used in this project cannot be maintained for 96 hours without feeding.

Therefore, all experimental animals were fed according to the following procedure: three times daily food was added until the fish ceased feeding, usually 15 to 20 minutes. Excess food was then removed. *Micropterus salmoides* larvae were fed *Artemia* nauplii and juveniles were fed live *Daphnia*, *M. cephalus* and *M. curema* were fed live *Cyclops*, and *T. carolinus* were fed live adult *Artemia* (when live *Artemia* was not available, either frozen *Artemia* or, rarely, Tetramin® was substituted). Chemical monitoring of the water at the end of each experiment rarely showed significant metabolite concentrations.

Twenty-five fish in each "protector" is the optimal number for adequate survival. There are many problems associated with counting very small, live, active fishes and consequently several individuals fewer or more than the desired number were frequently introduced into "protectors". In addition some cannibalism was observed. Cannibalism occurred at a variable rate which could not be precisely determined in every case.

Because of potential counting errors in placing fish in the "protectors" and variable amounts of cannibalism during tests, the initial *n* (number of experimental animals) is taken to be the number of dead recorded and preserved at each observation time plus the number of animals alive at the termination of an experiment. The number dead was recorded at the end of each 24 hour period in the test. Thus, if only 23 fish can be accounted for in a given "protector" at the end of the experiment (total dead and live), percent mortality is based on this number. This procedure excludes the effect of cannibalism on the mortality data. The fact that the cannibalistic individual(s) may survive an exposure better than others because of this ready source of food is, however, masked.

The procedures followed here effectively cancel out mortality resulting from predation both by other animals and by cannibalism which together probably represent the major cause of death in natural populations. This still leaves the "natural mortality syndrome" of inexplicable deaths of animals maintained under "optimal" conditions. The procedure for apportioning animals in the several conditions of each test did not completely

exclude bias from this source because it did not insure complete randomization.

Temperature Experiments

In temperature tests, temperature was controlled by thermoregulated heaters. Over the range of temperature to be tested, experimental units were maintained at 5°C increments. Salinity was maintained constant and oxygen at saturation. The range tested for each species is given in Table 2.

Salinity Experiments

In salinity experiments, tests were conducted at 5 °/oo increments over the selected range for each species. Water of the desired salinity was prepared by dilution of artificial seawater (Instant Ocean Synthetic Sea Salts®, Aquarium Systems, Inc.) with tap water. If salinities higher than the stock solution were required, Instant Ocean Synthetic Sea Salts® were added. Salinity was measured with a hydrometer to ±0.5 °/oo. Temperature was kept constant at 23-24°C, oxygen at saturation. Test ranges are given in Table 2.

Reduced Dissolved Oxygen Experiments

Four levels of dissolved oxygen were tested, 10, 30, 75, and 100% saturation. The oxygen dilution systems to produce reduced dissolved oxygen levels consisted of 1 quart mixing bottles with separate air and nitrogen inflows monitored by manifold valves and flowmeters. Air from the mixing bottles was then diffused directly into the water in experimental tanks through 1 inch airstones. Water in experimental tanks was maintained free from contact with oxygen-saturated air by closing the plastic liners and providing an air vent. Oxygen concentration was monitored with a Galvanic Cell Oxygen Analyzer (Precision Scientific) and Winkler titrations.

Toxaphene Experiments

Toxaphene used in both the fish and crustacean portions of this project was obtained in two forms from Southern Mill Creek Products Company, Inc., of Tampa, Florida. The first form, used only in preliminary screening experiments, has the trade name of Toxaphene EM-6 and contains 60% Toxaphene (chlorine content 67-69%), 35% xylene-range aromatic hydrocarbon solvent, and 5% inert ingredients. This is called 6 pound per gallon Toxaphene.

The second form, which is presently utilized in all acute and interaction tests, Toxaphene EM-8, contains 71.6% Toxaphene (chlorine content 67-69%), 23% xylene, and 5.4% inert ingredients, and is called 8 pound per gallon Toxaphene. Only one lot was used throughout this research. No analyses for Toxaphene were required under the contract. The methods for preparation of stock and experimental solutions developed by Mahdi (1966) were followed. Test concentrations for each test are summarized in Table 2.

TABLE 2.

RANGES OF TEMPERATURE, SALINITY, REDUCED DISSOLVED OXYGEN AND CONCENTRATION LEVELS OF TOXAPHENE TESTED FOR EACH SPECIES AND STAGE

Temperature		(^{o}C)
Micropterus salmoides	embryo	25 - 39
	sac-fry, juvenile	25 - 40
Mugil cephalus	embryo	22 - 38
	juvenile	25 - 40
Trachinotus carolinus	juvenile	26 - 39
Salinity		(^{o}/oo)
Micropterus salmoides	all stages	0 - 20
Mugil cephalus	embryo	0 - 65
	juvenile	0 - 68
Trachinotus carolinus	juvenile	0 - 60
Reduced Dissolved Oxygen		(%)
Micropterus salmoides	embryo	10 - 100
	sac-fry	30 - 100
Mugil cephalus	embryo	30 - 100
Trachinotus carolinus	juvenile	30 - 100
Toxaphene		(ppm)
Micropterus salmoides	embryo	0.005 - 5.00
	sac-fry	0.010 - 0.10
	juvenile	0.010 - 0.25
Mugil cephalus	embryo	0.005 - 0.50
	juvenile	0.005 - 0.50
Trachinotus carolinus	juvenile	0.010 - 0.25

Upon completion of the Toxaphene bioassay tests, a contract modification was negotiated to determine the concentration of Toxaphene in simulated bioassay tests without animals. Three concentrations were prepared in the same way as for bioassay tests in the polyethylene-lined styrofoam boxes. Samples were removed for analysis at 3 hr., 48 hr., and 96 hr. after solution preparation. The samples were then extracted with hexane, and analyzed by gas chromatographic methods.

Since the recovery of Toxaphene was very low, a subsequent experiment was conducted to develop a Toxaphene budget for the system at a single concentration. The solution was prepared at 0.5 ppm in the usual manner. A sample of the solution was taken at 3 hr. and 24 hr., extracted with hexane, and analyzed. The remaining solution was then drawn off carefully so that any precipitate would not be removed. The container was then rinsed with distilled water to remove particulate Toxaphene. The wash was extracted with hexane and analyzed. The container was then washed briefly with hexane to remove adsorbed Toxaphene and analyzed. That portion of the bag exposed to the solution was then cut into small pieces and extracted with hexane for twenty-four hours to remove absorbed Toxaphene. The hexane partially dissolved the plastic but this did not interfere with the gas chromatograph analysis. It was not possible to re-extract the plastic; therefore the completeness of recovery of absorbed Toxaphene is not known.

Interaction Tests

Five combinations of factors were tested: temperature-reduced dissolved oxygen, salinity-reduced dissolved oxygen, temperature-Toxaphene, salinity-Toxaphene, and reduced dissolved oxygen-Toxaphene. Conditions were established and maintained as described above for each parameter.

Levels to be tested were selected to be sublethal based on the results of the acute tolerance tests, ranging from an optimal level to just below the 96 hr TL_{50} level.

In acute and interaction tests involving eggs and sac-fry, there were 4 replicates at each test level or a total of about 100 individuals at each test level. For juveniles there were 2 replicates at each test level or approximately 50 individuals.

96 hr TL_{50} values were determined by the graphic method of Douderoff et al. (1951, Anon, 1965) with the data for replicates pooled.

Specimens from each test series were preserved for examination of gross morphology and histopathology. Two hundred ninety-two specimens from tests involving Toxaphene were sectioned at 6 μ and stained with hematoxylin-eosin for histological study of gill, pharyngeal region, digestive tract, liver, kidney, and epithelial tissues to determine if Toxaphene affects these tissues.

All Toxaphene tests were conducted in completely independent laboratory modules located outside of the main building complex at Aquatic Sciences, Inc. These research spaces were provided to prevent contamination of culture, life support, and other research areas in the main complex.

RESEARCH RESULTS

All three life history stages of Micropterus salmoides were included in acute and interaction exposures. The 96 hr temperature TL_{50} for all stages of M. salmoides ranged from 31.5°C for embryos to 37.2°C for juveniles. The 96 hr salinity TL_{50} for embryos was not established at levels up to 20 °/oo but was 15.8 °/oo for larvae and 12.5 °/oo for juveniles. The majority of embryos tested at 20 °/oo salinity were deformed at hatching. The 96 hr reduced dissolved oxygen TL_{50} ranged from 15.3% for embryos to 47.5% saturation for juveniles. These data are provided in Table 3.

TABLE 3.

96 hr TL_{50} VALUES FOR EACH STAGE OF EACH FISH SPECIES

Species	Stage	Temperature (°C)	Lower Salinity (°/oo)	Higher Salinity (°/oo)	Reduced Dissolved Oxygen (% sat.)
Micropterus salmoides	embryos	31.5	Does not exist	20.0	15.3
	sac-fry	33.5	0.0	15.8	48.0
	juveniles	37.2	0.0	12.5	47.5
Mugil cephalus	embryos	26.4	-	-	-
	juveniles	36.5	0.0	62.0	49.0
Trachinotus carolinus	juveniles	36.2	0.0	50.3	18.0

The temperature-reduced dissolved oxygen interaction test was conducted on larval M. salmoides. Highest mortality occurred at a temperature of 33°C (Table 4). An interaction test between salinity and reduced dissolved oxygen was conducted for both larvae and juveniles. Larvae experienced total mortality at a salinity level of 12 °/oo when oxygen concentration was 75% saturation (Table 4).

Because of problems encountered in acquiring larval Mugil cephalus and in obtaining sufficient numbers of embryos, only one test was conducted on embryos. All tests required for juvenile M. cephalus were completed.

TABLE 4.

PERCENT MORTALITY AFTER 96 HOURS IN INTERACTION TESTS FOR *Micropterus salmoides*

Sac-fry Larvae

		Temperature (°C)			Salinity (°/oo)		
		22-24	30	33	0	9	12
Reduced Dissolved Oxygen (% sat.)	75	*	13.6	88.0	—	40.0	100.0
	100	8.3	—	—	17.8	—	—

Juveniles

		Salinity (°/oo)		
		0	9	12
Reduced Dissolved Oxygen (% sat.)	75	—	40.0	58.0
	100	87.0	—	—

* - not tested

The 96 hr temperature TL_{50} for *M. cephalus* was 26.4°C for embryos and 36.5°C for juveniles. A 96 hr lower salinity TL_{50} was not observed for juveniles but a 96 hr upper salinity TL_{50} occurred at 62 °/oo. The 96 hr reduced dissolved oxygen TL_{50} for juveniles was established at 49% saturation. These results are summarized in Table 3.

No interaction tests or long term exposures were conducted with *M. cephalus*.

Juveniles of *Mugil curema* were utilized in interaction and long-term exposures. Highest mortalities were experienced in test series with 36°C in temperature-reduced dissolved oxygen exposures, with 60% salinity in salinity-dissolved oxygen tests (Table 5).

TABLE 5.

PERCENT MORTALITY AFTER 96 HOURS IN INTERACTION TESTS FOR *Mugil curema**

Juveniles

		Temperature (°C)				Salinity (°/oo)			
		23-24	24	33	36	35	54	57	60
Reduced Dissolved Oxygen (% sat.)	75	___	___	41.2	44.0	___	21.0	24.3	56.0
	100	31.3	24.2	___	___	31.5	___	___	___

A 96 hr temperature TL_{50} of 36.2°C was established for juvenile *T. carolinus*. A 96 hr lower salinity TL_{50} was not observed for juveniles but a 96 hr upper salinity TL_{50} of 50.3 °/oo was determined. The 96 hr reduced dissolved oxygen TL_{50} for juveniles was 18% saturation. These data are summarized in Table 3.

In interaction exposures, highest mortalities among juvenile *T. carolinus* were observed at 30% saturation of dissolved oxygen in the temperature-reduced dissolved oxygen and salinity-reduced dissolved oxygen. These data are reported in Table 6.

TABLE 6.

PERCENT MORTALITY AFTER 96 HOURS IN INTERACTION TESTS FOR *Trachinotus carolinus*

Juveniles

		Temperature (°C)			Salinity (°/oo)			
		22	32	35	33	42	45	48
Reduced Dissolved Oxygen (% sat.)	30	___	72.0	100.0	___	53.0	76.0	75.0
	75	___	4.0	6.0	___	23.0	18.0	28.0
	100	2.0	___	___	2.0	___	___	___

Toxaphene Concentrations in Bioassay Tests

No results of tests involving Toxaphene are reported because the methodology used was subsequently found to be inadequate for these tests. The use of plastic for test containers was shown to result in virtually complete removal of Toxaphene from the system. Therefore TL_{50} values were grossly overestimated and of no value.

The results of the analysis of Toxaphene over time in simulated bioassay tests are presented in Table 7. In both fresh and salt water, the concentration at 3 hr. after solution preparation was in all but one case less than 13% of the calculated concentration. After 48 hours only traces of Toxaphene were measured in all but one case.

TABLE 7.

ASSAYED TOXAPHENE CONCENTRATION IN SIMULATED BIOASSAY TEST WITH PLASTIC CULTURE VESSELS

Water Type	Nominal Concentration (ppm)	Calculated Concentration (ppm)	Assayed 0	Concentration	(ppm) on Day 4
Salt Water	0.50	0.479	0.062	< 0.001	< 0.001
30 °/oo	0.10	0.096	0.037	< 0.001	< 0.001
	0.05	0.048	0.0056	< 0.001	< 0.001
Fresh Water	0.5	0.479	0.062	< 0.013	< 0.001
	0.05	0.048	0.001	< 0.001	< 0.001

In a separate experiment we attempted to account for all Toxaphene introduced. This test was terminated at 24 hours and estimates were made of the Toxaphene in solution, in solid form, adsorbed to the plastic and absorbed to the plastic (Table 8). There was a Toxaphene concentration in solution of 0.0274 ppm at 24 hours. The total Toxaphene in solution was 132.7 µg. There was 24.1 µg in the distilled water (particulate fraction). The plastic accounted for most of the Toxaphene with 280.3 µg adsorbed and 319.0 µg absorbed. The total amount of Toxaphene accounted for was 756.1 µg or 39.5% of the amount introduced. The Toxaphene unaccounted for is believed to be associated with the residual undissolved but liquified plastic after decanting the hexane fraction from the extract to determine the absorbed fraction; i.e., the absorbed fraction was underestimated.

TABLE 8.

TOXAPHENE BUDGET AT 24 HR IN SIMULATED BIOASSAY TEST WITH PLASTIC CULTURE VESSELS

Fraction	µg
soluble	132.7
particulate	24.1
adsorbed	280.3
absorbed*	319.0
TOTAL	756.1

µg Toxaphene introduced 1916 µg
% recovered 39.5%

*extraction not complete

Histopathology

The species, stage, test condition, and number of specimens sectioned is summarized in Table 9. Morphological anomalies were noted among embryos of *Micropterus salmoides* and *Mugil cephalus* exposed to test situations. The majority of the larvae of *M. salmoides* which hatched from eggs exposed to 20 $^{o}/oo$ salinity were deformed in four ways: (1) curvature of the notochord causing a "humpback" condition; (2) shortened trunk region in several fry apparently resulting from lack of several embryonic somites; (3) distortion in the shape of the yolk sac in some fry; and (4) forward displacement of the yolk sac in others. As these anomalies did not occur in other newly-hatched fry of the same age from the same test series exposed to lower levels of salinity nor in those of the control series, these anatomical deformations are attributed to the higher salinity.

Histopathological effects were found in the head region of *Mugil cephalus* embryos exposed in a preliminary Toxaphene 96 hr TL_{50} test. The maximum Toxaphene concentration was 0.5 ppm in this series. Glandular structures in the optic region of those embryos exposed to the highest concentrations of Toxaphene were larger and more numerous than those exposed to lower concentrations and in the control series. These glandular structures appear to be mucous glands and their anomalous condition may be due to epithelial irritation by Toxaphene.

Histopathological effects were also noted in larvae of *Micropterus salmoides*. Necrosis was found in kidney tissues and the lining of the digestive tract of larvae which had been exposed for a period of 14 days to 10% of the 96 hr TL_{50} for Toxaphene administered in the food. Necrosis of kidney tissues was severe with near total destruction of the kidney tubules. There was no significant destruction of other organs detected.

TABLE 9.

SUMMARY OF FISH SPECIMENS EXAMINED
FOR HISTOPATHOLOGICAL STUDY

Species	Stage	Test Condition	Level	Number of Animals Examined
Micropterus salmoides	larva	Toxaphene	0.000 ppm	6
		Toxaphene	0.001 ppm	2
		Toxaphene	0.1 ppm	2
		Toxaphene/temperature	0.05 ppm/33°C	3
		Toxaphene/salinity	0.01 ppm/9 °/oo	4
			0.05 ppm/9 °/oo	6
			0.05 ppm/12 °/oo	9
		Toxaphene/reduced dissolved oxygen	0.01 ppm/75%	3
			0.05 ppm/75%	3
	juvenile	Toxaphene	0.00 ppm	3
		Toxaphene/temperature	0.01 ppm/35°C	2
			0.05 ppm/35°C	4
		Toxaphene/salinity	0.05 ppm/12 °/oo	4
		Toxaphene/reduced dissolved oxygen	0.5 ppm/75%	5
Mugil curema	juvenile	Toxaphene (14 day)	0.033 ppm	2
Mugil cephalus	egg	Toxaphene	0.00 ppm	13
		Toxaphene	0.5 ppm	15
	juvenile	Salinity	0.00 ppm	2

TABLE 9 (continued)

Species	Stage	Test Condition	Level	Number of Animals Examined
		Toxaphene (14 day)	0.033 ppm	2
Trachinotus carolinus	juvenile	Temperature	24°C	4
		Toxaphene	0.03 ppm	2
		Toxaphene	0.25 ppm	6
		Toxaphene (14 day)	0.0035 ppm	2
		Toxaphene (14 day)	0.017 ppm	2
		Toxaphene (14 day, in food)	0.033 ppm	2
		Toxaphene/temperature	0.01 ppm/35°C	4
		Toxaphene/reduced dissolved oxygen	0.1 ppm/30%	4
		Toxaphene/salinity	0.1 ppm/48 °/oo	2

No morphological or histological effects were observed in specimens exposed to other experimental variables. Further, no histopathological effects were observed in *T. carolinus* exposed to any experimental variable.

DISCUSSION

Mugil cephalus juveniles were most tolerant of elevated salinity (TL_{50} = 62 °/oo) followed by Trachinotus carolinus juveniles (TL_{50} = 50.3 °/oo. Juveniles of all those species tested tolerated fresh water (TL_{50} = 0.0 °/oo). Micropterus salmoides showed decreasing tolerance of elevated salinity with increasing developmental age (TL_{50} = 20 °/oo for embryos, 15.8 °/oo for larvae and 12.5 °/oo for juveniles).

The results of temperature tests are somewhat different. None of the juveniles used in tests were acclimated to laboratory temperatures of 25°C for more than 48 hours before these fishes entered temperature tests. The results for juveniles are in rather close agreement (96 hr TL_{50} for M. salmoides = 37.2°C; for M. cephalus = 36.5°C; and for T. carolinus = 36.2°C). This coincides well with results for upper temperature limits of many other warm acclimated organisms (Prosser, 1961). Larvae of M. salmoides are not as resistant to higher temperatures (96 hr TL_{50} = 33.5°C) and bass embryos are even less tolerant (96 hr TL_{50} = 31.5°C). Therefore, temperature tolerance increases with development from embryos to juveniles. This is highly significant with respect to injection of thermal effluents into areas in which fishes spawn, i.e., estuaries and bays.

Juveniles of M. salmoides and M. cephalus and larval M. salmoides showed close agreement in dissolved oxygen tests with 96 hr TL_{50}'s of 47.5%, 49%, and 48% saturation respectively. Embryos of Micropterus were most resistant to low levels of oxygen with a 96 hr TL_{50} of 15.3% saturation. Juvenile T. carolinus were quite resistant to reduced oxygen with a 96 hr TL_{50} of 18% saturation. It was noted that their activity during these tests slowed as oxygen content of the water was lowered. The gills of juvenile T. carolinus are probably more efficient in removing oxygen from water than are those of the other species, perhaps representing an adaptation to pelagic life.

The results of the chemical assay tests indicate that Toxaphene is rapidly removed from the test solution by the container. After as little as 3 hours only 13% is in solution and after 48 hours only a trace. This means that all 96 hr TL_{50}'s were grossly overestimated because virtually no Toxaphene was present during the majority of the test. The rapidity of removal precludes calculation of valid TL_{50} estimates for any time interval.

Interaction between sublethal levels of paired test factors was suggested in many if not all combinations tested. This conclusion is based on the fact that mortality for the combined action of variables at levels less than that required to produce 50% mortality (i.e. the 96 hr TL_{50}) was greater than 50% and in several cases was 100%. However the incomplete factorial design used precludes valid statistical treatment.

If synergistic interactions do occur between environmental parameters as suggested here, then 96 hr TL_{50} values provide only a guideline to the lethal and sublethal levels for the given set of exposure conditions tested and cannot be applied to situations where environmental levels are more or less stressful. Single factors rarely play a dominant role in nature. Therefore bioassay tests should include realistic levels of both natural and man-made parameters in multiple factor interaction designs to measure the credibility of results when applied to the natural environment.

Most tests for each species were performed with specimens from a single geographic location and all specimens in any single test were from a common source. In subsequent studies, it should be determined whether there are differences in tolerance to test parameters for animals derived from several geographic locations.

CRUSTACEA

INTRODUCTION

The purpose of this research was (1) to determine the median tolerance limit of larvae of selected decapod crustaceans for extremes of temperature, salinity and reduced dissolved oxygen concentration and for the pesticide Toxaphene, (2) to determine the interaction effect of pairs of the above parameters at sublethal levels (hereinafter called interaction tests), and (3) to detect histopathological effects at acute and sublethal concentration levels, especially for Toxaphene-exposed animals.

The species selected for study were the blue crab, Callinectes sapidus; the mud crab, Rhithropanopeus harrisii; the drift-line crab, Sesarma cinereum; and the pink shrimp, Penaeus duorarum. Callinectes sapidus and P. duorarum are commercially important species with major fisheries throughout most of their ranges along the Atlantic coast of North America. Rhithropanopeus harrisii and S. cinereum were selected for study for two reasons; they are both ecologically important in their respective habitats, and their larvae are better known physiologically than perhaps any other species.

All larval stages for each of these species have been described in the literature. Callinectes sapidus has 7 (occasionally 8) zoeal stages and a megalopa (Costlow and Bookhout, 1959). The four zoeal and one megalopal instars of R. harrisii were described from plankton specimens by Connolly (1925) and verified in culture by Chamberlain (1962) and Costlow, Bookhout and Monroe (1966). Sesarma cinereum has 4 zoeal and 1 megalopal instar in culture (Costlow and Bookhout, 1960). The naupliar, protozoeal, and mysis stages of Penaeus duorarum were described by Dobkin (1961) from planktonic specimens and verified by Ewald (1965) from laboratory-reared specimens.

The development of culture techniques has made available sufficient numbers of larvae for studies of larval ecology and physiology. Costlow (1967) examined the effects of temperature and salinity on development of the megalopa of C. sapidus but was unable to perform similar studies with the zoeal instars. Results of a complete study of the effects of temperature and salinity on all larval stages are available for S. cinereum (Costlow, Bookhout, and Monroe, 1960) and R. harrisii (Chamberlain, 1962; Costlow, Bookhout, and Monroe, 1966). In addition, studies have been made concerning the effect of eyestalk extirpation on these and other species for the larval stages (Costlow, 1966, 1968). Some data is available on free amino acids in C. sapidus and R. harrisii larvae (Costlow and Sastry, 1966), respiration for Uca, (Vernberg and Vernberg, 1964), and osmoregulation (for Cardisoma, Rhithropanopeus, and Libinia, (Kalber and Costlow, 1966, Costlow and Kalber, 1968) and Sesarma (Kalber and Costlow, unpublished). No data is available in the literature on the internal morphology-histology of larvae of any species except the hermit crab, Pagurus annulipes (Thompson, 1903).

MATERIALS AND METHODS

Ovigerous females of each brachyuran species were collected locally in south Florida and placed in aquaria until the eggs hatched. Sesarma cinereum were collected at Boca Raton, Palm Beach County, Florida, C. sapidus from the St. Lucie Estuary, Martin County, and R. harrisii from drainage ponds on the University of Miami Campus, Dade County, Florida. The females were maintained at 25°C, and a salinity comparable to that of their natural habitat (C. sapidus, 30 °/oo; R. harrisii, 25 °/oo; S. cinereum, 25 °/oo). Hatching occurred within a week after placing in hatching tanks. The adults were not fed during incubation of the eggs.

Larvae were maintained in the laboratory under standardized conditions until the desired stage was reached. Callinectes sapidus larvae were kept at 25 °/oo or, recently, 30 °/oo in 20.3 cm finger bowls and fed sea urchin blastulae-gastrulae and Artemia nauplii. In some recent experiments, Dunaliella salina was provided as food for zoea stage I and II. Sesarma cinereum larvae were maintained at 25°C, 25 °/oo, R. harrisii at 25°C, 25 °/oo. Both species were fed Artemia nauplii. The shrimp, P. duorarum, larvae were purchased at the desired stage (nauplius, protozoea, or mysis) from Seafarms, Inc., Key West, Florida. They were fed with the motile chlorophytan Dunaliella salina in the protozoeal stages and with Artemia nauplii during the mysis stage. The nauplii are non-feeding stages.

All experiments were conducted in 11.4 cm finger bowls. Bowls were examined daily for deaths and molts. The food organisms were provided as needed to maintain adequate food concentrations.

Temperature Experiments

In experiments with temperature as the experimental variable, the cultures were maintained in BOD boxes. Over the range of temperature to be tested, cultures were maintained at 5°C increments. Salinity was kept constant at the culture salinity used for each species. The range tested for each species is given in Table 10.

Salinity Experiments

In salinity experiments, tests were conducted at 5 °/oo intervals over the selected range for each species. Water of the desired salinities was prepared by dilution of artificial seawater (Instant Ocean Synthetic Sea Salts®, Aquarium Systems, Inc.) with distilled water. The stock solution had a salinity of 35 °/oo. To prepare medium with a higher salinity than stock, Instant Ocean Synthetic Sea Salts® were added to the stock solution. Salinity was measured with a hydrometer to ±0.5 °/oo. Temperature was kept constant at 25°C. The test ranges for each species are given in Table 10. Both upper and lower salinity 96 hr TL_{50} values were determined.

TABLE 10

RANGES OF TEMPERATURE AND SALINITY AND CONCENTRATION LEVELS OF TOXAPHENE TESTED FOR EACH SPECIES AND STAGE

Temperature		(°C)
Sesarma cinereum	all stages	25 - 40
Penaeus duorarum	all stages	25 - 40
Callinectes sapidus	S I - IV	25 - 40
Rhithropanopeus harrisii	all stages	25 - 40
Salinity		(°/oo)
Sesarma cinereum	S I	10 - 40
	S II, S III	5 - 45
	S IV	5 - 50
	Meg	0 - 55
Penaeus duorarum	Nauplius	20 - 50
	Protozoea	15 - 50
	Mysis	20 - 55
Callinectes sapidus	S I, S II	15 - 40
	S III	10 - 45
	S IV	15 - 45
Rhithropanopeus harrisii	S I	0 - 40
	S II, S III	0 - 45
Toxaphene		(ppb)
Sesarma cinereum	S I	0, 0.4, 0.5, 0.6
	S II	0, 0.01, 0.05, 0.1, 0.5, 1.0
	S III, S IV	0, 0.5, 1.0, 5.0, 10.0
	Meg	0, 5, 10

Toxaphene (Cont'd)

Penaeus duorarum	Nauplius, Mysis	0, 5, 10
	Protozoea	0, 0.5, 1.0, 5.0
Rhithropanopeus harrisii	S I	0, 10, 20, 30, 40, 50

Reduced Dissolved Oxygen Experiments

Four levels of dissolved oxygen were tested; 100% sat., 75% sat., 30% sat., and 10% sat. These oxygen levels were produced by passing regulated amounts of an air-nitrogen mixture over the culture dishes placed in large plastic bags. A beaker of water placed in each bag served as a measurement vessel. Oxygen levels in the measurement vessel were determined daily with an oxygen electrode (Galvanic Cell Oxygen Analyser, Precision Scientific Co.) which was calibrated by Winkler titration. Salinity and temperature were kept optimal for each test species.

Toxaphene Experiments

A stock solution with a concentration of 10 ppm in distilled water was prepared using an emulsified concentrated preparation (available from Southern Mill Creek Products, South Miami, Florida). Specifications for the concentrate are given in Materials and Methods, Fish. Test solutions were prepared by adding the requisite amount of the stock solution to medium of the optimal salinity for each test species to produce the desired concentration. Concentration levels to be tested were determined in screening tests. All tests were run at the optimal temperature for the test species. Animals were introduced immediately after solutions were prepared. The levels tested for each species are given in Table 10.

Glassware used for these tests was segregated from that used in all other parts of the study. These tests were conducted in a separate independent laboratory module to avoid any possibility of contamination.

Upon completion of the bioassay studies reported herein, a contract modification was negotiated to test the concentration of Toxaphene in simulated bioassay tests without animals. Three concentrations were prepared in the same manner as for bioassay tests in 1 liter Pyrex® culture bowls. The larger bowl size was necessitated by the sample volume required for analysis. A separate bowl was prepared for each sampling time. Analyses were made 3 hr., 48 hr. and 96 hr. after preparation of the solutions. The samples were extracted with hexane and the extract analyzed by gas chromatographic methods.

Since the concentration of Toxaphene recovered was less than expected, a subsequent test was conducted to develop a Toxaphene budget to account for all Toxaphene as one concentration level. The solution was prepared

in the usual manner. The container was a larger volume glass vessel to preclude possible errors in preparation of replicate solutions. Samples were taken in the same manner as described in the previous section concerning tests on fish species.

Interaction Tests

Five combinations of factors were tested: temperature-reduced dissolved oxygen, salinity-reduced dissolved oxygen, temperature-Toxaphene, salinity-Toxaphene, and reduced dissolved oxygen-Toxaphene. Conditions were established and maintained in the same manner as described above for the acute tolerance tests.

Levels for each parameter were selected to be sublethal on the basis of the acute tolerance tests, ranging from the optimal level to just below the 96 hr TL_{50} level. Each experiment was conducted at two (in a few cases three) levels of each parameter with all possible combinations.

In most tests there were two replicates of 20 animals each or a total of 40 animals at each test level. In a few tests, four replicates of 10 animals each were used. In tests with *Penaeus duorarum*, some experiments involved four replicates of 20 animals each for a total of 80 animals.

Specimens for histopathological study were preserved in 7% formalin in tap water with calcium carbonate buffer. The sections were stained with eosin-hematoxylin, a general stain. Selected slides were then examined for histopathological abnormalities. Control animals served as a basis for morphology.

Data Analysis

TL_{50} values after 96 hr. were determined in the acute tolerance tests by the graphical method of Doudoroff, *et al*. (1951, Anon., 1960) with the data for replicates pooled.

The data for replicates within each experiment were tested for homogeneity with the χ^2 test. The data for replicates was then pooled and the differences between test conditions evaluated by χ^2 tests. The data for control conditions is the best available data concerning the survival rates one can expect under optimal conditions for these animals which have a natural mortality greater than zero under natural conditions.

The mortality rates of all stages of each species were compared with a χ^2 test. Interspecific comparisons were not attempted because the numbers of stages of the several species varied. If this had been attempted the number of comparisons would have been astronomical.

The results of each interaction test was subjected to a 2-way classification analysis of variance test to define significant interaction effects. This test determines whether there is a statistically signifi-

cant differences between the sum of the effects for each variable acting alone and the effect of the variables acting simultaneously. The percent mortality data was transformed by the $\sin^{-1}\sqrt{M/100}$ function as suggested by Bartlett (1957) for probabilities or proportions with binominal variance. Percent mortalities of 0 and 100 were transformed by the method described in Snedecor with Cochran (1968) to correct for bias at extreme probabilities.

Synergism is defined here as an excess of mortality when the variables are acting together versus when acting alone, i.e. the effect is more than additive.

There is considerable variability in the number of deaths per day under given conditions. This variability is infrequently significant at the 95% level when tested by χ^2-tests except in Penaeus. In most cases where significant differences were obtained, these differences were significant on one day only, indicating differences in timing of death rather than different responses. This reflects the problems of infrequent observations (relative to the duration of the test) and small sample size. In the case of Penaeus, under extreme conditions in certain tests, nauplii and protozoea showed significant differences in mortality between replicates that cannot be discounted as a product of observation procedure and sample size. In summary, there are only a few cases where replicates differed in response to a given set of conditions and these may be examples of the 1 in 20 chance that a difference will occur within a single population. Therefore, the data for replicates has been pooled before analysis for differences in mortality between different test conditions.

The 96 hr temperature TL_{50} for all stages of S. cinereum ranged from 36.3 to 37°C. For stage II and Meg there was no significant difference between the mortality rate at 25 and 35 C although the rate of mortality was always higher at 35 C than at 25 C. The lower salinity TL_{50} for 96 hr ranged from 7.3 - 12.8 °/oo for all zoeal stages and was less than 1 °/oo for the megalopa, while the upper salinity TL_{50} for 96 hr ranged from 36.5 to 52.0 °/oo (including megalopa). There was no consistent trend in lower salinity 96 hr TL_{50} but the upper salinity 96 hr TL_{50} increased during development from stage I zoea to megalopa. The range of salinity over which no significant difference in mortality occurred was 15 to 35 °/oo for zoea I, 10 to 40 °/oo for zoea II and III and 5 to 50 °/oo for the megalopa. For stage IV all comparisons were significant, but the range of acceptable salinities for high survival is 10 to 40 °/oo. Thus while there was no uniform trend in 96 hr TL_{50} with advancing development, there was an increase in the optimal salinity range. The 96 hr TL_{50} for reduced dissolved oxygen concentration ranged from 49.0 to 57.5% saturation. These values are of low precision because the test interval (30% sat. to 75% sat.) was rather broad. There was no significant difference between the mortality rates at 75 and 100% saturation except in stage II. At 30% saturation mortality was total after 24 hours in stages I and IV, after 48 hours in stage III, after 96 hours for the megalopa. Only two zoeae survived after 96 hours at 30% saturation in stage II. The 96 hr Toxaphene TL_{50} was 0.054 ppb for stage I zoea, increased about tenfold to 0.76 ppb for stage II zoea and 0.74 ppb for stage III zoea and increased about tenfold again to 6.8 ppb for stage IV zoea and 8.4 ppb for the megalopa. Percent survival versus concentration at 96 hr is shown for each stage tested in Figure 1. In stage I there was no significant difference in mortality at all concentrations from 0.00 to 0.05 ppb, in stages II and III (significant on day 3 only) from 0.0 to 0.5 ppb and in stage IV and megalopa, from 0.0 to 5.0 ppb. However there was in every case higher mortality in the presence of Toxaphene than in the control. The 96 hr TL_{50} values are summarized in Table 11.

The temperature-reduced dissolved oxygen interaction test showed no significant interaction effect for stage I zoeae or megalopae. For stage II zoea, percent mortality increased markedly at the highest temperature (34 C), but there was no effect of reducing the oxygen concentration. The difference in mortality at 34 C in the acute temperature test and the interaction test is attributed to the fact that the larvae were derived from different females in the two tests. For stages III and IV, there was no significant synergistic effect although the mortality when both parameters were extreme was higher than expected. In salinity-reduced dissolved oxygen tests there were no significant differences at any condition for any larval stage. In stage III, IV and megalopa there was a higher mortality when both parameters were extreme than was expected. In the megalopa there was an effect of salinity but not reduced dissolved oxygen. The data for interaction tests are summarized in Table 12.

TABLE 11.

TL_{50} VALUES AT 96 HR FOR EACH STAGE OF Sesarma cinereum

Stage	Temperature (°C)	Lower Salinity (°/oo)	Higher Salinity (°/oo)	Reduced Dissolved Oxygen (% sat.)	Toxaphene (ppb)
I	37.0	12.8	36.5	55.0	0.054
II	37.0	7.9	42.0	50.5	0.760
III	36.8	7.3	41.8	52.3	0.740
IV	36.3	8.7	46.0	49.0	6.8
Meg.	37.0		52.0	57.5	8.4

The temperature-Toxaphene tests show a significant synergistic effect for zoeal stages I and IV. The results for megalopae are anomalous, showing better survival when Toxaphene is present than in the controls. The difference is statistically significant at the 95% confidence level. This test should be repeated. The salinity-Toxaphene interaction tests also show a striking synergistic effect of high salinity and Toxaphene for stage I, with trends suggesting synergism in stages III, IV, and megalopa. For stage II there was no significant difference in mortality between any conditions in the test. In reduced dissolved oxygen-Toxaphene tests there was a significant synergistic effect in stages II and IV. The results for

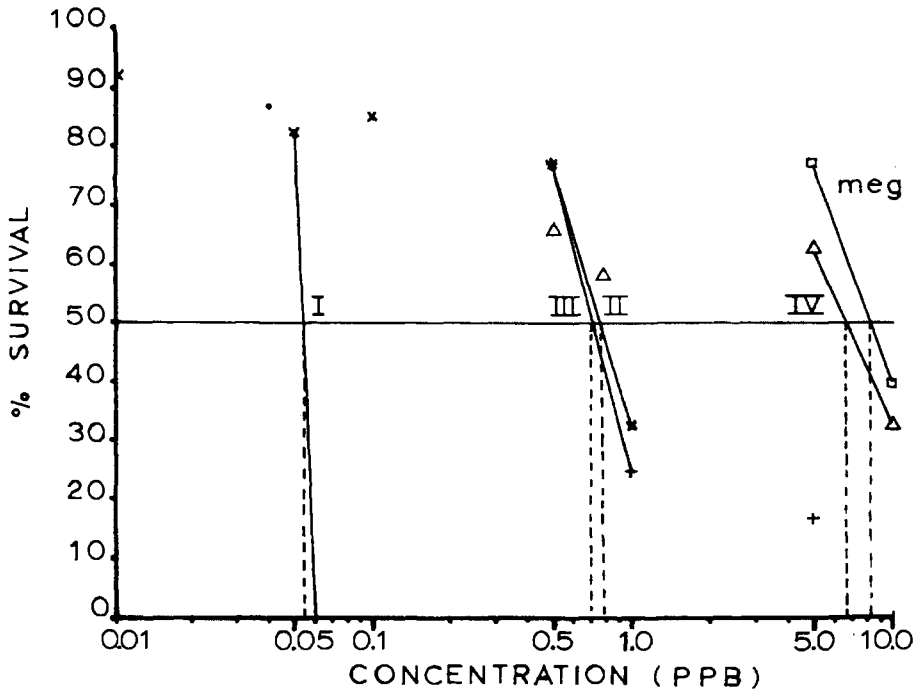

Figure 1. Percent survival versus Toxaphene concentration after 96 hr. exposure for the five zoeal and one megalopal stages of Sesarma cinereum.

• Stage I + Stage III □ Megalopa
x Stage II △ Stage IV

megalopae are anomalous. In this case mortality was significantly greater at 100% saturation than 75% saturation regardless of Toxaphene concentration which suggests an antagonistic effect. Further, mortality was significantly higher when Toxaphene was absent than at a Toxaphene concentration of 5 ppb. This result may be due to an error in data collection and the experiment should be repeated. The data for all interaction tests are summarized in Table 12.

TABLE 12.

PERCENT MORTALITY AFTER 96 HOURS IN INTERACTION TESTS FOR *Sesarma cinereum*

Stage I

		Temperature (°C)			Salinity (°/oo)		
		25	31	34	25	31	34
Reduced Dissolved Oxygen (% sat.)	75	1.25	6.75	6.25	2.50	6.25	8.75
	100	3.75	6.75	2.50	2.50	5.00	5.00

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	25	34	75	100
Toxaphene (ppb)	0.0	0.0	10.0	10.0	27.5	0	0
	0.05	0.0	62.5	17.5	100.0	5	0

Stage II

		Temperature (°C)			Salinity (°/oo)	
		25	31	34	30	40
Reduced Dissolved Oxygen (% sat.)	75	25.0	16.25	38.75	5.0	17.5
	100	20.75	13.75	35.00	10.0	20.0

TABLE 12 (continued)

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	30	40	75	100
Toxaphene (ppb)	0.0	2.5	22.5	7.5	0.0	20.0	2.5
	0.5	15.0	70.0	20.0	15.0	87.5	22.5

Stage III

		Temperature (°C)		Salinity (°/oo)	
		25	35	30	40
Reduced Dissolved Oxygen (% sat.)	75	25.0	77.5	10.0	57.5
	100	10.0	30.0	7.5	25.7

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	30	40	75	100
Toxaphene (ppb)	0.0	2.50	40.00	22.5	32.5	27.5	22.5
	0.5	2.50	67.75	22.5	45.0	32.5	10.0

TABLE 12 (continued)

Stage IV

		Temperature (°C)		Salinity (°/oo)	
		25	35	30	40
Reduced Dissolved Oxygen (% sat.)	75	32.5	77.5	35.0	47.5
	100	17.5	30.0	37.5	22.5

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	30	45	75	100
Toxaphene (ppb)	0	35.0	47.5	27.5	37.5	32.5	22.5
	5	27.5	80.0	40.0	85.0	100.0	32.5

Megalopa

		Temperature (°C)		Salinity (°/oo)	
		25	35	30	50
Reduced Dissolved Oxygen (% sat.)	75	15	30	12.5	47.5
	100	10	30	17.5	45.0

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	30	50	75	100
Toxaphene	0	17.5	17.5	10.0	40.0	7.5	25.0
	5	2.5	10.0	17.5	77.5	5.0	15.0

Interstage comparisons for S. cinereum revealed that there was a significantly different response to salinity and temperature for stage I versus all other stages and for stages III, IV and megalopa. The response to Toxaphene was significantly different for stage I versus all stages and stages II and III versus stage IV and megalopa.

The 96 hr temperature TL_{50} for P. duorarum was 36.3 - 36.5°C for naupliar, protozoeal and mysis stages. There was no significant difference in mortality between 25 and 35°C in the mysis. The lower salinity TL_{50} at 96 hr was 19.5 - 23.5 °/oo, the upper salinity TL_{50} at 96 hr was 47.0 - 51.0 °/oo with a distinct increase from protozoea to mysis. There was no significant difference in mortality from 25 to 45 °/oo for the nauplius, from slightly above 20 to 45 °/oo for the protozoea, and from 25 to 50 °/oo for the mysis. The 96 hr reduced dissolved oxygen TL_{50} was 43.5 - 54.8% saturation. There was no significant difference in mortality between 75 and 100% saturation. Mortality at 30% saturation was not total but always greater than 75%. The 96 hr Toxaphene TL_{50} decreased from 2.2 ppb for nauplii to 1.4 ppb for mysis. Percent survival versus concentration at 96 hr is shown in Figure 2 for each stage tested. There was a significant difference in mortality between controls and experimental animals at all Toxaphene concentrations. These TL_{50} values are summarized in Table 13.

TABLE 13.

TL_{50} VALUES AT 96 HR FOR THE LARVAL STAGES OF Penaeus duorarum

Stage	Temperature (°C)	Lower Salinity (°/oo)	Upper Salinity (°/oo)	Reduced Dissolved Oxygen (% sat.)	Toxaphene (ppb)
nauplius	36.5	22.8	47.0	48.0	2.2
protozoea	36.3	19.5	47.3	43.5	1.8
mysis	36.5	23.5	51.0	54.8	1.4

The temperature-reduced dissolved oxygen test showed distinct synergistic effects in the mysis, and no synergism in the other stages. Significant interaction of salinity and reduced dissolved oxygen was not observed; however there was an increase in mortality at high salinity-reduced dissolved oxygen in every stage.

There was a significant interaction at every stage in temperature-Toxaphene tests. A significant synergism of salinity and Toxaphene was ob-

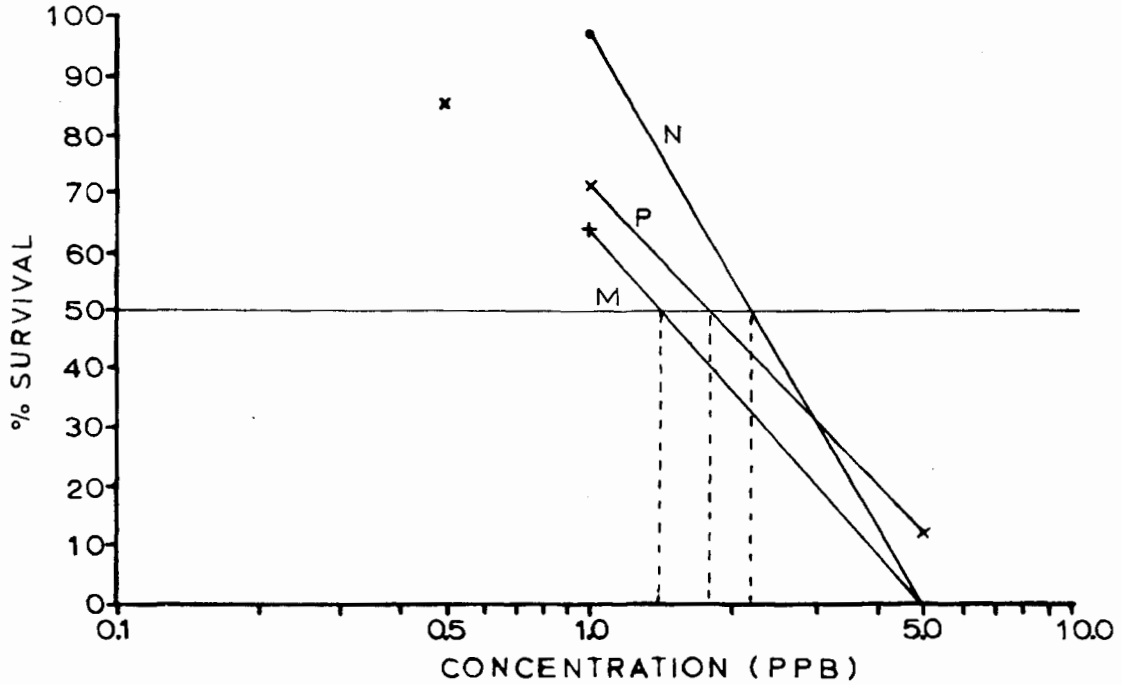

Figure 2. Percent survival *versus* Toxaphene concentration after 96 hr. exposure for the three larval stages of *Penaeus duorarum*.

o nauplii x protozoeae + mysis

served in the mysis stage. The nauplius stage showed significant mortality only when Toxaphene was present. At reduced oxygen levels a synergistic effect was not observed. The data for interaction tests are summarized in Table 14.

TABLE 14.

PERCENT MORTALITY AFTER 96 HOURS IN INTERACTION TESTS FOR *Penaeus duorarum*

nauplius

		Temperature (°C)		Salinity (°/oo)	
		25	35	35	45
Reduced Dissolved Oxygen (% sat.)	75	0.0	77.5	7.5	15.0
	100	5.0	42.5	0.0	10.0

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	35	45	75	100
Toxaphene (ppb)	0.0	10.0	32.5	0.0	0.0	0.0	0.0
	1.0	20.0	100.0	17.5	15.0	2.5	5.0

protozoea

		Temperature (°C)		Salinity (°/oo)	
		25	35	35	45
Reduced Dissolved Oxygen (% sat.)	75	30.0	40.0	12.5	25.0
	100	7.5	32.5	12.5	17.5

TABLE 14 (continued)

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	35	45	75	100
Toxaphene (ppb)	0.0	5.0	37.5	22.5	25.0	32.5	10.0
	1.0	27.5	97.5	22.5	40.0	87.5	15.0

Mysis

		Temperature (°C)		Salinity (°/oo)	
		25	35	35	50
Reduced Dissolved Oxygen (% sat.)	75	37.5	70.0	37.5	67.5
	100	35.0	37.5	32.5	42.5

		Temperature (°C)		Salinity (°/oo)		Reduced Dissolved Oxygen (% sat.)	
		25	35	35	50	75	100
Toxaphene (ppb)	0	15	25	17.5	32.5	12.5	15.0
	1	30	90	15.0	67.5	12.5	15.0

In interstage comparisons for P. duorarum, the responses of all stages to all parameters differed significantly even though 96 hr TL_{50} values were quite similar. This resulted from low survival under all conditions including optimal for the mysis stages, relative to the other stages and differences in the shape of the mortality curves for each stage.

Acute tests for C. sapidus were completed for stages I to IV for environmental parameters only. This resulted from problems encountered in obtaining ovigerous females and low survival rates of early stages. Low

survival rates of early larval stages are believed to be representative of survival rates in nature and not solely a reflection of inadequacies of culture technique.

The 96 hr temperature TL_{50} was 35.7 to 37°C for the first four zoeal stages of C. sapidus. There was no significant difference in mortality from 25 to 35 C except in Stage III. The lower salinity TL_{50} at 96 hr was 17.5 to 19.0 °/oo for stages I, II, and IV, but only 14.0 °/oo for stage III. This latter value is lower than expected. The upper salinity TL_{50} at 96 hr ranged from 37.0 °/oo for stage I and II zoeae to 41 to 42 °/oo for stage III and IV zoeae respectively. There was no significant difference in mortality from 20 to 35 °/oo for stage I and II, from 20 to 40 °/oo for stage III and from slightly above 30 to 40 °/oo for stage IV. The 96 hr reduced dissolved oxygen 96 hr TL_{50} was 56.0 to 60.5% saturation for all stages tested. There was no significant difference in mortality between 75 and 100% saturation except in stage I. The 96 hr TL_{50} values are summarized in Table 15.

TABLE 15.

TL_{50} VALUES AT 96 HR FOR THE FIRST FOUR ZOEAL STAGES OF Callinectes sapidus

Stage	Temperature (°C)	Lower Salinity (°/oo)	Higher Salinity (°/oo)	Reduced Dissolved Oxygen (% sat.)
I	37.0	17.5	37.0	56.0
II	36.0	18.3	37.0	60.5
III	35.7	14.0	41.0	59.0
IV	36.3	19.0	42.0	60.5

Interaction tests were completed for stage I through III zoea (excluding pairs involving Toxaphene). For stage I and II zoeae there was a synergistic effect between elevated temperature and reduced oxygen levels. For stage III, there was an effect noted only for temperature. In salinity-reduced dissolved oxygen tests, there was a synergistic effect in stage I but only an effect of salinity in stage III. The data for interaction tests are summarized in Table 16.

TABLE 16.

PERCENT MORTALITY AFTER 96 HOURS IN INTERACTION TESTS FOR THE FIRST THREE ZOEAL STAGES OF *Callinectes sapidus*

Stage I

		Temperature (°C)		Salinity (°/oo)	
		25	35	25	35
Reduced Dissolved Oxygen (% sat.)	100	7.5	35.0	5.0	12.5
	75	25.0	100.0	27.5	67.5

Stage II

		Temperature (°C)		Salinity (°/oo)	
		25	35	30	35
Reduced Dissolved Oxygen (% sat.)	100	20.0	25.0	25	35
	75	27.5	77.5	30	60

Stage III

		Temperature (°C)		Salinity (°/oo)	
		25	35	30	40
Reduced Dissolved Oxygen (% sat.)	100	25.0	62.5	22.5	40.0
	75	25.0	65.0	37.5	55.0

In interstage comparisons for *C. sapidus*, the response to salinity differed between all four stages tested. The response to temperature was the same for stages I and III. The response of stage IV to reduced dissolved oxygen was significantly different from the other stages.

Ovigerous R. harrisii were scarce during the course of this study, perhaps as a result of the bi-annual severe drought in southern Florida. Temperature tests were completed for all stages. The 96 hr temperature TL_{50} was 37.0 to 37.3°C in every case. There was no significant difference in mortality between 25 and 35°C except in stage III. Salinity tests were completed only for stages I to III. The lower salinity TL_{50} at 96 hr does not exist for stage I zoea and lies somewhere between 0 and 5 °/oo for stages II and III. Insufficient test concentrations in this salinity range preclude a more exact determination of the lower salinity 96 hr TL_{50}. The 96 hr upper salinity TL_{50} was 37 °/oo for stage I, 47.5 °/oo for stage II and 42.5 °/oo for stage III. There was no significant difference in mortality between 0 and 35 °/oo in stage I and between 5 and slightly less than 40 °/oo in stages II and III. The 96 hr reduced dissolved oxygen TL_{50} was 45% for stage I, and 41.0% for stage II, the only stages tested. There was no significant difference in mortality between 75 and 100% saturation for stage I, but significant differences were found be tween 30 and 75% saturation and 10 and 30% saturation for both stages. The 96 hr Toxaphene TL_{50} for stage I was 43.75 ppm with no other tests completed (Figure 3). There was no significant difference in mortality over the range 0.0 to 40.0 ppb Toxaphene. The 96 hr TL_{50} values are summarized in Table 17.

TABLE 17.

TL_{50} VALUES AT 96 HR FOR EACH STAGE OF Rhithropanopeus harrisii

Stage	Temperature (°C)	Lower Salinity (°/oo)	Upper Salinity (°/oo)	Reduced Dissolved Oxygen (% sat.)	Toxaphene (ppb)
I	37.0	does not exist	37.0	45	43.75
II	37.3	(2.5)	47.5	41.0	288-345*
III	37.0	(2.5)	42.5		290-430*
IV	37.0	does not exist	35		
Meg	37.0				

*Based on preliminary screening tests

The only interaction test completed was salinity-reduced dissolved oxygen for stage I. There was no evidence of combined action of these parameters. These data are summarized in Table 18. Survival was signi-

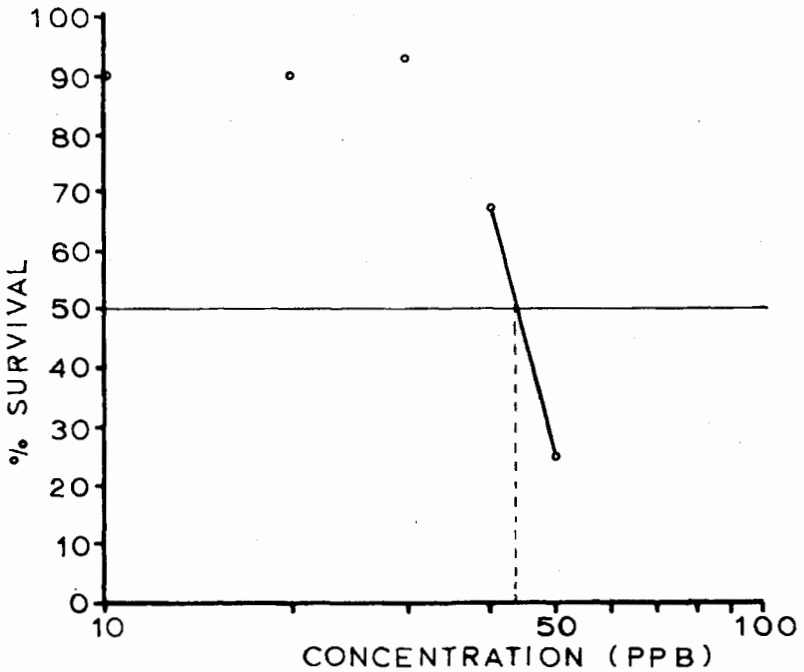

Figure 3. Percent survival versus Toxaphene concentration after 96 hr. exposure for zoeal stage I of Rhithropanopeus harrisii.

ficantly better at 34 $^{o}/oo$, 100% saturation than at any other salinity and at the same salinity in the acute test for salinity.

TABLE 18.

PERCENT MORTALITY AFTER 96 HOURS IN AN INTERACTION TEST FOR Rhithropanopeus harrisii

		Salinity ($^{o}/oo$)		
		25	31	34
Reduced Dissolved Oxygen (% sat.)	75	10.00	7.50	11.25
	100	6.25	3.75	0.00

Some preliminary screening tests were completed in addition to the above tests. A preliminary test of the effect of salinity on stage IV zoeae showed that the lower salinity 96 hr TL_{50} does not exist. The salinity range tested did not include the upper salinity 96 hr TL_{50} which exceeds 35 $^{o}/oo$. Two preliminary tests of Toxaphene on stage II zoea give 96 hr TL_{50} values of 288 ppb and 345 ppb. These tests are summarized in Table 17.

In interstage comparisons for R. harrisii, temperature is the only parameter for which a complete series of comparisons is possible. There was no significant difference in the response to temperature for any stage.

The data for the analysis of Toxaphene over time in simulated bioassay tests are presented in Table 19. The concentration at 3 hr was approximately 29.2% of the calculated value at a nominal concentration of 0.5 ppm and 89.6% at 0.1 ppm. In the other concentration (0.05 ppm) the assayed concentration exceeded the expected by about 100%. The reason for this aberrant result is not apparent.

In a separate experiment we determined the distribution of Toxaphene in the test system after 24 hr at a concentration of 0.50 ppm. The data is presented in Table 20. At 3 hr the Toxaphene concentration was 0.359 ppm, and at 24 hr it was 0.475 ppm. This increase in concentration at 24 hr was noted in several duplicate experiments to the one reported here. The explanation seems to be that the Toxaphene went into solution slowly. The previous test indicates that the concentration decreased to a level

TABLE 19.

ASSAYED TOXAPHENE CONCENTRATION IN SIMULATED BIOASSAY TEST WITH GLASS CULTURE VESSELS

Nominal Concentration (ppm)	Calculated Concentration (ppm)	Assayed Concentration (ppm) Days 0	2	4
0.50	0.479	0.140	0.130	0.058
0.10	0.096	0.086	0.075	0.078
0.05	0.048	0.099	0.210	0.084

approximately equal to that at 3 hr, most probably by adsorption to the glass. At 24 hr, 13 µg were present in particulate form, and 10 µg were adsorbed to the glass. No absorbed Toxaphene was observed. The total Toxaphene recovered was 892.1 µg or 93.1% of the amount introduced. Considering the number of assays involved with their attendant errors, and the crude nature of the procedure to estimate the particulate fraction, this percent recover is very complete.

TABLE 20.

TOXAPHENE BUDGET AT 24 HR IN SIMULATED BIOASSAY TEST WITH GLASS CULTURE VESSELS

Fraction	µg
soluble	869.1
particulate	13.0
adsorbed	10.0
absorbed	0.0
TOTAL	892.1

ug Toxaphene introduced	958 µg
% recovered	93.1 %

The lack of conformity between the measured concentration at 3 hr in the concentration-time study and the Toxaphene budget test at a nominal concentration of 0.5 ppm is very puzzling. The anomalous results in the concentration-time study may provide an explanation since the percentage in solution at this nominal concentration was surprisingly low. We place greater confidence in the second test because the data was repeatable in replicate tests. The lack of conformity may also derive from the use of one liter culture bowls in the concentration time study versus larger volume glass containers with a different configuration and hence surface to volume ratio in the budget test.

TABLE 21.

SUMMARY OF CRUSTACEAN SPECIMENS
EXAMINED FOR HISTOPATHOLOGICAL STUDY

Species	Stage	Number of Control Animals Examined	Number of Experimental Animals Examined	Toxaphene Concentration (ppb)
Sesarma cinereum	I	3	2	0.03
			2	0.04
	II	6	10	0.04
	III	6	5	0.04
Callinectes sapidus	I	3	1	0.0005
			1	0.00001
	II	7	6	0.01
Rhithropanopeus harrisii	I	8	3	10.0
	II	7	2	100.0
			2	200.0
	III	10	2	400.0
	IV	10	3	200.0

Histopathology

Table 21 specifies the species, stage, number of animals, and exposure levels for those slides examined. In stage I of *S. cinereum*, the hepatopancreas had vacuolated granulated cells in one specimen coupled with contraction of the intestine. The other specimens showed no noticeable effects. In stage II, 20% of the specimens showed no effects, 50% had vacuolated granulated hepatopancreas cells, and 30% exhibited

necrotic spaces. Four of these specimens exhibited intestinal contraction, one a slight dilation, and five no apparent effect. In stage III, all specimens exhibited extensive degeneration of the hepatopancreas and 80% showed contraction of the intestine.

Stage I C. sapidus larvae showed no histological changes compared to controls at either 5×10^{-4} or 1×10^{-5} ppb Toxaphene. In stage II, hepatopancreas damage similar to that found in S. cinereum was noted in 50% of the specimens. The exposure concentration for stage II was 1×10^{-2} ppb, several orders of magnitude higher than the exposure level for stage I.

The same histological effects were observed in stage I, II, and IV R. harrisii larvae. In stage I, one specimen also exhibited necrosis of the intestine and sloughing of the stomach epithelium. Stages II and IV exhibited damage to the nervous tissue with irregular spaces apparent between the fibers.

In all three species, deposition of orange-brown pigment has been noted in body spaces, especially along the intestine. This pigment deposition is not observed in control animals. The pigment is not soluble in water, alcohol, or xylene.

No histological changes were observed in other organs of the zoeae. There was no evidence of bacterial or fungal invasion in the Toxaphene exposed animals.

DISCUSSION

The 96 hr temperature TL_{50} for all stages of all species tested ranged from 35.7 to 37°C. This range is comparable to upper lethal temperature limits for a variety of warm acclimated organisms (see for example Prosser, 1961). In the experiments described here the acclimation temperature was in every case 25°C, or about the optimal temperature for each species. No data are available in the literature on the upper lethal limits for animals acclimated at lower or higher temperatures. One would expect the values for those stages of Callinectes sapidus not tested to fall within the above range.

Costlow, Bookhout, and Monroe (1960) obtained complete development of S. cinereum at 30°C, 20 and 25 °/oo, but not at salinities above and below this range. Even at these salinities, the percent reaching the juvenile stage at 30°C was less than 10 percent. A similar result was obtained for R. harrisii though the range of salinities permitting complete development and the level of success, were both much greater (Costlow, Bookhout and Monroe, 1966). This is not surprising in this very eurytolerant species.

The effect of temperatures on larvae of P. duorarum has recently been studied by Thorhaug, Devany, and Murphy (1970). Development of nauplii to protozoea occurred only from 24 to 31.5 C although survival was high for a 10 hour period from 15 to 37°C. The median lethal limit for protozoea I and III was 37.0 to 37.8 C and 35.7 to 36.7 C respectively which agrees favorably with our results although their tests were of short duration (equal to the intermolt duration of each stage, generally 18 to 24 hours). The upper lethal limit for the mysis stage was 36.9 to 37.4 C, again very similar to our result.

The species tested differ markedly with respect to the salinity range in their respective habitats. S. cinereum is an estuarine species which spends a major portion of its life above the waterline though near salt water. However, like other semi-terrestrial crabs, it must return to water for reproduction (Williams, 1965). The larvae have a lower 96 hr TL_{50} ranging around 10 °/oo which is near the level at the upstream limit of natural distribution of adults. The upper salinity limit increased from 36.5 °/oo to 52 °/oo from stage I zoea to the megalopa. Larvae flushed from an estuary into the sea would therefore be capable of surviving and developing and could reinvade the estuary as megalopae or juveniles. Complete development to the juvenile for S. cinereum has been observed at 20 and 26.5 °/oo but not at 12.5 and 31.1 °/oo at 20, 25 and 30°C (Costlow, Bookhout, and Monroe, 1960).

The life cycle of P. duorarum has been reviewed in Williams (1965). Early juveniles migrate into estuaries where growth is rapid. The adults migrate out of the estuary and spawn in open waters. The larval stages are passed in the lower reaches of the estuary or offshore. The lower salinity limit was 19.5 °/oo or above, commensurate with the normal dis-

tribution of these larvae. The upper salinity limit was very high at ca 50 $^{o}/oo$, far in excess of concentrations apt to be encountered in nature.

C. sapidus migrates upstream during the juvenile period and grows to adult size in brackish or fresh waters. When sexual maturity is reached, it migrates in the reverse direction into regions where salinities exceed 20 $^{o}/oo$ where eggs hatch (Van Engel, 1958). It has previously been demonstrated that eggs of C. sapidus do not hatch at salinities lower than about 15 $^{o}/oo$ and complete development only occurs at salinities above 20 $^{o}/oo$ (Sandoz and Rogers, 1944; Costlow and Bookhout, 1959). This salinity is somewhat higher than the lower lethal limit based on a TL_{50} at 96 hr of 17.5 to 19.0 $^{o}/oo$ (and only 14.0 $^{o}/oo$ for stage III) reported here. However, it was not determined as a property of the contract research whether larvae which survived after 96 hours could complete development to the juvenile at these low salinities. The upper salinity limits of 37 to 42 $^{o}/oo$ are slightly higher than normal seawater and probably exceed levels ever encountered by larvae in nature.

Costlow (1967) investigated the effects of temperature and salinity on the development of the megalopa of C. sapidus. The megalopa developed to the juvenile over the range of 15 to 30°C at suitable salinities and over a range of 5 to 40 $^{o}/oo$ at suitable temperatures. Development at 5 $^{o}/oo$ occurred only at 25 and 30°C and at 40 $^{o}/oo$ at all temperatures tested. No data is available from this study for comparison.

R. harrisii is a brackish water crab which as an adult ranges from virtually fresh water to mid salinity regions, although it is capable of surviving in normal seawater. For stages I to IV zoea, the lower salinity limit either does not exist or is well below 5 $^{o}/oo$. The upper salinity limit was 37 $^{o}/oo$ or above for all zoeal instars. Costlow, Bookhout and Monroe (1966) observed complete development for 8% of the larvae cultured at 25°C, 40 $^{o}/oo$, and 22% of the larvae cultured at 25°C, 35 $^{o}/oo$.

It has been reported in numerous studies that death under adverse conditions is frequently associated closely with molting (see for example Roberts, 1971a). It would seem that when the larva molts, its defenses are lowered making it more susceptible to stress conditions. In these tests, the same effect was noted in cases where molting occurred during the course of the test. However, in the majority of the tests, molting did not occur during the course of the test.

Because of the above observation, one must consider whether TL_{50} determinations after 96 hr are meaningful for these organisms. The TL_{50} value at 96 hr would presumably be higher than is actually the "true" value, that is the animals appear more tolerant than they really are. Analysis of this point was not required by contract. The data of Costlow, et al. (1960, 1962, 1966) is based on a different approach and encompasses this consideration; however, direct statistical comparisons of their data with that presented here is not possible. The permissible

ranges for temperature and salinity derived from our 96 hr TL_{50} determinations are broader than those based on the ability of larvae to complete development. This supports the above contention.

The reduced dissolved oxygen TL_{50} at 96 hr was near 50% saturation for S. cinereum and P. duorarum which are moderately tolerant species with regard to many parameters. C. sapidus, the least tolerant species had a reduced dissolved oxygen 96 hr TL_{50} approaching 60% saturation, whereas the most tolerant species, R. harrisii, had a value 41-45% saturation for all stages tested. The trend of decreasing tolerance of larvae to reduced dissolved oxygen with increasing fragility of the larvae is quite reasonable. No data are available in the literature for comparison.

S. cinereum was very sensitive to Toxaphene in zoeal stage I, increased in tolerance by ten fold in stages II and III, and ten fold again in stages IV and megalopa. The same trend is suggested by the data for R. harrisii. However, R. harrisii was approximately 1000 times more tolerant than S. cinereum in stage I and about 400 times more tolerant in stages II and III. Complete data are not available for C. sapidus; however a few preliminary experiments suggest that this species is much less tolerant than S. cinereum. Values for P. duorarum in all stages were slightly higher than values for stage II and III S. cinereum. There was a slight decrease in tolerance as the larvae developed from the nauplius to the mysis stage.

In the temperature-reduced dissolved oxygen interaction tests, there was no synergistic effect for any stage of S. cinereum. For C. sapidus, however, there was a synergistic effect in stages I and II, though surprisingly, not in stage III. A synergistic effect of temperature-reduced dissolved oxygen was observed only in the mysis stage of P. duorarum.

The results for S. cinereum in salinity-reduced dissolved oxygen tests showed the same trend with no synergistic effects for any stage. For C. sapidus there were large synergistic effects for stage I only. The only data for R. harrisii showed no synergistic effect for stage I. There was no statistically significant evidence of synergistic action on all stages of P. duorarum.

Data for interaction tests involving Toxaphene are available for S. cinereum and P. duorarum. There was a significant interaction of temperature and Toxaphene for all stages of P. duorarum and for stages I and IV of S. cinereum. Similarly, there was a synergistic effect of elevated salinity for stage I of S. cinereum and the mysis stage of P. duorarum. There was also a synergistic effect of reduced dissolved oxygen for zoeal stages II and IV of S. cinereum. As noted above, the results for the megalopa are exactly the opposite. This antagonistic effect is suspect. It is suggested that this test be repeated. A synergistic effect of reduced dissolved oxygen was also noted for the mysis of P. duorarum but not earlier stages.

No tests were conducted on the interaction effects of temperature and salinity. Costlow, Bookhout and Monroe (1960, 1966) have shown that there are such effects for all stages of S. cinereum and R. harrisii. Costlow (1967) reported the same types of effects for the megalopa of C. sapidus.

The present results indicating a synergistic interaction between two test parameters could reflect one of three processes. The simultaneous action of two parameters may accelerate the rate at which the response is achieved with no change in the final degree of response (ultimate lethal dose). Alternatively, the simultaneous action of two parameters may lead to a change in the ultimate lethal dose which exceeds the sum of independent responses to each parameter with no change in the time to achieve the ultimate lethal dose. Finally, both rate and ultimate lethal dose may be affected. These alternatives cannot be distinguished from the present tests because the ultimate lethal dose cannot be estimated from the data. It is doubtful that the TL_{50} equals the ultimate lethal dose, especially since the most sensitive period (ecdysis) in the larval period generally does not occur within the test period.

The evidence presented here indicates that in establishing permissible levels of Toxaphene in natural environments, consideration must be given to the effects of environmental factors such as temperature, salinity, and oxygen concentration, especially at the extremes of the range tolerated by the species which will be exposed to the pesticide. On the basis of available data and the refractory nature of C. sapidus larvae in culture, one would expect this species to be least tolerant of these tested with significant synergistic effects.

The analyses of Toxaphene concentration indicate that 75 to 90% of the Toxaphene was in solution (excluding suspect assays). The concentration of Toxaphene in solution increased from 3 hr to 24 hr after solution preparation and then decreased slowly until the end of the test. This would indicate that TL_{50} estimates may be 10 to 25% higher than the actual TL_{50}'s. Correction of the TL_{50} values is not warranted as the basis of the available analysis data. These results point out the necessity of frequent chemical analyses with every bioassay test on the actual test solutions.

The only histological changes observed in preliminary studies for Toxaphene-exposed S. cinereum and C. sapidus were a contraction of the intestine and progressive vacuolation and necrosis of the hepatopancreas. These conditions may develop more rapidly in older than younger zoeae; however, an inadequate number of larvae have been examined to be certain on this point. The same conditions were observed with R. harrisii. In addition, R. harrisii showed some deterioration of the nervous system.

During exposure tests, it was observed that animals in high Toxaphene concentrations became disoriented, swam slower, and frequently flexed and extended the telson. This telson flip response is a common response

of decapod larvae to stressful conditions (Roberts, 1971b) and not a specific response to Toxaphene. There was no histological evidence of damage to the nervous system except in *R. harrisii*.

The evidence presently available suggests that the site of action of Toxaphene is the digestive system, in particular the hepatopancreas. It is desirable to examine additional specimens exposed for long periods to lower concentrations or specimens exposed to high concentrations for shorter times. In this way it would be possible to follow the course of hepatopancreas degeneration.

GENERAL DISCUSSION

The results of temperature tolerance tests for juvenile fishes and all decapod larvae were in close agreement (96 hr TL_{50} = 35 to 37°C). As noted above, this coincides with values for numerous other warm acclimated organisms (Prosser, 1961). In contrast, bass larvae were slightly less resistant (96 hr TL_{50} = 33.5°C) and bass embryos still less tolerant (96 hr TL_{50} = 31.5°C).

The heated effluent from fossil fuel plants frequently reaches levels of 32-33°C (and sometimes 39-40°C) near the outfall, and dissipates slowly with distance from the outfall. This temperature is within the tolerance range of the species tested (at least for temporary exposures) except for bass eggs and larvae. Effluents closer in temperature to the lethal limit can be expected to cause considerable mortality.

Harder (1952a, 1952b) demonstrated that species in several phyla including Arthropoda (decapods) and Chordata (fishes) are capable of responding to gradients of environmental parameters by avoidance. Most of his work related to avoidance of salinity gradients, but he did conduct a few experiments with temperature gradients. It is likely that species used in the present tests have this capability although no studies of this potentiality were required under the present contract. Such avoidance of waters of adverse thermal levels would serve to prevent high mortalities but at the same time would restrict the volume of water available to the species for support of its populations.

The salinity range tolerated by all species corresponds to the salinity ranges within their respective distribution ranges or, in some cases, slightly exceeds the latter range. This latter observation can be explained in several ways. First, it may reflect the failure to consider the most sensitive periods for the stages tested as noted in each of the proceeding sections. Second, it may result from the inability of the organisms to compete with other animals when living in waters with salinities approaching the lethal limits. Third, it has been demonstrated that some decapod larvae avoid water with a salinity within the range acceptable for complete development but approaching the lethal limit (Scarratt and Raine, 1967; Roberts, 1971b). It is reasonable to expect the same thing to be true for species tested under this contract.

While oxygen availability is a limiting factor only in local areas and then rarely, it may become limiting in regions of primary and secondary pollution where BOD and COD are high. Based on the studies reported here, concentrations below 50 percent saturation at optimal temperature and salinity are lethal for decapod larvae, larval and

juvenile bass, and juvenile mullet. Bass embryos and juvenile pompano tolerate oxygen levels of 15.3% and 18% saturation respectively. There is a trend for species eurytolerant to other stresses to be slightly more tolerant of reduced oxygen concentrations than less eurytolerant species. There are significant synergistic effects with temperature and salinity which probably reflects the increased metabolic demands in meeting the challenge of extreme temperatures and salinities.

Avoidance of low oxygen concentrations has been tested in four species of fish by Whittmore, Warren, and Doudoroff (1960). Included in this study were late juvenile - early adult largemouth bass (Micropterus salmoides, 50-90 mm total length). This species avoided water with an oxygen concentration of 1.5 mg/l (15.8% saturation) but did not avoid concentrations of 3.0 mg/l (32.6% saturation) or above. Two other species tested (chinook salmon and coho salmon) exhibited avoidance at 4.5 mg/l (20.6% saturation) at 22.8°C and 3.0 mg/l (28.3% saturation) at 13.2°C. Bluegills responded in the same manner as largemouth bass. These authors concluded that these fishes avoided waters with oxygen concentrations higher than that concentration causing mortality within 24 hours. This point merits further investigation.

The fishes studied at all stages were much less tolerant of Toxaphene than either Sesarma cinereum, Rhithropanopeus harrisii or Penaeus duorarum. We suspect that Callinectes sapidus is much less tolerant than any other species tested. The degree to which fish are less tolerant than decapod larvae is much greater than indicated by direct comparison of TL_{50} values defined here because the values for fish are gross overestimates.

It has been shown that the sheepshead minnow (Cyprinodon variegatus) avoided water containing certain pesticides (Hansen, 1969) and salmon avoided heavy metal ions (Sprague, 1964). No similar studies have been reported in the literature for decapod larvae. It seems reasonable that some avoidance capability exists for the fish and decapods studied although tests of this hypothesis were not required under this contract. If this is true, it implies that habitat limitation might result from pesticide presence rather than increased mortality. Obviously this would not be possible for fish embryos and perhaps also sac-fry larvae. However, these stages are more tolerant than juveniles of largemouth bass.

Toxaphene has very low solubility in aqueous media. It enters the environment in a xylene carrier which is non-miscible with water. In preparing our test solutions a Toxaphene-xylene solution was used. The maximum amount of xylene which could have been present in the final test solutions was less than 5×10^{-8} ml/l at the highest Toxaphene concentration tested (50 ppb Toxaphene) assuming xylene remained in the aqueous solutions. No xylene control groups were tested. Xylene residues (and volatile hydrocarbons) evaporate rapidly and hence could have had little or no effect on our results. Better solution of Toxaphene would probably have been achieved by including a surfactant in solution preparation as suggested by Mount and Brungs (1966).

Although the plastic-lined vessels used to maintain fish have been demonstrated to have life support characteristics as good as or better than glass, they are not suitable for bioassay tests involving pesticides. Plastics rapidly ad- and absorb organic pesticides. Our tests suggest that 92% is sorbed within 24 hours and virtually 100% within 48 hours. As has already been pointed out the TL_{50} values obtained for fish are gross overestimates and hence not reported.

In many interaction tests, synergistic effects between Toxaphene and all environmental parameters were suggested by the data for crustaceans but in only a few cases were these effects statistically demonstrable. The failure to show statistical significance for decapod larvae is attributable to several factors: choice of test levels, number of replicates, number of test levels. More attention should be paid to statistical requirements to demonstrate synergism in experimental design.

REMEDIAL SITE ASSESSMENT DECISION – EPA Region 04

Site Name: DELRAY CHEMICAL COMPANY - ATLANTIC AVENUE

Alias(es):

City: DELRAY BEACH **County or Parish:** PALM BEACH **State:** FL

Refer to Report Dated: 02/27/2015 **EPA ID:** FLN000403223

Report Developed By: STATE **State ID:** 321756

Report Type: Preliminary Assessment (00X) #001 **Decision Date:** 03/25/2015

- [ ] **1. Further Remedial Site Assessment Under CERCLA (Superfund) is not required because:**
- [x] **2. Further Assessment Needed Under CERCLA.**
  Higher priority for further assessment
- [ ] **3. Remedial study/cleanup needed.**

Decision/Rationale:

The surficial aquifer system (Biscayne aquifer) is the primary source of drinking water in Palm Beach County and the site is in an area of moderate karst terrain and underlain by a karst aquifer. A population of 82,757, served by 74 PWS wells exists within a 4-mile TDL of the site. Given the discontinuous presence of any clay retarding layers, the surficial aquifer system is considered a single hydrogeologic unit. No previous investigation of the groundwater at the site was discovered during the file review. Therefore, based on the findings of the Preliminary Assessment and a review of EPA CERCLA Superfund criteria, the groundwater migration pathway is a pathway of concern, and a CERCLA Site Inspection (SI) is recommended.

Decision/Rationale (Continued):

Site Decision Made By: Corey Hendrix

Signature: COREY HENDRIX Digitally signed by COREY HENDRIX DN: c=US, o=U.S. Government, ou=USEPA, ou=Staff, cn=COREY HENDRIX, dnQualifier=0000025662 Date: 2015.06.17 13:54:04 -04'00'

Decision Date: 03/25/2015