HSWMR

Hazardous Substance & Waste Management Research, Inc.

2976 Wellington Circle West
Tallahassee, Florida 32309
Phone: (850) 681-6894
Fax: (850) 906-9777
www.hswmr.com

December 2, 2014

Mr. John Di Censo
Town Manager
Town of Surfside
9293 Harding Ave.
Surfside, FL 33154

Dear Mr. Di Censo:

This letter report represents my technical analysis and conclusions regarding sand samples collected from the beachfront at locations between 88th Street and 95th Street in the Town of Surfside on October 31, 2014 by LandScience, Inc. and analyzed by the Florida Spectrum Environmental Services laboratory report dated November 10, 2014. My conclusions are as follows:

- *for Total Recoverable Petroleum Hydrocarbons, all results were either below detection limits or were considerably less than the respective Florida Department of Environmental Protection (FDEP) residential Soil Cleanup Target Level based upon direct exposure considerations;*

- *chemical analysis of the sand samples for arsenic is consistent with natural background for this and other areas of coastal Florida, as indicated by a body of sampling data from a number of reputable sources. Such arsenic background ranges from less than 1 mg/kg to over 15 mg/kg in Miami-Dade County with a central tendency estimate of 5.2 mg/kg. Samples collected from both control sand locations and renourishment sand locations (2.39 mg/kg to 6.46 mg/kg) fall in the low to middle of the background range;*

- *for other metals, all results were either below detection limits (cadmium, mercury, silver) or were considerably less than the respective Florida Department of Environmental Protection (FDEP) default residential Soil Cleanup Target Levels based upon direct exposure considerations (barium, chromium, lead, selenium);*

- *for organochlorine pesticides, including common termiticides,, all results were either below detection limits (19 substances) or were considerably less than the respective Florida Department of Environmental Protection (FDEP) default residential Soil Cleanup Target Level based on direct exposure considerations (4,4'-DDT in one sample only);*

- *for polychlorinated biphenyls (PCBs), all results were either below detection limits (6 substances) or were considerably less than the respective Florida Department of Environmental Protection (FDEP) default residential Soil Cleanup Target Level based upon direct exposure considerations (PCB-1254 in one sample only);*

- *results of Synthetic Precipitation Leaching Procedure (SPLP) testing were either below detection limits (cadmium, mercury, selenium, silver), or were very low in the context of their applicable protective guidelines (arsenic, barium, chromium, lead); and,*

- *there are no significant health risks posed to children, to adults, or to pets by the observed background concentrations of petroleum hydrocarbons, arsenic, other metals, organochlorine pesticides, or PCBs in the beach sand.*

The technical bases for those conclusions are provided in detail in the following sections. In preparation of this analysis, I have reviewed the following information sources:

- Beach sand chemical testing data, Town of Surfside, from LandScience, Inc. and Florida Spectrum Environmental Services, Inc. as reported on November 11 2014 for sand samples collected October 31, 2014;

- Correspondence and supplementary material from Dr. Samir Elmir, Florida Department of Health in Miami-Dade, to Michael P. Crotty, Town Manager, Town of Surfside, dated May 14, 2014, regarding arsenic concentrations in beach sand at the Surf Club location (FDOH, 2014);

- Review of information and personal communication with Mr. Wilbur Mayorga, P.E., Chief, Environmental Monitoring and Restoration Division of the Miami-Dade County Department of Environmental Resources Management (DERM) regarding natural and anthropogenic (human-related) background arsenic concentrations in Miami-Dade County soil and sediment, including beach sand;

- Review of data from Kimley-Horn beach sand investigation (May, 2014) and associated Geosyntec correspondence;

- Scientific literature, technical reports on naturally occurring or anthropogenic arsenic concentrations in Florida soils and marine sediment/sand and health-based guidelines for potential exposures to selected analytes of interest to this study; and,

- My letter to Michael Crotty dated May 20, 2014. Portions of that letter are reproduced here for completeness.

My Summary and Conclusions at the end of this letter report are directed toward an evaluation of the extent to which the available data permit a conclusion regarding quality of renourishment beach sand on Town of Surfside beaches.

Data Presentation and Discussion

Laboratory analysis was performed on eight (8) samples of beach sand collected by LandScience on October 31, 2014, related to a beach renourishment project conducted in the Town of Surfside near the Surf Club. Six (6) composite sand samples, each consisting of 6 subsamples, were collected from areas where renourishment sand was placed in early 2014, and two (2) similar composite samples were collected from control locations located north (Haulover Park) and south (North Shore Open Space Park) of the renourishment area, as described by LandScience (2014). Sand samples were analyzed for "total concentrations", expressed in milligrams per kilogram (mg/kg) for the following analyte categories:

- Total Recoverable Petroleum Hydrocarbons (TRPH);
- Eight (8) RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver);
- 20 chlorinated hydrocarbon pesticides; and,
- Seven (7) polychlorinated biphenyl isomers (PCBs).

No substance in any sand sample, with the exception of arsenic, exceeded its Florida Department of Environmental Protection (DEP) default residential Soil Cleanup Target Level (SCTL), as shown on Table 1 (attached). Arsenic ranged from 3.8 to 6.46 mg/kg in the renourishment sand samples (mean 5.4 mg/kg), and from 1.8 to 2.39 mg/kg in the control sand samples. The DEP default residential SCTL for arsenic is 2.1 mg/kg. As discussed subsequently in this letter, the 2.1 mg/kg guideline assumes simultaneous oral, dermal, and inhalation exposure for 350 days/year and for 30 years, including both children and adults. That level represents a conservative, acceptable health-based target level with a reasonable margin of safety that is quite unlikely to underestimate risks. The present detected values were less than the values of 7.0 to 7.8 mg/kg previously reported for renourishment sand by Terracon (2014). The detected values in renourishment sand and control sand were in the range found on barrier islands in Miami-Dade County, and soils in the County.

Based on evaluation of the previous similar data for sand samples, the Florida Department of Health (FDOH) concluded that there was not a significant increased health risk related to exposure to arsenic in the beach sand, even assuming lifetime exposure (FDOH, 2014). The FDOH statement supplemented the earlier conclusions of Dr. Samir Elmir, Ph.D, P.E., Director of Environmental Health & Engineering Services for the Florida Department of Health in Miami-Dade. In addition, Mr. Wilbur Mayorga, P.E., Chief of the Environmental Monitoring and Restoration Division of the Miami-Dade County Department of Environmental Resources Management (DERM) has concluded that the test results are consistent with naturally occurring arsenic levels on the barrier islands in Miami-Dade County, which showed a Minimum Variance Unbiased Estimate (MVUE) of 5.2 mg/kg and a maximum of 15.1 mg/kg (Mayorga,

2004; Mayorga, 2014; Surfside, 2014). As noted in the following section, naturally occurring background is indicative of conditions that are geological in origin and do not represent human activities. These issues also were discussed in greater detail in my May 20, 2014 letter to Mr. Crotty.

Subsequent to my May 20, 2014 letter, an opinion letter on the arsenic subject was submitted by Geosyntec (2014). That letter identified additional analytical data for arsenic in 14 sand samples collected by Kimley-Horn (2014) at various locations from South Pointe to Haulover Inlet. Those sand samples excluded any locations on which the Surf Club renourishment sand had been placed within the Town of Surfside. Arsenic concentrations in those sand samples ranged from 2.0 to 11.0 mg/kg. Two of the May, 2014 Kimley-Horn locations were approximately coincident with control sand locations collected by LandScience in October, 2014. The Kimley-Horn samples exhibited greater arsenic concentrations at both locations in comparison to those reported by LandScience. Geosyntec concluded that the Kimley-Horn sand samples, as well as those collected by Terracon in the Town of Surfside, exhibited conditions that were "consistent with naturally occurring levels common to marine sands." The same can be said for all of the LandScience samples.

In addition to totals analysis for metals and selected organic substances as described previously, at the direction of the Sand Committee a Synthetic Precipitation Leaching Procedure (SPLP; USEPA Method 1312) test was conducted on sand samples for the RCRA metals, under the direction of LandScience (2014). The SPLP method was designed by USEPA as a way to evaluate effects of acid rain on land-disposed wastes, specifically to assess the likelihood that groundwater would be affected by leaching. It is used in that fashion by Florida DEP and by Miami-Dade County as well. Typically, when groundwater is not reasonably expected to be used as a drinking water source due to low production rates or poor water quality issues (e.g., natural chlorides, total dissolved solids [TDS], taste, or odor characteristics), comparison between SPLP data and the Florida DEP "Low Yield/Poor Quality" criterion is made (DEP, 2005; Chapter 62-777, F.A.C.). That "Low Yield/Poor Quality" criterion is equal to 10x the applicable chemical-specific groundwater criterion. SPLP data are not used by any agency of which I am aware in the assessment of direct contact exposure considerations. Rather, the chemical-specific SCTL is used for that purpose. A comparison among the sand sample data and the applicable criteria is presented in Table 1.

In one or more sand samples, the SPLP results showed detectable concentrations of arsenic, barium, chromium, and/or lead. However, in no instance did any reported SPLP concentration exceed its "Low Yield/Poor Quality" criterion.

Arsenic in Soils and Marine Sands as a Natural Background Issue

Natural background concentrations of arsenic in Florida soil have been reported to range from less than one mg/kg to greater than 60 mg/kg, depending upon soil type and geographic location (e.g., Brinkman and Ryan, 1998; Chen et al., 1999a; Chen et al.,

1999b; Chen et al., 2001; Gustavsson et al., 2001; Ma et al., 1997; Mayorga, 2004; Miami-Dade County, 2014). These soil types include upland environments, wetlands, and materials derived from aquatic environments (e.g., sediments, beach sand).

The natural occurrence of arsenic in the aquatic environment is commonly associated with marine organisms and the shelly, sedimentary layers that are of marine origin (Lunde, 1977; Cai et al., 2002), and uncontaminated coastal area marine sediments regularly contain from about 5 to 15 mg/kg arsenic (Neff, 1997; Moore and Ramamoorthy, 1984). Background sediments from Biscayne Bay and other Florida estuaries or coastal areas contain natural background levels of arsenic ranging from less than 10 mg/kg to over 60 mg/kg (Schropp and Windom, 1988; Windom et al., 1989; Schropp et al., 1990; USEPA, 2001). Valette-Silver et al. (1999) collected sediments from Biscayne Bay near the mouth of the Miami River and reported an average arsenic concentration of 5.1 ug/g (5.1 mg/kg), with a range of about 3 to 23 mg/kg. Those authors also sampled bivalve molluscs (oysters or mussels) from local Florida coastal waters, reporting arsenic concentrations in those specimens from approximately 5 to 65 mg/kg. Finally, the authors reported a median unadjusted total arsenic value of 16 mg/kg for southeastern U.S coastal sediments. Similar observations have been made regarding sediments in other states along the East Coast (e.g., NJ; Barringer et al., 2013).

There is little doubt or disagreement that results presented for the Surfside beach samples are consistent with generally expected arsenic levels in Florida soils/sediments that may be characterized by limestone deposits and coastal marine, seashell-derived material. Based on results of a DEP-sponsored study of different soil types across the state (Chen et al., 2001; Chen et al., 2002) and a Miami-Dade County beaches and coastal barrier islands study (Mayorga, 2004), arsenic concentrations in Surfside beach sand are consistent with local naturally occurring background conditions. They are the natural concentration ranges that would exist even if no human beings were present.

Human Health Considerations

A variety of national and international environmental and health organizations, as well as independent toxicologists, have evaluated occurrence, exposure potential and toxicology of environmental arsenic forms (e.g., ATSDR, 2007; Hughes et al., 2011; NAS, 2014; USEPA, 2005; USEPA, 2007). Those scientific and health-based assessments have concluded that, while arsenic certainly has the capability in some circumstances to cause adverse health effects, likelihood of effects is strongly influenced by important aspects of observed arsenic concentration, chemical form, and exposure potential.

Because arsenic is naturally occurring and ubiquitous in the environment at various concentrations, humans are exposed to the substance from a number of sources, including through our normal diet (Adams et al., 1994; ATSDR, 2007; ATSDR, 1990; Borum and Abernathy, 1994; USEPA, 2005; USEPA, 2007; WHO, 2001). ATSDR (2007) states that the highest dietary levels of arsenic are found in seafood, meats, and grains. Typical U.S. dietary levels of arsenic range from 0.02 mg/kg in grains and cereals to

0.14 mg/kg in meat, fish and poultry (Gartrell et al., 1986). Shellfish and saltwater fish typically contain the highest levels of total arsenic (average about 4 to 5 mg/kg, maximum up to 170 mg/kg). It has been observed that the organic arsenic forms which are typically present in seafood can dramatically elevate arsenic levels in human urine, though these organic arsenic forms are generally considered to be less harmful than inorganic arsenic forms at similar concentrations. Common foods which contain more than 50 micrograms of arsenic/kilogram of food (ug/kg; a microgram is one millionth of a gram) include tuna (fresh, canned, and casserole), fish sticks, fried shrimp, fried haddock, clam chowder, turkey breast, rice, mushrooms, and olive oil or safflower oil (Adams et al., 1994). A substantial portion of the arsenic in fish tissue is present in the essentially nontoxic trimethylated form known as arsenobetaine (90-100% of fish arsenic; Nriagu, 1994); however, dairy products, meat, poultry, and cereals contain a majority of their arsenic in an inorganic form (Borum and Abernathy, 1994). There is good evidence that arsenic actually may be a necessary human nutrient at some level in some species, because it appears to play an essential role in the normal metabolic processes of man and other mammals (ATSDR, 2007; NRC, 1989; Uthus, 1994; Uthus, 1997; USEPA, 2014a). However, a recommended daily intake quantity for arsenic in any form has not yet been established.

When all sources of exposure (food, water, air, and soil) are combined in an intake analysis, ATSDR (2007) estimated that the U.S. general population consumes approximately 46 micrograms of arsenic per day (46 ug/day), most of which is in organic forms. Borum and Abernathy (1994) calculated that humans ingest between 10 and 20 ug of inorganic arsenic per day, and ATSDR (1990) put this figure at an average of 50 ug/day (range 8 to 104 ug/day), of which about 30% is in the inorganic form (~70% organic forms). People who eat large amounts of seafood may consume 50 ug or more of arsenic per day from that source alone (Adams et al., 1994). Cigarette smokers may be exposed to higher arsenic quantities than the general population due to its presence in tobacco products.

The significance of arsenic contact and subsequent intake differs according to the route of potential exposure (ATSDR, 2007; Hughes et al., 2011; Teaf and Covert, 2012). From an environmental perspective, particularly regarding exposure to soils and sediments, ingestion is the principal route, and it dominates the calculation of protective exposure limits. Dermal and inhalation pathways contribute much less for separate reasons. Dermal absorption of arsenic is considerably less efficient than oral absorption, and airborne arsenic in association with soils, even in situations where the soils are uncovered and subject to wind erosion, typically represents a minor intake route.

As a point of reference for the sand data characterization as described previously, a discussion of the Florida Department of Environmental Protection (DEP) Soil Cleanup Target Level (SCTL) is warranted. It must be recognized that the type, frequency, and intensity of potential exposure, not just the concentration of a substance in soil, is critical to an appropriate evaluation of potential health risks. In that regard, the default residential SCTL is not strictly an appropriate criterion to use for potential beach exposures, since residents don't actually live <u>on</u> the beach itself, though they may visit

frequently. That SCTL value often is cited as an appropriate guideline for comparisons to all types of soil samples, though in this instance that is not appropriate.

The present default direct exposure residential SCTL for arsenic is 2.1 mg/kg (DEP, 2005), a value which is based on a 30 year unrestricted childhood/adult aggregate residential exposure scenario which assumes a soil ingestion rate of about 120 mg/day for 350 days/year and a target cancer risk of $1x10^{-6}$ ("one–in-one-million"; a population increase of one cancer in one million individuals beyond the baseline expected cancer rate, assuming lifetime exposure). The DEP process, and that of other toxicologists as well, simultaneously considers that there is a possibility of a "childhood only" exposure scenario, typically assuming an age range up to six years. Considering daily exposure for that entire childhood period, and addressing potential noncancer health effects for arsenic, the childhood scenario yields a protective arsenic soil concentration of 78 mg/kg, a value much greater than the concentrations that have been reported for the beach sand. Thus, children are not at significant risk. Because agencies, in this case DEP or Miami-Dade DERM, use the more restrictive of the two possible exposure scenarios, the 2.1 mg/kg value becomes the default, even though a considerably less restrictive concentration is specifically protective of a childhood scenario. Similarly, in response to potential concerns that toxic effects from arsenic aside from a cancer risk may represent a hazard, a scenario which considers only potential noncarcinogenic effects for the 30 year childhood/adult residential soil exposure circumstance yields a protective concentration for arsenic in excess of 400 mg/kg. Again that value is far greater than the concentrations observed in the beach sand, demonstrating that other possible effects from arsenic are not significant.

DEP also has developed a direct exposure SCTL of 12 mg/kg for arsenic where contact is expected to occur under commercial/industrial circumstances (DEP, 2005). This scenario is based on 25 year adult worker exposure considerations, assuming the potential for oral, dermal, and inhalation routes of exposure, with a soil ingestion rate of 50 mg/day for 250 days/year and a target cancer risk of $1x10^{-6}$. The commercial/industrial criterion, while the exposure assumptions may be more comparable to frequency of beach sand ingestion exposure, also is not be entirely appropriate since the ancillary exposure pathways (i.e., inhalation, dermal) are not comparable between workers and beachgoers (more intense for commercial/industrial).

Finally, DEP has developed and employed a provisional recreational exposure scenario for arsenic of 5.5 mg/kg (DEP, 2006), based on a conservative child/adolescent exposure scenario of 14 years duration, assuming all three exposure routes, a soil ingestion rate of 129 mg/day for 200 days/year, and a target cancer risk goal of $1x10^{-6}$. That 5.5 mg/kg value, or similar guidelines, has been applied at sites with various nonresidential, recreational aspects, such as rails-to-trails facilities, parks, and schools.

The provisional recreational "park" criterion is conceptually the most applicable in this instance, with the understanding that a single criterion may not encompass the range of potential exposures, since beach use is highly variable. As noted, DEP has used a similar scenario in evaluating potential school facilities as well in the past, and the exposure parameters for adults are most similar to the conservative commercial

industrial exposure scenario (e.g., 5 days per week, 50 weeks per year, 25 years duration, with oral/dermal/inhalation possibilities). The detected arsenic concentrations in the renourishment beach sand at Surfside are in the range of both the provisional recreational criterion and the default commercial/industrial guideline. This indicates that there is not a significant health risk from exposure to those levels of arsenic in the sand. In that conclusion, I concur with the previously identified opinions of the Florida Department of Health representatives.

It also should be noted that a review of 35 states other than Florida that report residential cleanup targets or health-based protective criteria for arsenic in soil, shows that at least 20 of those states utilize a default screening target concentration that exceeds 2.1 mg/kg, with values ranging from 3.9 mg/kg to 24 mg/kg. In addition, the states of AZ, CT, IL, IA, KS, KY, MA, MN, MO, NH, NJ, NY, PA, RI, WA employ protective soil cleanup guidelines ranging from 7 to 40 mg/kg, based upon natural background considerations (Teaf et al., 2010; Teaf and Covert, 2012). At a number of Florida sites, the U.S. EPA has implemented soil cleanup targets of 20 mg/kg or more in residential or other unrestricted land use cases. Thus, while the Florida DEP and some local jurisdictions have exercised their prerogative to set a highly conservative guideline with respect to default protective soil arsenic concentrations, an exceedance of the 2.1 mg/kg residential criterion does not indicate that hazards to human health exist.

As an example of the foregoing, a study was conducted in Florida by the Department of Health in partnership with the federal Agency for Toxic Substances and Disease Registry (FDOH/ATSDR, 1996b). That study involved the Barker Chemical Site in Inglis, Levy County, FL. The site was an inactive chemical facility that formerly produced phosphate fertilizer from ore that had an elevated arsenic content. Disposal of waste from that facility resulted in soil in some residential areas that was contaminated with relatively high levels of arsenic. Preliminary studies of soil in residential areas of Inglis revealed arsenic concentrations up to 3,000 mg/kg. Other studies undertaken by the U.S. EPA at Inglis detected arsenic concentrations in soil up to 687 mg/kg in residential areas (FDOH/ATSDR, 1996a). The Florida Department of Health performed both hair and urine analysis for arsenic for 25 residents of the area including children, who were judged to have had the greatest soil exposure potential. The Department of Health reported <u>no</u> detectable arsenic in over 83% of urine samples, with the detected values being within the normal reference range (<50 ug arsenic/gram creatinine) for those where it was detected. Similar results were found for the analysis of arsenic in hair samples. The Florida Department of Health concluded that none of the test participants had results indicating excessive exposure to environmental arsenic and recommended that no further public health activities were warranted. Thus, even at relatively extreme arsenic soil concentrations, persistent exposure and absorption could not be demonstrated. Other studies in states where arsenic in soils is naturally elevated have yielded similar results for adults and children, demonstrating very limited potential risks from soil exposure (Boyce et al., 2008; Teaf et al., 2010).

Occasionally, a question is posed regarding contact with soil by pets. I am not aware of evidence to suggest that cats, dogs, or other pets are more sensitive to arsenic than human beings. In fact, metabolic data for dogs and humans suggest that humans are

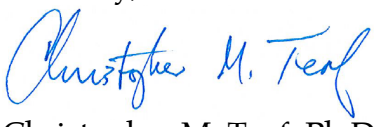
the more sensitive species (Hughes et al., 2011). Background soil concentrations, or levels set for protection of humans, are considered to be protective of pets as well.

Summary and Conclusions

The observed concentrations of arsenic in the renourishment beach sand tested near the Surf Club in the Town of Surfside, and the similarity between those concentrations and local background arsenic concentrations, demonstrates a condition consistent with naturally occurring sources. For reasons outlined in this letter, the observed concentrations of arsenic and other substances, coupled with an understanding of potential exposure circumstances related to the beach sand and a comparison to various health-based concentrations for the tested substances, do not represent significant human health risks.

Please call Bruce Tuovila or me at (850) 681-6894 when you have had an opportunity to review these materials, so we can address any questions or comments that you may have.

Sincerely,



Christopher M. Teaf, Ph.D.
President & Director of Toxicology

CMT:bt

Attachments
Table 1
References Cited

DRAFT

Data Summary for Sand Samples, Town of Surfside

November, 2014

		SCTL	Leachability	Sample Number																Any Value
Chemical Class	Units	Criterion*	Criterion**	**CCSS-1**	*Qualifier*	**CCSS-2**	*Qualifier*	**CSS-1**	*Qualifier*	**CSS-2**	*Qualifier*	**CSS-3**	*Qualifier*	**CSS-4**	*Qualifier*	**CSS-5**	Qualifier	CSS-6	Qualifier	Exceeds
TRPH	*mg/kg*	460	2400	0.190	U	6.70		0.190	U	0.190	U	0.190	U	5.68		12.9		2.00		*No*
Metals	*mg/kg*																			
Arsenic		2.1	see SPLP	2.39		1.80		6.46		4.57		3.80		5.84		5.39		6.44		*No*
Barium		120	16,000	5.44		5.93		8.41		5.38		5.80		8.95		7.29		8.72		*No*
Cadmium		82	75	0.00380	U	0.00380	U	0.00380	U	0.00380	U	0.00380	U	0.00380	U	0.00380	U	0.00380	U	*No*
Chromium		210	380	4.42		3.07		4.99		4.07		3.80		4.08		4.04		4.07		*No*
Lead		400	see SPLP	0.559		0.317		4.85		2.01		1.75		5.24		3.54		2.62		*No*
Mercury		3	21	0.0270	U	0.0270	U	0.0270	U	0.0270	U	0.0270	U	0.0270	U	0.0270	U	0.0270	U	*No*
Selenium		440	52	0.661		0.794		0.618		0.553		0.600		0.556		0.699		0.581		*No*
Silver		410	170	0.00550	U	0.00550	U	0.00550	U	0.00550	U	0.00550	U	0.00550	U	0.00550	U	0.00550	U	*No*
Organochlorine Pesticides	*mg/kg*																			
4,4'-DDE		2.9	180	0.000144	U	0.000144	U	0.000144	U	0.000144	U	0.000144	U	0.000144	U	0.000144	U	0.000144	U	*No*
4,4'-DDT		2.9	110	0.000239	U	0.000239	U	0.000239	U	0.000239	U	0.000239	U	0.0138		0.000239	U	0.000239	U	*No*
4,4'-DDD		4.2	58	0.000126	U	0.000126	U	0.000126	U	0.000126	U	0.000126	U	0.000126	U	0.000126	U	0.000126	U	*No*
Aldrin		0.06	2	0.000153	U	0.000153	U	0.000153	U	0.000153	U	0.000153	U	0.000153	U	0.000153	U	0.000153	U	*No*
alpha-BHC		0.1	0.003	0.0000659	U	0.0000659	U	0.0000659	U	0.0000659	U	0.0000659	U	0.0000659	U	0.0000659	U	0.0000659	U	*No*
beta-BHC		0.5	0.01	0.000154	U	0.000154	U	0.000154	U	0.000154	U	0.000154	U	0.000154	U	0.000154	U	0.000154	U	*No*
delta-BHC		24	2	0.000177	U	0.000177	U	0.000177	U	0.000177	U	0.000177	U	0.000177	U	0.000177	U	0.000177	U	*No*
gamma-BHC (Lindane)		0.7	0.09	0.000148	U	0.000148	U	0.000148	U	0.000148	U	0.000148	U	0.000148	U	0.000148	U	0.000148	U	*No*
Chlordane		2.8	96	0.000269	U	0.000269	U	0.000269	U	0.000269	U	0.000269	U	0.000269	U	0.000269	U	0.000269	U	*No*
Dieldrin		0.06	0.02	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	*No*
Endosulfan I		450	38	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	*No*
Endosulfan II		450	38	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	0.000196	U	*No*
Endosulfan sulfate		450	38	0.000206	U	0.000206	U	0.000206	U	0.000206	U	0.000206	U	0.000206	U	0.000206	U	0.000206	U	*No*
Endrin		25	10	0.000156	U	0.000156	U	0.000156	U	0.000156	U	0.000156	U	0.000156	U	0.000156	U	0.000156	U	*No*
Endrin aldehyde		NA	NA	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	*No*
Endrin ketone		NA	NA	0.000324	U	0.000324	U	0.000324	U	0.000324	U	0.000324	U	0.000324	U	0.000324	U	0.000324	U	*No*
Heptachlor		0.2	230	0.000183	U	0.000183	U	0.000183	U	0.000183	U	0.000183	U	0.000183	U	0.000183	U	0.000183	U	*No*
Heptachlor epoxide		0.1	6	0.000174	U	0.000174	U	0.000174	U	0.000174	U	0.000174	U	0.000174	U	0.000174	U	0.000174	U	*No*
Methoxychlor		420	1600	0.000149	U	0.000149	U	0.000149	U	0.000149	U	0.000149	U	0.000149	U	0.000149	U	0.000149	U	*No*
Toxaphene		0.9	310	0.00893	U	0.00893	U	0.00893	U	0.00893	U	0.00893	U	0.00893	U	0.00893	U	0.00893	U	*No*
Polychlorinated Biphenyls	*mg/kg*																			
PCB-1016		0.5***	170***	0.00129	U	0.00129	U	0.00129	U	0.00129	U	0.00129	U	0.00129	U	0.00129	U	0.00129	U	*No*
PCB-1221		0.5	170	0.000739	U	0.000739	U	0.000739	U	0.000739	U	0.000739	U	0.000739	U	0.000739	U	0.000739	U	*No*
PCB-1232		0.5	170	0.00195	U	0.00195	U	0.00195	U	0.00195	U	0.00195	U	0.00195	U	0.00195	U	0.00195	U	*No*
PCB-1242		0.5	170	0.000775	U	0.000775	U	0.000775	U	0.000775	U	0.000775	U	0.000775	U	0.000775	U	0.000775	U	*No*
PCB-1248		0.5	170	0.000480	U	0.000480	U	0.000480	U	0.000480	U	0.000480	U	0.000480	U	0.000480	U	0.000480	U	*No*
PCB-1254		0.5	170	0.000786	U	0.000786	U	0.000786	U	0.0863		0.000786	U	0.000786	U	0.000786	U	0.000786	U	*No*
PCB-1260		0.5	170	0.00144	U	0.00144	U	0.00144	U	0.00144	U	0.00144	U	0.00144	U	0.00144	U	0.00144	U	*No*
SPLP Metals	*mg/L*																			
Arsenic		NA	0.10	0.00138	U	0.00138	U	0.00900		0.00138	I	0.00138	U	0.0100		0.00138	I	0.00138	I	*No*
Barium		NA	20	0.000236		0.0880		0.0610		0.0610		0.0340		0.0640		0.0400		0.0370		*No*
Cadmium		NA	0.05	0.000211	U	0.000211	U	0.000211	U	0.000211	U	0.000211	U	0.000211	U	0.000211	U	0.000211	U	*No*
Chromium		NA	1.0	0.000751	U	0.000751	U	0.00800		0.00300		0.00300		0.0110		0.00500		0.00500		*No*
Lead		NA	0.15	0.00292	U	0.00292	U	0.0380		0.0120		0.0100		0.0500		0.0200		0.0170		*No*
Mercury		NA	0.02	0.0000630	U	0.0000630	U	0.0000630	U	0.0000630	U	0.0000630	U	0.0000630	U	0.0000630	U	0.0000630	U	*No*
Selenium		NA	0.5	0.00455	U	0.00455	U	0.00455	U	0.00455	U	0.00455	U	0.00455	U	0.00455	U	0.00455	U	*No*
Silver		NA	1.0	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	0.000260	U	*No*

* *Default Residential Soil Cleanup Target Level (SCTL) per 62-777, F.A.C; Florida DEP, 2005*

** *Low Yield / Poor Quality per 62-777, F.A.C; Florida DEP, 2005*

*** *Total for PCB mxsture*

U *Below Laboratory Reported Method Detection Limit (MDL)*

I *Between Laboratory Reported Method Detection Limit (MDL) and Practical Quabtitation Limit (PQL)*

NA Not Applicable

References Cited

Adams, M.A. et al. 1994. Dietary intake and hazards of arsenic. Chapter 4. In: Chappell, et al. (eds). Arsenic: Exposure and Health. Science and Technology Letters, Essex, UK.

ATSDR (Agency for Toxic Substances and Disease Registry). 1990. Case Studies in Environmental Medicine: Arsenic. Atlanta, GA. June, 1990.

ATSDR (Agency for Toxic Substances and Disease Registry). 2007. Toxicological Profile for Arsenic. Atlanta, GA. August, 2007.

Barringer, J.L. et al. 2013. Arsenic in New Jersey Coastal Plain Streams, Sediments, and Shallow Groundwater: Effects of Different Geological Sources, and Anthrpogenic Inputs on Biogeochemical and Physical Mobilization Processes. Prepared in cooperation with the NJ Department of Environmental Protection. Scientific Investigations Report 2013-5107.

Borum, D.R. and C.O. Abernathy. 1994. Human oral exposure to inorganic arsenic. Chapter 3 in Chappell et al. (eds.). Arsenic: Exposure and Health. Science and Technology Letters. Essex, UK.

Boyce, C.P. et al. 2008. Probabilistic analysis of human health risks associated with background concentrations of inorganix arsenic: Use of a margin of exposure approach. Human and Ecological Risk Assessment 14: 1159-1201.

Brinkman, R. and J. Ryan. 1998. Background concentration of metals in Florida soils. Florida Center for Solid and Hazardous Waste Management, Gainesville, FL. Report #97-6.

Cai, Y., Cabrera, J.C., Georgiadis, M., et al. 2002. Assessment of arsenic mobility in the soils of some golf courses in South Florida. Sci. Total Environ. 291:123-134.

Chen, M., L.Q. Ma and W.G. Harris. 1999a. Baseline concentrations of 15 trace elements in Florida surface soils. Journal of Environmental Quality. 28(4): 1173-1181.

Chen, M., L.Q. Ma, W.G. Harris and A.G. Hornesby. 1999b. Background concentrations of metals in Florida surface soils. Taxonomic and geographic distributions of total-total and total-recoverable concentrations of selected trace metals. Florida Center for Solid and Hazardous Waste Management, Gainesville, FL. Report #99-7

Chen, M, L.Q. Ma, C.G. Hoogeweg and W.G. Harris. 2001. Arsenic background concentrations in Florida, U.S.A. surface soils: determination and interpretation. Environmental Forensics 2: 117-126.

Chen, M., Ma, L.Q., Harris, W.G. 2002. Arsenic concentrations in Florida surface soils: Influence of soil type and properties. Soil Sci. Soc. Am. J. 66:632-640.

DEP (Florida Department of Environmental Protection). 2005. Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C. February, 2005.

DEP (Florida Department of Environmental Protection). 2006. Rails to trails program assessment guidelines. Presented by Ligia Mora-Applegate. May 23, 2006.

DEP (Florida Department of Environmental Protection. 2014. Correspondence and technical reports related to sand testing. April-May 2014.

FDOH (Florida Department of Health)/ATSDR (Agency for Toxic Substances and Disease Registry). 1996a. Health Consultation. Barker Chemical Site, Inglis, Levy County, Florida. August 8, 1996.

FDOH (Florida Department of Health)/ATSDR (Agency for Toxic Substances and Disease Registry). 1996b. Exposure Investigation Report, Barker Chemical Site, Inglis, Levy County, Florida. August 13, 1996.

FDOH (Florida Department of Health). 2014. E-mail from Dr. Samir Elmir, Miami Dade Health Department, to Michael P. Crotty, Town Manager, Town of Surfside, regarding arsenic found in beach sand at the Surf Club. May 14, 2014.

Gartrell, M.J. et al. 1986. Pesticides, selected elements, and other chemicals in adult total diet samples, October 1980-March 1982. J. Assn. Off. Anal. Chem. 69:146; as cited in ATSDR, 2007.

Geosyntec. 2014. Correspondence from Dr. Keith Tolson, dated May 24, 2014.

Gustavsson, N. et al. 2001. Geochemical Landscapes of the Conterminous United States – New Map Presentations for 22 Elements. U.S. Geological Survey Professional Paper 1648. November, 2001.

Hughes, M.F. et al. 2011. Arsenic exposure and toxicology: A historical perspective. Toxicological Sciences 123(2): 305-332.

Kimley-Horn. 2014. Laboratory data reports and sample location figures. May, 2014

LandScience. 2014. Personal communication, laboratory data report, and sampling location figures. November, 2104.

Lunde, G. 1977. Occurrence and transformation of arsenic in the marine environment. Environmental Health Perspectives 19: 47-52.

Ma, L.Q., F. Tan, and W.G. Harris. 1997. Concentrations and distributions of eleven metals in Florida soils. Journal of Environmental Quality. 26(3): 769-775.

Mayorga, W. 2004. Memorandum from Wilbur Mayorga, Pollution Remediation Section, to Jose Gonzales, Pollution Control Division, regarding natural background soil concentrations for the barrier islands of Miami-Dade County. November 7, 2004.

Mayorga, W. 2014. Personal communication. May, 2014.

Miami-Dade County. 2014. Miami-Dade County Anthropogenic Background Study. Miami-Dade Environmental Monitoring and Restoration Division. April 3, 2014.

Moore, J.W. and S. Ramamoorthy. 1984. Heavy Metals in Natural Waters. Springer Verlag. New York, NY.

Neff, J.M. 1997. Ecotoxicology of arsenic in the marine environment. Environ. Toxicol. Chem. 16(5):917-927.

NAS (National Academy of Sciences). 2014. Critical Aspects of EPA's IRIS Assessment of Inorganic Arsenic. Interim Report.

NRC (National Research Council). 1989. Recommended Dietary Allowances. 10th Edition. National Research Council/National Academy Press, Washington, D.C.

Nriagu, J.O. (ed). 1994. Arsenic in the Environment, Part II: Human Health and Ecosystem Effects. Wiley Interscience, New York, NY.

Schropp, S.J. and H.L. Windom. 1988. A Guide to the Interpretation of Metal Concentrations in Estuarine Sediments. April 1988.

Schropp, S.J. et al. 1990. Interpretation of metal concentrations in estuarine sediments of Florida using aluminum as a reference element. Estuaries 13(3):227-235.

Surfside (Town of Surfside). 2014. Update. Sand Testing Results. May 14, 2014.

Teaf, C.M., and D.J. Covert. 2012. Risk considerations related to arsenic exposure: Drinking water ingestion versus dietary intake or soil exposure. Proceedings of the Annual International Conference on Soils, Sediments, Water and Energy. Volume 17(1): 114-122.

Teaf, C.M., D.J. Covert, P.A. Teaf, E. Page, and M.J. Starks. 2010. Arsenic Cleanup Criteria for Soils in the US and Abroad: Comparing Guidelines and Understanding Inconsistencies. Soil & Sediment Contamination Volume 15, Chapter 9, pp. 94-102..

Terracon (Terracon Consultants, Inc.). 2014. Beach sand chemical testing, Town of Surfside, Miami-Dade County, Florida. May 9, 2014.

USEPA (U.S. Environmental Protection Agency). 2001. Florida's Inshore Marine Monitoring and Assessment Program (IMAP). Annual Report, Year Two. Environmental Research laboratory Office of Research and Development. U.S. EPA Gulf Breeze, Florida 32561. IMAP Annual Report 2000/2001. May 9, 2001.

Available on the website located at http://www.floridamarine.org/features/categroy_sub.asp?id=3448.

USEPA (U.S. Environmental Protection Agency). 2005. Toxicological Review of Ingested Inorganic Arsenic.

USEPA (U.S. Environmental Protection Agency). 2007. Inorganic arsenic. TEACH Chemical Summary.

USEPA (U.S. Environmental Protection Agency). 2014a. Integrated Risk Information System – Inorganic Arsenic. Available on the website located at http://www.epa.gov/iris/subst/0278.htm.

Uthus, E.O. 1994. Arsenic essentiality studies and factors affecting its importance. pp. 199-208. In: Chappell, et al. (eds). Arsenic: Exposure and Health. Science and Technology Letters, Essex, UK.

Uthus, E.O. 1997. Arsenic: Essentiality and estimation of a possible requirement. Annual Meeting of the Society for Risk Analysis, Washington, DC. December 7-10, 1997.

Valette-Silver, N.J., Riedel, G.F., Crecelius, E.A. 1999. Elevated arsenic concentrations in bivalves from the southeast coasts of the USA. Marine Environ. Res. 48:311-333.

Windom, H.L., Schropp, S.J., Calder, F.D., et al. 1989. Natural trace metal concentrations in estuarine and coastal marine sediments of the southeastern United States. Environ. Sci. Technol. 23(3):314-320.

WHO. 2001. Environmental Health Criteria 224: Arsenic and Arsenic Compounds. World Health Organization, Geneva, Switzerland.