Lake Hopatcong
Submerged Aquatic Vegetation Analysis 2018
Morris and Sussex Counties, New Jersey

Prepared for:

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1.0 Introduction

Princeton Hydro, LLC was contracted by the Lake Hopatcong Commission to conduct submerged aquatic vegetation (SAV) surveys of near-shore locations throughout Lake Hopatcong, Morris and Sussex Counties, NJ. Due to high densities of aquatic macrophyte communities noted along many shoreline areas, various chemical treatment techniques have been implemented to manage nuisance densities. Typically, certified applicators are contracted by private property owners or nearshore homeowner groups to conduct these treatments of aquatic pesticides. A yearly mechanical weed harvesting program has also been in operation since the mid 1980's. The program has been overseen by the Lake Hopatcong Regional Planning Board as well as the Lake Hopatcong Commission and is currently being overseen and operated by the State Park division of NJDEP. In recent years, other potential management have been suggested and discussed in the control of nuisance plant growth in various cove and nearshore areas, such as hydro-raking or the stocking of sterile grass carp.

Princeton Hydro conducted a near-shore submerged aquatic vegetation (SAV) survey at Lake Hopatcong on 1 August 2018. The purpose of this survey was to establish an inventory of the SAV community within Lake Hopatcong, and identify nuisance plant densities and invasive/endangered species locations. This information will subsequently be used going forward to help track shifts in community composition as plant management techniques continue. The program will aid in providing another means of identifying new invasive species such as hydrilla. Please note this once a year, semi-quantitative SAV survey will augment, and not replace, the Commission's standard water quality monitoring program or the volunteer plant identification program overseen by the Lake Hopatcong Foundation. This routine, once a year, annual survey will allow Princeton Hydro to quantify the effectiveness of new and old plant management techniques, as well as assess local weather and climactic impacts on the aquatic macrophyte community. Finally, the collection of such data, particularly the quantitative plant data collected throughout the River Styx / Crescent Cove section of the lake, will provide "pre-stocking" data that may be required if NJDEP, Division of Fish and Wildlife provides authorization to stocking this part of the lake with sterile grass carp as a demonstration project.

The following report discusses the results of the SAV survey conducted on 1 August 2018.

2.0 Methods and Materials

The SAV survey in Lake Hopatcong was conducted at a number of near-shore locations around the lake on 1 August 2018. A total of twenty two (22) sampling locations were selected by Princeton Hydro spanning the entirety of the lake, as shown in Figures 1 and 2 (Appendix I).

Within the sampling area, sampling locations were chosen with approximately 1 meter in depth or less. Once located, the sampling station was recorded using a hand-held GPS device. A 1 m^2 floating quadrat was placed over a stand of plants within the designated sampling areas. Two areas were between an island and the shoreline, in which case plots were sampled along both the main shore and island shore. The area inside the quadrat, defined on the bed of the lake by drop chains, was observed and surveyed using an Aquascope and/or rake grabs and all plants that fell within the quadrat were identified to species. Species identifications were made utilizing previous identification knowledge and various aquatic plant field guides including (Borman, 1997, Hellquist, 1980). Species were semi-quantitatively ranked according to the following guidance:

- Abundant (greater than or equal to 50% of area)
- Common (between 10 and 50% of area)
- Present (less than or equal to 10% of area)

Locations within the River Styx/Crescent Cove area were all harvested for further analysis. The above sediment plant material was placed into plastic bags and transported to Princeton Hydro's Biological Laboratory in a cooler with ice and weighed by species to the nearest gram (wet weight). The following section provides the results of this survey.

3.0 Results and Discussion

3.1 Community Composition Analysis

SAV community structure results within Lake Hopatcong from the August 2018 sampling event are provided in Table 3.1.

Community composition and abundance were highly variable throughout the lake. High densities of species were observed with Landing Cove, as shown by the two stations located in this area. HC-1 was characterized by an abundance of white water lily, and lower densities of slender naiad, while HC-2 had a more diverse plant community. HC-2 was dominated by slender naiad and contained moderate densities of tape grass. Lower densities of large leaf pondweed and Eurasian watermilfoil were also noted at this site. HC-3 had one of the greatest levels of diversity observed during this event, yielding 9 different species. The SAV community was characterized by moderate densities of slender naiad, tape grass, Robbin's pondweed, coontail and *Nitella*. Stations at Ingram and King Coves (HC-4 and HC-5) were comprised of similar communities, with varying densities of tape grass, large leaf pondweed and Robbin's pondweed. Robbins's pondweed is identified and listed as an endangered species within New Jersey, and was only observed HC-3, HC-4 and HC-5 during this survey.

HC-11 in Van Every Cove consisted entirely of moderate amounts of tape grass. While not present in nuisance densities during this event, it could easily take over the plot due to lack of competition. Communities observed within Great Cove (HC-12) were dominated by slender naiad and *Nitella,* with light densities of tape grass, coontail, Eurasian watermilfoil and variable leaf pondweed. Low abundance and diversity was observed within Davis Cove (HC-13) and the cove adjacent to N Cherry Rd (HC-18), both with only two species present. Tape grass and Eurasian watermilfoil were observed at HC-13, while slender naiad and spatterdock were identified at HC-18. Byram Cove (HC-14) was also characterized by low diversity with low densities of slender naiad, tape grass and coontail. Henderson Cove (HC-15) showed nuisance growth of tape grass during this event. Moderate densities of elodea and coontail were also identified at this station, along with light densities of the invasive Eurasian watermilfoil. Plant densities were moderate adjacent to the Brights Cove bridge (HC-20), mainly dominated by coontail and tape grass. Slender naiad, large leaf pondweed, Eurasian watermilfoil and curly leaf pondweed were also present. Curly leaf pondweed is considered an invasive species at Lake Hopatcong, but was present sparingly throughout the lake.

Two sampling locations were chosen adjacent to islands, including Halsey Island and Liffy Island. Plots were sampled against both the mainland and island shores at both these sites. Stations at Halsey Island (HC-16 and HC-17) yielded a similar community composition. HC-16 (island shore) was dominated by slender naiad and contained moderate to low densities of elodea, coontail, Eurasian watermilfoil and tape grass. The main shoreline was dominated by the macroalgae *Nitella*, with moderate densities of slender naiad. Low densities of tape grass, Eurasian watermilfoil, large leaf pondweed, coontail and elodea were also present. The stations observed at Liffy Island (HC-21 and HC-22) were relatively similar with a few minor differences in composition and abundance. HC-21 (island shore) was characterized by copious amounts of floating macrophytes, including white water lily and watershield, and moderate densities of tapegrass and slender naiad. Lower densities of elodea, coontail, common bladderwort, humped bladderwort and brittle naiad. Moderate densities of floating macrophytes were also observed at HC-22, but were comprised primarily of watershield. Common bladderwort was common at this station, while tape grass, Eurasian watermilfoil, coontail, humped bladderwort and brittle naiad were present. Humped bladderwort (*Utricularia gibba*) is listed as an endangered species within New Jersey, and was only present at three stations during this vegetation survey. The only other station with humped bladderwort present was HC-19. This station was mainly dominated by floating macrophytes, with low densities of coontail and common bladderwort also observed.

The presence of various invasive species is a concern for the health of the lake and other, more desirable, native plants. If these plants are left unchecked, they can take over entire areas of the lake, outcompeting natives and eliminating valuable habitat for fish and other aquatic organisms. This can cause a shift in the ecosystem and ultimately the health of the waterbody. The main species of concern are Eurasian Watermilfoil (*Myriophyllum spicatum*), Curly Leaf Pondweed (*Potamogeton crispus*) and tapegrass (*Vallisneria americana*). While tapegrass is actually a native to this region and does have a value relative to aquatic habitats, it often attains nuisance densities within Lake Hopatcong. Water chestnut (*Trapa natans*) is also an invasive species that has been identified in Lake Hopatcong over the last five to seven years but has been closely monitored and hand pulled. No water chestnut was identified in any of the sampling plots for this study. Eurasian Watermilfoil was noted at 13 of the stations during this survey in low densities, only listed as common at HC-7 in Crescent Cove. Curly Leaf Pondweed was also found in low densities, and was only present at 3 stations. Tape grass was observed in variable densities throughout 14 of the sampling stations.

Table 3.1: Lake Hopatcong 2018 SAV

Location	Station	White Water Lily	Slender naiad	Tape Grass	Large Leaf Pondweed	Eurasian watermilfoil	Robbin's Pondweed	Elodea	Coontail	Nitella	Chara	Curly Leaf Pondweed	Variable Leaf Pondweed	Spatterdock	Watershield	Common Bladderwort	Humped/ Creeping Bladderwort	Brittle naiad	Aquatic Moss	Benthic algae
		Nymphaea odorata	*Najas flexilis*	*Vallisneria americana*	*Potamogeton amplifolius*	*Myriophyllum spicatum*	*Potamogeton robbinsii*	*Elodea canadensis*	*Ceratophyllum demersum*	*Nitella Flexilis*	*Chara sp.*	*Potamogeton crispus*	*Potamogeton gramineus*	*Nuphar advena*	*Brasenia schreberi*	*Utricularia vulgaris*	*Utricalaria gibba*	*Najas minor*	*Fontinalis sp.*	
Landing	HC-1	A	P																	P
Landing Island	HC-2		A	C	P	P														
Near Silver Springs	HC-3		C	C	P	P	C	P	C	C	P									
King Cove	HC-4			P	A		P													
Ingram Cove	HC-5			A	P		P													
River Styx	HC-6				P	P			P										A	
Crescent Cove	HC-7		P			C			P			P						P		A
Crescent Cove	HC-8					P			P											A
Crescent Cove	HC-9											P (dead)								A
Crescent Cove	HC-10					P														P
Van Every Cove	HC-11			C																
Great Cove	HC-12		A	P		P			P	C			P							
Davis Cove	HC-13			P		P														
Byram Cove	HC-14		P	P					P											
Henderson Cove	HC-15			A		P		C	C											
Halsey Island Shore	HC-16		A	P		P		C	P											
Halsey Main Shore	HC-17		C	P	P	P		P	P	A										
N Cherry Rd Cove	HC-18		P											P						
Below Espanong Rd Bridge	HC-19	P							P						A	P	P			
Flash Marina	HC-20		P	C	P	P			C			P								P
Liffy Island	HC-21	A	C	C				P	P						P	P	P	P		
Liffy Main Shore	HC-22			P		P			P					C	C	C	P	P		

3.2 River Styx/Crescent Cove Analysis

SAV community structure results at the River Styx and Crescent Cove sampling stations from the August 2018 sampling event are presented in Table 3.2.

Table 3.2: River Styx/Crescent Cove 2018 SAV

Location	Station	Slender naiad	Brittle naiad	Large Leaf Pondweed	Eurasian watermilfoil	Coontail	Curly Leaf Pondweed	Aquatic Moss	Benthic algae	Total Mass
		Najas flexilis	*Najas minor*	*Potamogeton amplifolius*	*Myriophyllum spicatum*	*Ceratophyllum demersum*	*Potamogeton crispus*	*Fontinalis sp.*	*Lyngbya*	(g/m2)
River Styx	HC-6			P	P	P		A		415.61
Crescent Cove	HC-7	P	P		C	P	P		A	115.66
Crescent Cove	HC-8				P	P			A	3.16
Crescent Cove	HC-9						P (dead)		A	<1.00
Crescent Cove	HC-10				P				P	4.10

Overall, low macrophyte densities at stations within the River Styx/Crescent Cove area were observed during the 1 August 2018 survey. Lowest biomass values were identified at HC-8, HC-9 and HC-10 ranging from <1.00 g to 4.10 g of macrophytes observed. The community at HC-8 was comprised of very low densities of coontail (native) and Eurasian watermilfoil (invasive). EWM was also present at HC-10, while minimal densities of dead curly leaf pondweed (invasive) were observed at HC-9. Station HC-7 yielded biomass values of 115.66 g/m^2 during this survey, and yielded the highest species richness of these station, comprised of five macrophyte species. Three native species, slender naiad, brittle naiad and coontail, were identified as present at this station. Similarly, two invasive macrophytes, EWM and curly leaf pondweed were observed as common and present. Benthic algae was observed at the above stations, with heavy mats observed on the sediment at HC-7, HC-8 and HC-9, and low densities at HC-10. This mat algae was not included during biomass measurements. Highest biomass was observed at HC-6 during this survey with 415.61 g/m^2, and was composed predominantly of aquatic moss. EWM, curly leaf pondweed and large leaf pondweed were also identified as present at this time.

Biomass was further broken down by species to determine exact abundance, which can help determine if future management practices are more effective on some plants rather than others. Biomass data collected from these five sites can be found in Table 3.3 below.

Table 3.3: River Styx/Crescent Cove Biomass			
Station	Common Name	Scientific Name	Mass (g/m2)
HC6	Aquatic Moss	*Fontinalis sp.*	357.71
	Large-leaf Pondweed	*Potamogeton amplifolius*	26.45
	Coontail	*Ceratophyllum demersum*	31.45
	Eurasian Watermilfoil	*Myriophyllum spicatum*	<1
HC7	Curlyleaf Pondweed	*Potamogeton crispus*	<1
	Thin-leaf pondweed	*Potamogeton pusillus*	<1
	Elodea	*Elodea canadensis*	<1
	Brittle Naiad	*Najas minor*	<1
	Slender Naiad	*Najas flexilis*	11.34
	Coontail	*Ceratophyllum demersum*	7.16
	Eurasian Watermilfoil	*Myriophyllum spicatum*	97.16
HC8	Coontail	*Ceratophyllum demersum*	<1
	Eurasian Watermilfoil	*Myriophyllum spicatum*	3.16
HC9	Curlyleaf Pondweed	*Potamogeton crispus*	<1 (dead)
HC10	Eurasian Watermilfoil	*Myriophyllum spicatum*	4.1

As mentioned above, Station HC-6 was predominately comprised of aquatic moss, making up 86% (357.71 g/m^2) of the harvested sample. The remainder of the sample was made up of 6.3% large leaf pondweed (26.54 g/m^2), 7.5% coontail (31.45 g/m^2) and trace amounts of EWM. Four of the identified species found at HC-7 were present in trace amounts (<1 g). Eurasian watermilfoil dominated this sample making up 84% (97.16 g/m^2) of the community composition. Both coontail and slender naiad made up smaller portions of the community, 6.1% and 9.8%, respectively. HC-8 was characterized by low densities of both species, with EWM making up the majority of the sample, while trace amounts of coontail was identified. Only one macrophyte species was observed at both HC-9 and HC-10.

It should be noted that the River Styx / Crescent Cove section of the lake typically experiences extremely high densities of nuisance SAV biomass, with EWM frequently being the dominant species. EWM has been well documented to grow to the surface and spread out, shading out other, more desirable species. There were at least three factors responsible for the lower than expected SAV densities in this section of the lake:

- This part of the lake was harvested at least once, maybe twice, over the course of the 2018 growing season
- Sections of this part of the lake were probably selectively treated with aquatic herbicides for SAV control
- The wet, cooler conditions of 2018 resulted in overall lower SAV densities when compared to observed densities in 2016 and 2017, which were drier and warmer.

4.0 Summary and Recommendation

Princeton Hydro conducted a mid-summer submerged aquatic vegetation survey at 20 separate near-shore stations at Lake Hopatcong on 1 August 2018. This survey was conducted at the request of the Lake Hopatcong Commission in order to determine the abundance and distribution of the macrophyte community throughout the lake.

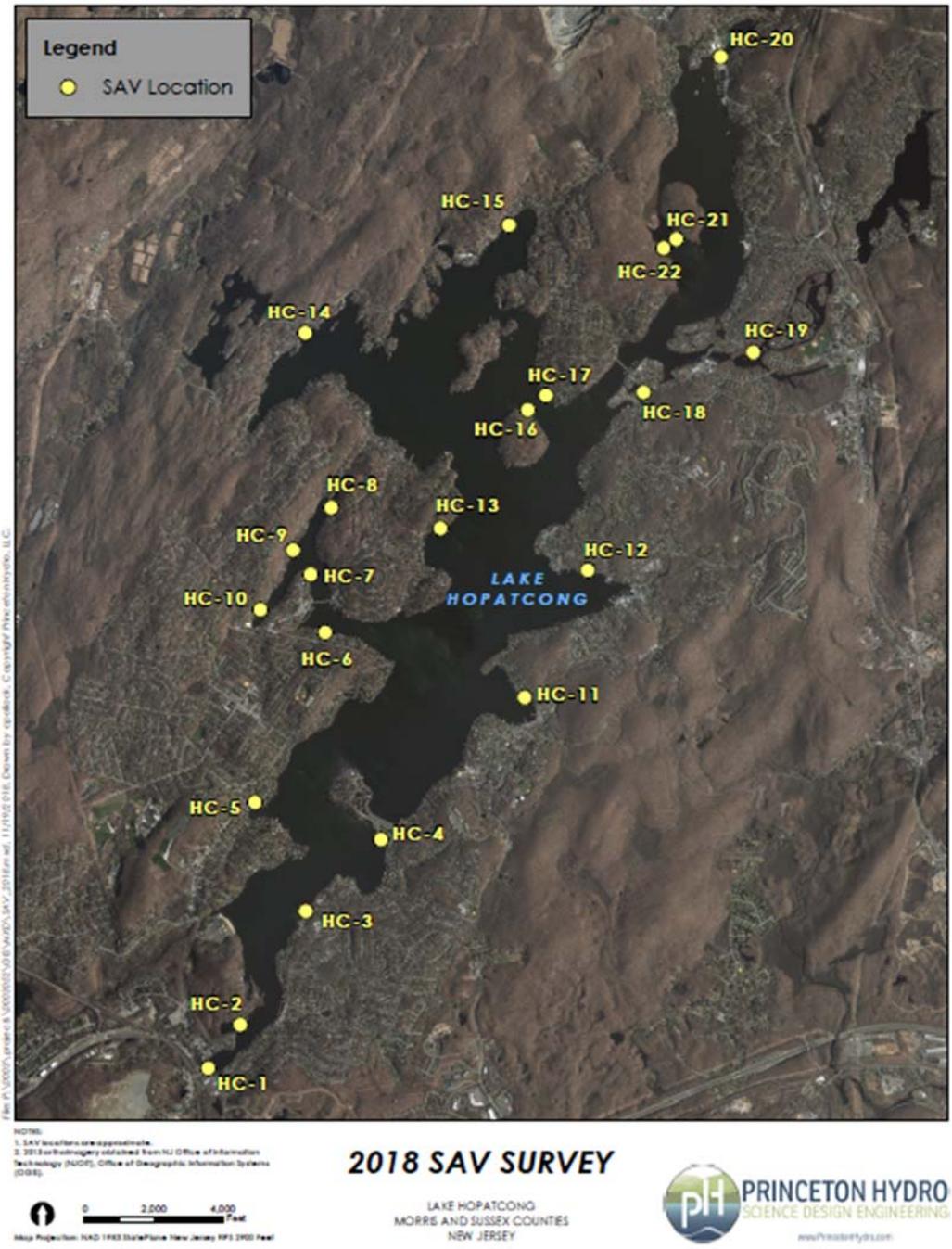
The most commonly found plants during this survey were Slender Naiad (*Najas flexilis*), Tape Grass (*Vallisneria americana*), Eurasian Watermilfoil (*Myriophyllum spicatum*) and Coontail (*Ceratophyllum demersum*). The majority of the macrophytes identified were native, but two invasive species were identified during this survey, including Eurasian Watermilfoil (observed at 13 sites) and Curly Leaf Pondweed (observed at 3 sites). Two endangered species were also observed during this survey, including Robbin's pondweed (*Potamogeton robinsii*) and humped bladderwort (*Utricularia gibba*). Both Robbin's pondweed and humped bladderwort were identified at three stations during this survey. Robbin's pondweed was observed at HC-3 (Silver Springs), HC-4 (King Cove) and HC-5 (Ingram Cove), while humped bladderwort was identified at HC-19 (Espanong Rd Bridge), HC-21 and HC-22 (Liffy Island and Liffy Main). River Styx / Crescent Cove quantitative analysis showed low densities of plants throughout the cove; however, this was attributed to active in-lake plant management activities, as well as the relatively wet and cool growing season of 2018. Typically, the River Styx / Crescent Cove section of the lake experiences some of the highest densities of SAV, particularly during the early part of the growing season, prior to any chemical treatments or mechanical harvesting. In addition, Eurasian Watermilfoil was observed at four of the five sites in this area of the lake.

It is recommended that an annual survey of similar scope take place in order to track the macrophyte community, creating a historical database. However, it is also recommended that in 2019, an additional quantitative SAV survey be conducted in the River Styx / Crescent Cove section of the lake earlier in the growing season (May), prior to the initiation of the weed harvesting to better document the high / nuisance densities of SAV in this section of the lake.

The generated SAV database of Lake Hopatcong can be utilized to assess the effectiveness of various management practices, weather and climactic influences and can serve to easily identify invasive species introduction to an area.

APPENDIX I

Figures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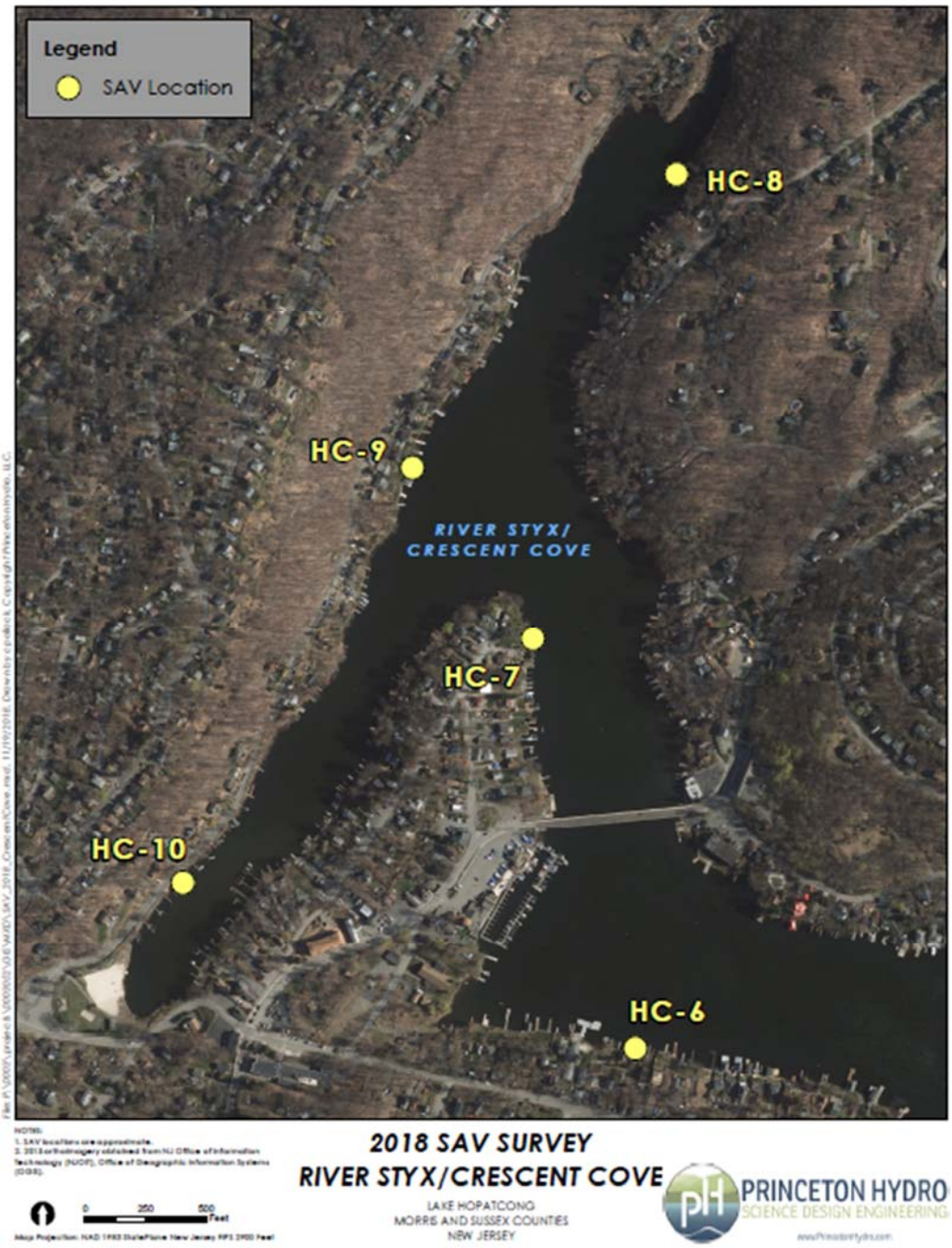
SAV Location
HC-20
HC-15
HC-21
HC-22
HC-14
HC-19
HC-17
HC-18
HC-16
HC-8
HC-13
HC-9
HC-12
HC-7
LAKE
HOPATCONG
HC-10
HC-6
HC-11
HC-5
HC-4
HC-3
HC-2
HC-1
2018 SAV SURVEY
LAKE HOPATCONG
MORRIS AND SUSSEX COUNTIES
NEW JERSEY
PRINCETON HYDRO
SCIENCE DESIGN ENGINEERING


Legend
SAV Location
HC-8
HC-9
RIVER STYX/
CRESCENT COVE
HC-7
HC-10
HC-6
2018 SAV SURVEY
RIVER STYX/CRESCENT COVE
LAKE HOPATCONG
MORRIS AND SUSSEX COUNTIES
NEW JERSEY
PRINCETON HYDRO
SCIENCE DESIGN ENGINEERING