CITY OF SANIBEL
ALGAE INFESTATION MANAGEMENT PROJECT
FACT-FINDING SITE VISIT
STAFF REPORT

As presented to
Sanibel City Council
May 1st, 2007

City of Sanibel
Staff Credentials

Robert K. Loflin, Ph.D., Director, City of Sanibel Natural Resources Department

Director Loflin's training and experience include a Ph.D. in Biology from the University of Miami, over 20 years experience in south Florida ecosystems, and expertise in marine biology, ornithology, coastal systems, environmental restoration, land management and grant acquisition and management. Recent awards include a Special Achievement Award from the Florida Beaches and Shores Preservation Association (2000) and a Partnership Award for Environmental Restoration from the Coastal America Program (2002.) Recent accomplishments include the 265-acre restoration of the Sanibel Gardens Preserve; the removal of all Brazilian Pepper from the J.N. "Ding" Darling National Wildlife Refuge and all Sanibel public conservation lands; a $2.1 million grant for the acquisition of Pond Apple Park (2002) and a $1.38 million grant for the removal of hurricane debris from island waterways (2004.)

Scott Krawczuk, E.I., Deputy Director, City of Sanibel Public Works Department

Mr. Scott Krawczuk's training and experience include a Bachelor of Science Degree in Ocean Engineering from the Florida Institute of Technology, and over 12 years of experience in engineering design, facilities construction and facilities management. Mr. Krawczuk previously worked as a Project Engineer for the US Army Corps of Engineers, Fort Monmouth, Tinton Falls, New Jersey, where he was responsible for the overall management of three major facilities construction projects. Mr. Krawczuk is affiliated with the Florida Engineering Society Calusa Chapter and the American Public Works Association.

James Evans, Environmental Health & Water Quality Specialist, City of Sanibel Natural Resources Department

Mr. James Evans, Environmental Biologist, training and experience include a Bachelor's Degree in Environmental Studies with an emphasis in Aquatic Ecosystems from FGCU, where he was an Honor Graduate, and is currently completing his Master's Degree from FGCU in Environmental Science (MS) with an emphasis on Marine Science. Mr. Evans is currently working on his thesis research, "The effects of altered freshwater flow on the trophic relationships of gelatinous zooplankton and ichtyoplankton in Estero Bay, Florida." Mr. Evans has over 9 years of experience in local, state, and federal permitting for environmental restoration projects including Environmental Resources Permits through the South Florida Water Management District and the Florida Department of Environmental Protection, and nationwide permits through the US Army Corps of Engineers. Mr. Evans currently serves as Project Manager on the Charlotte Harbor National Estuary Program Water Quality Monitoring Network, San Carlos Bay Stratum; a member of the Charlotte Harbor National Estuary Program's Technical Advisory Committee; Lee County Coastal Advisory Council; and a board member for the Southwest Florida Watershed Council. Mr. Evans is the recipient of the 1995 Soldier of the Year Award from the 1-107th Armor Battalion and 38th Infantry Brigade, Ohio National Guard; the 2002 Coastal America Partnership Award; and was selected from among his peers as the City of Sanibel's 2005 Employee of the Year.

City of Sanibel
Algae Investigation Management Project
Fact-Finding Site Visit
Staff Report
April 2007

Purpose of Trip

City of Sanibel Natural Resources Department Director Robert K. Loflin, Ph.D., Environmental Biologist James Evans III and Public Works Department Deputy Director Scott Krawczuk, E.I., were sent to Oahu, Hawaii, to investigate how the state handles its severe problems with exotic marine macroalgae (seaweed). The intent of the fact-finding trip was to observe and learn about their existing programs of macroalgal management and to make preliminary determinations as to the potential applicability of these management techniques to the ongoing severe macroalgal blooms in the waters surrounding Sanibel.

Work Accomplished

Staff met and worked directly in the field with the University of Hawaii, the State Department of Lands and Natural Resources (DLNR) and The Nature Conservancy experts on macroalgal control. The "Supersucker Junior" and "Senior" algae removal vessels were examined and evaluated in detail (see exhibit A). City staff observed and participated in the actual operation of these vessels on coral patch reefs in Kaneohe Bay near the University of Hawaii's Coconut Island Marine Research Laboratory. City staff conducted underwater surveys on coral patch reefs that had previously been cleared of algae and compared them to areas nearby that were still heavily covered with macroalgae to determine the efficacy of the removal work. Working underwater with the algae management partnership members (see Exhibit E), City staff assisted in the labor intensive work of removing algae from affected coral reefs, checking for and liberating invertebrate by-catch (sponges, pieces of live coral, small crabs, etc.), and feeding the algae into the opening of the suction pump hose underwater from which it was hydraulically pumped to the nearby vessel (see Exhibit A).

Following underwater operations, we helped transfer the algae to ~60lb. mesh bags and on to the marina dock and traveled to nearby taro farms where the algae is utilized as organic compost (Exhibit B). We met with the taro farmers and received information and guidance on the mulch, compost and other agricultural techniques used by these subsistence organic farmers and the applicability of those methods in Florida. We participated in an algae management partnership meeting at the University of Hawaii in Honolulu at which we presented Sanibel's algae problem to participants and solicited and received advice and additional contact information.

The Waikiki Beach clean-up equipment used by the hotels was also observed and photographed in operation. City staff also consulted with the Public Works Department of the County of Maui to discuss actions they took to deal with a multi-year bloom event which resulted in heavy drift algae on Maui beaches and has since diminished to minor amounts over the past 5 years. Maui's beach algae situation was apparently very similar in many respects to what Sanibel is now experiencing. In addition, City staff inspected a small scale experimental sea urchin mariculture facility run by the University of Hawaii on Coconut Island. Sea urchins feed on invasive algae and the program is designed to test whether augmenting patch reef populations of urchins will improve native herbivore control of the bits of algae remaining following manual removal with the supersucker.

Information Gathered

The Oahu "supersucker" algae removal program is extremely important in reducing and controlling invasive exotic algae infestations on living coral reefs in Hawaii. Areas cleared of algae appear to show complete recovery resulting in healthy coral reef systems. This program utilizes inshore vessels equipped with specially modified water pumps equipped with hydraulic hose and floats to keep the hose from impacting coral. This type of operation may well have application in the shallow waters of the J. N. "Ding" Darling National Wildlife Refuge to remove green filamentous algae covering the seagrass and other marine bottom types if it is considered desirable and feasible by the Refuge Manager. The shallow draft of the vessel, and the ability of the operator to carefully direct what is removed and to exclude by-catch is a potentially environmentally sound mechanical method to assist in grassbed recovery.

However, its applicability for macroalgae removal in the open Gulf of Mexico is severely limited. The operation is a time consuming and labor intensive process. The work is conducted on fairly small (1/2-4 acre) coral patch reefs in very clear water. Considering the extent of the algae beds offshore of Sanibel's 11 miles of gulf front, algae removal using this technology would be extremely costly and relatively slow. It would require multiple commercially certified SCUBA divers experienced in working in murky waters and much larger vessels/barges than those used in the protected bays of Oahu. Additionally, weather and sea conditions such as cold fronts, thunderstorms and poor visibility in the open Gulf would result in regular periods where operations would be impossible. The maximum algae collection rate ever achieved by the larger of the Hawaii based vessels under ideal conditions was 800 lbs. of wet algae per hour by an experienced diver or a total of ~3200 lbs (~1.6 tons) during a normal four hour dive day (the physical safe limits of commercial SCUBA diving for an individual diver). In contrast, City of Sanibel Public Works Director Gates Castle, P.E., estimated the weight of wet algae on a 1,000 foot length of Sanibel beach with a 30-foot wide, 1 foot deep algae load as 500 tons. Given that 1000 feet is a small portion of Sanibel's gulf front , the extent of this capacity issue is obvious (see photos Exhibit A and videos regarding the limited capacity of this operation for high volumes of macroalgae).

The use of wet algae directly collected from reefs as is for compost by organic taro farmers has proven successful for numerous crop species including taro, corn and sweet

potatoes. The algae is worked into the existing field soils to increase the organic and nutrient content. No detrimental effects of salt were noted, but certainly after the material was dried and after a significant rainfall or two, salt should not be an issue in a composting program here either. It should be noted that the nutrient content of the primary algae causing problems on Sanibel beaches, *Gracilaria* sp., is much higher than that of the Hawaiian species, likely improving its effectiveness as compost and perhaps serving to reduce fertilizer needs of whatever horticultural application it might be used for, be it commercial agricultural or residential landscaping/gardening uses.

Three methods of mechanical beach clean-up were able to be evaluated during the trip. At Waikiki Beach in Honolulu on the island of Oahu, the hotels use a Barber Beach Rake model 400 (Exhibit C) which is a relatively small machine with only a 1 cubic yard storage bin that is primarily used for picking up litter such as cigarette butts from the beach every morning. The largest machine this company makes is the model 600, which still only has a 2 cubic yard capacity, far short of what we would need to remove algae from our beaches. There was an internet report of algae problems on Waikiki Beach but it turns out that photo was of algae growing on rocks in front of a seawall at low tide. In fact, no one could remember ever having a problem with algae washing up on Waikiki Beach. Exotic algae on coral reefs and rocks offshore is periodically cleaned-off by divers and brought to shore by citizen volunteers via a human chain formation (as part of the University of Hawaii and The Nature Conservancy's environmental education programs).

The second and third methods evaluated were used on the island of Maui by the County of Maui. After working to clean-up similar large volume piles of algae on Maui beaches with a front end loader, Maui County then switched to a specialized piece of heavy equipment. This was a modified potato harvester developed by Gallenberg Technologies in Wisconsin and called the "Beachmaster 2000" (Exhibit D). Maui County Public Works Construction and Maintenance Supervisor described this machine as a "failure in the long term" due to saltwater corrosion and associated chronic mechanical breakdowns and its excessive removal of beach sand. The County then returned to a front-end loader based wet rake and compost program that utilized nearby County owned land as a compost site (Exhibit D). **Odor control and removal of sand from the beach were cited by County staff as the biggest challenges with this method.** The program received excellent community support with the extensive pick-up and use of the compost by islanders. The program staff worked to minimize the drawbacks as best they could. Sand recovery was never attempted from the compost site.

In discussion with several algae experts at the University of Hawaii and with the State's DLNR staff, **at the extreme volumes of algae on the beach Sanibel is experiencing, all recommended removal of the algae both to reduce the potential for nutrient re-cycling and leaching back into the nearshore waters and to minimize the chance that offshore winds or currents could return living pieces of algae back offshore where they might re-attach. They also advised that it would be preferable to remove the algae offshore before it reached the shoreline to protect shorebird habitat.** These individuals are considered among the world's foremost experts on dealing with

macroalgal infestations. These conclusions seem to be the consensus of most, if not all, of the algae experts, both in Hawaii and in Florida with whom we have consulted regarding the situation on Sanibel.

Conclusions and Recommendations

Currently, after thoroughly evaluating the anticipated positives and negatives of mechanical algae removal from the beach and receiving guidance from numerous experts in the field, City staff recommends that we continue to move forward as directed by City Council with a careful experimental program to investigate the best mechanical method of "on beach" algae removal with the least environmental impacts. The County of Maui, as described above, has had very similar challenges with algae accumulations on the beach and following years of experimentation, has developed a successful rake and mulch program. We should take advantage of their experience and experiment with the techniques that they have found successful to evaluate whether similar methods might be appropriate for Sanibel.

It should be recognized that the previously utilized beach clean-up methods employed by both Sanibel and the Town of Fort Myers Beach, involved the drying of the algae high up on the beach prior to removal from the beach. This both disturbs the entire beach for shorebird nesting, roosting and feeding activities and precludes the ability of beachgoers to set up a spot with towels and or chairs on the beach in a normal manner. It also allows the decay process to begin, thereby potentially returning nutrients and/or organic particles back into the nearshore waters and producing noxious odors.

Therefore, based on this fact-finding trip and research done to date, staff further recommends that the City conduct a pilot project with the algae collected wet at the waters edge by front-end loader equipped with a rake, and taken along the beach below the wrack line to the nearest beach access, and loaded into either dump trucks or roll-off dumpsters. Furthermore, staff suggests that the City conduct an initially small scale pilot composting operation. Two potential on-island compost sites that have been identified for the pilot project to date are: 1) the Sanibel Gardens hurricane debris burn site off Island Inn Road, 2) the Gavin site just west of Tarpon Bay Road within the Refuge. Previous post-hurricane burn operations at both these sites have resulted in complaints from adjacent property owners regarding odor.

Alternatively, the algae could be hauled directly to a commercial agricultural operation off island, to be composted for horticultural use. Several advantages to composting on island include: a) the sand that is inevitably and unavoidably collected with the algae at least remains on the island even if it is not practicable to return it to the beaches; if it leaves the island, it is gone forever; b) an active compost program used by residents and businesses on the island could serve to involve the community in the solutions to this chronic problem and potentially reduce the need for fertilizers that are undoubtedly exacerbating nutrient pollution of local waters. As on Maui, odor control and returning the inadvertently collected sand to the beaches would also be expected to pose a challenge to be overcome.

Staff strongly recommends not to send the algae to an incinerator or open air burn operation as a long term solution as that would only return the nitrogen and carbon to the atmosphere, potentially resulting in some portion of these detrimental components to be deposited back into local waters.

The most promising method of offshore macroalgae removal for Sanibel may be a trawling operation similar (or perhaps nearly identical to) that used locally for pink shrimp harvest. Shrimp boats could conceivably trawl for algae in mapped beds, haul the algae on deck, sort and release by-catch such as shrimp, seahorses, mollusks, etc., and potentially transfer the algae to an adjacent barge. Numerous technical, logistical and environmental challenges would need to be addressed including potential impacts on sea turtles especially during their nesting season. A feasibility study of the potential for offshore algae removal utilizing shrimp trawlers is recommended.

Next Steps

1. Continue experimental mechanical algae removal testing on the beach in a manner that does not interfere with snowy plover or sea turtle nesting. If this cannot be done, then equipment evaluation should be limited to non-plover nesting sections of the beach or delayed until after nesting season is completed in July. City Public Works Director Gates Castle, P.E. has at the present time identified 4 mechanical algae removal methods as a priority to test and evaluate.
2. Experiment with the use of shrimp trawlers to remove algae in mapped algae beds offshore. The City's Natural Resources Department will take the lead in this feasibility study and evaluate environmental impacts.
3. Use the information gathered in the experimental phase above to develop a pilot compost program.
4. Proceed with algae research project in partnership with Lee County to determine and evaluate the extent, cause and dynamics of the macroalgae problem via the recently approved RFQ.
5. Provide the U.S. Fish and Wildlife Service the results of City staff analysis from this fact-finding trip in order for the Refuge Manager to consider the potential feasibility for use of a pump vessel similar to the "supersucker" to remove filamentous green algae from seagrass beds in the J. N. "Ding" Darling NWR.
6. Continue to address the long term causes of the water quality problem in the waters surrounding Sanibel by continuing to work with the Corps of Engineers, the South Florida Water Management District, the State of Florida and all other involved governmental entities to reduce the nutrient loading and excessive freshwater discharges that have clearly been the underlying cause of this damaging algae bloom.
7. Continue to seek funding which may exceed several millions dollars per year, to pay for the above.

Exhibits List

Exhibit A - Super Sucker Jr. and Sr. Specifications and Photos

Exhibit B - Taro Farming Operation Photos

Exhibit C – Barber Surf Rake Specifications and Photos

Exhibit D – County of Maui Beach Cleanup Operations Summary, Equipment Specifications, and Photos

Exhibit E – Hawaii Algae Management Team Contact List

Exhibit F – Miscellaneous Photos CD

Exhibit G – Super Sucker Operation Video

Exhibit A

Super Sucker Jr. and Sr. Specifications and Photos

EQUIPMENT SPECIFICATIONS

"SUPER SUCKER JUNIOR"

This equipment was observed on April 11, 2007 with representatives from the University of Hawaii, the State Department of Land and Natural Resources, and the Nature Conservancy. City staff observed and aided in the removal of algae from coral patch reefs within Kaneohe Bay.

Length – 16 feet
Beam – 8 feet
Draft – 1.5 feet
Power – 25 horsepower Yamaha gasoline engine

Pontoon based work barge. Pontoons are prefabricated and basically a plastic outer shell filled with foam floatation. Steel structural decking with fiberglass mesh placed on top to allow water to flow through but trap any remnants of algae on deck for disposal.

"Super Sucker Junior" is basically a scaled down version of the Senior. This version is self-propelled and is trailerable so it can be delivered to various sites on the island of Oahu and not restricted by one point of origin like the Senior barge. This operation only requires one scout boat instead of two.

Two 4-horsepower Honda WDP30X diaphragm pumps installed at the bow for algae removal operation. Flexible hose is used to suck the algae from the coral patch reefs. The pumps can push approximately 80 gallons of water per minute through the mesh storage bags. Floats and clips taken from the longline fishing industry are fastened to the hoses to allow them to float on the surface so not to damage the coral below.

Two divers work in the water directing the suction hoses (one diver for each hose). The divers pull the alien algae from the coral patch reef by hand and feed it into the suction hose to be pumped to the mesh bags. This operation can collect ± 1,000 lbs of algae per day. Most of the algae removal work is performed in 2' to 25' of water depth.

Two deck hands monitor the operation from the barge. Once the mesh bags are full of algae (± 60 lbs in weight) they are transferred to the support boat. There is no sorting table on the "Super Sucker Junior" as the algae is directly pumped into the mesh bags.

Total operation requires five people to operate: two divers to operate the suction hoses in the water, two deck hands, and one supervisor.

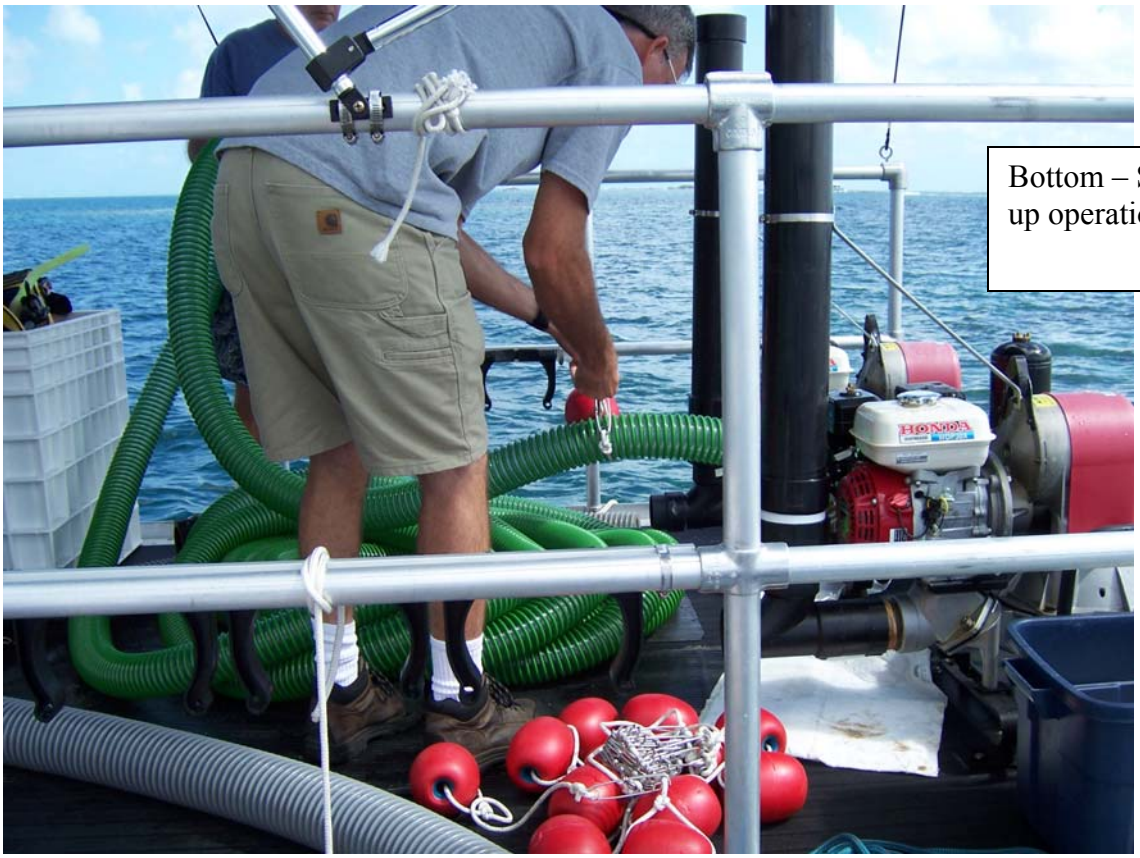
Construction Cost Estimate:

Collection Platform

Pontoons	$8,000
Material and Fabrication	$22,000
Trailer	$4,000
Pump and Hoses (est.)	$3,000
Dive Gear	$3,000
Deck equipment and Supplies	$5,000
Total	**$45,000**

Note: This barge was constructed in-house by University of Hawaii personnel and cleans areas that are only ½ to 4 acres in size. The size of algae beds offshore of Sanibel are much larger and preliminary offshore surveys conducted by City staff indicate that the estimated coverage of the algae surveyed from Lighthouse Beach to the end of West Gulf Drive is over 1,500 acres.

Top- “Super Sucker Junior”



Bottom – Setting up operations

Top – Dive operations

Bottom – Pumping algae into mesh bags for disposal

Top – “Super Sucker Junior” view from the water

Bottom – “Super Sucker Junior” underwater algae removal operations

EQUIPMENT SPECIFICATIONS

"SUPER SUCKER SENIOR"

This equipment was observed on April 9th & 12th, 2007 with representatives from the University of Hawaii, the State Department of Land and Natural Resources, and the Nature Conservancy. City staff observed and aided in the removal of algae from coral patch reefs within Kaneohe Bay.

Length – 25 feet
Beam – 13 feet

Pontoon based work barge. Pontoons are prefabricated and basically a plastic outer shell filled with foam floatation. Steel structural decking with fiberglass mesh placed on top to allow water to flow through but trap any remnants of algae on deck for disposal.

"Super Sucker Senior" is not self-propelled and needs to be towed to the work site. The range of this barge is limited due to this towing operation. Two support boats are needed to tow the barge to the work site and act as scout boats. Once on site the barge is anchored into position and then shifted as necessary.

40-hp bio-diesel fueled venturi style gold mining pump installed at bow for algae removal operation. 100' of 4" diameter flexible hose is used to suck the algae from the coral patch reefs. The pump can push approximately 300 gallons per minute through the sorting table. Floats and clips taken from the longline fishing industry are fastened to the hose to allow it to float on the surface so not to damage the coral below. This style of pump allows marine life to pass through without being harmed by an impeller and can be returned to the ocean. Air compressor installed at the stern of the barge so divers can work without bulky tanks.

Two divers usually work in the water directing the suction hose. The divers pull the alien algae from the coral patch reef by hand and feed it into the suction hose to be pumped to the sorting table. This operation can collect ± 800 lbs of algae per hour or ± 3,000 lbs per day. Most of the algae removal work is performed in 2' to 25' of water depth.

Pump discharges onto a mesh-screen-topped wood sorting table. Two (2) technicians work on either side of the sorting table to pull out marine life by-catch and return this by-catch to the coral patch reef. Algae is then pushed into mesh bags attached to notches in the sorting table. Once bags are full of algae (± 60 lbs in weight) they are stored in large plastic bins on the main work barge or transferred to one of the support boats.

Total operation requires four to five people to operate. One or two divers to operate the suction hose in the water, two technicians at the sorting table, and one supervisor.

Construction Cost Estimate:

Collection Platform	
Pontoons	$8,038
Material and Fabrication	$23,249
Pump and Hoses (est.)	$15,000
Air Compressor and Dive Gear	
Compressor and hoses	$5,969
Dive Gear	$2,928
Deck equipment and Supplies	$6,793
Total	**$61,977**

Note: This barge was constructed in-house by University of Hawaii personnel and cleans areas that are only ½ to 4 acres in size. The size of algae beds offshore of Sanibel are much larger and preliminary offshore surveys conducted by City staff indicate that the estimated coverage of the algae surveyed from Lighthouse Beach to the end of West Gulf Drive is over 1,500 acres.

Top- Stern of "Super Sucker Senior"

Bottom - Bow of "Super Sucker Senior"

Top - 40-hp venturi gold mine style pump fueled by biodiesel

Bottom - Sorting table operation

Top – “Super Sucker Senior” view from the water

Bottom – “Super Sucker Senior” underwater algae removal operations

Exhibit B

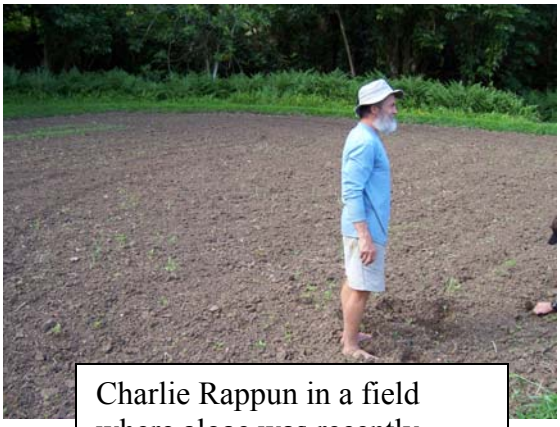
Taro Farming Operation Photos

Algae used on sweet potato fields

Taro field

Taro field – flooded as part of the growing practice

Fields ready for planting taro

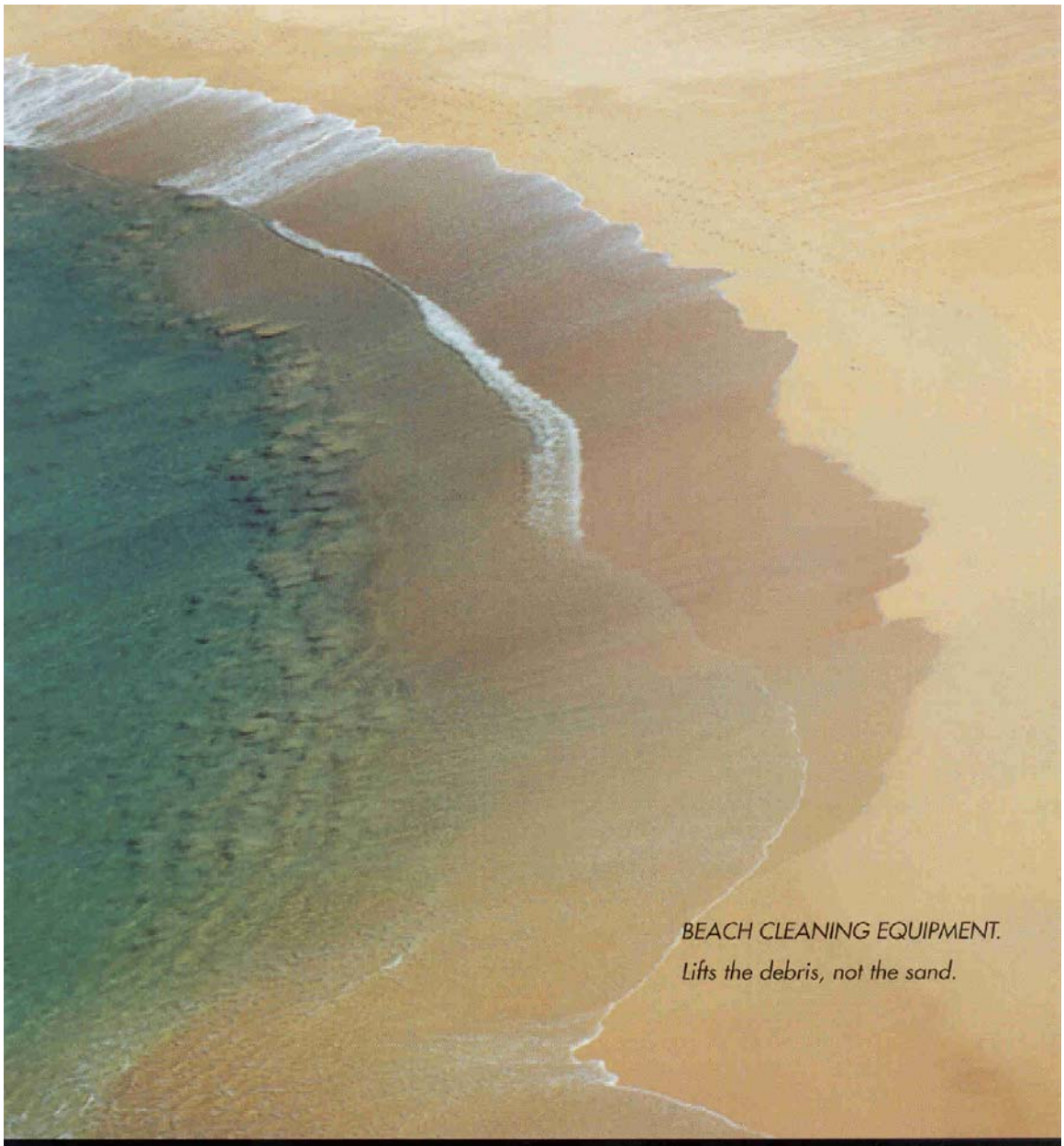


Charlie Rappun in a field where algae was recently tilled into the ground

Field with algae tilled in and ready to be planted

Exhibit C

Barber Surf Rake Specifications and Photos



BEACH CLEANING EQUIPMENT.
Lifts the debris, not the sand.

BARBER SURF RAKE®

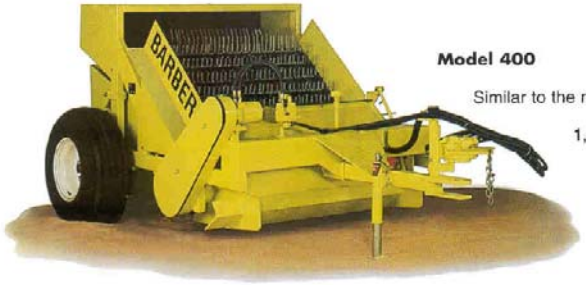
THE COMPLETE LINE OF BARBER SURF RAKES®

Model 600HD

At 3,800 pounds, the 600HD is H. Barber & Sons' largest Surf Rake®. It has been successfully used in a variety of municipal applications. Cleaning up to eight acres an hour with its seven foot wide cleaning width, the 600HD has the greatest cleaning capacity of any beachcleaner. The 2 cubic yard hopper can lift up to 3,700 pounds of material and dump its contents hydraulically from a clearance height of nine feet.

Model 400HD

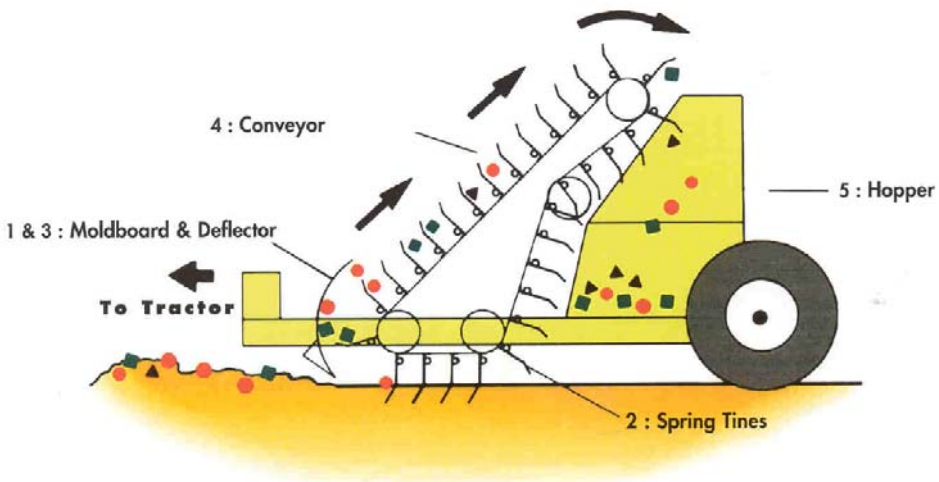
The model 400HD is an excellent choice for resorts, hotels and lakeshore communities. At 2,700 pounds, it is H. Barber & Sons' moderate-size Surf Rake®. The 400HD is equipped with a one cubic yard hopper which will lift 2,400 pounds of debris to a dumping height of eight and a half feet. This mid-sized model uses the same heavy-duty conveyor and dump components as the 600HD. The 400HD can clean up to five acres per hour.



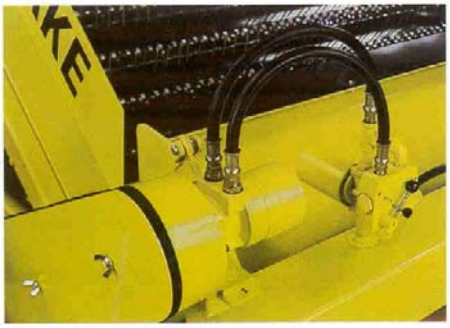
Model 400

Similar to the model 400HD, the model 400 is the smallest Surf Rake®. It weighs 1,900 pounds and can lift up to 2,000 pounds in its 3/4 cubic yard hopper. Its hydraulic dump discards material neatly on the ground. Within one hour, the model 400 can effectively clean up to four acres.

HOW IT WORKS



The Barber Surf Rake® is a unique mechanical rake operated by one person from the seat of a towing tractor. It provides safe, fast and efficient beach cleaning. Here is how it works: **1.** The *moldboard* levels uneven areas in the sand. **2.** Stainless steel *spring tines,* mounted on a belt-covered bar flight conveyor, rake debris from the sand toward **3.** an adjustable *deflector* plate. As a result, refuse is deposited on **4.** the elevating portion of the *conveyor* to **5.** the hydraulically raised and tripped *hopper*. The result: a clean, safe and well-manicured beach.

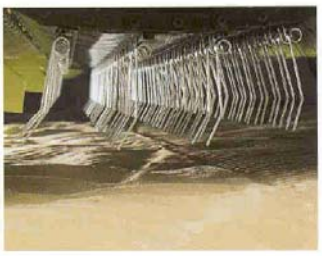


◀ HYDRAULIC DRIVE

The Barber Surf Rake® features a new hydraulic drive for smooth operation with major advantages. First, it provides excellent maneuverability. Power is transferred through a flexible hose, allowing the Surf Rake® to clean while turning in the tightest of areas. Second, the Surf Rake's® flow control permits fine adjustments of the conveyor belt speed, independent of the tractor. Third, the hydraulic drive promotes operator safety by eliminating exposed turning shafts. Fourth, the adjustable overflow engages and resets automatically to protect the Surf Rake® from oversized objects.

EXTRA STRENGTH STAINLESS STEEL TINE ▶

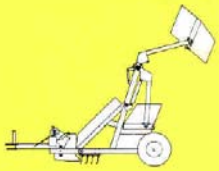
A new, double torsion, three coil stainless steel tine offers long life, great durability and resistance to corrosion.



◀ THOROUGH CLEANING

Hundreds of stainless steel tines, mounted in offset rows, rake through the sand every second, removing the unwanted debris. Even the smallest objects such as glass, cigarette butts and pop-tops are captured by the Surf Rake® and deposited in the hopper.

SPECIFICATIONS



MODELS	600HD	400HD	400
HYDRAULIC DRIVE	Completely sealed and protected by full flow filter. Large capacity spline mounted cast iron pump, hydraulic motor, flow control, and built-in overflow protection.	Completely sealed and protected by full flow filter. Large capacity spline mounted cast iron pump, hydraulic motor, flow control, and built-in overflow protection.	Completely sealed and protected by full flow filter. Large capacity spline mounted cast iron pump, hydraulic motor, flow control, and built-in overflow protection.
HYDRAULIC FLOW	12 gallons per minute	12 gallons per minute	12 gallons per minute
HYDRAULIC CAPACITY	13 gallons	10 gallons	10 gallons
CYLINDERS	Lift 3 1/2 " 18 " single acting Trip 2 " x 5 " single acting	Lift 3 1/2 " x 18 " single acting Trip 2 " x 5 " single acting	Trip 1 1/2 " x 10 " single acting
CONVEYOR	Of bar flight type with chain and sprocket drive, covered with continuous 6' wide belt, and mounted thereon stainless steel spring tines.	Of bar flight type with chain and sprocket drive, covered with continuous 4' wide belt, and mounted thereon stainless steel spring tines.	Of bar flight type with chain and sprocket drive, covered with continuous 4' wide belt, and mounted thereon stainless steel spring tines
HOPPER	2 cubic yard (3700#cap.) Hot dip galvanized	1 cubic yard (2400#cap.) Hot dip galvanized	3/4 cubic yard (2000#cap.)
DUMP HEIGHT	9 feet	8 1/2 feet	Ground
TIRES	36 x 13.5 x 15 high flotatation design	31 x 13.5 x 15 high flotation design	31 x 13.5 x 15 high flotation design
OPERATING SPEEDS	1.0 to 15.0 miles per hour	1.0 to 15.0 miles per hour	1.0 to 15.0 miles per hour
CLEANING WIDTH	7 feet (6 feet of deep cleaning)	6 feet (4 feet of deep cleaning)	6 feet (4 feet of deep cleaning)
CLEANING DEPTH	Adjustable to 6 "	Adjustable to 6 "	Adjustable to 6 "
DIMENSIONS	Height: 7'6 " Length: 13'1 " Width: 7'6 "	Height: 7'6 " Length: 11'9 " Width: 7'6 "	Height: 4'5 " Length: 9'10 " Width: 7'6 "
WEIGHT	Approximately 3800#	Approximately 2700#	Approximately 1900#
PAINT	Dupont IMRON® Polyurethane enamel	Dupont IMRON® Polyurethane enamel	Dupont IMRON® Polyurethane enamel
FINISHING ATTACHMENT	To smooth the sand and eliminate tire marks for a minimum 9 foot wide path- optional.	To smooth the sand and eliminate tire marks for a minimum 9 foot wide path- optional.	To smooth the sand and eliminate tire marks for a minimum 9 foot wide path- optional.
GALVANIZATION	All frame and body parts Hot Dip Galvanized - optional.	All frame and body parts Hot Dip Galvanized - optional.	All frame and body parts Hot Dip Galvanized - optional.
PERFORMANCE	Cleans 2 to 8 acres per hour	Cleans 1 to 5 acres per hour	Cleans 1 to 4 acres per hour
TRACTOR REQUIREMENTS	60 PTO horsepower 4-wheel drive agricultural type tractor with 30" rear wheels.	35 PTO horsepower 4-wheel drive agricultural type tractor with 28" rear wheels	30 PTO horsepower 4-wheel drive agricultural type tractor with 28" rear wheels

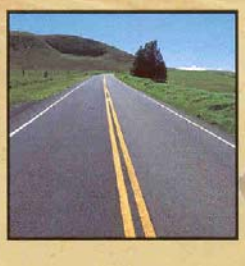
540 RPM rear PTO, 3 point hitch, and 1 remote hydraulic valve (minimum) with raise, hold, and float positions. This is a general guideline. Larger or smaller tractors may be used depending on beach conditions.

DEBRIS REMOVED

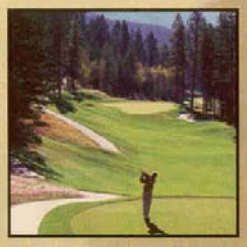
Broken glass, plastic, syringes, cigarette butts, pop-tops, straws, cans, tar balls, stones 1/2" to 4" in diameter, sea grass, sea weed, fish, small pieces of wood.

The manufacturer reserves the right to change the specifications without notice and without incurring obligation. The information contained herein is from data available at the time of printing.

The World Leader in Tine Raking Cleaning Equipment.



Litter collection machines for both paved surfaces and grass areas. Truck towed and tractor towed models for all applications.



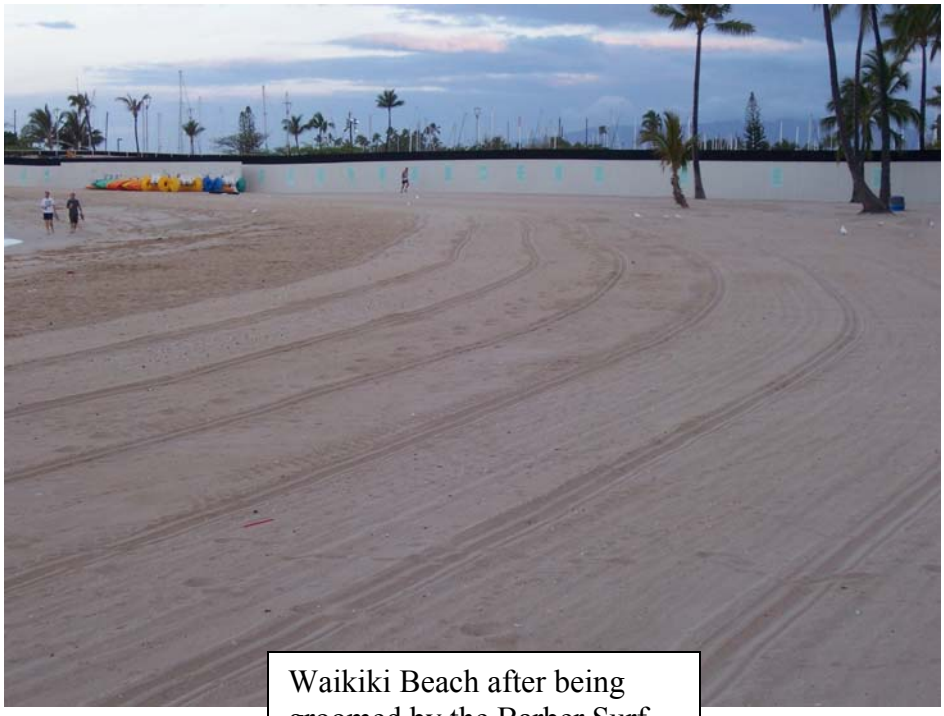
Stone pickers that remove debris and level work area in one pass. A variety of models for different size jobs.

World leader in beach cleaning equipment for more than 35 years. Models for all beaches and conditions.

BARBER

H. Barber & Sons, Inc. 15 Raytkwich Drive Naugatuck, CT 06770
Telephone (203) 729-9000 Fax (203) 729-4000 www.hbarber.com

Barber Surf Rake in operation on Waikiki Beach in front of the Hilton Hawaiian Village



Waikiki Beach after being groomed by the Barber Surf Rake

Exhibit D

County of Maui Beach Cleanup Operations
Summary, Equipment Specifications, and Photos

The County of Maui has had a similar problem with algae washing ashore on its south shore beaches since the early 1990s. The algae was deemed a nuisance by the County and decided to have it cleaned from the beaches by the County Highway Division at first using existing County owned equipment. The following information was obtained by phone calls, e-mails, and information received by mail from the Highways Division Superintendent of the County of Maui in charge of the algae removal operations.

The source of the algae problem on Maui was thought to be increased nutrients into the Pacific by various point sources. Waste water plants dumped treated sewage water into the Pacific, and currently have been modified to use deep well injection systems. A large pineapple plant was also considered as a source of nutrients due to water releases. The pineapple plant was altered to filter water prior to releasing in the ocean.

The initial algae removal operation consisted of front end loader and backhoe combination machines similar to the Case 580 SL machine currently owned by the City of Sanibel. Trial and error was involved, but the County personnel developed a technique of filling the front end bucket completely with algae and then continuing to push additional algae on the beach into manageable piles. These piles would than be gathered by the same type of equipment and placed on County property just outside and adjacent to the beach area.

These piles would then be allowed to dry out in the sun for periods of time up to twelve weeks and would be turned over with equipment a few times during this period. During this time approximately 80% of the water would leach out of the algae and the remnants could be hauled to a green waste composting facility to be recycled or just spread out on the county lands to be mixed with the existing soil. One of the problems with this operation was the amount of sand collected with the algae removal. Sand would cling to the wet algae as it was gathered and in turn be hauled away. The County tried to recycle some of the sand after the algae dried out by basically hauling the material back to the beach, but there was a fair amount of organics returned with the sand.

The algae problem on Maui has been a cyclical event coming and going every couple of years. At the worst times the County was cleaning approximately 1,000 tons of algae per day from the beach. During this period it was difficult to keep up with the large volumes of algae and the odor of decaying algae received many complaints, so the algae removed from the beaches was hauled directly to the green waste compost recycling centers using dump trucks and dumpsters. After some time of performing this operation, all but one of the compost facilities refused to accept the algae due to the sand and rocks mixed in causing damage to the facilities tub grinder machines.

About four to five years ago the County researched and purchased a piece of equipment called a “Beachmaster 2000” manufactured by Gallenberg Technologies located in Antigo, Wisconsin. This equipment was basically a modified potato harvester with a shaker belt system. Equipment would pick up algae with a belt system and remove sand

along the shaker belt and deposit the algae in a three cubic yard hopper that could be hydraulically dumped to a height of nine feet. The "Beachmaster 2000" was purchased by the County to more efficiently remove the algae and to remove less sand from the beach than the loader operation. The machine was put into use by the County for only two years and they experienced many mechanical failures with the machine and were disappointed with the amounts of sand the machine still removed from the beach.

Currently the County has returned to the front end loader and backhoe combination machine method of algae removal from the beach, but their algae problem has been almost non-existent over the past four to five years.

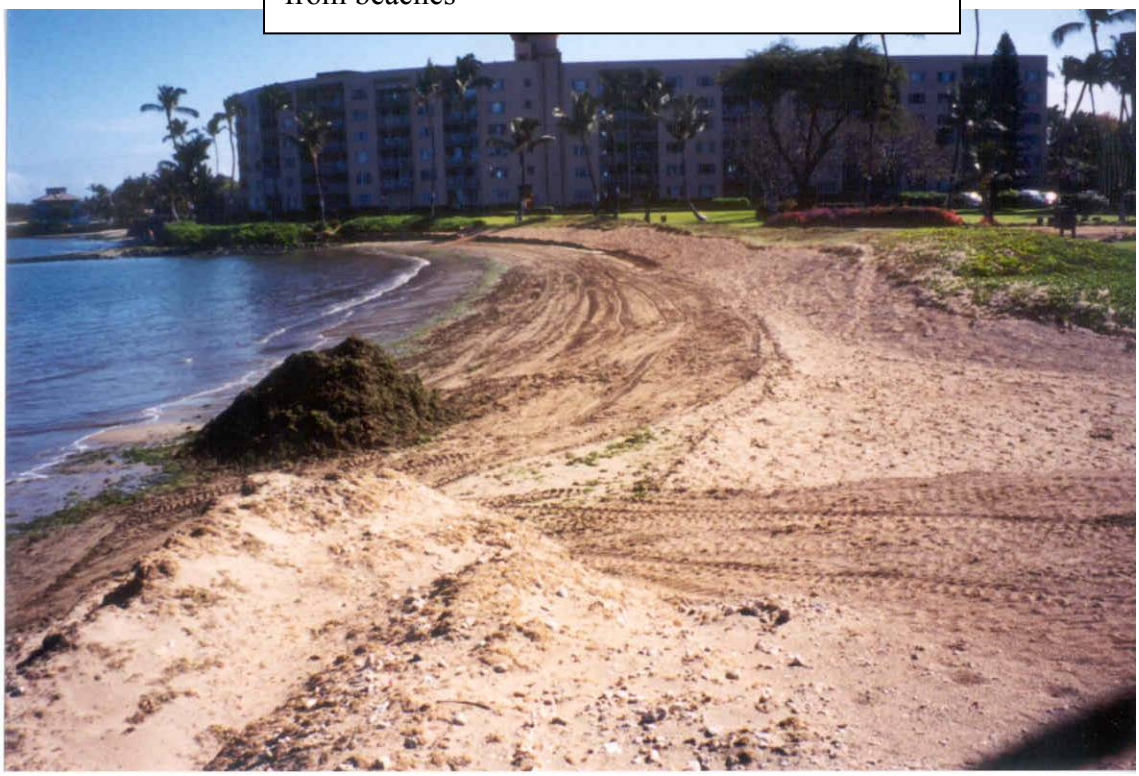
(See attached internal County of Maui memos for additional background information)

Contact information:

Leonard B. Costa
Highways Division Superintendent
County of Maui
Department of Public Works
Highways Division
1827 Kaohu Street
Wailuku, Maui, Hawaii 96793

"Beachmaster 2000" manufacturer
Gallenberg Technologies
Ron Gallenberg
W9120 Cherry Road
Antigo, WI 54409
www.gallenbergtech.com

County of Maui front end loader and backhoe combination machine method of algae removal from beaches



"BEACHMASTER 2000" equipment

Model: SPXL80-1.5 & 3.0 Self Propelled Beach Cleaner
Specifications as follows:

Cleaning width 68" standard (74" with sweeps)
Cleaning depth 0" to 8"
Cleaning speed: 0 to 15 mph
Hopper capacity: 1.5 cubic yards standard, 3.0 optional
Dump height: 9'-0"
Engine: 80 hp Kabota diesel with 50 gallon fuel capacity
Drive system: full time 4wd hydrostatic with 4 speed ranges
Hydraulic capacity: 40 gallons
Length: 20'-8" (with 1.5 cy hopper)
Height: 9'-6"
Weight: 11,000 lbs
Flashers and lighting package standard.

Algae problem on Maui Beaches

Beachmaster 2000 in operation on Maui

Beachmaster 2000 in operation on Maui

Beachmaster 2000 dumping algae into piles on Maui

Memo from the County of Maui's Department of Public Works and Waste Management regarding the "Beach Master 2000"

JAMES "KIMO" APANA
Mayor

CHARLES JENCKS
Director

DAVID C. GOODE
Deputy Director

Telephone: (808) 243-7845
Fax: (808) 243-7955

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS AND WASTE MANAGEMENT
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAII 96793

RALPH NAGAMINE, L.S., P.E.
Land Use and Codes Administration

Wastewater Reclamation Division

LLOYD P.C.W. LEE, P.E.
Engineering Division

BRIAN HASHIRO, P.E.
Highways Division

ANDREW M. HIROSE
Solid Waste Division

June 20, 2000

Ed Meyer
110 - 110th Ave. Suite 425
Bellevue, Wa. 98004

Ref: Beach Master Demo 4/14/00 — Jack G. Linn letter 4/25/00

Dear Ed:

The Beach Master is not the perfect solution but I thought it was the best I've seen for wet seaweed consolidation and handling. It is more efficient in dry sand, but it also does a reasonable job in wet sand and seaweed. Absolute, sand free seaweed consolidation is still not possible with this machine. It was suggested that a longer shaker and a larger bucket would better apply to our situation. The designer was going to evaluate this possibility for us.

A. The 30" floatation tires can go partially into the water this may/can add to the cleanliness of the pick up of seaweed. It looks as though it will remove more sand than what we've been doing in the past.

B. I don't know of any "buyer" for a semi-clean product. Compost / recycling use only at this time.

C. I assume that the County will be helping with the maintenance repairs (breakdowns). A reasonable amount of maintenance (washing, greasing, oil changes) will have to be done by the operator.

D. Probably the final cost may be $120,000.00 for the modified machine. Hopefully the Federal Grant of $500,000.00 will pay for the start up. (Truck, bins, etc.)

E. I hope to make seaweed free to composter's to start. Some get 20% more for their compost when it contains seaweed. After a while it may be feasible to charge the hauling costs to these receivers once the market is established. Seaweed may be deposited into roll on/off containers, hauled to composting sites by private contractors, and hauling fees paid directly to the haulers by the composting companies.

There are many other factors and problems to consider, and more adjustments that may have to be made along the way. It may or not work. It think that if the Feds are willing to support our efforts ($), its worth trying new ideas. We're still trying to come up with a final written plan. Nothings written in blood yet.

Sincerely,

Leonard B, Costa

February 4, 2002

To: Sam Pintz / UH

From: Leonard B. Costa / Highways Superintendent

Subject: Seaweed on Maui

Seaweed has been a "problem" only because it "seems" (eye of the beholder) to collect in front of beaches that are highly visible (Kihei tourist / vacation areas). While other beaches collect seaweed, as well, they are tolerated better (no one if any complains). Our primary Division objective is Highways and not beaches. We do pick up though, "nuisances" on the beaches, with the usual reference to dead sea animals, logs, fish nets, tires, etc. While seaweed is a "natural " occurrence it now is a "nuisance" mainly to condo owners. Again, eye of the beholder.

We have three areas of concern each year that we help with. Kihei is the largest activity of seaweed influx. The condos from Maui Sunset to Menehune Shores in Kihei pays a private contractor and estimated $60,000 a year to collect and either berm (beach dune restoration) or stock the seaweed which Highways hauls to a composting company. The composting company does not pay for the seaweed or the hauling at this time. The second area is the Kahului Harbor, in which seaweed gets caught between the five ton boulders fronting Harbor Lights Condo and rots (three feet deep between boulders). And also collects in an area just fronting the boat launch ramp of the harbor. We hire a vac truck at @ $200/hr. to vac up the seaweed from between the boulders as the rising tide raises it. We also pay for a private contractor to collects it from the boat launch area. This is paid for by the County. We also pay for plastic bags in Lahaina, the third area of concern. Again, seaweed fronting the "private" condos in Napili. The seaweed is not readily accessible and the condos are asked to collect it themselves and haul it out to the road where we can pick it up. While 9,000 plus bags was collected this 2001 year, its weight is possibly only 225 tons. Just a small portion of what is there. The condos are content with the effort, but mother nature usually does the major work of clean up every year.

Rotting seaweed smell like sewer. Sulfur dioxide. It is terrible, but when it happens fronting a vacation resort condo, it is a disaster.

The costs I am sending for the last two years only reflect the County's dollars and efforts in the above and not inclusive of the private aid. When I first started to assist in this matter seaweed pick up and hauling costs for the County was about $257 a ton. I have gotten it reduced to $16.38 a ton with some free bee hauling by private contractors, homeowners, back yard farmers, and regular farmers who want to utilize seaweed as a fertilizer. Many people want the seaweed but do not want to pay for the hauling.

2000 yr. Cost the County $38.01 a ton to pick up and haul 4116 tons of seaweed to the compost company for processing.

2001 yr. Cost the County $16.38 a ton to pick up and haul 5406 tons of seaweed to the compost

company for processing.

The 2928 tons collected does not represent the true tonnage of seaweed washed up on the beaches of Maui. About five times that is processed right into the berming process on the beach dune replenishing. The 2928 tons are what I call "dry tons" as the seaweed may be stocked during a period of about twelve weeks and at which time about 80 % of the water leaches out before we pick up the seaweed for hauling. This means that the stocked seaweed hauled may originally have represented many times over in actual original tonnage stocked. This is true for the Process in Kihei and the Kahului Harbor. Lahaina's private cleanup efforts pretty much pick up over night collections in back of the condos.

I have enclosed a picture of a preliminary test machine, modified potato picker / beach cleaner, to try to better our clean up process in Kihei. Our intent is to leave as much sand on the beach as possible and only pick up "seaweed" if possible. It has never been tried or proven effective as yet. It's cost will be about $133,000.00. We may be heros or the biggest fools around with this machine. We ordered the self propelled model rather than the pull behind version as some of the beaches are narrow and the turn radius is better than the self contained version.

Exhibit E

Hawaii Algae Management Team Contact List

Hawaii Algae Management Contacts

Brian Parscal, Operations Supervisor
University of Hawaii
45-1143 Haleloke Pl.
Kaneohe, HI 96744

Anthony Montgomery
Division of Aquatic Resources
Department of Land and Natural Resources
1151 Punchbowl St. Room 330
Honolulu, HI 96813

Dr. Celia Smith, Professor
University of Hawaii at Manoa
Department of Botany
St. John Plant Science Laboratory
3190 Maile Way, Room 101
Honolulu, HI 96822

Cynthia Hunter, Ph. D., Assistant Professor
Marine Biology
University of Hawaii
2450 Campus Road Dean 2
Honolulu, HI 96822

Eric Conklin, Marine Science Advisor
The Nature Conservancy of Hawai'i
923 Nu`uanu Avenue
Honolulu, HI 96817

Leonard B. Costa, Highways Division Superintendent
County of Maui
Department of Public Works
Highways Division
1827 Kaohu Street
Wailuku, Maui, Hawaii 96793

"Beachmaster 2000" manufacturer
Gallenberg Technologies
Ron Gallenberg
W9120 Cherry Road
Antigo, WI 54409

Exhibit F

Miscellaneous Photos CD

Exhibit G

Super Sucker Operation Video