Table VII-1. WATER QUALITY TREATMENT AND CONTROL TECHNOLOGIES CURRENTLY BEING USED IN DRYDOCKS

Purpose	Technology	Pollutants Possibly Affected	Applicability
Clean-up of Abrasive From Drydock Floor	Front Loader	FLO, SUS, SET, HM	GD, FD
	Hand Shovel and Broom	FLO, SUS, SET, HM	GD, FD
From Drainage Trenches	Backhoe	FLO, SUS, SET, HM	GD
	Hand Shovel	FLO, SUS, SET, HM	GD
Control of Wastewater Flows	Sill, Channeling, or Trench Drain for Control of Gate Leakage and Hydrostatic Relief	FLO, SUS, SET, HM, O	

FLO = Floating Solids
SUS = Suspended Solids
SET = Settleable Solids
O = Oil and Grease
HM = Heavy Metals and Other Chemical Constituents
pH = pH
Air = Particulates
SOLIDS = Solid Waste
GD = Graving Dock
FD = Floating Drydock

Table VII-2. WATER QUALITY TREATMENT AND CONTROL TECHNOLOGIES UNDER DEVELOPMENT OR NOT BEING USED IN DRYDOCKS

Purpose	Technology	Pollutants Intended To Be Affected	Applicability
Clean-up of Abrasive From Drydock Floor	Mechanical Sweeper	FLOW, SET, SUS, HM	GD, FD
From Drydock Floor or Drainage Trenches	Vacuum Recovery Equipment (Stationary or Mobile)	FLO, SET, SUS, HM	GD, FD
Alternative To Conventional Dry	Water Cone Abrasive Blasting	AIR	GD, FD
Abrasive Blasting	Wet Abrasive Blasting	AIR	GD, FD
	Hydroblasting (Steady Stream or Cavitation)	AIR, SET, SUS, HM, SOLIDS	GD, FD
	Closed-Cycle Abrasive Blast and Recovery	AIR, SET, SUS, HM, SOLIDS	GD, FD
	Cyclone Separation and Chemical-Physical Pretreatment	AIR, SET, SUS, HM, SOLIDS pH	GD, FD
Control of Wastewater Flows	Channeling for Improved Floor Drainage	SET, SUS, HM, O	GD
	Curbing & Channeling on Floating Drydocks	SET, SUS, HM, O	FD
	Scrupper Boxes, Hose, Piping, and/or Pumps for Clean Water Discharges	SET, SUS, HM, O	GD, FD
	Cover Plates to Prevent Abrasive from Entering Drainage System	SET, SUS, HM	GD
	Containment of Flows from Wet Blasting	SET, SUS, HM, O	GD, FD
Treatment of Wastewater Flows	Baffle Arrangement for Settling in the Drainage System	SET, SUS	GD
	Contained Absorbent in Discharge Flow Path	O	GD
	Wire Mesh in Discharge Flow Path	FLO	GD
	Adaptation of Pontoons for Settling Solids	SET, SUS, O	FD
Access for Clean-up Operations	Flat Floor Overlay	FLOW, SET, SUS, HM	GD, FD
	Removal of Bilge Block Slides	FLO, SET, SUS, HM	GD, FD
	Increased Keel Block	FLO, SET, SUS, HM	GD, FD
	Clearance	FLO, SET, SUS, HM	GD, FD
	Hydraulic Bilge Blocks	FLO, SET, SUS, HM	GD, FD

S = Sewage
FLO = Floating Solids
SUS = Suspended Solids
SET = Settleable Solids
O = Oil and Grease
HM = Heavy Metals and Other Constituents
pH = pH
AIR = Particulates
GD = Graving Docks
FD = Floating Drydocks
SOLIDS = Solid Waste

Table VII-3. REPORTED APPLICATION OF THE TREATMENT AND CONTROL TECHNOLOGIES

Purpose	Technology	Shipyards Visited							Shipyards Contacted (H Through A		
		A	B	C	D	E	F	G	Use	Do Not Use	Insufficient Information
Clean-Up of Abrasive From Drydock Floor	Front Loader	*	*	*	*	*	X	*	21	7	2
	Mechanical Sweeper	X	X	*	X	*	X	X	1	27	2
	Hand Shovel	*	*	*	*	*	X	*	26	1	3
	Broom	X	X	X	*	*	X	X	5	20	5
	Vacuum Recovery Equipment	X	X	X	Z	X	X	X	2	26	2
From Drainage Ditches	Backhoe	X	X	NA	X	X	*	NA	0	.0	30
	Hand Shovel	*	*	NA	*	*	*	NA	0	0	30
	Vacuum Recovery Equipment	X	X	NA	Z	X	X	NA	0	0	30
	Container Lifted by Crane	X	X	NA	X	X	*	NA	0	0	30
Alternative to Conventional Dry Abrasive Blasting	Water Cone Abrasive Blasting	X	X	X	*	X	X	X	0	0	30
	Wet Abrasive Blasting	X	X	X	*	*	X	X	0	4	26
	Hydroblasting										
	Steady Stream	X	X	X	X	X	X	X	3	4	23
	Cavitation	X	X	X	X	X	X	X	0	0	30
	Closed Cycle Abrasive Blast and Recovery	X	X	X	Z	X	X	Z	1	28	1
	Cyclone Separation Chemical-Physical Pretreatment	X	X	X	X	Z	X	X	0	0	30
Control of Waste-water flows	Sill, Channeling, or Trench Drain for Control of Gate Leakage and Hydrostatic Relief	*	*	NA	*	*	*	NA	0	0	30
	Channeling for Improved Floor Drainage	X	X	X	*	X	X	X	0	0	30
	Curbing and Channeling of Floating Drydocks	X	NA	X	X	NA	NA	X	0	0	30
	Scupper Boxes, Hose, Piping, and Pumps for Clean Water Discharges	*	*	*	*	*	X	X	4	5	21
	Cover Plates to Prevent Abrasive from Entering Drainage System	X	X	NA	X	*	X	NA	0	0	30
	Containment of Floor from Wet Blasting	X	NA	NA	X	*	NA	NA	0	0	30
Treatment of Wastewater Flows	Baffle Arrangement for Settling in the Drainage System	X	Z	NA	X	X	X	NA	0	0	30
	Contained Absorbent in Drainage Discharge Flow Path	X	X	NA	X	X		NA	0	0	30
	Wire Mesh in Drainage Discharge Flow Path	X	X	NA	X	NA	NA	NA	0	0	30
	Adaptation of Pontoons for Settling Solids	X	NA	X	X	NA	NA	X	0	0	30

NOTE: * = Use
X = Do Not Use
Z = Planned, Infrequent Use, or Under Development
NA= Not Applicable

Most of the facilities visited perform a manual pick up of large debris prior to each undocking. Such debris includes scrap metal, large wood chips or blocks, metal cans, scrap paper, paint cans, and the like. After this manual pick up, with the aid of shovels, the debris is deposited into receptacles on the drydock floor for removal and disposal. Some shipyards require this procedure at the end of each shift. Upon completion of this phase, only spent abrasive and other small sized debris remain on the drydock floor. A variety of procedures and technologies to remove the remaining substances were observed.

At many shipyards, no efforts are made to remove spent abrasive from the drydock floor prior to flooding. Docks servicing fresh water vessels rarely do any extensive blasting and consequently do not have spent abrasive to collect. In some cases contractual requirements do not allow time for clean up. Some companies regard the clean up process as difficult, time-consuming, labor-intensive, and hence expensive. The practice of no clean up was observed in smaller or older drydocks, particularly those with raised bilge block slides and those not requiring keel or bilge block movement prior to the next docking. The necessity for clean up is perceived at these docks only when accumulations of spent abrasive reach such levels that it interferes with keel or bilge block placement or movement, creates hazardous working conditions, or reduces productivity. Those conditions may be reached after only a few ships have been serviced or after many. Clean up may be as frequent as weekly or as infrequent as semiannually.

When clean up is necessary, front loaders are usually placed on the drydock floor. With graving docks, cranes are required to lower the machinery into the dock basin. The front loader is often modified to permit access to the floor beneath the ships hull and consequently to operate while the ship is still in dock. The loaders scrape and push the spent abrasive into piles. Men with shovels and the front loaders then place the accumulated waste in containers or hoppers.

When bilge block slides are present or low keel blocks are employed, the efficiency of operation of the front loaders is greatly reduced. The equipment has difficulty in passing over bilge block slides. Frequent stopping and starting, climbing and falling wears down the equipment and is time consuming. Laborers with shovels must manually clean areas inacessible to the front loader, such as beneath the hull and around the blocks and slides.

To remove the remaining grit some shipyards use manual sweepers. Workers with push brooms sweep the abrasive into piles which are transferred to the hoppers.

In a few instances mechanical sweepers are also used. One sweeper, a modified 1-3/4 ton truck, employs horizontal and vertical rotary brushes to loosen and pick up spent abrasive and other debris from the floor. These wastes are collected inside the sweeper. The sweeper can make two passes along the length of the dock before becoming full; then it must be emptied before continuing. The sweeper dumps its contents in a pile on the floor of the drydock. The pile is then loaded into containers by front loaders and laborers with shovels.

The mechanical sweeper has no arrangements for reaching around or under obstructions. It is also too high to clean under ships and can only clean those areas over which it passes. The sweeper cannot operate effectively unless the floor is clear of removable obstructions such as scupper hoses, hoppers of abrasive, scaffolding, and materials being used in the drydock (paint cans, metal plates, etc.). Thus, the sweeper does not begin clean up until after exterior work on the hull has been completed. When a large ship has been docked, there is little clearance along the sides or at the end of the dock. In such cases, space does not allow for the sweeper to be used prior to undocking.

Shipyard A has two graving docks and three floating drydocks It utilizes scupper boxes and hoses to direct cooling water discharges from the vessel to the drydock drains and ultimately to the harbor. Graving dock caisson leaks are intercepted at the outboard end of the dock and pumped back to the harbor without coming into contact with solid wastes on the floor of the graving dock. Hydrostatic leakage flows to drainage trenches along the periphery of the floor and is pumped to the harbor. The wastes are invariably wet and packed from flooding or sinking of the dock, from rain, and from the movement and placement of equipment, men and materials. This makes the drydock floor at Shipyard A difficult to clean thoroughly. Also, Shipyard A drydocks have bilge block slides that are raised above the dock surface and interfere with cleaning operations.

Clean up occurs whenever abrasive buildup has reached a depth such that the bilge blocks can no longer be repositioned on the bilge slides. This is necessary following approximately five dockings. When clean up is necessary, front loaders are brought in to scoop and scrape the drydock floor. Wastes are accumulated in piles, then collected in containers using front loaders and shovels. The containers are lifted out of the drydock by cranes and placed onto or emptied into trucks. Laborers with hand shovels accompany the front loaders, primarily under the hull and at the bilge blocks and their slides.

Shipyard B has five graving docks and cleans up spent abrasive and related debris prior to each undocking. The clean up procedure of Shipyard B is identical to that of Shipyard A except that it is performed more frequently. As the time for undocking approaches, front loaders and laborers with shovels clean the floor. In Shipyard B, the wastes are frequently dry. Shipyard B has no raised bilge block slides. Thus, the clean up at Shipyard B is ordinarily less time consuming per occurrence than the clean up at Shipyard A. Shipyard B uses scupper boxes and hoses to direct cooling water discharges to the drydock drains. The hoses observed, however, were in poor shape and considerable leakage flowed across the drydock floor. The discharges are pumped from the drains to the harbor. Caisson leakage is intercepted at the outboard end of the docks and pumped to the harbor. Hydrostatic relief and leakage waters flow to trenches along the periphery of the dock and are pumped to the harbor.

Shipyard C has two flush decked floating drydocks and also cleans prior to and after each undocking. The cleaning is performed using a mechanical sweeper and a front loader. The sweeper and front loader are utilized to clean as best as practicable before flooding. Following flooding and undocking of the vessel, the sweeper and front loader are returned to the dock and work unimpeded (except for the keel blocks and bilge blocks) and effect a complete cleaning operation. In every case, the sweeper completes its clean up including areas previously inaccessible subsequent to flooding, undocking, and deflooding but before the docking of the next vessel.

Shipyard D has three graving docks and two floating drydocks. Clean up of spent abrasive and associated debris is performed on a continuing basis. Upon completion of a blasting operation, front loaders and shovels are brought in to collect the wastes into piles and then load them into containers. This operation may occur several times during a single docking depending on the scheduling of abrasive blasting. Following the use of front loaders and shovels, laborers use push brooms to sweep the docks. Just before undocking, the front loaders, shovels, and brooms are returned to the drydock floor for a final comprehensive clean up. On occasion, remaining wastes are hosed to the drainage system. The drainage system and the flooding tunnel are shovelled out on an as-required basis, but not necessarily prior to each undocking. Scupper boxes and hoses are attached to the vessel in drydock to direct cooling waters to drains discharging to the harbor. Hydrostatic leakage water and water from internal tank blasting units flow across the drydock floor to overboard drains where they are pumped to the harbor.

Shipyard E has one graving dock. The clean up at Shipyard E begins with front loaders and shovels. The shovellers accompany the front loaders in addition to cleaning those areas the front loaders cannot reach or cannot clean effectively, such as at corners and surfaces or between bilge blocks. Wastes are consolidated into piles before being loaded into containers. A mechanical sweeper follows the front loaders and shovels. The sweeper works like the sweeper at Shipyard

c. If these procedures do not result in a satisfactory floor condition, shovels and push brooms are used to complete the job. Flooding ports in the dock floor are shovelled out prior to each undocking. The flooding tunnel is inspected and shovelled out if necessary. Stairways are swept manually, as are the utility dugouts and the altar. Areas adjacent to the dock are cleaned by a small, mobile, mechanical sweeper the size of a small front loader. No hosing of abrasive is performed at Shipyard E during the clean up prior to undocking. Clean up of abrasive and debris occurs for each ship at the end of its stay in the drydock, not on an ongoing basis as is the practice at Shipyard D. Scupper boxes and hoses are attached to the vessel after drydocking to direct cooling water discharges to drains to the harbor. The graving dock was dry with no evidence of hydrostatic relief or leakage water in the dock during the visit to this shipyard.

All of the shipyards described up to this point service primarily saltwater ships which require high levels of abrasive blasting. Some shipyards service only freshwater ships. Clean-up procedures and technologies at these yards are correspondingly different.

Shipyard F has two graving docks and services vessels that sail in fresh (inland) waters. This facility does very little abrasive blasting. Ships at this yard receive no abrasive blast treatment at all to remove paints. Shipyard F has no mechanized equipment for the removal of spent abrasive and other granular debris. It performs no clean up of such materials prior to undocking. Large debris is picked up manually. After flooding, undocking, and the subsequent deflooding, material accumulated on the drydock floor (which at this point includes silt and other debris which entered during flooding) is hosed to the drainage trenches. Hosing of the dock floor is carried out in order to maintain clean working conditions and to improve productivity. Therefore, the clean up is not always complete, especially at the ends of the dock, near the drainage trenches and away from working or dock entry areas. Little hosing is done on minor accumulations around the keel blocks or bilge blocks if no block movement is necessary. Periodically (every few months), the trenches fill and require cleaning. All drainage water from the graving docks is pumped into a sluice. A floating box containing an absorbent for oil and grease completely blocks the discharge end of the sluice. Water can flow under (the box extends only a short distance below the surface) and through the box, but floating oil and grease are removed by the absorbent.

All vessels are evacuated and shut down during drydocking: consequently, little or no water of any type is discharged to the graving docks during the servicing period. Caisson leaks and hydrostatic relief or leakage waters are collected in trenches and pumped through the sluice to the harbor.

Shipyard G has two floating drydocks. During ship repair on one of the floating drydocks (a flush deck dock), spent abrasive is consolidated into piles using front loaders and shovels. The piles are loaded into containers for disposal. This activity begins soon after abrasive blast operations have ended regardless of the remaining period for the ship to be in dock. Shipyard G does more abrasive blasting than Shipyard F, but rarely at levels comparable to the saltwater shipyards A, B, C, D, and E. Normally, the crew does not remain on board during drydocking at Shipyard G. Since shipboard services are shut down there are no cooling water discharges. On the second floating drydock (having bilge block slides on deck), spent paint and abrasive is cleaned up only when accumulations interfere with vessel repair operations or cause safety hazards. This occurs about twice a year. The vessel is evacuated during drydocking; consequently, there are no discharges from the ship.

CONTROL AND TREATMENT OF WASTEWATER FLOWS

In addition to clean up of solid wastes from the drydock floor, efforts to control and treat wastewater flows are being undertaken at many facilities. In the dewatered graving dock there are two streams of wastewater during ship repair operations: (1) cooling and process wastewater discharges, and (2) flows from various sources such as caisson leaks, hydrostatic relief or leakage, and industrial or process wastewater. Floating drydocks also have these wastewaters, with the exception of caisson and hydrostatic leaks. Process wastewaters include discharges from air scrubbers, wet grit blasting, and tank and bilge cleaning. Tank and bilge cleaning wastes are oil and water mixtures. A collection and holding tank system, usually the Wheeler (TM) type, is used to remove and separate this waste. Other wastewaters may be directed by hoses or allowed to flow across the floor into the graving dock drainage system, or directly to ambient waters from floating drydock pontoon decks. Miscellaneous water flows come from such sources as hydrostatic relief, non-contact cooling discharges, gate leakage, and pipe and fitting leakage. Existing dock drainage system designs allow process wastewaters to mix with other wastewater. They may contact solid wastes on the deck or in the trench before being discharged into ambient waters.

The volume of wastewater discharged from a ship in drydock may depend upon the point in the docking cycle. As shipboard equipment which uses water is being shut down following docking, the volume of discharge decreases. The continuing volume of discharge from the ship will depend upon the size of the crew remaining on board while in drydock. Some ship operators, such as the U.S. Navy, keep most of the operating crew on board even when the ship is drydocked for an extended period. This practice generates considerable volumes of wastewater. Other operators may shut down all equipment and remove the entire crew even for short drydocking periods.

Another factor bearing on the volume of water passing through a drydock is the effectiveness and level of maintenance effort applied by shipyard facility personnel to the many fittings and valves in the drydock potable and nonpotable water systems. Industrial water usage is minimal and higher flows occur only if wet abrasive blasting, water cone blasting, or hydroblasting is used. The use of hoses for clean up also contributes to wastewater volume. Drydock industrial waters are sometimes controlled by channels, sills, and drainage trenches. Some graving docks have arrangements for intercepting flows and conducting the water to drainage systems. This reduces contact of gate leakage and hydrostatic relief water solids on the drydock floor. Floating drydocks, on the other hand, generally lack arrangements for the containment of flows, and have no hydrostatic or gate leakage.

Graving dock drainage system designs vary widely but all involve networks of gutters, trenches, and/or culverts which serve to collect the heavier settleable solids transported in industrial wastewater flows. Unless promptly removed this debris may come in contact with water flows. To protect drainage pumps from excessive wear or damage, some drainage systems are designed with settling basins or sand traps to intercept and settle even the lighter particles. This removes transported particles from the discharge flow but may increase contact of water with solid wastes. Some of these settling locations, such as shallow transverse and longitudinal gutters in the drydock floor are relatively easy to clean out. Large longitudinal drainage culverts under the walls of graving docks can be extremely difficult to clean.

TREATMENT AND CONTROL TECHNOLOGIES UNDER DEVELOPMENT OR NOT IN COMMON USE

Many technologies are being developed that potentially can reduce solid waste, expedite clean up and control wastewater flows. In the section on "Control or Clean Up of Abrasive Through Access In Clean Up Operations" these technologies are discussed. The second half of Table VII-1 has summarized these developmental projects.

Control or Clean Up of Abrasive

High-suction vacuum grit removal equipment, such as the Vacu-Veyor (TM) unit, is used extensively to collect and remove debris from blasting operations in the ship's interior. Occasionally, however, the situation accommodates placing a container directly beneath an access hole cut through the ship's side, to collect the debris directly. Several existing kinds of equipment, not originally designed for drydock use, are being evaluated and modified to facilitate the removal of spent abrasive and debris. Vacu-Veyor (TM) units are relatively simple devices which are used in removing dry abrasive and debris from internal tank blasting operations and occasionally from drydock floors. They suffer, however, from a lack of mobility and the airborne particulate material cannot be effectively contained when blown into open skip boxes (Reference 9). At least one shipyard is attempting to develop this equipment by enclosing the container and making the unit more easily moveable. Two other complex, high-suction vacuum machines are being evaluated and developed by shipyard facilities. They are the VAC-ALL (TM) (References 8, 9, & 12) and the VACTOR 700 (TM) (References 6 & 8) units. Both of these units have demonstrated tremendous capability to move large amounts of grit in a relatively short time but both, in their present configuration, have many limitations for drydock application. A third type of vacuum equipment being evaluated for use in removing grit and debris from drydock floors is a low profile self-propelled device called the ULTRA-VAC (TM) Grit Vacuum. It shows the most promise for application in flush floored drydocks and can best be described as a powerful vacuum cleaner on wheels (References 8, 9, & 12). Until a design evolves from the development of these three types of vacuum equipment that will meet the needs of the varying drydock characteristics, most facilities will be forced to resort to labor intensive, time consuming techniques to remove debris.

Alternatives to conventional dry abrasive blasting include water cone abrasive blasting, wet abrasive blasting, hydroblasting (steady stream or cavitation), and closed cycle abrasive blast and recovery. Some of these techniques have potential for reducing or eliminating the quantity of solids required in blasting but some substitute a water pollution problem for an air pollution problem. None of these technologies can completely replace conventional dry abrasive blasting and all are in various stages of development. Table VII-2 indicates which shipyards contacted are currently practicing these alternatives.

A variation of the wet grit method of abrasive blasting, called water cone, water envelopment, or water ring, is fairly new but rapidly gaining popularity particularly with increasing use of organotin antifouling paints on some Navy ships. This process projects a cone of water around the stream of air and abrasive as it leaves the hose nozzle. This is accomplished by a simple water ring accessory which fits around any standard blasting hose nozzle. This method has the advantages of dry grit blasting with less dust production. It does, however, add to the volume of industrial wastewater and rust inhibitors, when added, are present in the wastewaters (References 7 and 9).

Hydroblasting is a surface preparation method used when extensive, heavy abrading is not a requirement. In one technique a cavitating water jet is used as the abrading material. As explained in Reference 13:

> "The basic concept simply consists of inducing the growth of vapor-filled cavities within a relatively low velocity liquid

jet. By proper adjustment of the distance between the nozzle and the surface to be fragmented, these cavities are permitted to grow from the point of formation, and then to collapse on that surface in the high pressure stagnation region where the jet impacts the solid material. Because the collapse energy is concentrated over many, very small areas at collapse, extremely high, very localized stresses are produced. This local amplification of pressure provides the cavitating water jet with a great advantage over a steady non-cavitating jet operating at the same pump pressure and flow rate."

Considerable success in laboratory experiments is claimed for the CAVIJET (TM) method but results of field evaluation are not available.

Several versions of closed-cycle vacuum abrasive blasting equipment are undergoing engineering development and operational evaluation at various shipyard facilities. They all operate on the principle of automatically recovering and reusing abrasives. Abraded coatings and fouling are sometimes separated and contained for land disposal. The machines, when operating as designed, are expected to eliminate both air and water pollution problems resulting from dust emissions and from solid wastes entering the drydock drainage system. If steel shot is used as the abrasive and is recovered, the solid waste load is reduced many times. Steel shot retains its cutting power even after repeated reuse. The closed-cycle blaster has limits however. These machines will not completely supplant other surface preparation techniques since they are large, heavy, and require considerable space for maneuvering. In addition, they are not designed to function on other than nearly flat or gently curving surfaces. More detailed information regarding come of these machines is provided in technical references to this document, particularly those prepared by or for the U.S. Navy.

Control of Wastewater Flow

The control and treatment of wastewater flows is critically tied to the segregation of wastewater streams. This philosophy is best expressed in a quote from Reference 6:

> "The key to cessation of unnecessary liquid waste generation...is seen as segregation of wastes as completely as possible and reasonable. Unpolluted waters should be segregated from contaminated solid wastes and vice versa.
>
> An appropriate system to collect and convey liquid waste must be capable of maintaining segregation until contaminated wastes are removed from the drydock and unpolluted wastes are properly discharged to harbor receiving waters."

This report proceeds with definitions of systems and techniques to segregate, collect, and transfer contaminated and uncontaminated wastewater streams (and materials causing contamination) to environmentally acceptable treatment systems.

A similar philosophy of approach was reported in Reference 11:

> "A practical solution to eliminate the large volume of polluted wastewater discharge into the harbor would be segregation of clean water flows from both spent abrasive and any already polluted wastewaters. This is the basis for the following recommendations. Wastewaters can be divided into three streams. The first stream, comprised of hydrostatic water, ships' cooling water, and miscellaneous other equipment cooling water discharges, could be collected in what will be henceforth called the clean water conduit. These unpolluted waters could be discharged directly into the harbor without treatment. The second stream, comprised of drydock sanitary wastewater and ships' non-oily wastewater, could be collected in a sanitary sewer and pumped to a municipal sewage treatment plant. The third stream, comprising all other wastewater discharges including ships' oily wastewater, dock floor wash water, miscellaneous equipment washings, spills, sewer leaks, rain, and clean water which accidentally contacts the dock floor, could be collected in an industrial wastewater sewer and pumped to an industrial wastewater treatment facility."

The facility that served as a model for these two studies is planning the implementation of the recommended improvements.

Segregation of water flows is accomplished by physical isolation. Collection can be through either or both in-floor and above-floor plumbing systems. For example, above-floor systems can be fabricated from PVC piping and attached adjacent to keel blocks.

<u>Treatment of Wastewater Flows</u>

Innovative controls will be installed at one shipyard in its graving docks having large transverse trenches or cross drains near the outboard or drain end. Involved is an arrangement of baffles in the cross drain as a means of minimizing the discharge of settleable solids and floating material. The baffles will be installed so as to use the cross drain as a settling pond. A baffle acts as a dam to establish a water level and hence a retention time for settleable solids to separate. Water flowing over the top of this baffle will go directly to the drainage pump. Upstream of this overflow dam, a second baffle will be installed to form an underflow dam for holding floating debris, oil, or other substances for collection and removal prior to flooding the drydock. Both baffles will be removable, and provisions will be made to drain off the water held behind them. Settleable solids contained within the cross trench will be removed for land disposal. The baffles will be installed after the ship is secure in the dock and the initial dewatering has been completed. The installation will not minimize the contact of solids with water streams, but is expected to reduce the potential of solids transport.

At one facility (Shipyard F), graving dock discharges, other than dewatering, are directed through a flume prior to emission to the adjacent river. Across this flume, near the discharge end, a floating box-like structure is placed in the flume after dewatering. The box-like structure holds a screen across the surface of the flow to prevent floating trash and debris from entering ambient waters. It is filled with absorbent material which removes oil and grease from the discharge flow. The absorbent material is replaced as needed.

Access In Clean-Up Operations

Two items of drydock design make efforts to clean up industrial wastes, such as abrasive blasting debris, more difficult and costly. They are the height of keel blocks and the existence of raised slides across the floor (or pontoon deck) for movement of bilge blocks.

Almost all existing drydocks have keel block heights of 3-1/2 to 6 feet. Older docks tend to have smaller keel blocks. With short keel blocks the working space between the drydock deck and ship bottom is too restricted for men using shovels and brooms to effectively clean up blasting debris and for using mechanized techniques currently available. This situation is most severe when the ship has a wide beam and a flat bottom. At least one new graving dock, currently under construction, will have 10-foot high keel blocks.

Graving docks and floating drydocks which have bilge block slides present a particularly severe problem to clean-up activities.

These solids establish corners and crevices from which fine debris is difficult to remove. They interfere with the movement of wheeled equipment and increase maintenance costs of the equipment used to clean up blasting debris (such as small front loaders). The positioning of these tracks across the flow direction of launch water may be beneficial, however, in acting as a submerged weir or dam, trapping sediment that would otherwise wash away.

NON-WATER QUALITY ENVIRONMENTAL ASPECTS

The control and treatment technologies described in this section are designed to improve the water quality of drydock discharges. However, some of these technologies also impact, either favorably or unfavorably, on other environmental concerns, particularly air pollution and solid waste. This subsection addresses those impacts.

Air Pollution Several control technologies provide alternatives to conventional dry abrasive blasting. These alternatives include wet abrasive blasting, hydroblasting using either steady stream or cavitation, water cone abrasive blasting, closed cycle abrasive blast and recovery equipment, and chemical stripping. Comparison of these alternatives must include many considerations among which are the desirability and thoroughness of surface preparation, speed of application, labor costs, equipment modifications, capital required, occupational health and safety, and effects of possible contamination of water flows. However, all of the alternatives are extremely effective in the reduction or elimination of one of the most detrimental aspects associated with dry abrasive blasting, namely the production of airborne particulates.

Upon impact, abrasive particles fracture. The larger fragments fall to the drydock floor or occasionally to adjacent land or water areas. Smaller fragments, however, become airborne or suspended, along with some particles released from the blasted surface. Depending on the wind, they may travel appreciable distances. Shifting to harder blast media reduces these effects only slightly.

Most of the technologies listed above have been developed more as air pollution control measures than water pollution control measures. Closed-cycle abrasive blast and recovery equipment uses a vacuum to pull blast particles from the air as they are released. This equipment (of which there are several types in various stages of development) is not totally successful in the recovery of blast particles; however, the characteristic plume of dust emanating from dry abrasive blasting is eliminated and the level of airborne particulates and suspended solids is drastically reduced. Wet abrasive blasting and water cone abrasive blasting prevent the production of airborne particles by wetting blast fragments. The moisture-laden fragments then fall to the drydock floor or drip down the structure being blasted. Wet abrasive blasting is a particularly effective means of improving air quality in blasting. Water cone abrasive blasting, though not as effective, still reduces the air pollution problem to a local one involving only the blast nozzle operator and those in the immediate vicinity. Hydroblasting preempts the problem of abrasive fragmentation by eliminating the source, i.e., the abrasive. Only particles from the surface being blasted must be contended with and in hydroblasting, these particles are wet, causing virtually all to drop. Chemical stripping completely eliminates airborne particulates since it involves no blasting. Chemicals are brushed on, allowed to work, then scraped off manually. Because slow, labor-intensive methods are required, chemical stripping is used very little. This technology trades off particulate emission for hydrocarbons and other chemical vapors caused by its high volatility. Closed-cycle blasters under development which use steel shot show promise of eliminating essentially all air and water pollution from blasting operations.

Vacuum material handling equipment can be a source of particulate emission where open collection containers are used. The magnitude of this emission depends on the geometry of the collection system, the volume and rate of material being moved, and the material composition, particularly its moisture content and particle weight. Vacuum equipment is ordinarily diesel powered and thereby contributes hydrocarbons, nitrogen oxides, carbon monoxide, and other emissions associated with diesel engine combustion. Mobile units have greater fossil fuel energy requirements than stationary units and thus produce higher levels of air pollution.

A number of the control technologies similarly affect air quality through requirements for power from local combustion equipment. Mobile sweepers and front loaders are examples. Pumping equipment on mobile floating drydocks are usually diesel powered, so that drydock design changes which result in the installation of pumping equipment may add to air emissions. Such design changes include modifying floating drydock pontoons for use as settling tanks, adding filtration equipment or extensive new piping, and other efforts to segregate wastewater flows which require additional pumping. Air emissions may not increase if the pumping requirements are split without increasing input energy requirements. Hydroblasting, by avoiding air as a propellant, reduces air emissions from local air compressor stations. This reduction occurs at the expense of emissions from the alternate compression source. The practice of shutting down shipboard equipment while in drydock also reduces air emissions, in this case, from fossil fueled equipment on board.

Solid Waste

Conventional dry abrasive blasting creates appreciable accumulations of solid waste. Where it is applicable, closed-cycle blast and recovery equipment can greatly reduce the quantity of abrasive required and alleviate the clean up of spent paint and abrasive. Disposal of the material, whether from open or closed-cycle blasting is required. Generally, solid wastes will be transported by a contractor to landfill disposal sites. Though the degree to which the wastes are potentially harmful has not been assessed, several considerations appear warranted. In order to ensure long-term protection of the environment from potentially harmful constituents, special considerations of disposal sites should be made. Landfill sites should be selected which prevent horizontal and vertical migration of constituents to ground or surface waters. In cases where geologic conditions are not suitable adequate mechanical precautions (e.g., impervious liners) may be required to ensure long-term protection of the environment. A program of routine periodic sampling and analysis of leachates may be advisable. Where appropriate, the location of solid hazardous materials disposal sites, if any, should be permanently recorded in the appropriate office of legal jurisdiction.

Of particular concern is the disposal of the new organotin wastes. These toxic compounds which are sometimes used in antifouling paints may be present in the spent paint, as well as originating from paint spills and overspray. Currently the Navy, for example, requires that these wastes be sealed in drums and shipped to a properly managed landfill. These precautions are taken to prevent runoff, seepage, and possibly leaching of organotin compounds.

Other Environmental Aspects

In addition to air pollution and solid waste, some of the water control and treatment technologies exhibit minor effects in other environmental areas. The shut down of shipboard services reduces cooling water discharges and consequent thermal pollution. Noise is also reduced. Alternative technologies to dry abrasive blasting which do not employ air as a propellant (hydroblasting and wet abrasive blasting) reduce the load on shore-based air compressors and less heat is added to the water. Thermal discharges from this source are thus reduced. Vacuum material handling equipment and other engine-driven equipment (closed cycle abrasive blast and recovery equipment, mobile sweepers, front loaders, etc.) add to the general noise level in the drydocks.

SECTION VIII

COST OF TREATMENT AND CONTROL TECHNOLOGY

INTRODUCTION

The economics of currently applied treatment and control technology were obtained during shipyard visits. The technologies, as listed in Section VII, include:

- Technologies for the clean up of abrasive
- Alternatives to conventional dry abrasive blasting
- Control technologies for wastewater flows excluding sewage
- Treatment technologies for wastewater flows excluding sewage

The costs of clean-up and best management practices were developed from information obtained during visits to shipyards A through G. These represent a composite of costs for these seven facilities, and are not specific to any one of them. This information was obtained during the period March through May of 1976 and has not been adjusted for inflation occurring since that period.

The reported and observed application of these technologies appears in Table VII-2. Clean up of abrasive is practiced at each of the shipyards visited and has been for many years. Much cost information is available concerning technology for the clean up of abrasive. With the exception of scupper boxes and piping, and design features for the control of gate leakage and hydrostatic relief water, the other treatment and control technologies have found little application among the shipyards visited. Many of these technologies are in the planning, research, or experimental stages of development and could not be evaluated with respect to economics since actual cost data (particularly operation and maintenance costs) are unavailable. The cost data applies to current technologies for the clean up of abrasive as reported and observed during the shipyard visit program. Developmental methods are not considered.

Throughout the history of conventional dry abrasive blasting, it has been necessary for shipyards which use appreciable amounts of abrasive in their docks to clean it up periodically solely to continue in business. Abrasive on the drydock floor can adversely affect working conditions and productivity. It can hamper the placement and movement of bilge blocks. It hampers the movement of mechanized equipment. Consequently, shipyards have performed periodic clean up of abrasive from the drydock floor. However, in 1974, the EPA, through its

National Field Investigations Center in Denver, Colorado, recommended that shipyards increase their efforts to prevent wastewaters from contacting abrasive on the drydock floor and to clean up to "broom clean" conditions prior to flooding or sinking.

Response to EPA's recommendations has been mixed. It is very difficult to segregate clean-up costs for environmental purposes at these shipyards and those costs which would have been incurred during the normal course of business. The estimated costs developed here reflect stepped up efforts to reduce effluent discharges to nearby water bodies. But no effort is made to isolate the cost of these stepped up efforts. Costs presented later in this section are total costs of clean-up operations as currently performed.

The cost data include capital, labor, operating, and maintenance costs incurred directly during clean-up operations. Certain indirect costs could not be estimated accurately and are not included. A thorough clean up of drydock floor space, trenches, tunnels, and altars can lead to increased drydock time per ship. If such time is allowed for in contract arrangements with shipowners, busy shipyard operators may find that they cannot service as many ships per year and must correspondingly suffer a drop in revenue. If increased time for clean-up activities is not allowed for, the shipyard is faced with the loss in revenue or additional charges to the ship owner. Frequently at shipyards in this position, complete clean up prior to flooding is not performed. Either way, time delays create dissatisfied customers, and can harm shipyard reputations and good will as well as current and future business prospects. These are important considerations which can produce hidden costs not recognized as clean-up related.

On the other hand, the clean up of abrasive prior to flooding may provide some economic benefits. When abrasive blasting has been particularly heavy, collection of the abrasive may be required to profitably carry out repair operations on a vessel. Thus, increased clean-up efforts may provide benefits as well as increase costs. However, this section does not present a cost/benefit analysis of the operation. Only those costs are included that directly result from the clean-up methods discussed.

IDENTIFICATION OF METHODOLOGY CURRENTLY USED IN BEST MANAGEMENT PRACTICES

Best Management Practices, previously defined, are directed toward clean up within the dock working area and control of water and wastewater flows into and out of the dock. Wide differences are found between facilities and conditions in facilities, and as a result of these differences, Best Management as practiced at one dock may be either inadequate or unnecessarily extensive if applied to another dock.

Any attempt to define a total cost of Best Management and to apply this to specific facilities is misleading because of the differences encountered. A preferred approach to defining cost is to evaluate costs of individual operations, which can be applied in Best Management Practices, and normalize these to a standard application time, or extent. From such data the costs of Best Management can then be synthesized for individual docks depending upon the specific operations of Best Management required and the time or extent of these operations. This approach admittedly will not permit an exact definition of costs because the components going into the values will not account for variations between facilities, for example labor rates. However, it will be possible to compare the costs attributed to different degrees of Best Management Practices for any given facility and to determine combinations of operations which may achieve equivalent results at reduced expenditures.

Only costs associated with routine clean-up operations of Best Management Practices are considered here. Costs resulting from events such as oil and paint spills are not due to normal operations and are not incurred on a regular basis. The operations considered, in principal, can be applied in any facility but all would not necessarily be applied at any given facility.

The cost of segregation and control of water and wastewater flows is not addressed. Most such efforts require structural modifications to the facility. This aspect of Best Management Practices is dock specific. Differences in facility ages, construction, size and configuration, and geologic and meteorologic conditions prohibit any valid effort to generalize with respect to costs of modifications needed to achieve water and wastewater segregation and control.

Clean-up operations for which costs are estimated here include both mechanical and manual techniques. Mechanical operations use front loaders, sweepers, backhoes, vacuum equipment, and closed cycle blasting. Worker use of shovels, brooms, and hoses are manual operations and in some cases are needed in combination with mechanical methods.

UNIT COSTS OF BEST MANAGEMENT PRACTICES

The elements of cost which combine to make up the costs associated with Best Management Practices include capital investment and depreciation, operating and maintenance costs for equipment, labor costs (with overhead), and contract costs where contractual arrangements are made. When equipment is used for multiple purposes, only one of which relates to the clean-up operations, the cost attributed to management practices must be prorated on the basis of the fractional time so used.

The approach used in this section has been to define the costs associated with methodologies used for clean up. These costs have been normalized to one eight-hour shift. For comparing various techniques which may be used in an existing facility, the unit costs per shift will be multiplied by the number of shifts required for the cleanup cycle.

Clean-up techniques and methodologies included in this breakdown involve use of front loader, mechanical sweeper, vacuum equipment, and backhoe operations. Labor costs for support of these operations, as opposed to the direct operation costs, are separately identified and in most instances represent manual operations when considered alone. Disposal costs are estimated on the basis of unit volume.

Table VIII-1 summarizes the clean-up methodologies which may be used to implement Best Management Practices. The applicability of each method is shown. Where the cost of equipment or method varied due to the presence of raised bilge block slides, two entries have been made to allow for this effect. This has been done because of the higher maintenance costs and life of mechanical equipment subjected to operation over raised bilge block slides. Under these conditions, depreciation over a three year period is used as opposed to eight years for service in a dock having a smooth floor.

Table VIII-2 shows an estimated cost of solid waste removal from shipyards.

Table VIII-1. UNIT COSTS OF SELECTED OPERATIONS WHICH MAY BE USED IN BEST MANAGEMENT PRACTICES

	Large Front Loader		Small Front Loader		Mechanical Sweepers			Supporting Crane Operations	
	Smooth Dock Floor	Raised Bilge Block Slides	Smooth Dock Floor	Raised Bilge Block Slides	Large	Small	Backhoe		
Capital Equipment Cost	$15,000	$15,000	$8,000	$8,000	$35,000	$3,000	$15,000	NA	
Depreciation Period, Yrs	8	1	8	3	8	8	8	NA	
Annual Depreciation	$ 1,875	$ 5,000	$1,000	$2,667	$ 4,375	$ 375	$ 1,875	NA	
Depreciation Chargeable to one 8 hr shift	$ 1.71	$ 4.57	$0.91	$2.44	$ 4.00	$0.34	$ 1.71	NA	
Operating Labor									
Skill Level	Operator	Operator	Operator	Operator	Operator	Operator	Operator	Operator	Rigger
Number of Operators	1	1	1	1	1	1	1	1	2
Hourly Rate with Overhead	$11.80	$11.80	$11.80	$11.80	$11.80	$11.80	$11.80	$ 17.00	$ 10.0
Cost per 8 hr shift	$94.40	$94.40	$94.40	$94.40	$94.40	$94.40	$94.40	$136.00	$160.00
Operating and Maintenance Cost									
Annual Maintenance	$ 1,500	$ 3,000	$ 800	$ 1,600	$ 5,250	$ 600	$ 2,250	NA	
Maintenance Chargeable to one 8 hr shift	$ 1.37	$ 2.74	$ 0.73	$ 1.46	$ 4.79	$ 0.55	$ 2.05	NA	
Fuel, Oil, etc. per 8 hr shift	$20.00	$20.00	$13.00	$13.00	$26.00	$13.00	$13.00	NA	
Cost of Operation	$117.48/ Shift	$121.71/ Shift	$109.04/ Shift	$111.30/ Shift	$129.19/ Shift	$108.29/ Shift	$111.16	$37.00/hr	
Purpose of Operation	Cleanup of Debris		Cleanup of Debris		Cleanup of Spent Paint and Abrasive		Cleanup of Debris from Drainage Trenches	Move Equipment and Containers	
Additional Support Services Required, Not Included in Cost of Operation	Shovellers, Crane	Shovellers, Crane	Shovellers, Crane	Shovellers, Crane	Crane	Crane	Crane	NA	

Manual Support Operations

	Shoveling	Sweeping	Hosing		Tunnel Cleanout: Preparation	Tunnel Cleanout: Cleanout
Operating Labor Costs						
Skill Level	Shovelers	Sweepers	Nozzle men	Assistants	Electrical/Mechanical	Shovelers
Number of Operators	1	1	2	2	4	5
Hourly Rate with Overhead	$8.90	$8.90	$8.90	$8.90	$9.00	$8.90
Cost per 8 hr shift	$71.20	$71.20	$142.40	$142.40	$288.00	$356.00
Cost of Operation	$71.20/ Shift	$71.20/ Shift	$284.80/Shift		$288.00/Shift	$356.00/ Shift
Purpose of Operation	Cleanup of Spent Paint and Abrasive from Dock Floor				Lighting and Ventilation in Tunnels	Cleanout of Accumulated Debris from Tunnel

Note: (1) NA - Not Applicable (2) Cost data as of March to May, 1976

Table VIII-2. COST OF DISPOSAL OF SOLID WASTE REMOVED FROM DOCKS (INCLUDES HAULING AND LANDFILL FEES)

	Tons of Debris Per Ship	Volume Cubic Yds	Number of Containers	Total Cost $ per Clean Up
Light Blasting	200	128	8	1,000
Heavy	1,350	862	53	6,625

Notes:

1. Cost Data as of March to May, 1976.
2. Bulk Density assumed 116 lb/cu ft.
3. Standard container has 16.4 cubic yard volume.
4. Cost per standard container is $125 for removal and disposal.

In using the costs presented in Tables VIII-1 and VIII-2 the operations required for best management techniques can be synthesized. Where mechanical equipment has been defined, only the cost of operating the equipment is included. Additional costs resulting from the need for shovellers to work in conjunction with front loaders (or for crane operation to move machinery and collected debris to and from the dock) must be added to define total cost of each operation. Finally, these costs are approximate and do not reflect regional variations, and are based on costs prevailing during the conduct of this study in 1976.

COSTS ATTRIBUTED TO BEST MANAGEMENT PRACTICES VS. ENVIRONMENTAL COSTS

Regardless of other considerations clean up of graving docks and floating drydocks must be performed at some time simply to permit the repair and maintenance operations to be carried out. Some facilities may find frequent clean up a necessary part of their total work effort, while others may routinely go for long time periods between clean up. Cost of clean up performed as normal maintenance cannot be considered environmental charges.

Likewise, the cost of implementing a formal Best Management Practices program cannot be charged entirely to environmental restrictions. Such a program would be directed toward the management objectives, and these are primarily for operational purposes. It is possible that an actual cost benefit may be realized as a result of a formal program to remove wastes at regular times, but a detailed cost analysis would be necessary to demonstrate the actual effect.

Only two operations have been identified which, in some instances, may represent environmental costs: (1) implementation of a management program requiring clean up at a frequency in great excess of that necessary to achieve Best Management Practices, (2) costs incurred as a result of special solids disposal methods required solely for environmental protection.

In the first of these, only such costs resulting from the excess practices imposed could be related to environmental concern. In the more probable case such a program would be adopted at the discretion of the facility management. Only where local regulations may be stringent enough to force this type of program could part of it be attributed to protecting the environment.

The second example is more clear cut. In general contractual arrangements are in force for ultimate disposal of abrasive blasting debris. This material most frequently is landfilled. Many landfills are regulated to prevent contamination of ground and surface waters by the materials disposed of in them. Some are not. It may be necessary, in certain cases, to alter disposal practices by changing to certified land fills in order to prevent potential damage to groundwater by leaching constituents from abrasive blasting debris. In particular, the disposal of organotin-based debris has been controlled by Naval policies which require that it be sealed in steel drums. Costs resulting from these practices may be considered environmentally incurred.

In summary, shipyards which are currently operating under Best Management Practices programs probably will experience no adverse effects in terms of excessive costs or reduced operations. Where increased effort is necessary by other shipyards to achieve Best Management Practices, minor effects may be noted.

SECTION IX

ACKNOWLEDGEMENTS

The Environmental Protection Agency expresses appreciation for the support in preparing this document provided by Hittman Associates, Inc., Columbia, Maryland, under the overall direction of Mr. Burton C. Becker, Vice President, Operations. Mr. Dwight B. Emerson and Mr. Jack Preston Overman shared direction of the day-to-day work on the project.

Appreciation is extended to the staff of the Environmental Engineering Department of Hittman Associates for their assistance during this program. Specifically our thanks to:

Mr. V. Bruce May, Senior Chemical Engineer
Ms. Barbara A. White, Manuscript Coordinator
Mr. Thomas V. Bolan, III, Mechanical Engineer
Mr. Craig S. Koralek, Chemical Engineer
Mr. Phillip E. Brown, Environmental Engineer
Mr. J. Patrick Carr, Consultant, U.S. Navy (Ret.)

Acknowledgement and appreciation is given to Mr. Robert Blaser, Hamilton Standard, Division of United Technologies Corporation, who made an invaluable contribution to the preparation of this document.

Acknowledgement and appreciation is also given to Mr. Harold B. Coughlin, Chief, Guidelines Implementation Branch, Effluent Guidelines Division, for administrative support and to Ms. Kaye Starr, Ms. Nancy Zrubek, and Ms. Carol Swann for their tireless and dedicated effort in this manuscript.

SECTION X

REFERENCES AND BIBLOIGRAPHY

REFERENCES

1. Hamilton Standard, Inc., Draft Development Document for Effluent Limitations Guidelines and Standards of Performance for the Machinery & Mechanical Products Manufacturing Point Source Category, EPA Contract No. 68-01-2914, Washington, DC, June 1975.

2. U.S. Environmental Protection Agency, Rationale for Water Pollution Control at Shipbuilding and Ship Repair Facilities, National Field Investigations Center, Denver, Colorado, August 1974.

3. U.S. Department of the Navy, Design Manual-Drydocking Facilities, DM-29, Naval Facilities Engineering Command, Alexandria, Virginia, February 1974.

4. Automation Industries, Inc., Environmental Impact Assessment of Floating Drydocks Operated by the U.S. Navy, Vitro Laboratories Division, Silver Spring, Maryland, May 1975.

5. Engineering-Science, Inc., Pollutional Effects of Drydock Discharges, Berkeley, California, October 1973.

6. Moffatt & Nichol, Engineers, Industrial Waste and Ship Wastewater Collection and Disposal Facility: Drydocks 1, 2, and 3, Long Beach Naval Shipyard, Long Beach, California, November 1975.

7. Birnbaum, Bruce, Experimental Grit Blasting of the U.S.S. James Monroe (SSBN 662) Aboard the U.S.S. Alamagordo (ARDM 2) at Naval Weapons Station, Charleston, South Carolina, Naval Ship Engineering Center, Hyattsville, Maryland, October, 1975.

8. U.S. Department of the Navy, Final Environmental Impact Statement: Abrasive Blasting of Naval Ships' Hulls, Washington, DC, November 1975.

9. Ticker, A. and Rodgers, S., Abatement of Pollution Caused by Abrasive Blasting: Status in Naval Shipyards, Report 4549, Naval Ship Research and Development Center, Bethesda, Maryland, July 1975.

10. U.S. Department of Navy, "Military Specification: Sand, Sandblast; and Grain, Abrasive - Ship Hull Blast Cleaning," Military Specification MIL-S-22262 (Ships), Washington, DC, December 4, 1959.

11. Alig, Craig S., Long Beach Naval Shipyard Drydock Wastewater Discharge Study, Report 4557, Naval Ship Research and Development Center, Bethesda, Maryland, December 1975.

12. Marks, Earl E., "Report on the Application and Use Experience of the VAC-ALL Grit Removal Machine," Code 971, Long Beach Naval Shipyard, Long Beach, California, 1974.

13. Conn, Andrew F. and Rudy, S. Lee, Parameters for a Ship Hull Cleaning System Using the CAVIJETTM Cavitating Water Jet Method, Hydronautics, Inc., Laurel, Maryland, July 1975.

14. Ray, T.B., "Water Pollution Control Plant," submitted to the State of Virginia Water Control Board as a requirement of NPDES Permit #VA 4804, Newport News Shipbuilding and Drydock Co., Newport News, Virginia, 1975.

15. U.S. Environmental Protection Agency. Draft Report to the San Diego Regional Water Quality Control Board on Guidelines for the Control of Shipyard Pollutants, National Field Investigations Center, Denver, Colorado, July 1, 1974.

16. Carr, Dodd S. and Kronstein, Max, "Antifouling Mechanism of Shipbottom Finishes," Modern Paint and Coatings, Palmerton Publishing Co., New York, New York, December 1975, pp. 23-27.

17. Barry, Joseph N., "Staff Report on Wastes Associated with Shipbuilding and Repair Facilities in San Diego Bay," California Regional Water Quality Control Board, San Diego Region, San Diego, California, June 1972.

BIBLIOGRAPHY

1. Academy of Natural Sciences of Philadelphia, "Summary of Leaching Study for Sun Shipbuilding and Dry Dock Company," Division of Limnology and Ecology, Philadephia, Pennsylvania, 1974.

2. Alig, Craig S., Long Beach Naval Shipyard Drydock Wastewater Discharge Study, Report 4557, Naval Ship Research and Development Center, Bethesda, Maryland, December 1975.

3. Automation Industries, Inc., Environmental Impact Assessment of Floating Drydocks Operated by the U.S. Navy, Vitro Laboratories Division, Silver spring, Maryland, May 1975.

4. Barry, Joseph N., "Staff Report on Wastes Associated With Shipbuilding and Repair Facilities In San Diego Bay," California Regional Water Quality Control Board, San Diego Region, San Diego, California, June 1972.

5. Birnbaum, Bruce, Experimental Grit Blasting of the U.S.S. James Monroe (SSBN 622) Aboard the U.S.S. Alamagordo (ARDM 2) at Naval Weapons Station, Charleston, South Carolina, Naval Ship Engineering Center, Hyattsville, Maryland, October, 1975.

6. California Air Resources Board, "Abrasive Blasting, Title 17, California Administrative Code, Subchapter 6, State of California, Sacramento, California, February 3, 1976.

7. California Water Resources Control Board, Water Quality Control Plan for Ocean Waters of California, State of California, Sacramento, California, July 6, 1972.

8. Chan, D.B. and Saam, Richard D., "Drydock Wastewater Treatment Study," U.S. Navy, Civil Engineering Laboratory, Construction Battalion Center, Port Hueneme, California, June 1975.

9. Conn, Andrew F. and Rudy, S. Lee, Parameters for a Ship Hull Cleaning System Using The CAVIJETTM Cavitating Water Jet Method, Hydronautics, Inc., Laurel, Maryland, July 1975.

10. Engineering-Science, Inc., Lower James River Basin Comprehensive Water Quality Management Study, Planning Bulletin 217-B, State of Virginia Water Control Boad, Richmond, Virginia, July 1974.

11. Engineering-Science, Inc., Pollutional Effects of Drydock Discharges, Berkeley, California, October 1973.

12. Hamilton Standard, Inc., Draft Development Document For Effluent Limitations Guidelines and Standards of Performance for the Machinery & Mechanical Products Manufacturing Point Source Category, EPA Contract No. 68-01-2914, Washington, DC, June 1975.

13. Huggett, R.J., Analyses of Sediment and Elutriate Samples from the James River, Virginia, Virginia Institute of Marine Science, Gloucester Point, Virginia, July 1975.

14. Huggett, R.J., Study of Channel Sediments: Baltimore Harbor, Norfolk Harbor, York Entrance Channel, Virginia Institute of Marine Science, Gloucester Point, Virginia, 1972.

15. Hurst, W. Calvin and Whiteneck, L.L., An Analysis of the Impact From Completion of Yard Modernization, Todd Shipyards Corporation, Los Angeles Division, San Pedro, California, Berths 103-109, Engineering Feasibility Studies, Inc., Los Angeles, California, April 1975.

16. Johnson, Patricia G. and Villa, Orterio, Jr., Distribution of Metals In Baltimore Harbor Sediments, Technical Report 59, U.S. Environmental Protection Agency, Annapolis Field Office, Annapolis, Maryland, 1974.

17. Marks, Earl E., "Report on the Application and Use Experience of the VAC-ALL Grit Removal Machine," Code 971, Long Beach Naval Shipyard, Long Beach, California, 1974.

18. Moffatt & Nichol, Engineers, Industrial Waste and Ship Wastewater Collection and Disposal Facility: Drydocks 1, 2 and 3, Long Beach Naval Shipyard, Long Beach, California, November 1975.

19. Newport News Shipbuilding and Dry Dock Company, "EPA Survey of Wastewater Discharge from Graving #10 During the Repair and Painting of the SS Claude Conway, May 1975," Laboratory Services Report No. N-5327, Newport News, Virginia, December 5, 1974.

20. Partek Corporation of Houston, "Partek Liqua-Blaster TM," Houston, Texas, 1976.

21. Pennington, J.C., untitled letter to T.B. Ray at Newport News Shipbuilding and Dry Dock Company, U.S. Environmental Protection Agency, National Field Investigations Center, Denver, Colorado, August 1974.

22. Price, R.A., "Texstar, Inc. Automatic Descaling Equipment Demonstration at Avondale Shipyards, Inc.," memorandum, Avondale Shipyards, Inc., New Orleans, Louisiana, June 24, 1975.

23. Ray, T.B., "Comments on the Draft Development Document for Machinery and Mechanical Products Manufacturers," letter to the U.S. Environmental Protection Agency, Newport News Shipbuilding and Dry Dock Co., Newport News, Virginia, August 1975.

24. Ray, T.B., "Water Pollution Control Plan," submitted to the State of Virginia Water Control Board as a requirement of NPDES Permit #VA 0004804, Newport News Shipbuilding and Dry Dock Co., Newport News, Virginia 1975.

25. Ticker, A. and Rodgers, S., Abatement of Pollution Caused by Abrasive Blasting; Status in Naval Shipyards, Report 4549, Naval Ship Research and Development Center, Bethesda, Maryland, July 1975.

26. Shierman, E.G., A Demonstration of the Myers-Sherman Vactor Model 700, U.S. Navy, Long Beach Naval Shipyard, Long Beach, California, 1975.

27. U.S. Congress, Current Status of Shipyards, 1974 - Part 2, hearings before the Seapower Subcommittee of the Committee on Armed Services, House of

28. U.S. Department of Commerce and U.S. Department of Defense, Principal Shipbuilding and Repair Facilities of the United States, Naval Sea Systems Command, Washington, DC, 1970.

29. U.S. Department of Defense, "Military Specification: Paint, Antifouling, Vinyl-Red (Formula No. 121/63), Military Specficiation MIL-P-15931B, Amendment 2, Washington, DC, April 13, 1970.

30. U.S. Department of Defense, "Military Specification: Primer Coating, Shipyard, Vinyl-Red Lead (Formula 119), Military Specification MIL-P-15929C, Washington, DC, October 24, 1972.

31. U.S. Department of the Navy, Design Manual - Drydocking Facilities, DM-29, Naval Facilities Engineering Command, Alexandria, Virginia, February 1974.

32. U.S. Department of the Navy, Docking Instructions and Routine Work in Drydock, Naval Ships' Technical Manual Chapter 9070, Naval Sea Systems Command, Washington, DC, November 1, 1972.

33. U.S. Department of the Navy, Environmental Protection Manual, OPNAV Instruction 6240.3, Office of the Chief of Naval Operations, Washington, DC, 1975.

34. U.S. Department of the Navy, Final Environmental Impact Statement: Abrasive Blasting of Naval Ships' Hulls, Naval Sea Systems Command, Washington, DC, November 1975.

35. U.S. Department of the Navy, "Military Specification: Sand, Sandblast; and Grain, Abrasive - Ship Hull Blast Cleaning," Military Specification MIL-S-22262 (Ships), Washington, DC, December 4, 1959.

36. U.S. Department of the Navy, "'Mini Scope': Shipalt ARD-193, Industrial Waste Disposal,: Boston Naval Shipyard, Code 2060.2, Boston, Massachusetts, September 12, 1975.

37. U.S. Department of the Navy, P-174 Drydock Water Pollution Abatement, Fiscal Year - 1979, Military Construction Program, Long Beach Naval Shipyard, Long Beach, California, May 1, 1976.

38. U.S. Department of the Navy, "Revised Sandblasting Procedures," Naval Ships' Technical Manual Chapter 9190, Amendment 1, Naval Sea Systems Command, Washington, DC, August 1, 1975.

39. U.S. Department of the Navy, A Study of Sediments and Soil Samples From Pearl Harbor Area, Facilities Engineering Command, Civil Engineering Laboratory, Port Hueneme, California, March 1973.

40. U.S. Environmental Protection Agency, "Determination of Metals in Salt Water by Atomic Absorption," National Field Investigations Center, Denver, Colorado, 1974.

41. U.S. Environmental Protection Agency, Draft Report to the San Diego Regional Water Quality Control Board on Guidelines for the Control of Shipyard Pollutants, National Field Investigations Center, Denver, Colorado, July 1, 1974.

42. U.S. Environmental Protection Agency, Rationale for Water Pollution Control at Shipbuilding and Ship Repair Facilities, National Field Investigations Center, Denver, Colorado, August 1974.

43. U.S. Environmental Protection Agency, "Study Plan for Shipyard Field Survey, Newport News, Virginia," National Field Investigations Center, Denver, Colorado, May 1974.

44. Virginia Institute of Marine Science, Study of Channel Sediments, James River and Hampton Roads Area, Gloucester Point, Virginia, August 1971.

45. Carr, Dodd S. and Kronstein, Max, "Anti-fouling Mechanism of Shipbottom Finishes," Modern Paint and Coatings, Palmerton Publishing Co., New York, New York December 1975, pp. 23-27.

46. "At Last, A Lasting Bottom Paint," Washington Star News, Washington, DC, April 4, 1976.

47. "Bay's Project on Schedule," World Dredging and Marine Construction, Symcon Publishing Co., San Pedro, California, April 1976, p. 8.

48. Hassani, Jay J. and Millard, Charles F., "Graving Dock for 300,000-Ton Ships," Civil Engineering, American Society of Civil Engineers, New York, New York, June 1971.

49. "Navy Device Soaks Up Spilled Oil," Navy Times, Washington, DC, April 12, 1976, p. 44.

50. "New Paint Keeps Barnacles At Bay," Navy Times, Washington, DC, April 19, 1976, p. 3.

51. Clark, Allen, "Shipyard Problems with Oily Wastes," Proceedings of the International Conference on Waste Oil Recovery and Reuse, February 12-14, 1974, Information Transfer, Inc., Rockville, Maryland, 1974.

52. United States Department of Defense and Department of Commerce, Principal Shipbuilding and Repair Facilities of the United States, Office of the Coordinator for Ship Repair and Conversion, Naval Sea Systems Command, September 1, 1978.

SECTION XI

GLOSSARY

Anticorrosive paints - the initial layer(s) of paint on a ship's hull. The purpose of these paints is to prevent rusting.

Antifouling paints - the final layer(s) of paint applied to a ship's hull. They inhibit the growth of marine organisms on a ship's hull.

Bare Metal - hull metal that has had all paint and marine organisms abraded in preparation for repainting.

Building Basins - a graving dock used solely for ship construction.

Bilge water - water and oil that collects in the lower hull.

Bilge blocks - side blocks placed on the drydock floor. They are located according to the dimensions specific to a particular ship and help stabilize and support the drydocked ship.

Bilge block slides - raised lateral tracks built into many older docks, used to move and position bilge blocks.

Broomed clean - see "Scraped or Broomed clean".

Closed cycle blaster - a type of abrasive blaster that reuses abrasive, usually steel shot, and often collects removed paint and marine organisms.

Cooling water - non-potable water used for shipboard purposes such as air-conditioning and condenser cooling during the drydocked period.

Deflooding - the pumping out of the flooded (filled) drydocks.

Dewatering - see deflooding.

Dock leakage - hydrostatic relief water, gate seepage, and other water leakage other than ship originating wastes that leak into the dock floor.

Drainage discharge - the daily effluent from a drydock. This does not include deflooding water.

Dregs - silt, grit, or other particles deposited on a dock floor during dewatering.

Dry abrasive blasting - a process to remove paint, rust, and marine organisms from a ship's hull. The abrasive usually a copper slag or sand, is conveyed in a medium of high pressure air through a nozzle.

Drydock - either a graving dock or a floating drydock. Also to place a ship in drydock.

Flap gate - a rigid one piece gate hanged at the bottom.

Floating - raising of a submerged floating drydock.

Floating caisson gate - the most common type of graving dock gate. It is floatable and can be moved to permit entry and departure of the ship.

Floating drydock - a submersible moveable platform to enable repairs and maintenance of ships out of water.

Flooded dock - the filled dock following flooding.

Flooding - the filling of a graving dock with water to permit entry or departure of a ship.

Flush deck construction - a flat dock floor not having permanent bilge block slides.

Fresh grit - unused abrasive.

Front loaders - a type of machinery, similar to a bull dozer used to scrap collect and transfer spent paint, grit and marine organisms that collect on the dock floor during blasting.

Gate - the closure that separates a graving dock from the harbor. It is removed to permit entry and departure of the ship.

Graving dock - a dry basin, below water level that is used for repair and maintenance of ships.

Grit - abrasive.

Hydroblasting - the use of a high pressure water stream to remove paint, rust, and marine organisms from a ship's hull.

Hydrostatic relief - the water that leaks into a dock through holes and cracks in the floors and walls of a graving dock. This equilibrates groundwater pressure.

Keel blocks - blocks positioned on the floor of the dock, fitted to match the keel surface of the ship. The drydocked ship is positioned on the blocks.

Launch water - the water in a flooded graving dock.

Manual clean up - use of shovels, brooms, and other equipment which is not power operated to clean the dock floor.

Mechanical clean up - use of machinery, such as front end loaders, mechanical sweepers, or vacuum cleaners to clean the dock floor.

Miter gate - a pair of gate leaves, hinged at the dock walls which swing open to allow passage of a ship into and from a graving dock.

Primer - see "anticorrosive paints."

Sand - often used to describe any dry abrasive.

Sand blast - dry abrasive blasting.

Sand sweep - a light dry abrasive blast used to remove only the outer layers of paint and marine growth from a ships hull.

"Scraped or Broomed Clean" - using shovels, mechanical loaders, mechanical sweepers, or brooms to remove abrasive blasting debris.

Scupper boxes - containers used to collect water that runs off a ship deck.

Shipboard wastes - all effluent discharges originating from a drydocked ship. Included are sanitary wastes, bilge water, cooling water, and cleaning wastes.

Sinking - flooding of caissons and lowering of floating drydock to permit a ship to be positioned over the dock prior to floating of the dock and docking.

Slurry blasting - see "wet abrasive blasting."

Soil chutes - flexible hoses, usually made of rubber coated nylon or canvas used to transfer shipboard wastes from the docked vessel to the appropriate disposal system.

Spent abrasive - used grit and spent paint, rust, and marine organisms that collect on the dock floor during blasting.

Stripping - see "drainage discharge."

Wash down - the hosing down of the dock, and sides of the ship following docking to remove silt, marine organisms, etc.

Water cone abrasive blasting - a type of blasting that uses a cone of water to surround the stream of air and abrasive as they leave the nozzle.

Wet abrasive blasting - a process to remove paint, rust, and marine growth from ship's hulls, in which high pressure water propels an abrasive.

White metal - see "bare metal."

TABLE

METRIC TABLE

CONVERSION TABLE

MULTIPLY (ENGLISH UNITS)		by	TO OBTAIN (METRIC UNITS)	
ENGLISH UNIT	ABBREVIATION	CONVERSION	ABBREVIATION	METRIC UNIT
acre	ac	0.405	ha	hectares
acre - feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram - calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories/kilogram
cubic feet/minute	cfm	0.028	cu m/min	cubic meters/minute
cubic feet/second	cfs	1.7	cu m/min	cubic meters/minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Fahrenheit	°F	0.555(°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liters
gallon/minute	gpm	0.0631	l/sec	liters/second
horsepower	hp	0.7457	kw	killowatts
inches	in	2.54	cm	centimeters
inches of mercury	in Hg	0.03342	atm	atmospheres
pounds	lb	0.454	kg	kilograms
million gallons/day	mgd	3,785	cu m/day	cubic meters/day
mile	mi	1.609	km	kilometer
pound/square inch (gauge)	psig	(0.06805 psig +1)*	atm	atmospheres (absolute)
square feet	sq ft	0.0929	sq m	square meters
square inches	sq in	6.452	sq cm	square centimeters
ton (short)	ton	0.907	kkg	metric ton (1000 kilograms)
yard	yd	0.9144	m	meter

* Actual conversion, not a multiplier

☆ U. S. GOVERNMENT PRINTING OFFICE : 1979 O - 307-065

PLEASE NOTE:

Site/Parcel Numbering -- This notebook contains references to "Parcel 1," which has been the designation for the "Port Industrial Yard" property (401 Alexander Avenue) at the end of the Hylebos peninsula and at the Mouth of the Hylebos Waterway. See HCC "Summary of Existing Information" (January 1995). In the Trustees' Settlement Report, "Parcel 1" is designated "Site 56" and named the "AK-WA Shipbuilding Site."

This notebook also contains references to "Parcel 2," which has been the designation for the former Occidental property at 605 Alexander Avenue (but not including the former PRI Northwest property at 709 Alexander Avenue). Id. The Trustees' Settlement Report includes "Parcel 2" in "Site 57" named the "Occidental Site" (encompassing both the former Occidental and PRI properties).

PARCEL #1 PCB CONTAMINATION

SAMPLING RESULTS, MAPS, AND PHOTOGRAPHS SHOWING THAT PARCEL #1 IS A MAJOR CONTRIBUTOR OF PCBS TO THE MOUTH OF THE HYLEBOS WATERWAY

SAMPLING RESULTS, MAPS, AND PHOTOGRAPHS SHOWING THAT PARCEL #1 IS A MAJOR CONTRIBUTOR OF PCBS TO THE MOUTH OF THE HYLEBOS WATERWAY

Tab 1: Table from the Port of Tacoma Report dated November 19, 1993 which is attached as Appendix A, showing contaminants (including PCBs) found in storm sewer catch basins on Parcel #1. These catch basins drain to the Hylebos Waterway.

Tab 2: Map (derived from the same Port of Tacoma Report) showing the location of the catch basins and the storm sewer lines on Parcel #1.

Tab 3: Map illustrating the "before cleaning" and "after cleaning" concentrations of PCBs in the storm sewer catch basins on Parcel #1. Note especially the extremely high 24,000 ppb hit of PCBs at the outfall of one of the storm sewer lines. That particular storm sewer line drains a significant transformer location.

Tab 4: Portions of Map No. 1 from the Archives Report. Substation No. 1, and its transformer banks, are highlighted in yellow. The locations of catch basins IY-16, 1Y-17, and IY-18 are also shown. These catch basins drain the transformer bank area, and feed the sewer line that empties onto the hit of 24,000 ppb PCBs in the Hylebos (See Tab 3).

Tab 5: Undated WW II-era photograph showing Substation No. 1. This building still stands on Parcel #1. Sewer catch basin IY-17 is at the right hand corner of this building, just below the bottom of the photograph.

Tab 6: Photograph dated May 30, 1942, showing Substation No. 1 (the cubical cement building with three large windows immediately behind the large flat roof). Note that a portion of the bank of transformers is visible to the left of this building behind the picket fence. The Hylebos Waterway appears in the background of the photograph.

Tab 7: Map illustrating the drainage of the bank of transformers at Substation No. 1, to the high hit of PCBs in the Hylebos Waterway.

Tab 8: Photograph dated January 29, 1942, looking north towards the Mouth of the Hylebos, with a transformer house circled on the overlay. This and the other transformer houses along the Hylebos Waterway on Parcel #1 were constructed directly on top of the wooden-planked pier, thus allowing transformer oils to leak directly into the Hylebos Waterway.

Tab 9: Aerial photograph dated September 30, 1941, looking southeast up the Hylebos, showing a transformer house being constructed directly over the Hylebos Waterway.

Tab 10: Photograph dated October 31, 1941, showing both transformer houses on Outfitting Pier No. 3, over the Hylebos Waterway, as depicted previously in Tabs 8 and 9.

Tab 11: Photograph dated December 30, 1941, showing a third transformer house built directly over the Hylebos Waterway. The three transformer houses are all constructed on wood planking directly above the Waterway.

Tab 1

This table shows contaminants (including PCBs) found in storm sewer catch basins on Parcel #1.[1] There were two sampling events: January, 1993, and September, 1993. The catch basins were cleaned out in March, 1993, between the sampling events. However, the results of the second sampling event in September, 1993, showed that the catch basins continued to be highly contaminated with PCBs, arsenic, lead, mercury, copper and zinc. This occurred because the sewer lines between the catch basins remained contaminated from the surrounding soil, and flushed their contaminants, including PCBs, back into the cleaned catch basins.

[1] Source: Report by Harding Lawson Associates for the Port of Tacoma dated November 19, 1993 (attached to this summary as Appendix A).

TABLE 1

PORT OF TACOMA INDUSTRIAL YARD CATCH BASIN SEDIMENT SAMPLING RESULTS

SAMPLE	VOLUME (Cu.Ft.)		WEIGHT (lb.)		ARSENIC (mg/kg)		LEAD (mg/kg)		MERCURY (mg/kg)		COPPER (mg/kg)		ZINC (mg/kg)		PCBs (mg/kg)	
	1/93	9/93	1/93	9/93	1/93	9/93	1/93	9/93	1/93	9/93	1/93	9/93	1/93	9/93	1/93	9/93
IY-1	0.23	0.07	14	4	<5	<5	205	200	<3	<3	541	214	809	765	0.27	0.32
IY-2	0.39	0.40	24	25	<5	<5	205	84	<3	<3	136	92.6	962	364	0.61	0.24
IT-3	0.25	–	16	–	<5	–	126	–	<3	–	204	–	538	–	0.20	–
IY-4	0.39	NA	24	NA	<5	<5	40	56	<3	<3	30	352	275	367	0.36	2.05
IY-5	5.35	NA	334	NA	<5	<5	335	650	<3	<3	618	283	1580	1450	1.50	0.81
IY-6	2.97	1.39	185	87	<5	<5	234	310	<3	<3	665	483	1190	686	0.57	0.35
IY-7	1.19	1.27	74	79	<5	<5	449	360	<3	<3	748	488	1085	852	0.61	0.56
IY-8	2.28	1.96	142	122	<5	<5	464	470	<3	<3	841	580	1340	1150	0.41	0.51
IY-9	--	--	--	–	--	–	–	–	–	–	–	–	–	–	–	--
IY-10	0.60	–	37	–	<5	–	302	–	<3	–	482	–	1110	--	0.46	–
IY-11	2.66	NA	166	NA	<5	<5	775	490	<3	<3	732	467	1740	1200	0.81	0.16
IY-12	0.60	0.15	37	9	<5	<5	417	240	<3	<3	549	414	1030	825	0.13	0.10
IY-13	1.80	0.69	112	44	<5	<5	366	350	<3	<3	502	639	1530	745	0.38	0.12
IY-14	3.79	NA	236	NA	<5	<5	188	220	<3	<3	1600	1230	445	853	<0.1	<0.05
IY-15	3.50	NA	218	NA	<5	<5	265	340	<3	<3	1800	1070	565	1180	<0.1	0.10
IY-16	1.79	1.79	112	112	<5	<5	1090	660	<3	<3	1630	1010	2140	1370	<0.1	0.20
IY-17	1.01	NA	63	NA	<5	<5	325	230	<3	<3	819	548	1030	1040	0.41	0.18
IY-18	0.30	0.15	19	9	<5	<5	150	120	<3	<3	737	516	873	623	0.13	0.27
IY-19	2.70	0.60	168	37	<5	<5	138	150	<3	<3	399	728	732	120	0.20	0.08
IY-20	2.70	0.90	168	56	<5	<5	166	160	<3	<3	763	112	1074	279	0.18	0.08
IY-21	1.87	0.49	117	31	<5	<5	188	290	<3	<3	874	382	3700	991	0.13	0.13
IY-22	1.20	2.67	75	166	<5	<5	220	300	<3	<3	733	435	951	692	0.20	0.14
IY-23	3.93	3.74	245	233	<5	<5	161	370	<3	<3	449	357	697	849	0.14	0.10
IY-24	1.57	0.69	98	43	<5	<5	468	160	<3	<3	592	164	879	699	0.42	0.18
IY-25	3.30	0.90	206	56	<5	<5	398	240	<3	<3	165	111	872	759	<0.1	<0.05
IY-27	2.10	NA	131	NA	<5	<5	242	830	<3	<3	363	377	720	948	0.37	0.16
IY-28	3.90	NA	243	NA	<5	<5	206	170	<3	<3	349	276	738	554	0.37	0.09
IY-29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
IY-30	0.67	NA	42	NA	<5	<5	185	200	<3	<3	373	346	1280	1190	0.26	0.24
IY-31	1.05	0.33	66	21	<5	<5	291	200	<3	<3	413	423	1110	974	0.71	0.28
IY-32	3.50	3.57	218	222	<5	<5	138	270	<3	<3	491	669	788	973	0.28	0.07
Avg.	1.99	1.21	124	7.5	<5	<5	301	301	<3	<3	641	473	1096	833	0.36	0.28
Total	57.59	21.76	3594	1356												

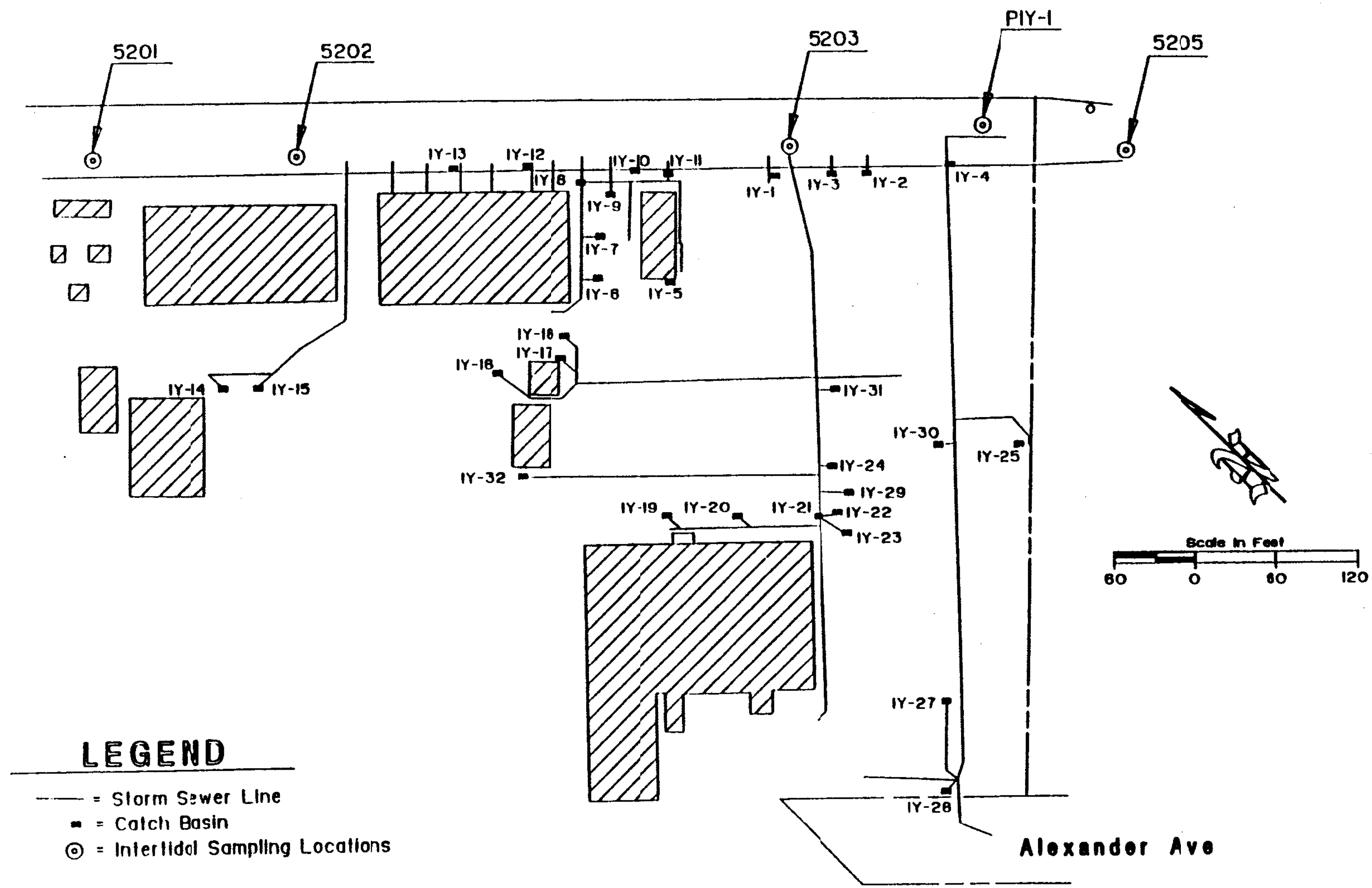
Notes:
1. Sampling was performed on January 20, 21, and 22, and September 27 and 28, 1993.
2. Weights assume sediment had a specific gravity of 1.0.

NA Not applicable due to an insufficient accumulation of sediment to determine volumes since the March 1993 cleanout of the catch basins.

– Sample not collected due to inaccessibility of catch basin.

Tab 2

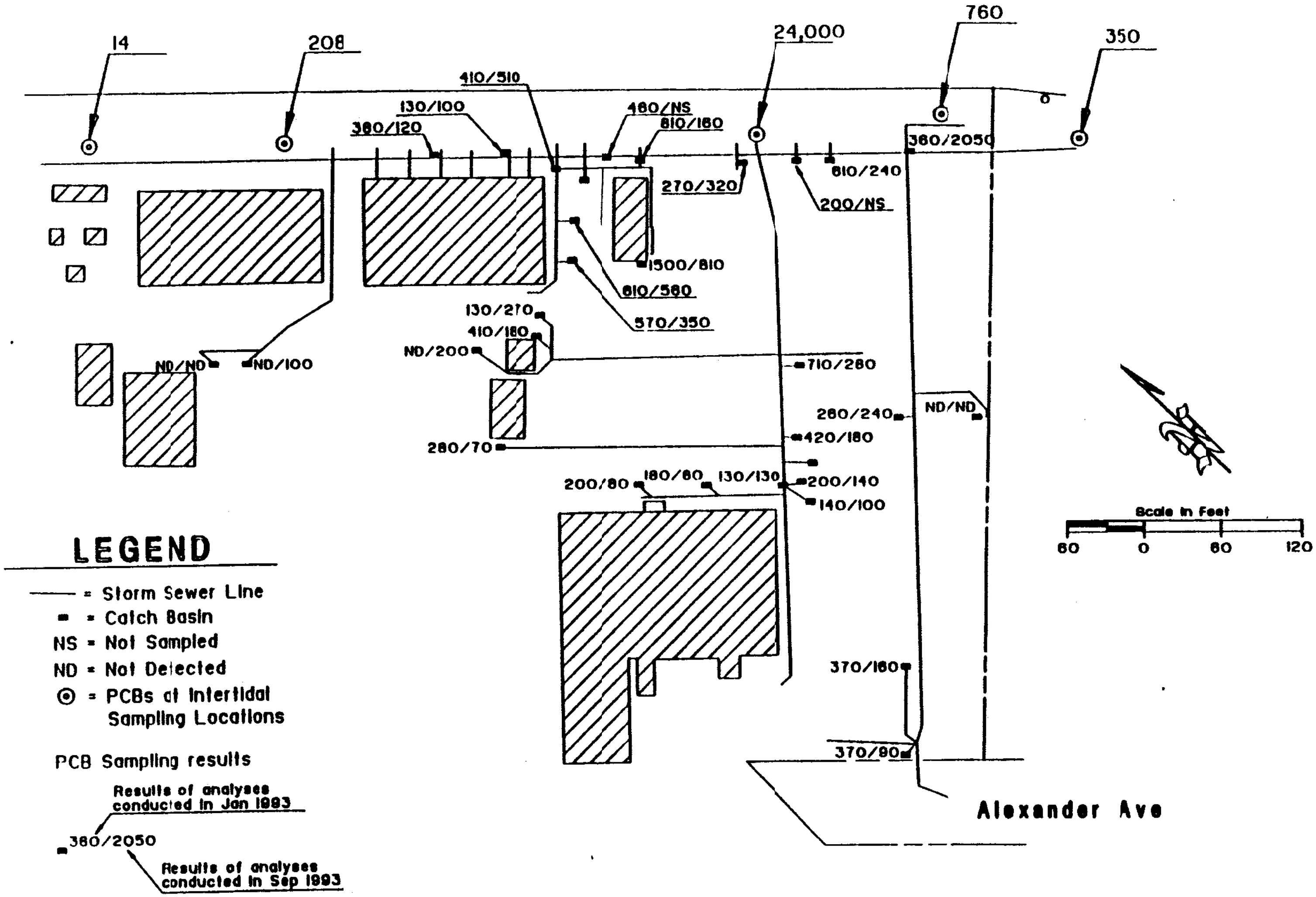
This map (derived from the same Port of Tacoma Report) shows the location of the catch basins and the storm sewer lines on Parcel #1. Also shown are several intertidal sampling locations along the Hylebos Waterway (Stations 5201, 5202, 5203, P1Y1 and 5205).



PCB Sampling Locations
Port of Tacoma Property

Tab 3

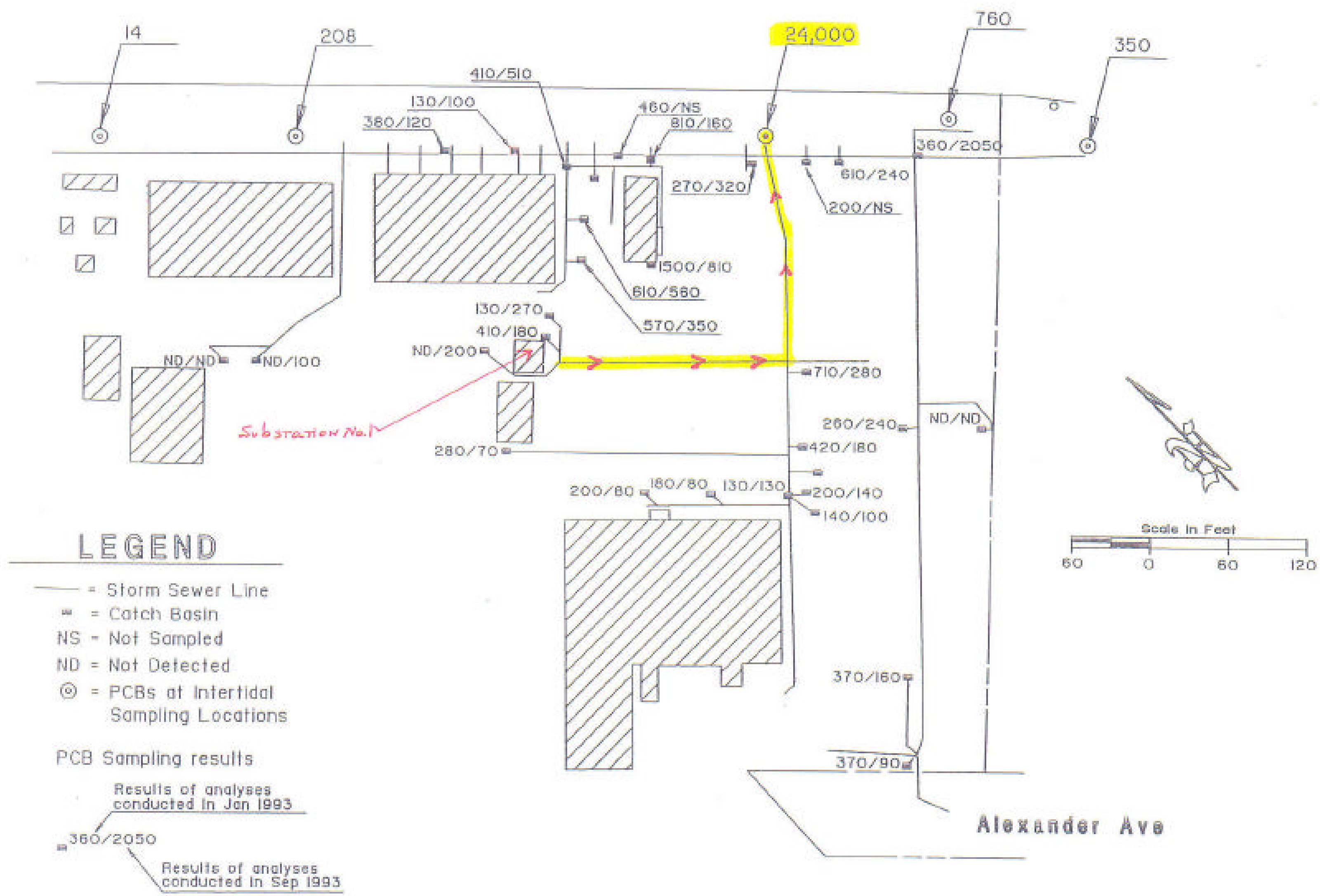
This map illustrates the "before cleaning" and "after cleaning" concentrations of PCBs in the storm sewer catch basins on Parcel #1. Also illustrated are the actual PCB concentrations (not qualified/dubious "J" values or "U" values) found in the intertidal sediments along the Hylebos. Note especially the extremely high 24,000 ppb hit of PCBs at the outfall of one of the storm sewer lines. That particular storm sewer line drains a significant transformer location.



PCB Data for Sewers on
Port of Tacoma Property

Tab 4

Portions of Map No. 1 from the Archives Report. Substation No. 1, and its transformer banks, are highlighted in yellow. The locations of catch basins IY-16, 1Y-17, and IY-18 are also shown. These catch basins drain the transformer bank area, and feed the sewer line that empties onto the hit of 24,000 ppb PCBs in the Hylebos (See Tab 3).



PCB Data for Sewers on
Port of Tacoma Property

Tab 5

Undated photograph showing Substation No. 1. This building still stands on Parcel #1. Sewer catch basin IY-17 is at the right hand corner of this building, just below the bottom of the photograph.


SUB
STATION
KEEP OUT

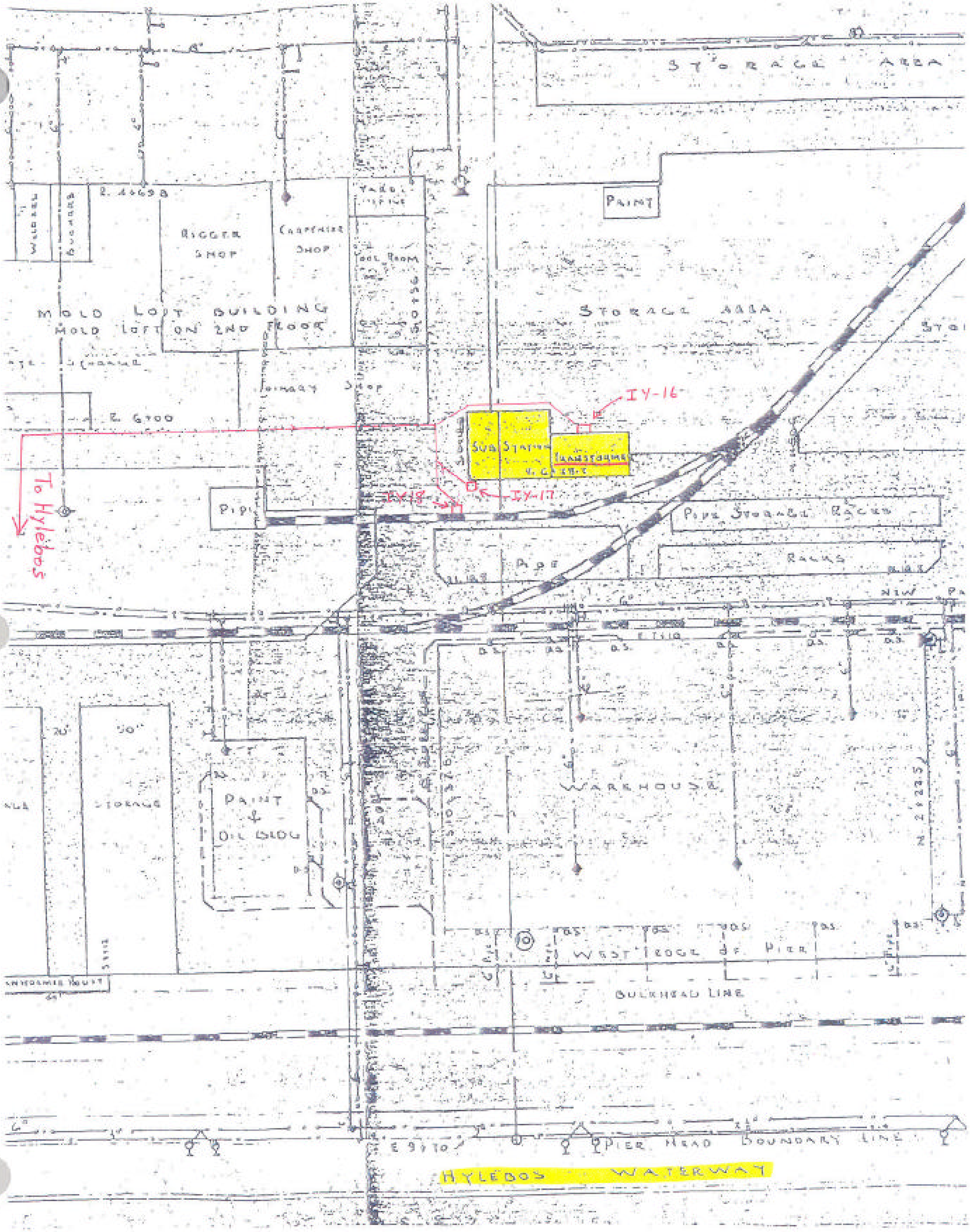
Tab 6

Photograph dated May 30, 1942 showing Substation No. 1 (the cubical cement building with three large windows immediately behind the large flat roof). Note that a portion of the bank of transformers is visible to the left of this building behind the picket fence. The Hylebos Waterway appears in the background of the photograph.

SEATTLE-TACOMA SHIPBUILDING CORP.
TACOMA, WASHINGTON
U. S. MARITIME COMMISSION
FACILITIES CONTRACT MCc-1951
LOOKING EAST SHOWING NEW TOOL
ROOM BUILDING.
MAY 30, 1942. NEGATIVE NO. 30

Tab 7

Map illustrating the drainage of the bank of transformers at Substation No. 1, to the high hit of PCBs in the Hylebos Waterway.


STORAGE AREA
PAINT
RIGGER SHOP
CARPENTER SHOP
TOOL ROOM
MOLD LOFT BUILDING
MOLD LOFT ON 2ND FLOOR
STORAGE AREA
IY-16
SUB STATION
TRANSFORMER
IY-17
IY-18
To Hylebos
PIPE STORAGE RACKS
RACKS
PIPE
WAREHOUSE
PAINT & OIL BLDG
STORAGE
WEST EDGE OF PIER
BULKHEAD LINE
PIER HEAD BOUNDARY LINE
HYLEBOS WATERWAY

Tab 8

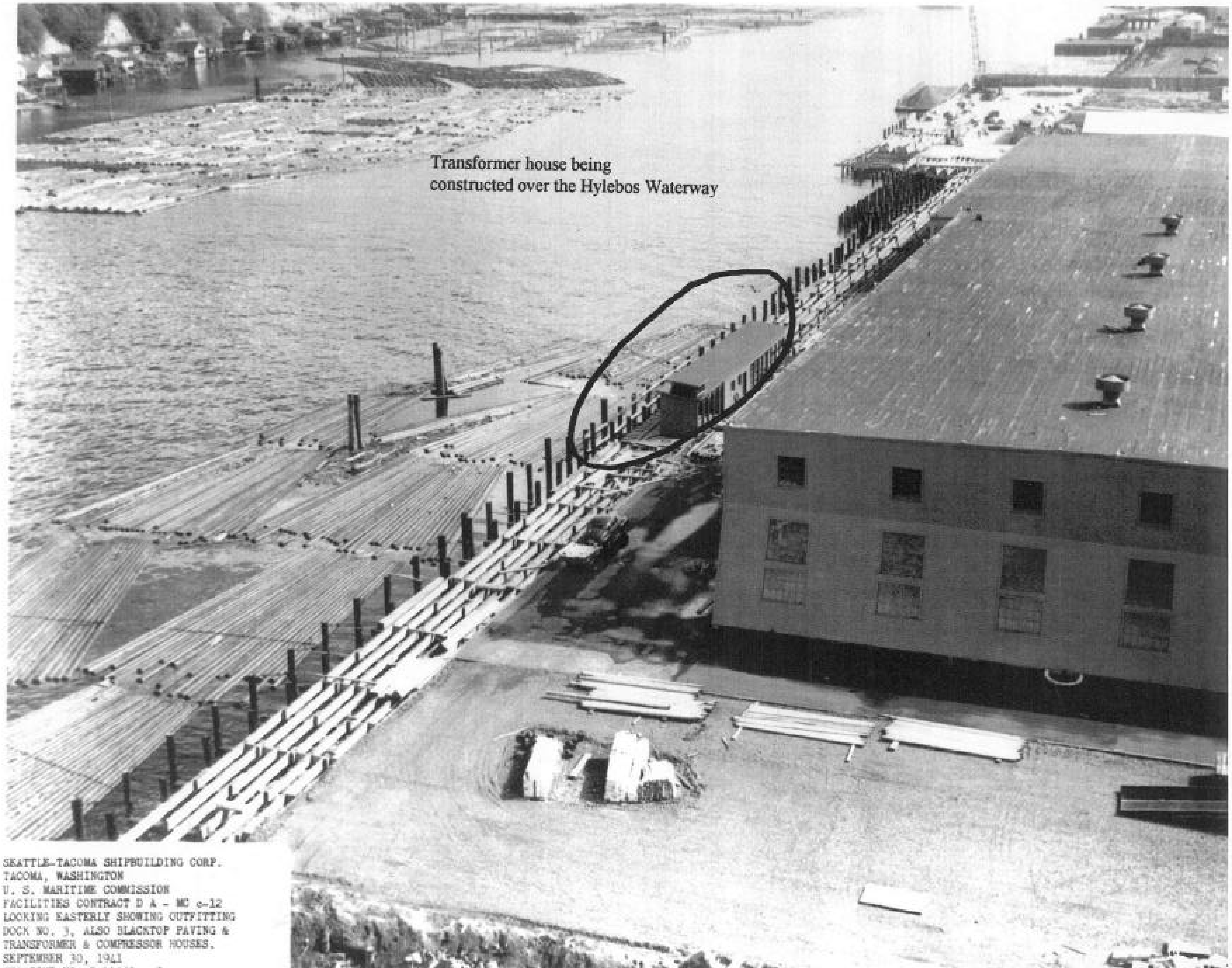
Photograph dated January 29, 1942 looking north towards the Mouth of the Hylebos, with a transformer house circled on the overlay. This is Transformer House No. 98 on Archives Map #6. This and other transformer locations are highlighted in yellow on the maps numbered 1, 2 and 6 in the Archives Report. This and the other transformer houses along the Hylebos Waterway on Parcel #1 were constructed directly on top of the wooden-planked pier, thus allowing transformer oils to leak directly into the Hylebos Waterway. This is also Building No. 547 labeled "Switch and Transformer Shed" in the legend to the Archives Report Map No. 8.

SEATTLE-TACOMA SHIPBUILDING CORPORATION
TACOMA, WASHINGTON
U. S. MARITIME COMMISSION
FACILITIES CONTRACT D A - M C e-12
TAKEN FROM TOP OF WATER TOWER LOOKING NORTH SHOWING PART OF STORAGE YARD, OUTFITTING PIER NO. 3, PART OF OUTFITTING PIER NO. 2, PAINT SHOP, WAREHOUSE AND SHOP BLDGS. JAN. 29/42.
NOS. 163, 164 & 165 WHEN PLACED TOGETHER FORM A PANORAMA OF YARD. NEG. NO. 165

Turner Richards Studio, Tacoma

Tab 9

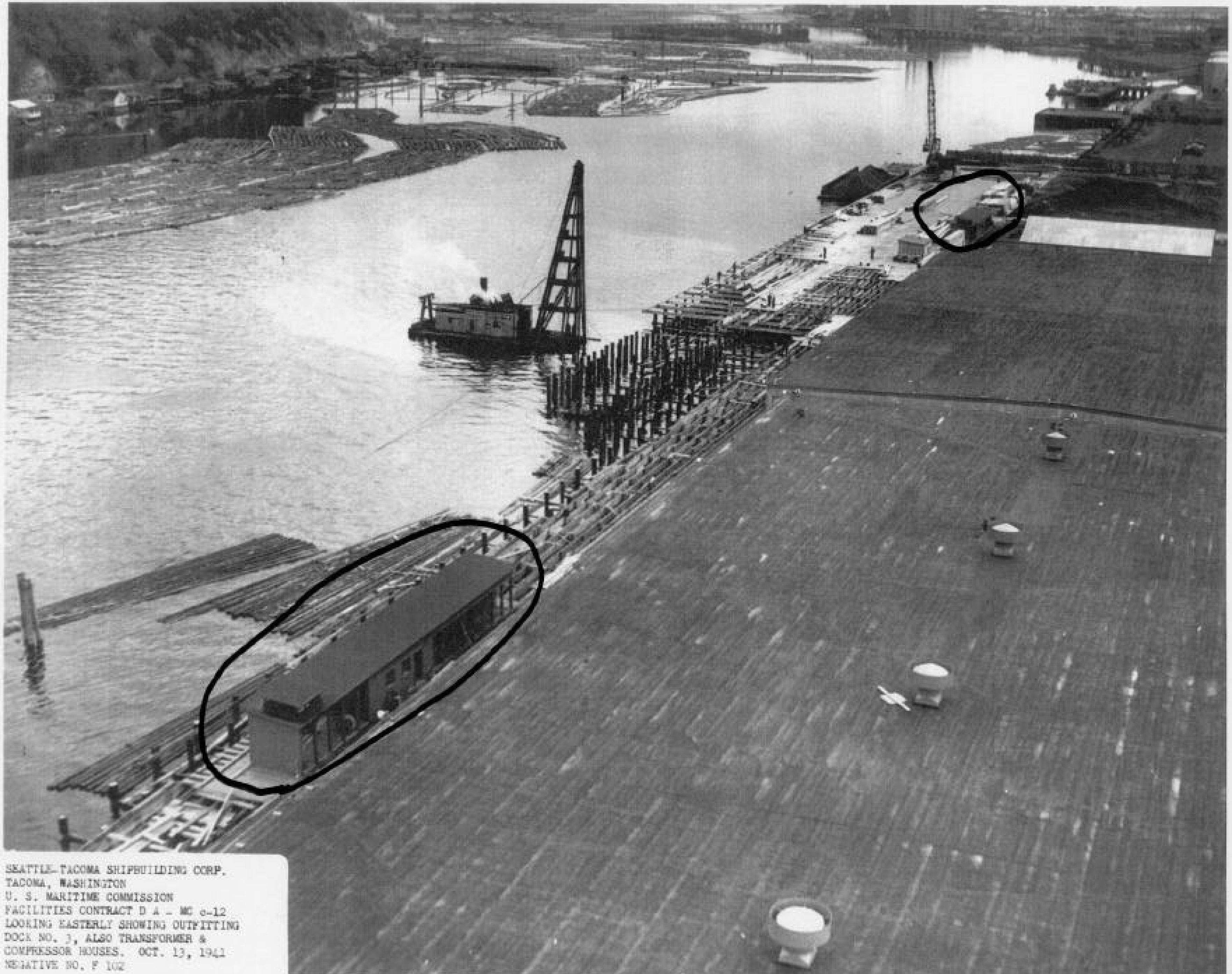
Aerial photograph dated September 30, 1941, looking southeast up the Hylebos, showing a transformer house being constructed directly over the Hylebos Waterway. This is the same structure as the "Transformer House" on the Hylebos side of the "Shops Building" in Map 1 in the Archives Report. This same structure is also shown on Maps 2, 6, and 8 from that Report. It was located on yet-to-be-completed Outfitting Pier No. 3.



SEATTLE-TACOMA SHIPBUILDING CORP.
TACOMA, WASHINGTON
U. S. MARITIME COMMISSION
FACILITIES CONTRACT D A - MC c-12
LOOKING EASTERLY SHOWING OUTFITTING
DOCK NO. 3, ALSO BLACKTOP PAVING &
TRANSFORMER & COMPRESSOR HOUSES.
SEPTEMBER 30, 1941
NEGATIVE NO. D 11961 - 8

Tab 10

Photograph dated October 31, 1941, showing both transformer houses on Outfitting Pier No. 3, over the Hylebos Waterway, as depicted previously in Tabs 8 and 9. The two transformer houses are circled on the overlay.



SEATTLE-TACOMA SHIPBUILDING CORP.
TACOMA, WASHINGTON
U. S. MARITIME COMMISSION
FACILITIES CONTRACT D A - MC c-12
LOOKING EASTERLY SHOWING OUTFITTING
DOCK NO. 3, ALSO TRANSFORMER &
COMPRESSOR HOUSES. OCT. 13, 1941
NEGATIVE NO. F 102

Tab 11

Photograph dated December 30, 1941, showing a third transformer house built directly over the Hylebos Waterway. The legend to the photo discusses "Outfitting Pier No. 3 showing transformer house at end of pier." The three transformer houses are all constructed on wood planking directly above the Waterway, and are circled on the overlay.

SEATTLE-TACOMA SHIPBUILDING CORP.
TACOMA, WASHINGTON
U. S. MARITIME COMMISSION
FACILITIES CONTRACT D A - M C c-12
OUTFITTING PIER NO. 3 SHOWING TRANS-
FORMER HOUSE AT END OF PIER.
DECEMBER 30, 1941
NEGATIVE NO. 153

PORT of TACOMA U.S.A.

November 19, 1993

Ms Joyce Mercuri
Washington Department of Ecology
Toxics Cleanup Program
Mail Stop LU-11
Olympia, WA 98504-6811

Re: Port of Tacoma Industrial Yard

Dear Ms. Mercuri;

During the last year, the Port has undertaken an independent cleanup action at the Port's Industrial Yard in accordance with tasks outlined in Dave Smith's December 10, 1992 letter to Leslie Sacha. This letter summarizes the work which has been accomplished to date in the Industrial Yard. The tasks listed below relate to items requested in Dave Smith's letter.

Task #	Description	Status
1. a.	Sample sandblast grit outside of AK-WAs lease area	Completed
1. b.	Remove sandblast grit from problem areas	Completed
2.	Test sediments in catch basins which drain to Hylebos Waterway (excluding AK-WAs)	Completed
3.	Clean out catch basins that discharge to Hylebos Waterway (excluding AK-WAs)	Completed
4.	Re-sample catch basins after 6 months	Completed
5.	Develop a schedule of inspection an maintenance for catch basins	In progress
6.	Characterize and remove barrels of waste material	Completed

Attached is a summary report which documents Tasks 1 through 4. Also attached is documentation showing removal of waste material (Task 6). We hope to complete Task 5 within the next month and will forward documentation to you when it is accomplished. If you have any questions on the attached information, please call me at (206) 383-5841.

Sincerely,

Suzanne Dudziak
Environmental Program Manager
SD/sd

enclosure

cc: Leslie Sacha w/o attachments
Dave Smith w/o attachments

Port of Tacoma Industrial Yard Catch Basin Investigation and Cleanup

Background

In May, 1991, Department of Ecology (Ecology) inspector Mike Herold sampled the sediment from a stormwater catch basin adjacent to Building 556 in the Port of Tacoma's Industrial Yard. The sample contained arsenic, copper, lead and zinc at levels above the sediment cleanup objectives for Commencement Bay. On October 9, 1992, Ecology staff Joyce Mercuri and Sandy Stephens inspected the Industrial Yard in an effort to identify possible sources of contamination to Hylebos Waterway. Several areas of concern were noted and documented in an Ecology inspection report dated October 9, 1992. On December 10, 1992, the Port received a letter from Dave Smith of Ecology requiring that steps be taken to clean up sediments discharging to Hylebos Waterway in the Industrial Yard.

This report documents the actions taken by the Port to address the concerns identified in Dave Smith's December 10, 1992 letter.

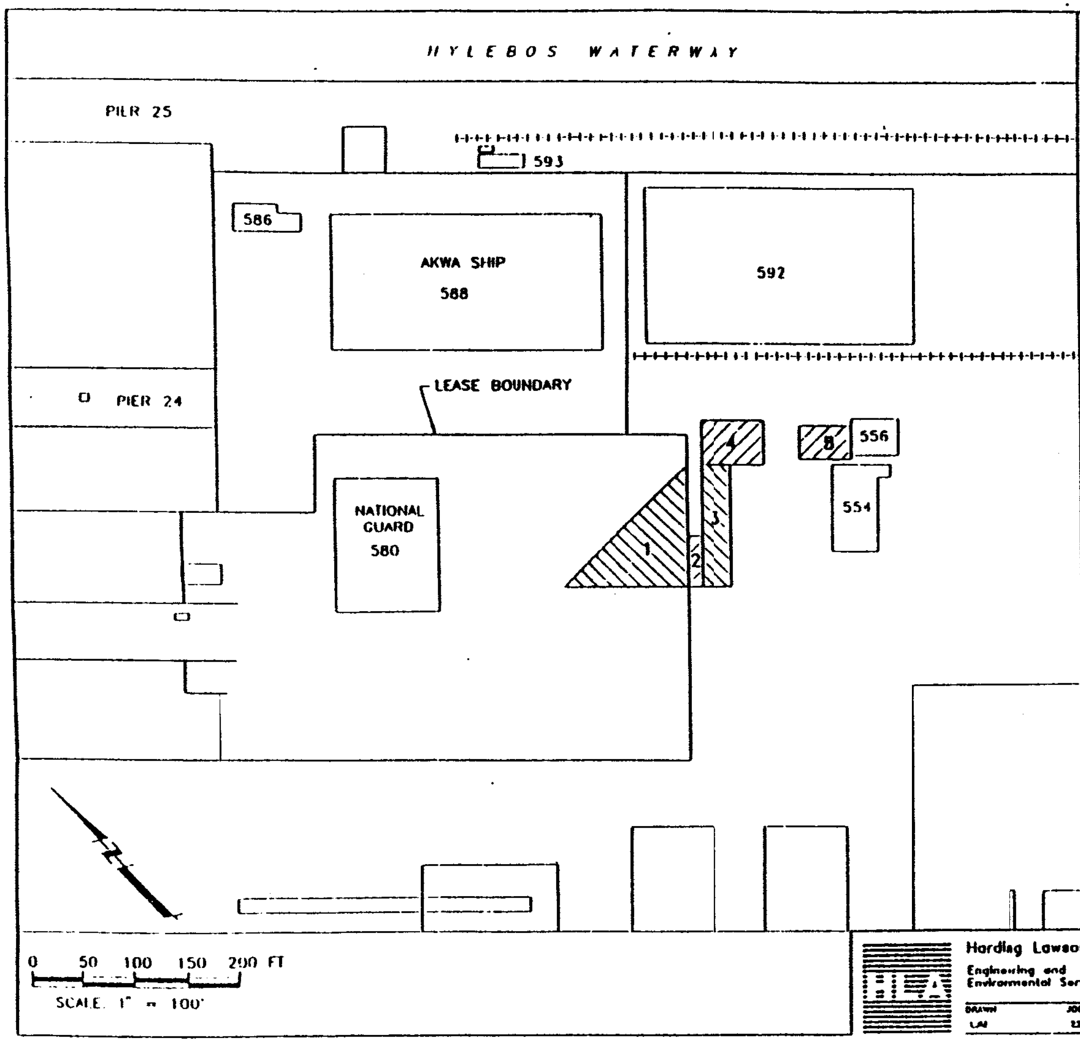
Field Program and Findings

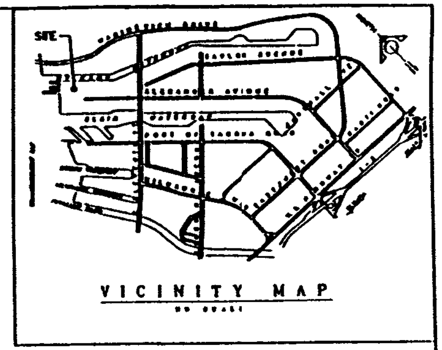
Following receipt Ecology's October 10, 1992 letter, the Port contracted with Harding Lawson Associates (HLA) to assist with the required work. HLA mapped and identified the quantity of sandblast grit requiring removal in January, 1993 (Attachment A). Samples of sandblast grit were collected and composited for analysis of TCLP As, Ba, Cd, Cr, Cu, Pb, Hg, Se, Ag, and Zn (Attachment B). Results of the analysis indicated that the material was not a hazardous waste and could be recycled by Holnam Cement, in Seattle, Washington. In November, 1993, sandblast grit identified by HLA was removed and transported to Holnam Cement for recycling.

During Ecology's October 9, 1992 inspection, three abandoned barrels containing liquid material were discovered. The Port subsequently tested the contents of each barrel and had them removed and disposed by Northwest Enviroservice Inc. The Hazardous Waste Manifest which documents disposal of this material is provided in Attachment C.

Catch basins which drain from the Industrial Yard to Hylebos Waterway were mapped and sampled in January, 1993. Results of the the sampling program are provided in HLA's April, 21, 1993 letter report (Attachment D). In March, 1993, catch basins were cleaned out by the Port. In September, 1993 the catch basins were re-sampled by the Port. Results of the second sampling program are provided in HLA's November 15, 1993 letter report (Attachment E).

ATT. A





LEGEND:

VISUAL EXTENT OF SANDBLAST GRIT

5 REFERS TO COMPOSITE SAMPLE NUMBER ANALYZED FOR TCLP METALS

Harding Lawson Associates
Engineering and Environmental Services

SANDBLAST GRIT SAMPLING AREAS
Port of Tacoma Industrial Yard

FIGURE 1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
LAI	12700.1		2-3-93	

ATT. B

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

January 12, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

METHOD BLANK
Date Analyzed: 1-7-93
Spectra Project: S301-031
Applies to Spectra #'s
0070 through 0074

TCLP Metals, mg/l

Arsenic	(As)	<0.05
Barium	(Ba)	0.056
Cadmium	(Cd)	<0.003
Chromium	(Cr)	<0.007
Lead	(Pb)	<0.04
Mercury	(Hg)	<0.03
Selenium	(Se)	<0.08
Silver	(Ag)	<0.007
Copper	(Cu)	<0.002
Zinc	(Zn)	0.054

TCLP by EPA Method 1311
Metals performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

January 12, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: G-1
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-6-93
Date Received: 1-6-93
Spectra Project: S301-031
Spectra #0070

TCLP Metals, mg/l

Arsenic	(As)	<0.05
Barium	(Ba)	0.632
Cadmium	(Cd)	<0.003
Chromium	(Cr)	0.017
Lead	(Pb)	0.51
Mercury	(Hg)	<0.03
Selenium	(Se)	<0.08
Silver	(Ag)	<0.007
Copper	(Cu)	4.74
Zinc	(Zn)	9.77

TCLP by EPA Method 1311
Metals performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

H11. C

*** FOR 24 HOUR EMERGENCY RESPONSE INFORMATION, CALL (206) 622-1090 ***

JOB# 42956 9-30-94

Please print or type (Form designed for use on elite (12-pitch) typewriter)

Form Approved. OMB No. 2050-0039 Expires 9-30-9X

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No: WAD982821159	Manifest Document No: 10226	2. Page 1 of 1	Information in the shaded areas is not required by Federal law

3. Generator's Name and Mailing Address
Port of Tacoma Industrial Yard
401 Alexander Avenue, Tacoma, WA 98401

4. Generator's Phone (206) 383-5841

A. State Manifest Document Number

B. State Generator's ID

5. Transporter 1 Company Name: Northwest EnviroService, Inc.
6. US EPA ID Number: WAD058367152

C. State Transporter's ID

D. Transporter's Phone (206)622-1090

7. Transporter 2 Company Name
8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9. Designated Facility Name and Site Address
Northwest EnviroService, Inc.
1500 Airport Way South
Seattle, WA 98134

10. US EPA ID Number: WAD058367152

G. State Facility's ID

H. Facility's Phone (206) 622-1090

	HM	11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	X	Hazardous waste, liquid, n.o.s. (2-butanone, toluene) 9, AN3082. PGIII [32].	1	DM	50	G	F003 F005 WT02
b.	X	Waste paint. 3, UN1263. PGIII	1	DM	25	G	D001 F003 F005 WT02
c.	X	Hazardous waste solid, n.o.s. (acetone, toluene). 9, NA3077. PGIII	1	DM	200	P	F003 F005 WT02
d.							

J. Additional Descriptions for Materials Listed Above
a)WPQ58979 - [18-1] Water mixed w/MEK<200ppm, n-butanol, 2-ethoxyethanol, MIBK, toluene, ethyl benzene, xylene, cyclohexanone - 60-D ¦¦¦b)WPQ58978 - [18-2] Solidified paint and water w/solvents, MEK<200ppm, isobutanol, toluene, MIBK, xylene, ethyl benzene, n-butanol -

K. Handling Codes for Wastes Listed Above
a) S01C S02T T44T
b) S01C T38C
c) S01C T38C

15. Special Handling Instructions and Additional Information
c)WPQ58977 - [18-3] Solidified paint w/acetone, 18 ppm MEK,
Due to arrive on 09/10/93. Load number 6448. Need sludge count done on lines 1a & 1b.

16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: Suzanne Dudziak on behalf of Port of Tacoma
Signature: [signature]
Month Day Year: 9 10 93

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: BRUCE D. WEYERMANN
Signature: [signature]
Month Day Year: 09 10 93

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19
Printed/Typed Name: William M. Gaskell
Signature: [signature]
Month Day Year: 9 10 93

EPA Form 8700-22 (Rev. 9-88) Previous editions are obsolete ORIGINAL-RETURN TO GENERATOR

9-17-93

Harding Lawson Associates

ATT. D

April 21, 1993

22789.1

Ms. Suzanne Dudziak
Port of Tacoma
P.O. Box 1837
Tacoma, Washington 98401

Dear Ms. Dudziak:

Interim Catch Basin Sediment Report
Port of Tacoma Industrial Yard

This letter report describes methods and analytical results for catch basin sediment sampling conducted January 20 through 22, 1993 in the Port of Tacoma's Industrial Yard. The current status for the planned disposal of these sediments is also discussed. This work was performed to fulfill a Washington Department of Ecology (Ecology) request (letter from Dave Smith to Leslie Sacha, December 10, 1992).

Methods

Catch basin sediment sampling was performed January 20-22 in the 29 catch basins within the Port of Tacoma's Industrial Yard which drain to the Hylebos Waterway (Figure 1). Heavy rains on January 21 caused some of the basins to overtop, and consequently some of the sediments were sampled from beneath a pool of water. Catch basins were located using a site map provided by the Port of Tacoma. Two of the identified catch basins had apparently been paved over and could therefore not be sampled (IY-9 and -29), and an additional two were located which were not on the site map (IY-24 and -32).

Sampling was performed with a polyethylene cup attached to an extendable pole. Four representative sediment subsamples from each catch basin were composited in a stainless steel bowl. The cup and bowl were rinsed with deionized water between samples. The samples were delivered to Spectra Laboratory for analysis of total arsenic, lead, mercury, copper, zinc and poly chlorinated biphenyls (PCB).

Sediment thickness was estimated by obtaining the total catch basin depth with a sounding pole and estimating the depth to the sediment with a weighted disk attached to a rope. The volume was calculated by multiplying this thickness by the measured basin area, and weights were calculated assuming a specific gravity near 1.0 due to the high moisture content of the sediment.

Results

Volumes, weights, and analytical results are provided on Table 1. The total weight of the sediments in the 29 basins was approximately 2 tons. Each sediment sample had arsenic and mercury levels below reported detection limits. Lead, copper, and zinc levels were variable, and averaged approximately 300, 640 and 1100 mg/kg, respectively. The highest lead level and second highest copper and zinc levels were found in IY-16, which drains a portion of the area containing sandblast grit. IY-17, which was sampled by Ecology in May 1991, had lead and zinc levels near the average for the basins, and the sixth highest copper level. The average PCB concentration was below 1 mg/kg.

As part of an initial evaluation into disposal options for this sediment, it was learned that total petroleum hydrocarbon (TPH) analyses would be necessary if the sediment was disposed in a landfill. Samples were subsequently composited by Spectra into three samples for TPH analyses (WTPH 418.1) using the following protocol. The 16 samples which had lead levels under 250 mg/kg (the MTCA Method A Cleanup level) were composited into a single sample; the seven samples with lead levels between 250 and 400 mg/kg were composited into a second sample and the remaining six samples were composited into a third sample. These three composites contained TPH levels of 6700 mg/kg, 8900 mg/kg and 14,000 mg/kg, respectively.

Status of Sediment Disposal

Our March 8, 1993 memorandum to you concerning catch basin sediment disposal options concluded that disposal costs at suitable landfills may be small compared to testing fees and other costs associated with regulatory compliance issues. The recommendation was made to continue to pursue disposal at the Roosevelt Regional landfill in Klickitat County due to moderate levels of testing and good environmental controls. Roosevelt's local hauler (Regional Disposal Co./Rabanco) requires analyses of PCBs and TPH. In addition, TCLP metals need to be analyzed, because TPH levels exceeded 5000 mg/kg (Joe Cassellini, pers. comm.). They also require a paint filter test be performed on the sediments once they are removed.

The sediment was pumped from each catch basin on March 23, 1993, placed on a storage pad bordered by hay bales, and covered by a tarp. The volume estimate of 300-450 cubic feet of removed sediment equates to approximately 10-15 tons, which is more than measured in the basins, likely due to water which was pumped with the sediment. Disposal fees, at $54/ton, are estimated to be less than $1000. We have recommended that sawdust be added and mixed with the sediments if it is believed that they will not pass the paint filter test. Sampling for TCLP metals, and the paint filter test, will be completed after it is believed the sediments will pass the paint filter test, and barring any unforeseen problems, the pumpings should be declared suitable for landfill disposal. The basins will be resampled in approximately 6 months, as requested by Ecology.

Please call if you have any questions concerning this letter report.

Very truly yours,

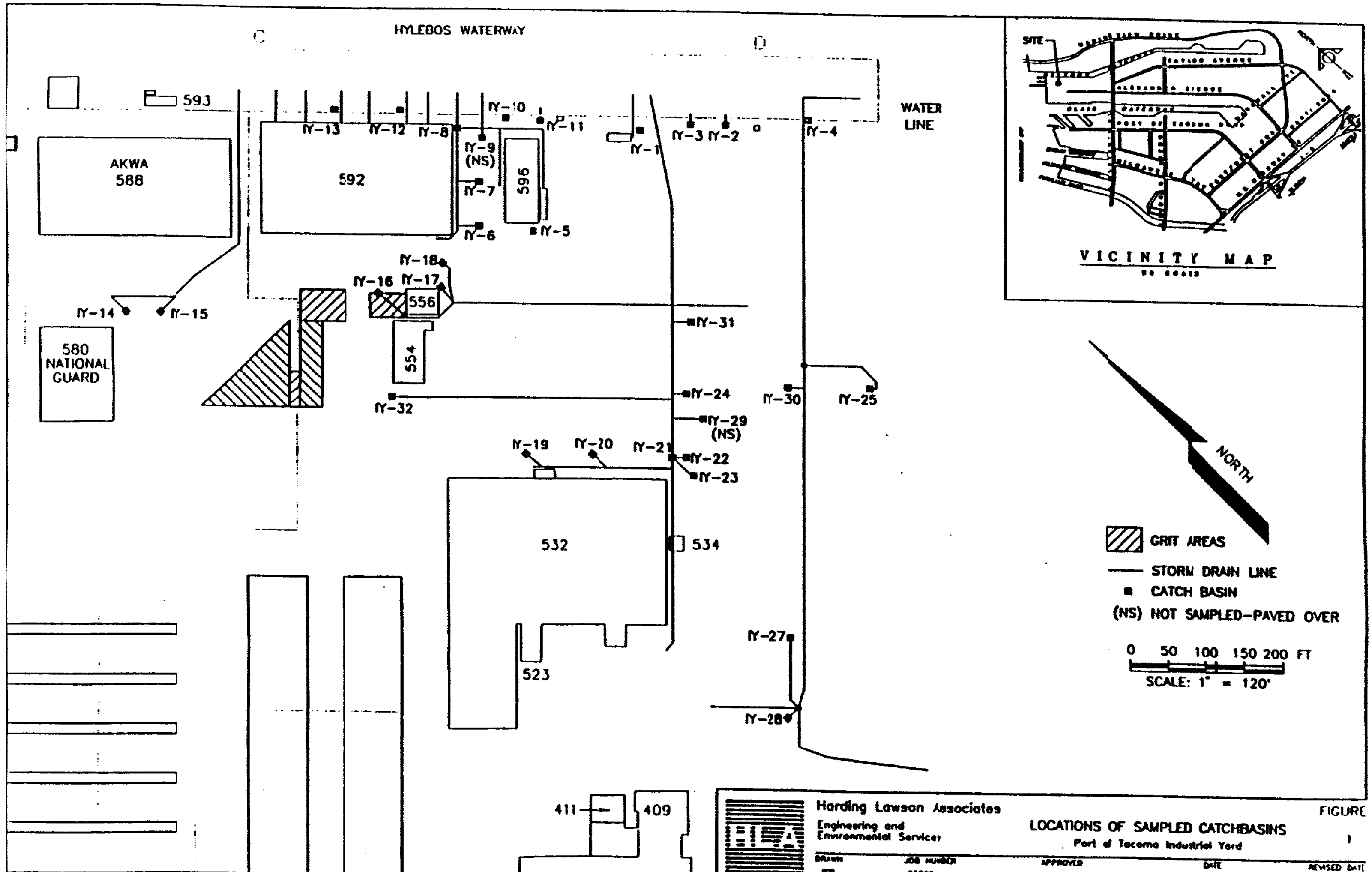
HARDING LAWSON ASSOCIATES

Clain Jones
Project Aquatic Scientist

Dan Balbiani, P.E.
Managing Principal Engineer

CJ:bb\93bb0282.ltr

Enclosure



Harding Lawson Associates
Engineering and Environmental Services

FIGURE 1

LOCATIONS OF SAMPLED CATCHBASINS
Port of Tacoma Industrial Yard

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
JSR	22789.1		3-24-93	

TABLE 1

PORT OF TACOMA INDUSTRIAL YARD

CATCH BASIN SEDIMENT SAMPLING RESULTS

SAMPLE	VOLUME (cu. ft.)	WEIGHT (lb.)	ARSENIC (mg/kg-dry)	LEAD (mg/kg-dry)	MERCURY (mg/kg-dry)	COPPER (mg/kg-dry)	ZINC (mg/kg-dry)	PCBs (mg/kg-dry)	Notes
IY-1	0.23	14	<5	205	<3	541	609	0.27	
IY-2	0.39	24	<5	205	<3	136	962	0.61	
IY-3	0.25	16	<5	126	<3	204	538	0.20	
IY-4	0.39	24	<5	40	<3	30	275	0.36	
IY-5	5.35	334	<5	335	<3	618	1580	1.50	
IY-6	2.97	185	<5	234	<3	665	1190	0.57	
IY-7	1.19	74	<5	449	<3	748	1085	0.61	
IY-8	2.28	142	<5	464	<3	841	1340	0.41	
IY-9	---	—	—	—	—	—	—	—	Paved over
IY-10	0.60	37	<5	302	<3	482	1110	0.46	
IY-11	2.66	166	<5	775	<3	732	1740	0.81	Under pool of water
IY-12	0.60	37	<5	417	<3	549	1030	0.13	
IY-13	1.80	112	<5	366	<3	502	1530	0.38	
IY-14	3.79	236	<5	188	<3	1600	445	<0.1	
IY-15	3.50	218	<5	265	<3	1800	565	<0.1	Under pool of water
IY-16	1.79	112	<5	1090	<3	1630	2140	<0.1	
IY-17	1.01	63	<5	325	<3	819	1030	0.41	
IY-18	0.30	19	<5	150	<3	737	873	0.13	
'-19	2.70	168	<5	138	<3	399	732	0.20	
/-20	2.70	168	<5	166	<3	763	1074	0.18	
IY-21	1.87	117	<5	188	<3	874	3700	0.13	
IY-22	1.20	75	<5	220	<3	733	951	0.20	
IY-23	3.93	245	<5	161	<3	449	697	0.14	
IY-24	1.57	98	<5	468	<3	592	879	0.42	
IY-25	3.30	206	<5	398	<3	165	872	<0.1	
IY-27	2.10	131	<5	242	<3	363	720	0.37	Under pool of water
IY-28	3.90	243	<5	206	<3	349	738	0.37	Under pool of water
IY-29	–	–	–	–	–	–	–	–	Paved over
IY-30	0.67	42	<5	185	<3	373	1280	0.26	
IY-31	1.05	66	<5	291	<3	413	1110	0.71	
IY-32	3.50	218	<5	138	<3	491	788	0.28	
Average	1.99	124	<5	301	<3	641	1096	0.36	
Total	57.59	3594							

Notes:

1. Sampling was performed on January 20, 21, and 22, 1993.
2. Weights assume sediment had a specific gravity of 1.0.
3. The sediment volumes in catch basins which were under water are approximate.

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-1
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0484

PCB's, mg/Kg		0.27	type 1260
Surrogate Recovery - tcm-Xylene 92%			
Total Metals, mg/Kg			
Arsenic	(As)	<5	
Lead	(Pb)	205	
Mercury	(Hg)	<3	
Copper	(Cu)	541	
Zinc	(Zn)	809	

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-2
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0485

PCB's, mg/Kg 0.61 type 1260

Surrogate Recovery - tcm-Xylene 88%

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	205
Mercury	(Hg)	<3
Copper	(Cu)	136
Zinc	(Zn)	962

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-3
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0486

PCB's, mg/Kg		0.20	type 1260
Surrogate Recovery - tcm-Xylene 102%			

<u>Total Metals, mg/Kg</u>

Arsenic	(As)	<5
Lead	(Pb)	126
Mercury	(Hg)	<3
Copper	(Cu)	204
Zinc	(Zn)	538

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-4
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0487

PCB's, mg/Kg		0.36	type 1260
Surrogate Recovery - tcm-Xylene 100%			

<u>Total Metals, mg/Kg</u>

Arsenic	(As)	<5
Lead	(Pb)	40
Mercury	(Hg)	<3
Copper	(Cu)	30
Zinc	(Zn)	275

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-5
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0489

PCB's, mg/Kg 1.50 type 1260
Surrogate Recovery - tcm-Xylene 91%

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	335
Mercury	(Hg)	<3
Copper	(Cu)	618
Zinc	(Zn)	1,580

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-6
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0488

PCB's, mg/Kg 0.57 type 1260
Surrogate Recovery - tcm-Xylene 90%

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	234
Mercury	(Hg)	<3
Copper	(Cu)	665
Zinc	(Zn)	1,190

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-7
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0490

PCB's, mg/Kg 0.61 type 1260
Surrogate Recovery - tcm-Xylene 58%

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	449
Mercury	(Hg)	<3
Copper	(Cu)	748
Zinc	(Zn)	1,085

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-8
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0492

PCB's, mg/Kg		0.41	type 1260
Surrogate Recovery - tcm-Xylene 68%			

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	464
Mercury	(Hg)	<3
Copper	(Cu)	841
Zinc	(Zn)	1,340

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-10
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0493

PCB's, mg/Kg — 0.46 type 1260
Surrogate Recovery - tcm-Xylene 74%

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	302
Mercury	(Hg)	<3
Copper	(Cu)	482
Zinc	(Zn)	1,110

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-11
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-21-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0507

PCB's, mg/Kg		0.81	type 1260
Surrogate Recovery - tcm-Xylene 79%			

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	775
Mercury	(Hg)	<3
Copper	(Cu)	732
Zinc	(Zn)	1,740

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-12
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0491

PCB's, mg/Kg 0.13 type 1260
Surrogate Recovery - tcm-Xylene 58%

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	417
Mercury	(Hg)	<3
Copper	(Cu)	549
Zinc	(Zn)	1,030

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-13
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0494

PCB's, mg/Kg	0.38	type 1260
Surrogate Recovery - tcm-Xylene 69%		

<u>Total Metals, mg/Kg</u>

Arsenic	(As)	<5
Lead	(Pb)	366
Mercury	(Hg)	<3
Copper	(Cu)	502
Zinc	(Zn)	1,530

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-14
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-21-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0496

PCB's, mg/Kg	<0.1
Surrogate Recovery - tcm-Xylene 65%	

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	188
Mercury	(Hg)	<3
Copper	(Cu)	1,600
Zinc	(Zn)	445

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-15
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-20-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0495

PCB's, mg/Kg		<0.1
Surrogate Recovery - tcm-Xylene 81%		

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	265
Mercury	(Hg)	<3
Copper	(Cu)	1,800
Zinc	(Zn)	565

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-16
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-21-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0497

PCB's, mg/Kg Surrogate Recovery - tcm-Xylene 92%		<0.1
Total Metals, mg/Kg		
Arsenic	(As)	<5
Lead	(Pb)	1,090
Mercury	(Hg)	<3
Copper	(Cu)	1,630
Zinc	(Zn)	2,140

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.
2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-17
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-21-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0499

PCB's, mg/Kg		0.41	type 1260
Surrogate Recovery - tcm-Xylene 65%			

Total Metals, mg/Kg

Arsenic	(As)	<5
Lead	(Pb)	325
Mercury	(Hg)	<3
Copper	(Cu)	819
Zinc	(Zn)	1,030

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist

SPECTRA Laboratories, Inc.

2221 Ross Way • Tacoma, WA 98421 • (206) 272-4850

February 3, 1993

Port of Tacoma
P.O. Box 1837
Tacoma, WA 98401

Attn: Suzanne Dudziak

Sample ID: IY-18
Project: 22789.1
Sample Matrix: Soil
Date Sampled: 1-21-93
Date Received: 1-22-93
Spectra Project: S301-151
Spectra #0498

PCB's, mg/Kg		0.13	type 1260
Surrogate Recovery - tcm-Xylene 65%			

<u>Total Metals, mg/Kg</u>

Arsenic	(As)	<5
Lead	(Pb)	150
Mercury	(Hg)	<3
Copper	(Cu)	737
Zinc	(Zn)	873

PCB's performed by EPA Method 8080
Total Metals testing performed by EPA Method 6010

SPECTRA LABORATORIES, INC.

Steven G. Hibbs, Chemist