

DRAFT

SIMPSON TIMBER COMPANY

DIOXIN STUDY

FINAL REPORT

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INTRODUCTION

BACKGROUND AND PURPOSE OF STUDY

The background of the Simpson Timber Company (STC) site in Shelton, Washington, is described in this section and in "Final Draft Test Report--Site 07, Wood-Fired Boiler WFB-4, National Dioxin Study, Tier 4: Combustion Sources" by Radian Corporation, May 30, 1986.

In brief summary, the events leading to this study are as follows:

- o STC agreed to participate in the National Dioxin Study, Tier 4 combustion sources.
- o Chlorinated dioxins and furans, including 2,3,7,8-TCDD, were found in baghouse residues at the STC powerplant (now decommissioned).
- o It was known that baghouse residues had been sent as slurries to two municipal wastewater treatment plants. Sludge from the treatment plants had been deposited at two public landfills, and baghouse residue had been deposited at a wood-waste landfill owned by STC. Effluent from the two

wastewater treatment plants had been discharged to Oakland Bay, an arm of Puget Sound.

- o The STC powerplant at Shelton had operated for about 50 years prior to the installation of the baghouses.
- o Because the events described above constituted a possible or actual release of toxic materials to the environment, STC and the U.S. EPA entered into a consent agreement to investigate the possible releases of dioxins and furans to the environment.

The consent agreement required the submission of a sampling plan, monthly reports, and a preliminary and final report on the results of the studies required by the consent agreement as described in the sampling plan. The sampling plan was submitted to EPA in July 1986. The preliminary report was submitted in January 1987. This report is the draft final report required by the consent agreement.

The studies implemented under the consent agreement had four major purposes:

- o Determine the chlorinated dioxin and furan content of the remaining baghouse residue and boiler ash from the decommissioned powerplant.

- o Determine the chlorinated dioxin and furan content of the residual sludge at the City of Shelton landfill (the only landfill with uncovered deposits of potentially contaminated sludge).
- o Determine if chlorinated dioxins and furans have been deposited in the surrounding area by discharges from the wastewater treatment plants or the stacks at STC.
- o Characterize the soils at the three landfills to determine whether there is any potential for chlorinated dioxins and furans to be transported to groundwater.

SITE HISTORY

A wood-burning powerplant belonging to Simpson Timber Company (STC) at Shelton, Washington, was sampled as part of the U.S. EPA National Dioxin Study of Tier 4 combustion sources. Chlorinated dioxins and furans were found in samples of residue in the emission control system of the low-pressure boiler. Concentrations of 2,3,7,8 TCDD averaged one part per billion in three samples of baghouse residue. The concentrations of all chlorinated dioxins and furans approached, or slightly exceeded, one part per million in the same three samples. The air emissions and bottom ash

that were sampled did not contain concentrations sufficient to cause concern by the U.S. EPA.

From 1926 to March of 1976 the STC boilers were operated without emission controls. In March of 1976 the baghouses on the boilers leading to the tall stack ("low pressure boilers") and short stack ("high pressure boilers") began operating. The two banks of baghouses produced about 3,000 pounds per day of residue when the boilers were operating. The residue consisted of about one-third unburned or charred-wood residue and two-thirds salt.

The baghouses were bypassed from July to September 1976 and July 1981 to February 1982. The tall-stack baghouse was disabled by fire in September 1984 and was not replaced. The short-stack boiler was shut down permanently on March 24, 1986, when the new powerplant came online. The tall-stack boiler was shut down permanently on May 6, 1986.

From March of 1976 to July of 1979 the baghouse residue was mixed with water and sent as a slurry to the old municipal sewage treatment plant. From July of 1979 to June of 1984 the slurried residue was sent to the new sewage treatment plant at Eagle Point (except for July 1981 to February 1982 when the baghouses were bypassed). The combined sludge from domestic sewage and from STC's baghouse residue was hauled to the City of Shelton landfill from March 1976 to November

1981. From December 1981 to June 1984 the combined domestic and STC sludge was hauled to the Mason County landfill.

From June 1984 to May 1986 the dry baghouse residue was hauled to STC's Dayton wood-waste landfill. The residue from the emission control system on the new powerplant is presently hauled to the Dayton site.

The locations of the three landfills are shown in Figure 1, which includes the City of Shelton as a reference point. Figure 1 is a composite of four U.S. Geological Survey 15-minute quadrangle sheets (7.5-minute sheets are not available for part of the region). The 15-minute quadrangles have not been revised to show recent geographic changes. The major feature not shown in Figure 1 is the U.S. Highway 101 bypass which now passes between the City of Shelton and the municipal landfill.

METHODS

CHARACTERISTICS OF DISPOSAL SITES

Landfills

Dayton Wood Waste Landfill. The Dayton wood-waste landfill is used by STC for disposal of wood waste from the Dayton

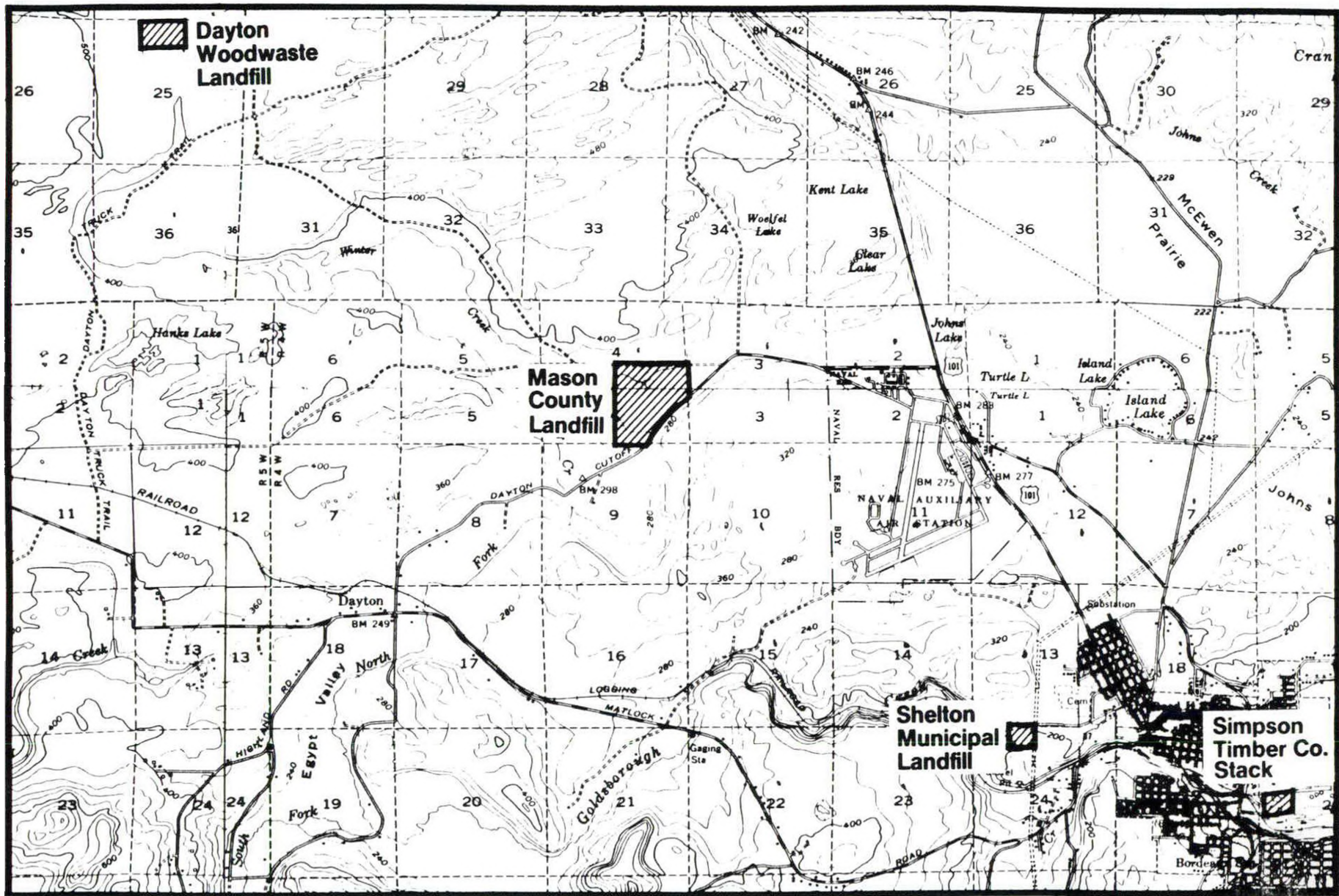


Figure 1
Simpson Timber Company
Waste Disposal Locations

log sorting yard and from Sawmill No. 5 which are both located within 3 miles of the site.

Disposal was on the ground surface with same-day coverage with a mixture of wood waste and dirt. Disposal is on the surface of the ground in an area that has been clear cut. There is no liner. Baghouse residue was hauled to the site approximately twice per week in the dumpsters in which it had accumulated. Approximately one load of baghouse residue was dumped for every 10 loads of wood waste (which often contains soil and rocks). The baghouse residue would generally be compacted to about one-third of its original volume during transportation, so the final ratio of the volumes of wood waste to baghouse residue at the time of disposal was about 25:1. Assuming that the soluble salts in the baghouse residue (about 70 percent by weight) eventually leach downward into the soil, the final ratio will (or has) become about 83:1.

The location of the baghouse residue is not known precisely because only about one load of waste in ten was residue. The general areas of the landfill where the baghouse residue was deposited are known and are shown in Figure 2.

The depth of wood waste and soil covering the baghouse residue varies, but the Dayton site has been completely filled and releveled and is now receiving a second layer of wood

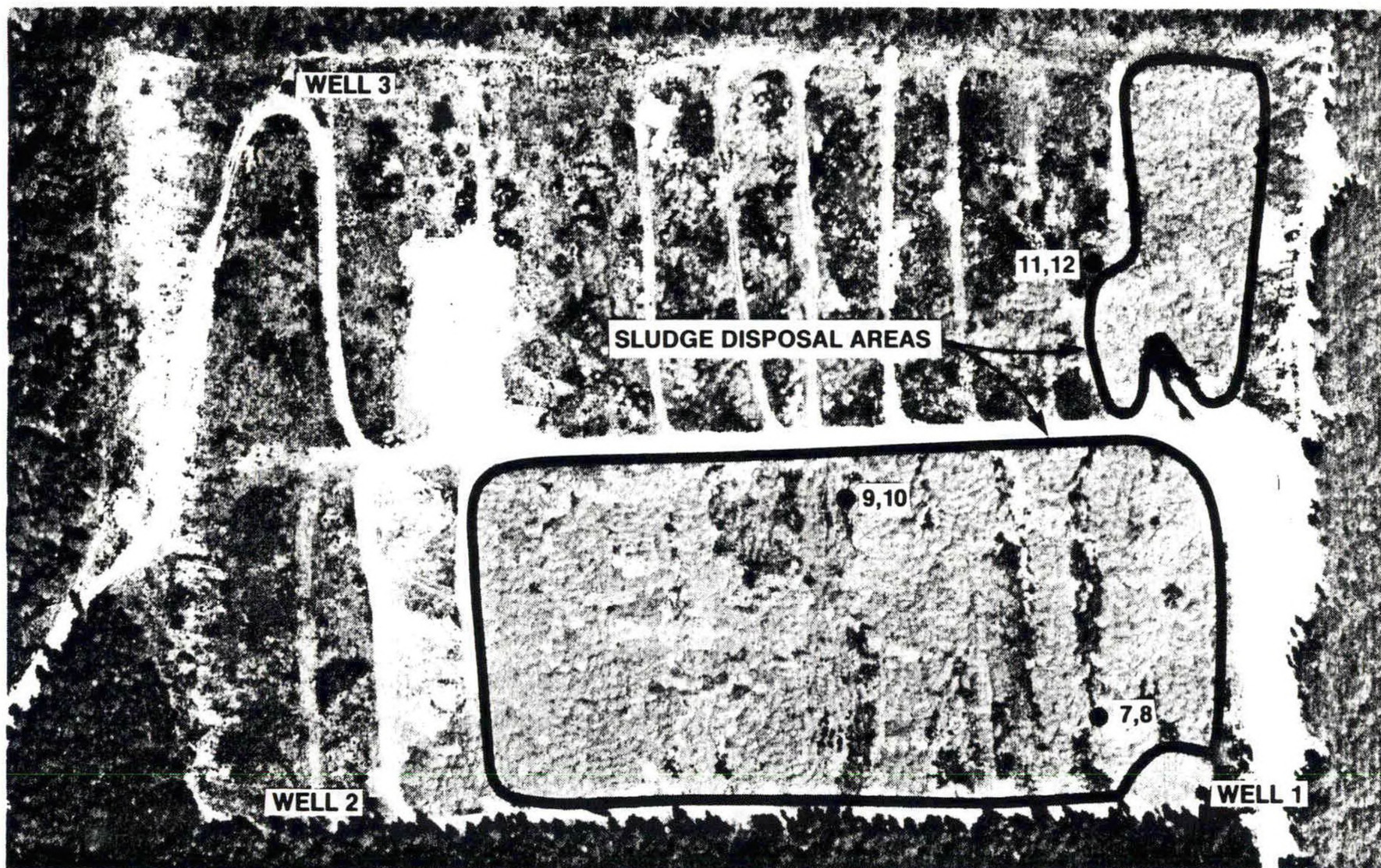


Figure 2
Dayton Wood Waste Landfill
Sample numbers correspond
to the digit portion of sample
numbers shown in Table 3.

waste. The baghouse residue is now completely covered with up to several feet of wood waste, soil, and rocks.

The total volume (compacted during transport) of baghouse residue at the Dayton site was calculated to be 650 cubic yards. That volume would be, or has possibly been, reduced to 195 cubic yards by dissolution of the salts. The volume of wood waste and dirt that is intermingled with and covering the baghouse residue was about 16,250 cubic yards as of October 1986; (the volume of wood waste has now been increased considerably).

The site is located in a glacial outwash channel north of Dayton, Washington, in Township 21, Range 5W, Section 25. The U.S. Geological Survey (Molenaar and Noble, 1970) described the general area of the landfill as a glacial outwash plain. Within the landfill, in the glacial outwash channel, the topography slopes gently toward the west, north, and south at an elevation of just under 450 feet above sea level.

The Skokomish River valley at the mouth of Vance Creek lies just over 2 miles to the north. The glacial outwash channel becomes the valley of Winter Creek (tributary to Goldsborough Creek) approximately 2 miles southeast of the landfill. Winter Creek is intermittent over its entire length.

The soils at the site are predominantly Grove series; gravelly, sandy loam described as excessively drained. Surface soils have a humus layer in gravelly sand. Subsurface soils are sometimes stained red or black and are acidic with pH increasing with depth.

Simpson Timber Company has installed three monitoring wells at the Dayton wood-waste landfill at the request of the Mason County Health Department. Drillers' logs indicate a depth to groundwater of 56 to 75 feet, with very little variation in soil type (Appendix A). The wells were drilled first to 60 to 80 feet in July and August of 1984, where groundwater was encountered. In March of 1985 the wells were deepened to 106 to 108 feet because the depth to the water table exceeded the depth of the wells in the fall of 1984. The wells have 6-inch steel casings and surface seals to 18 feet but no screens and no perforations. The locations of the wells are shown in Figure 2.

The monitoring wells are sampled for sodium chloride and trace metals to determine if salt from the baghouse residue is entering the groundwater. No unusual amounts of salts or metals have been observed (Appendix B).

The nearest domestic well is at Simpson's Mill No. 5, about 2 miles from the disposal site. The well serves the workers at the mill. It is completed at a depth of 124 feet in a

deeper aquifer, possibly the Skokomish gravel (Molenaar and Noble, 1970). Other wells in the vicinity of Hanks Lake, which is also about 2 miles south of the Dayton landfill, are shallower and may be in a local perched aquifer (Molenaar and Noble, 1970). Wells in the Skokomish valley 2 miles to the north are shallow but at much lower elevations. They are generally completed in river alluvium or the Skokomish gravel and are sometimes flowing wells. The wells at Hanks Lake and the Skokomish Valley serve individual households and farms. The recharge area for the Skokomish gravel is believed to include most or all of the outwash plain where the Dayton landfill is located.

Regional groundwater gradients are believed to generally follow the land contours in the outwash plain. The Dayton landfill is at or near the highest point in the outwash channel and, thus, may be near the highest part of a groundwater divide between the Skokomish valley and the drainages to the south. There are too few wells and even fewer measurements of groundwater levels to determine groundwater gradients with any certainty.

There are no liners at the Dayton landfill.

There is no visible evidence of erosion of soil or wood-waste piles or of surface movement of particulates in the area of

disposal. The permeable nature of the soil and site topography indicate that surface runoff is extremely unlikely.

The public has free access to the site, but the baghouse residue is buried under several feet of wood waste and dirt. There is no visible evidence of public use of the portions of the site where the baghouse residue is buried.

Mason County Landfill. The Mason County landfill is located northwest of the Shelton airport in Township 20, Range 4W, Section 4 at an elevation of about 300 feet above sea level. Figure 3 shows the landfill configuration, approximate location of the disposal area for sewage and STC sludge, and location of the three monitoring wells at the landfill.

Sludge was hauled to the Mason County landfill approximately twice per day in a full 2,300-gallon tank truck. From July 1979 to June 1984 approximately 3,370,000 gallons of sludge reported to contain 1-1/2 to 2 percent solids was disposed of at the County landfill. The average annual volume of solids (calculated based on 1.5 to 2.0 percent solids) was 27,220 to 36,290 gallons of which 60 to 80 percent originated at STC. The remainder (20 to 40 percent) was domestic sewage sludge. Baghouse residue mixed with municipal sewage sludge was disposed of in trenches as a slurry of 98 to 98.5 percent water. Individual trenches received multiple applications of sludge. After sufficient dewatering, the



Figure 3
Mason County Landfill
Sample numbers correspond
to the digit portion of sample
numbers shown in Table 3.

trenches were covered with native soil. All trenches containing baghouse residue have been covered with from a few inches to 2 feet of soil. One trench was subsequently used as an access road to other trenches. Discoloration of the soil suggests that some sludge may have worked its way to the surface of the ground.

The site is relatively flat in the area of the sludge trenches. There is an adjacent gravel pit (cover borrow pit) and elevated areas of garbage and cover material on adjacent parts of the landfill. The gravel pit is within 150 feet of the nearest sludge trench and is excavated to a depth of about 30 to 40 feet (estimated visually).

Beyond the western boundary of the landfill, there is a slight slope toward the channel of Witner Creek (intermittent). At the southeast corner of the landfill, there is a steeper slope toward the headwaters of the North Fork of Goldsborough Creek. There is an area of garbage fill between the sludge disposal area and the southeast corner of the landfill. The eastern boundary of the landfill is essentially flat and the northern boundary slopes gently upward.

Native surface soils are the same Grove series soils that occur at the Dayton disposal area.

Mason County placed three monitoring wells at the site as required by the County health department. One of the wells (No. 1) is a double-completion well with the deeper completion serving as a source of potable water for the landfill (Figure 3). Drillers' logs indicate a depth to groundwater of 37 to 44 feet from the tops of the well casings (Appendix A). Depth to groundwater was determined by Hart Crowser (1986) to be 25 to 45 feet at the landfill.

The double-completion well has a 6-inch casing to a depth of 174 feet and is perforated from 165 to 173 feet (steel casing, based on the method of perforation). A 2-inch galvanized casing extends to a depth of 175 feet inside the 6-inch casing. The 6-inch casing has a gravel pack from 90 feet to 174 feet and a cement seal from 86 feet to 90 feet. The 6-inch casing is perforated in the shallow aquifer at 45 to 75 feet. From a depth of 114 feet to 162 feet the well passes through a stratum of soft silty clay. Well No. 2 was drilled to a depth of 55 feet and well No. 3 to a depth of 60 feet. A water-bearing stratum was encountered at depths of 53 feet in both wells No. 2 and 3 (Appendix A). Casing size and material was not indicated in the driller's log for wells No. 2 and 3 or in other material provided to us by Mason County.

The shallow wells at the Mason County landfill were sampled one to three times per year from 1975 to the present. The

results of the testing are shown in Appendix B. The water-quality parameters that are measured show considerable variation but no consistent trends (Appendix B).

The potable water well for the landfill is about 150 yards from the nearest sludge trench and about 200 yards from the nearest garbage. The well is a double-completion well with potable water being drawn from a depth of 174 feet (groundwater surface at 39.8 feet). Static elevations in the two wells indicate a downward hydraulic gradient. A layer of soil with possible low permeability is indicated by the driller's log to lie between 94 and 162 feet below the top of the well. Other domestic wells are at a nearby auto-wrecking yard (1/2 mile), the state corrections facility (1 mile), and private residences in Sections 1, 2, 8, and 9; all 2 to 3 miles from the landfill.

Regional groundwater flows are believed to be toward the east and southeast in the vicinity of the landfill. The base map supplied to us by Mason County had equipotential lines drawn on it (by unknown authors) that include the measured static water levels in the three monitoring wells. (The logs for the three monitoring wells (Appendix A) indicate Richard J. Rongey, consulting geologist, as a possible author of a groundwater report). Direction of groundwater flow was confirmed by Hart Crowser (1986).

Domestic wells in the area, several of which are described by Molenaar and Noble (1970) appear to be completed in deeper aquifers. However, the variable glacial geology of the area suggests a strong likelihood of recharge from the shallower aquifers in places (Molenaar and Noble, 1970). The wells at the state correctional institution, the airport, the auto-wrecking yard, and residences and business in Sections 1 and 2 are probably downgradient in the regional aquifer. Hart Crowser (1986) measured a gradient of 0.0007 feet per foot in the shallow aquifer. The headwaters of the North Fork of Goldsborough Creek and the intermittent channel of Winter Creek are both at higher elevations than the static water level in the three monitoring wells.

There is no evidence of soil erosion or overland flow of particulates based on visual observation. Given the high permeability of the soil, surface runoff would be very infrequent.

The site is partially fenced and manned by security personnel at all times. The general public does not have access to the sludge disposal area. Landfill plans call for closure of the landfill over the next 4 years.

Shelton Municipal Landfill. The City of Shelton landfill is located west of Shelton at the end of West C Street in Township 20, Range 4W, Section 24 at an elevation of 160 to

200 feet above sea level. The volume of sludge hauled to the municipal landfill prior to July 1979 is not known to us. From July of 1979 to November 1981, 4,528,700 gallons of sludge with 1-1/2 to 2 percent solids were disposed of in the general area shown in Figure 4. Two berms were used to contain the sludge on city property at the downhill side. Some privately owned property lies at a lower elevation than the sludge disposal area within the closed basin containing the landfill. The city landfill has no liners.

Baghouse residue mixed with municipal sludge was discharged into a 100- by 150-foot portion of the city landfill (Figure 4). All of the sludge that went to the landfill is in that area. The sludge disposal area was not covered at the time of landfill closure so the sludge remains at the surface. It is covered with a dense growth of vegetation.

The city landfill site is a former gravel pit in a closed depression. The soils at the city landfill are highly permeable, sandy gravel and appear similar to the soils at the other two landfills.

The depth to groundwater is not known, but the site is 1/4 mile from Goldsborough Creek, which has an elevation 140 feet lower than the disposal area. The creek is a logical discharge point for shallow groundwater.

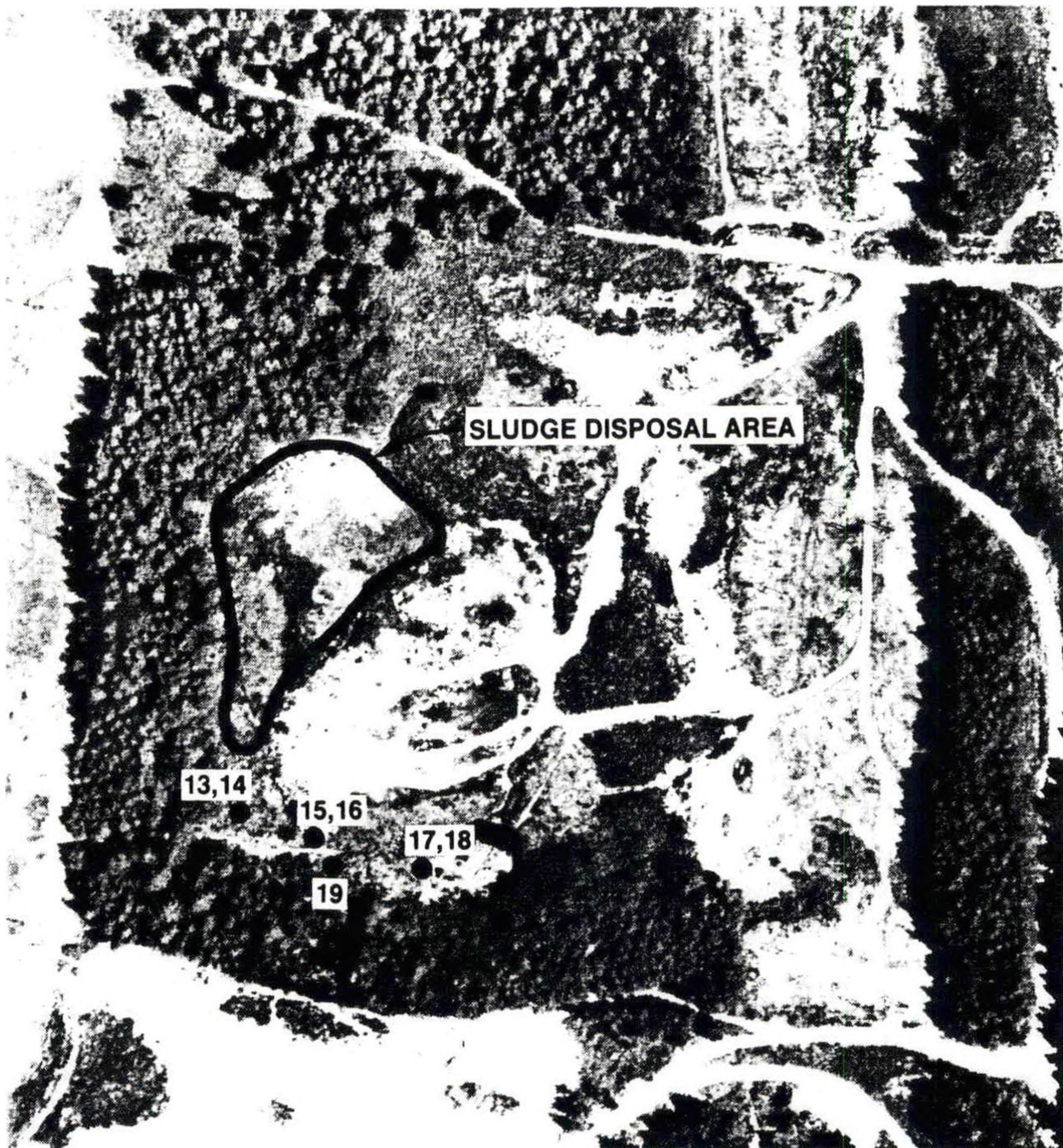


Figure 4
City of Shelton Landfill
Sample numbers correspond
to the digit portion of sample
numbers shown in Table 3.

There are no monitoring wells at the city landfill. A well 1 mile north at the Mason County fairgrounds is 501 feet deep. We could not find a well log indicating the depth of shallow groundwater. Shelton Springs, a free-flowing spring and the primary water supply for the City of Shelton is located 1.5 miles northeast of the landfill. The spring is at an elevation of about 200 feet and is free flowing from recessional outwash deposits. Other free-flowing conditions occur in the gorge of Goldsborough Creek 1 to 2 miles west of the site but at lower elevations. Wells to the east of the site are in the lower valley of Goldsborough Creek at elevations of 14 to 20 feet. Industrial wells in this area (STC) are several hundred feet deep.

One well log was found for Section 13 but the well elevation was recorded as 20 feet (not possible in Section 13). Elevations in Section 13 range from 200 to 320 feet but are 200 to 280 feet in inhabited areas. If the elevation of the well in question is 200 feet, the static water level north of the site would be 175 feet. Perched shallow aquifers have been observed in Township 20, Range 3W, Sections 6 and 18. Section 18 is the location of Shelton Springs and the perched aquifers are above the aquifer feeding the spring.

Gradients of shallow groundwater in the vicinity of the city landfill cannot be established with certainty from the available data. However, observations from wells and flowing

springs recorded by Molenaar and Noble (1970) and obtained from well logs at the Washington Department of Ecology are consistent with the hypothesis of a regional groundwater flow toward the southeast with scattered perched shallow aquifers flowing in unknown directions.

It is likely that there is a potable water well at Grayson Sand and Gravel Company, which is located between the disposal site and Goldsborough Creek. However, a well log was not located. Other domestic and industrial wells are located in sections to the north, northeast, and east of the city landfill. Two industrial wells and one domestic well were reported from Section 24 by Molenaar and Noble (1970). The industrial wells belong to STC and tap deep aquifers. The domestic well is a shallow (16-foot) dug well at an elevation of 115 feet south of Goldsborough Creek on Matlock Road.

In addition to Shelton Springs, the municipal water supply, there are numerous private wells in Township 20, Range 3W, Section 18. These wells and springs generally tap regional aquifers and are most likely located up and across gradient from the city landfill.

The disposal site is a closed depression with no opportunity for soil erosion or escape of sludge by surface movement.

The city landfill is officially closed but there are no restrictions to prevent access. There is evidence of occasional dumping. The City of Shelton also places some vegetation waste at the landfill. There is abundant evidence of use of the general area by off-road vehicles, but no evidence of use of the sludge disposal area, which is covered by undisturbed vegetation.

Municipal Waste Treatment Plants

It is possible that a portion of the residue was discharged to Oakland Bay and Hammersly Inlet with the liquid effluents from the former and existing municipal sewage treatment plants. However, periodic inspections of both treatment plants by the Washington Department of Ecology indicated that the waste from STC settled readily and did not cause excess discharges of solids.

The discharge of the former treatment plant was to an embayment with favorable conditions for the deposition of particulate matter. The discharge of the existing treatment plant is to Hammersly Inlet in an area of strong tidal currents with little opportunity for the deposition of fine particulate matter. Geotechnical studies done for the outfall indicate a gravelly substrate.

POTENTIAL EXPOSURE AND RISK

The study described in this report was designed to evaluate the potential exposure of, and risk to, the public from chlorinated dioxins and furans from the STC facility at Shelton. Potential points of exposure are as follows:

- o Baghouse residues at STC. (Only STC employees would be potentially exposed.)
- o Ambient soils at the STC plant in Shelton.
- o Sludges and residues deposited at the three landfills; either by direct contact, by migration of contaminated soil, or by movement of contamination to groundwater.
- o Ambient soils in areas of potential atmospheric deposition.
- o Sediment in Oakland Bay near the two municipal sewage treatment plants. (Potential exposure could be indirect via consumption of fish and shellfish.)

Exposure is determined by whether persons come in contact with contaminated material. If they do, and the potential intake of chlorinated dioxins and furans can be estimated,

risks can be conservatively estimated using an approach developed by Bellin and Barnes (1986), which is an interim policy of EPA (Thomas, 1987). If exposure to contaminated material does not occur, there are no increased risks.

SAMPLE COLLECTION

Facilities at STC in Shelton

Five samples were collected from the following STC facilities at Shelton on May 15, 1986: the two baghouses at the decommissioned powerplant, the two boilers at the decommissioned powerplant and the multicyclone at the new powerplant. Baghouse residues were collected as composite samples by scooping directly with the sample container. Residue from the baghouse for the low-pressure boiler was collected from the pipe that contains the cleaning auger (the low-pressure boiler baghouse was destroyed by fire in September 1984). Residue from the high-pressure boiler baghouse at the decommissioned powerplant (sampled by Radian Corporation for the National Dioxin Study) was collected directly from the dumpster used to collect and haul the residue for disposal.

Residual ash in the high-pressure boiler at the decommissioned powerplant was collected at four points along the combustion path, including the coolest part of the boiler. Residual ash in the low-pressure boiler was collected from

six locations in the upper part of the boiler (i.e., did not include bottom ash) and from a flange on the outside of the boiler at an access door. The material collected from the flange contained visible particles of charred wood. Residues from the boilers were collected by scraping material from the sides and bottom of the boilers with a precleaned hand trowel, and placing the sampled material directly into the sample jar.

Field notes are included in Appendix C.

Ambient Soils, and Sludge at the City Landfill

Composite samples of ambient soils were collected on July 22, 1986, from three areas that were determined by EPA to be the most likely areas of deposition of stack discharges. Those areas (Figure 5) were in the Hillcrest and Capitol Hill portions of Shelton, and from the Shorecrest subdivision on Munson Point (east of Shelton). Because permission could not be obtained from two landowners, the samples from the Hillcrest and Shorecrest areas were discarded, and new composite samples collected from those two areas on October 21, 1986, after selecting new sampling sites and receiving permission to sample. A composite sample was collected July 23, 1986, from an area where deposition of discharges from the STC facility was considered to be unlikely (control area, Figure 5).

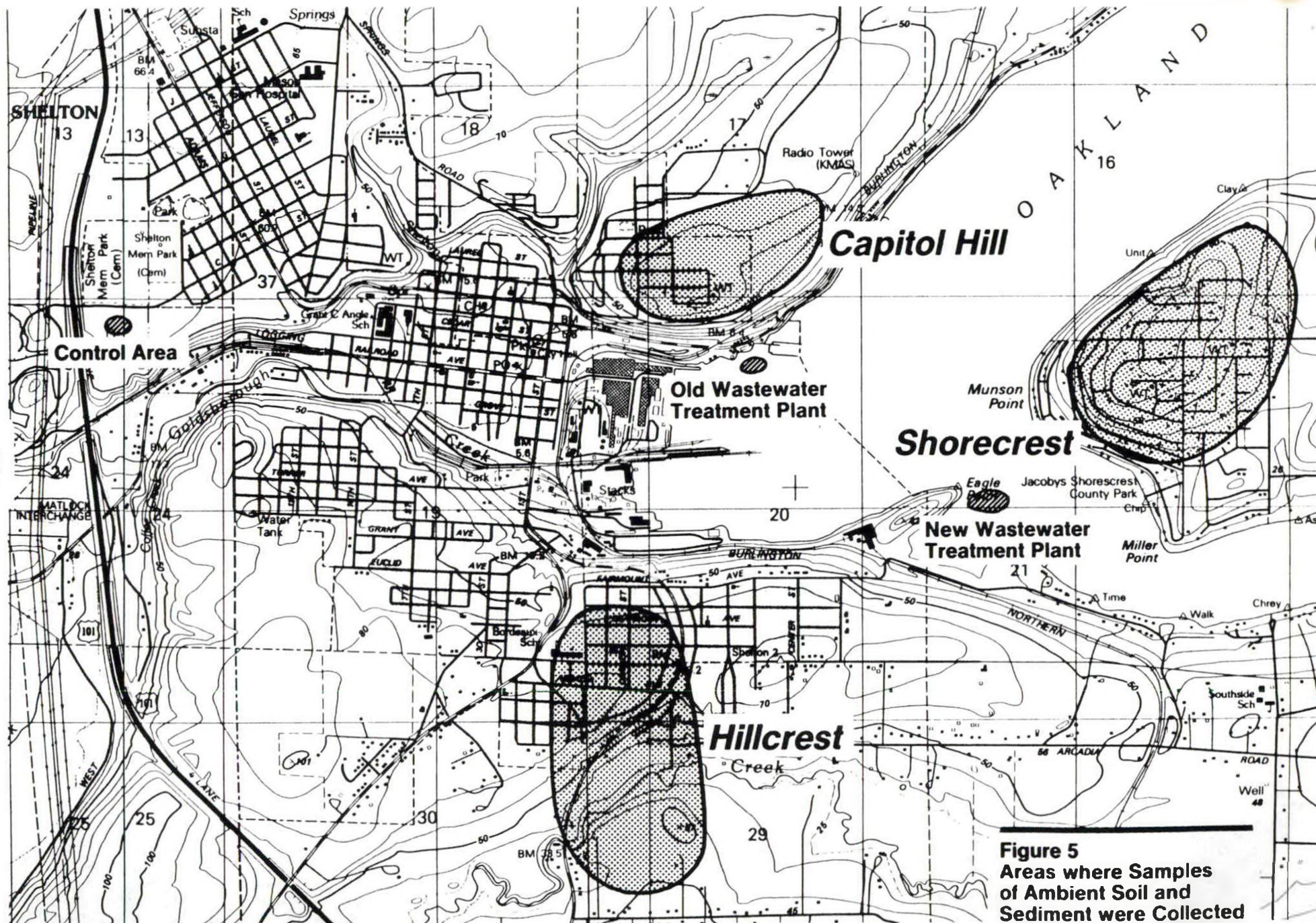


Figure 5
Areas where Samples
of Ambient Soil and
Sediment were Collected

Within each area, five individual samples were collected to form a single composite. The individual samples were collected from the locations shown in Figures 6-8. The five individual samples comprising the control composite sample were collected from the four corners and center of a 30-foot (9-m) square. Each individual sample was taken as a probe with a 2-inch precleaned tulip bulb planter following procedures established for the National Dioxin Study and described in detail in Appendix D. The individual samples were accumulated in a foil-covered, stainless-steel mixing bowl until the last sample was collected. They were then mixed thoroughly with the tulip bulb planter and placed in the sample container.

Ten samples of sludge were collected at the City of Shelton landfill from a portion of the sludge-disposal area that had been identified by a city employee as closest to the point of most recent dumping. This was done in an attempt to sample material that had the shortest possible time to undergo photodegradation. Four-inch-deep tulip bulb planter cores were collected and combined in the same way that the samples of ambient soil were because the unexpected thin layer of sludge, and gravelly nature of the underlying soil prevented the use of a Shelby tube (as specified in the Sampling Plan).

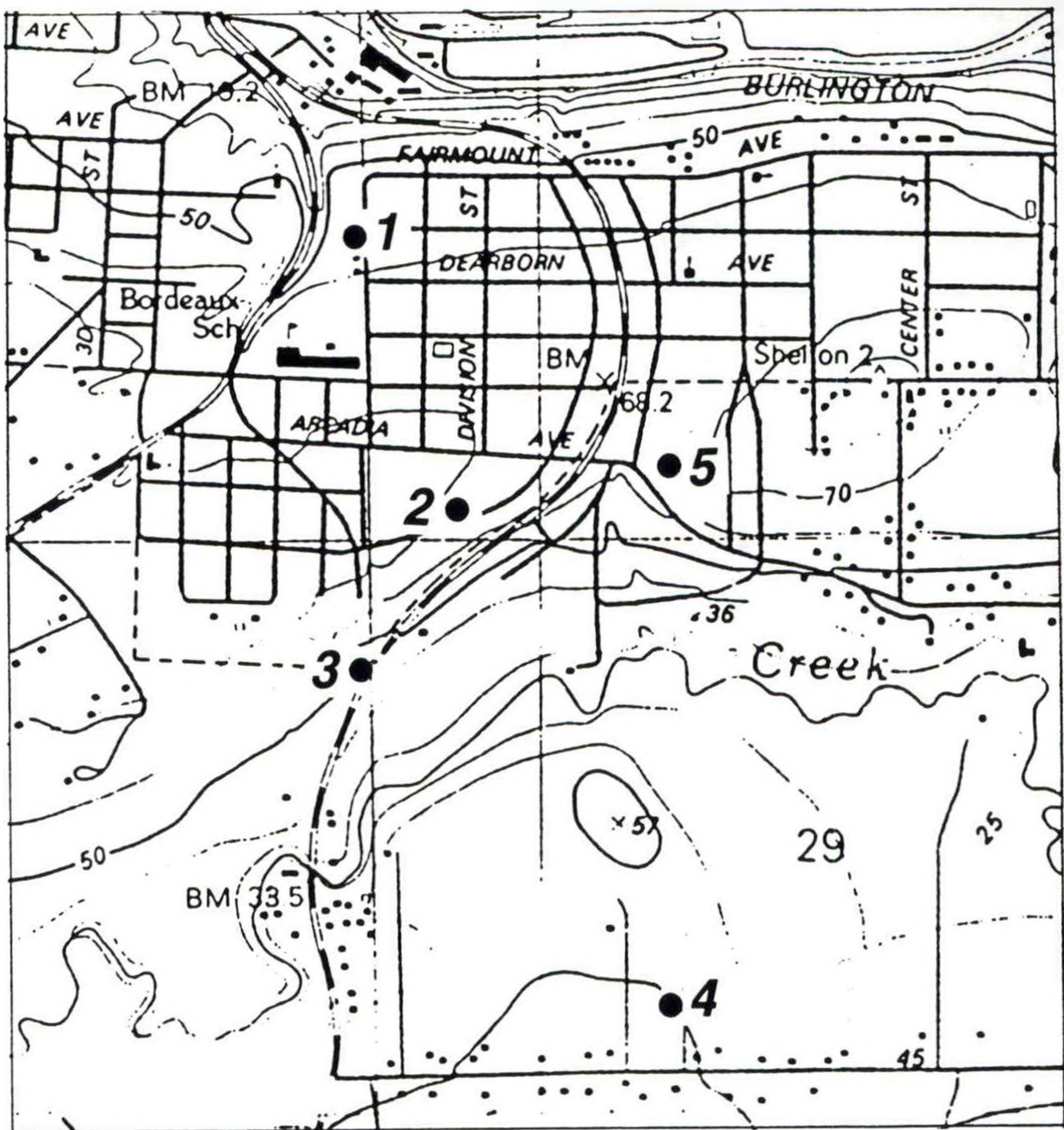


Figure 6
Locations Sampled
Hillcrest

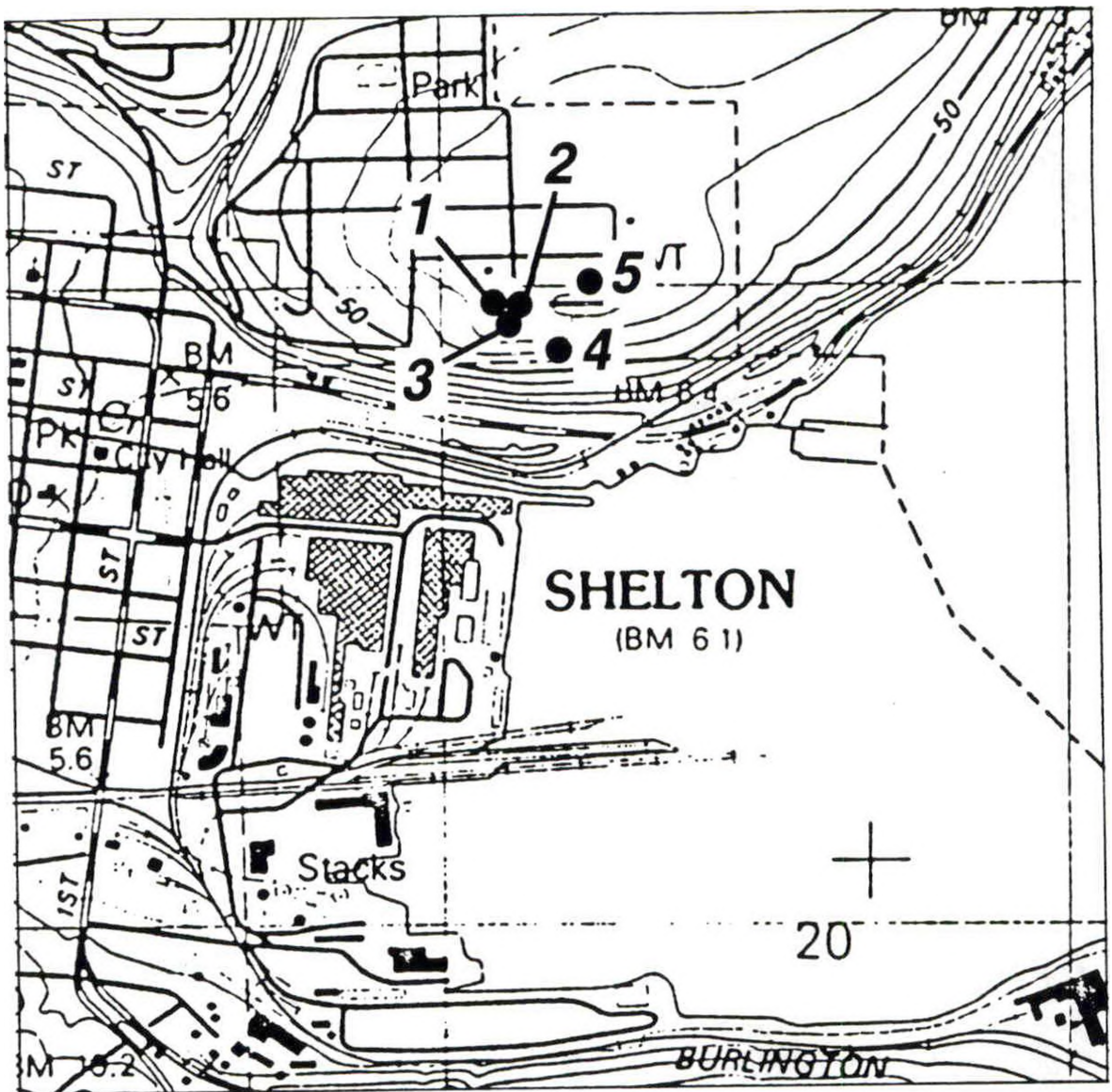


Figure 7
Locations Sampled
Capitol Hill

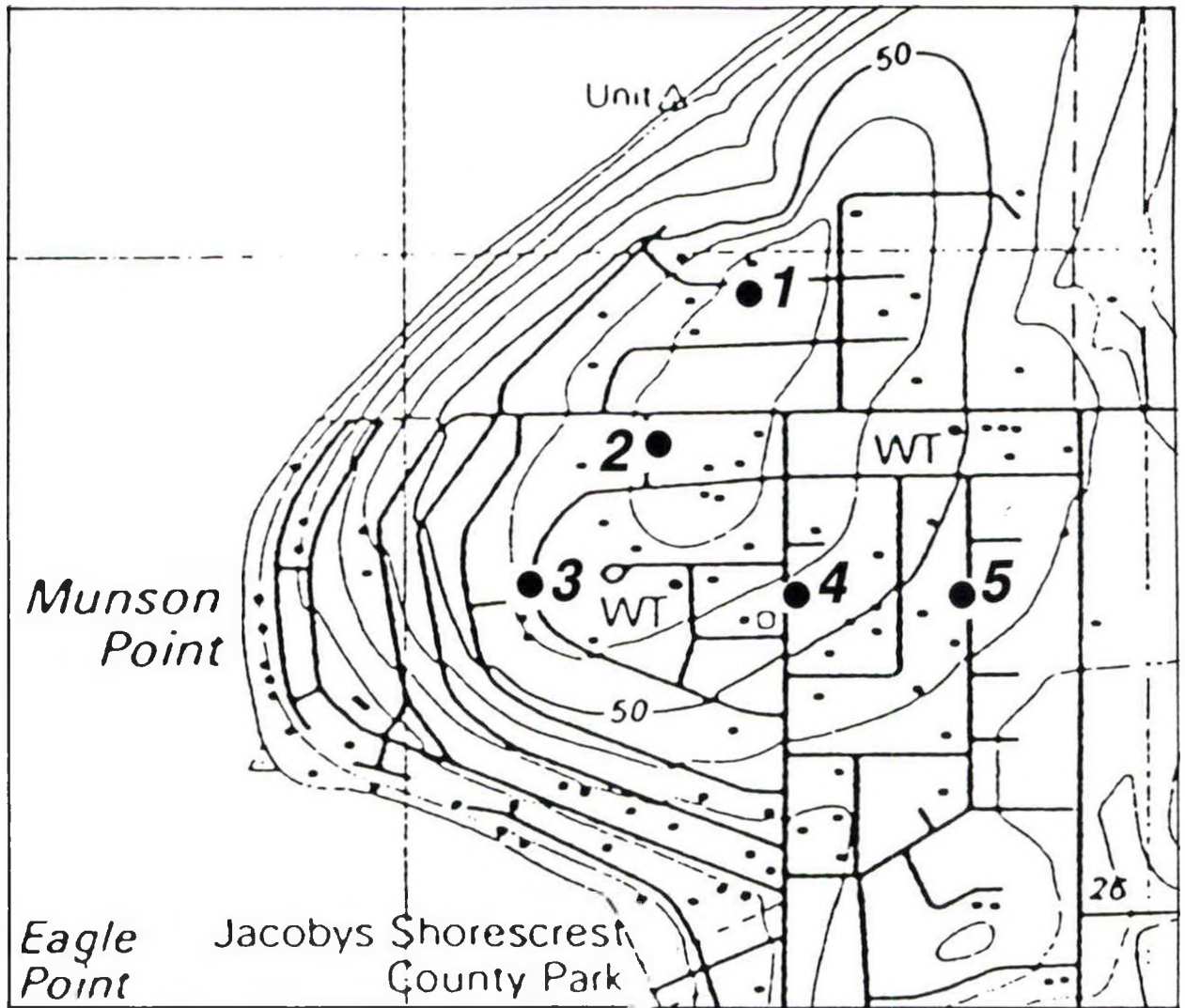


Figure 8
Locations Sampled
Shorescrest

Field notes from sampling ambient soils and sludge, are in Appendix C.

Samples of sludge and baghouse residue were not collected at the Dayton or Mason County landfills because the sludge and residue at those sites is covered and could not be sampled without disturbance. This was in accordance with the agreed-to sampling plan.

Sediment

Composites of five individual samples of sediment were obtained from the vicinity of the outfalls of each wastewater treatment plant (Figure 5). The sediment was collected using a ponar dredge. Each dredge sample was subsampled using a teflon core liner to obtain material from near the sediment-water interface. The subsamples were collected and combined in a stainless-steel mixing bowl, and then placed in the sample jars.

Landfill Soils

The soils at the landfills were sampled on July 29, 1986, and analyzed for particle size distribution and organic carbon content. These properties were analyzed in order to compare the landfill soils with the soils discussed below in

the TCDD mobility studies. Field notes are shown in Appendix C.

Samples were collected as near as possible to the sludge disposal areas without sampling in the disposal areas to avoid any possible disturbance of contaminated sludge or the necessity to handle the soils analyses for conventional parameters as dioxin-contaminated. An effort was made to collect soils that would be as similar as possible to those underlying the sludge-disposal areas.

At the Dayton site, we discovered that wood waste had not been deposited on the entire site, so it was possible to collect samples of soil within the disposal area. Those samples were collected from small patches of unfilled surface within the disposal area (Figure 2). The soils should be quite representative of the material upon which the baghouse residue was deposited, but probably are slightly enriched with organic matter now because of leachate from the wood waste.

At the Mason County landfill, sludge was disposed of in excavated trenches. The trenches were either shallow (2 to 3 feet) and wide, or deep (6 to 7 feet) and narrow. Four samples of soil were collected from the exposed cut in a borrow pit immediately west of the sludge-disposal area, and two were collected from a new cut in higher ground 15 feet

east of the sludge-disposal area (Figure 3). The samples from the side of the borrow pit were clearly of undisturbed native soil at appropriate depths. The samples from the new cut east of the sludge area may have been from soil that was moved during development of the landfill. Large organic matter of recent origin, including Douglas fir bark, was observed in the cut.

At the city landfill, soil samples were collected south of the sludge-disposal area from lightly disturbed surface soils or undisturbed subsurface soils (Figure 4). The soil samples were all collected from elevations lower than the surface of the sludge-disposal area. Samples CLC-13 through CLC-18 were pairs of samples from zero to 3 inches and 3 to 6 inches, from a lightly disturbed area (large vegetation removed). Sample CLC-19 was from undisturbed soil below the root zone in a recent cut at the south side of the depression within which the landfill is located.

The city landfill occupies a depression that appears to have been formed by past sand and gravel mining. It is likely that the sludge-disposal area was over unvegetated or lightly revegetated subsurface Grove series soils. The three surface and near-surface samples and the one subsurface sample are presumed to be representative of the soils underlying the sludge-disposal area.

At the City of Shelton and Dayton sites the soils were sampled at the zero- to 1-inch and 3- to 6-inch depths. One sample was collected from below the root zone at the city landfill to provide an indication of soil characteristics in the event the sludge was deposited in a recently excavated area. At the Mason County landfill, where the ash-sludge mixture was buried in trenches, the waste would be in contact with the deeper soil, and the 24- to 48-inch and 48- to 96-inch depths were sampled.

SAMPLE HANDLING AND SHIPPING

All samples collected at STC facilities, and of ambient soil, sludge, and sediment collected for analysis of chlorinated dioxins and furans were handled and shipped according to protocols established for the National Dioxin Study as described in Appendix D. Chain-of-custody procedures were followed for all samples collected for analysis of chlorinated dioxins and furans.

Bulk soil samples collected for analysis of silt, clay, and organic content were treated as ordinary samples. Bulk properties, screening, and percent silt and clay were determined in the soils laboratory at CH2M HILL in Bellevue, Washington (i.e., without shipping the samples). Subsamples of the less than two-millimeter fraction were sent to CH2M HILL

laboratories in Corvallis, Oregon for analysis for total organic carbon.

SAMPLE ANALYSIS

Physical properties of soil samples were determined through standard laboratory procedures: removal of large rocks, sieving through 2-mm screens, and hydrometer testing for silts and clays. Percent coarse material by mass was converted to percent by volume using specific gravities of 2.65 g per cc for rock and 1.3 g per cc for soil. Total organic carbon was determined using EPA SW 846 (2nd edition) method 9060.

Samples of powerplant residues, sludge, ambient soils, and sediment were analyzed by California Analytical Laboratories. Gas chromatograph/mass spectrometer analyses were done using procedures approved and used for contract work for EPA; (USEPA SW 846 Method 8280) as described in California Analytical enclosures in Appendix E of the Sampling Plan (CH2M HILL, June 1986). The only slight modification to method 8280 was the inclusion of more standards (Appendix E, Sampling Plan).

QUALITY ASSURANCE AND CONTROL

The quality assurance and control procedures, described more fully in Appendix D, followed the procedures established for

the National Dioxin Study to the extent feasible; and fully complied with the intent and effect of the procedures established for the National Dioxin Study.

Field-blank and performance samples supplied by EPA were handled and shipped in the same way and time that samples of ambient soil, sediment, and sludge were.

Laboratory quality control procedures have been supplied by California Analytical Laboratories, and are included as Appendixes E and F. Chain-of-custody reports, and sampling field notes are in Appendix C of this report. Photographic documentation of the sampling sites and procedures is on file at STC.

RESULTS

SIMPSON TIMBER COMPANY FACILITIES

Chlorinated dioxins and furans were present in the residue in both baghouses, and in much smaller amounts in the composite samples from the boilers; but 2,3,7,8-TCDD was found only in the low-pressure boiler, the baghouse residue from that boiler and in parts per trillion amounts in a composite of ten samples of soil collected for the EPA study at STC (Table 1). The low-pressure boiler and baghouse were not

TABLE 1 REPORTED CONCENTRATIONS (PARTS PER BILLION) OF CHLORINATED DIOXINS AND FURANS
IN SAMPLES COLLECTED FROM STC FACILITIES AT SHELTON COMPARED WITH OTHER COMMON SOURCES

Homologue or Isomer	New Powerplant Cyclone Residue	Low Pressure Boiler Baghouse	High Pressure Boiler Baghouse	Low Pressure Boiler Composite	High Pressure Boiler Composite	EPA Results From High Pressure Boiler Baghouse ^b (Range)	Wood Stoves (Western (U.S.)) (Range)	Fireplaces	
								25-Year Old	12-Year Old
Tetrachlorinated Furans (Total)	0.43	118	9.2	7.6	0.16	135 - 170			
2,3,7,8 TCDF	0.078	10.5 ^c	0.58	0.67	ND ^a	4.5 - 6.5			
Tetrachlorinated Dioxins (Total)	0.36	90	186	13.3	0.66	195 - 211			
2,3,7,8 TCDD	ND	4.2	ND	0.16	ND	0.8 - 1.2	0.0064 - 0.02		0.1
Pentachlorinated Furans (Total)	0.076	62	3.4	2.4	ND	71 - 77			
1,2,3,7,8 PCDF	ND	7.2	0.37	0.34	ND				
2,3,4,7,8 PCDF	ND	6.9	0.33	0.22	ND				
Pentachlorinated Dioxins (Total)	0.24	161	226	9.9	1.7	236 - 273	0.093 - 9.22	3.7 - 25.0	ND - 0.89
1,2,3,7,8 PCDD	ND	14.0	0.61	0.34	ND				
Hexachlorinated Furans (Total)	ND	26.7	2.3	1.0	ND	44 - 59			
1,2,3,4,7,8 Hexa CDF	ND	3.3	0.25	ND	ND				
1,2,3,6,7,8 Hexa CDF	ND	4.0	0.18	ND	ND				
1,2,3,7,8,9 Hexa CDF	ND	ND	ND	ND	ND				
2,3,4,6,7,8 Hexa CDF	ND	2.6	ND	ND	ND				
Hexachlorinated Dioxins (Total)	0.83	169	190	8.0	1.3	283 - 348			
1,2,3,4,7,8 Hexa CDD	ND	10.8	4.6	0.38	ND				
1,2,3,6,7,8 Hexa CDD	ND	9.0	3.0	0.25	ND				
1,2,3,7,8,9 Hexa CDDD	-----Not Analyzed-----								
Heptachlorinated Furans (Total)	ND	4.8	1.4	0.21	ND	24 - 38			
1,2,3,4,6,7,8 Hepta CDF	ND	2.8	0.34	0.16	ND				
1,2,3,4,7,8,9 Hepta CDF	ND	ND	ND	ND	ND				
Heptachlorinated Dioxins (Total)	0.12	57.1	34.6	2.2	0.54	252 - 410			
1,2,3,4,6,7,8 Hepta CDD	ND	31.5	21.0	1.0	ND				
Octachlorinated Furans (Total)	ND	0.51	ND	ND	ND	2.3 - 3.0			
Octachlorinated Dioxins (Total)	0.27	14.1	5.5	0.78	0.49	44 - 72			

^a ND = not detected. ^b From Table 5-22 of Keller, et al. (1986).

^c Sum of 2,3,7,8- plus 1,2,6,9- plus 2,3,4,8-TCDF.

sampled by Radian Corporation during the study for EPA. Samples from the high-pressure boiler baghouse, where 2,3,7,8-TCDD was observed in the EPA study, did not contain 2,3,7,8-TCDD when sampled in May 1986 with similar detection limits (Table 1). Residue from the baghouse for the low-pressure boiler contained 4.2 parts per billion of 2,3,7,8-TCDD.

The absolute amounts of each of the ten homologues of chlorinated dioxins and furans varied between the low-pressure boiler baghouse and the high-pressure boiler baghouse. Both baghouses in general had lower concentrations of all homologue groups than were observed in the samples collected for EPA from the baghouse of the high-pressure boiler (Table 1). The concentrations of all homologues in the residues from the boilers were generally one to two orders of magnitude lower than the concentrations in baghouse residue sampled for EPA; or, in the case of the high-pressure boiler, the higher-chlorinated furan homologues were not detected in the boiler residues. The sample of ambient soil collected for the EPA study had amounts of the tetra- through hexachlorinated homologues that were similar to the boiler residues and wood-stove ashes, and slightly greater amounts of the hepta- and octachlorinated homologues.

NEW POWERPLANT RESULTS

The multicyclone residue from the new powerplant did not contain any of the 2,3,7,8-chlorine-substituted isomers of dioxins and furans except for small amounts of 2,3,7,8 TCDF. Total chlorinated dioxins and furans were 1.58 ppb in the new powerplant residue, with all of the tetra- through octa-chlorinated homologues of dioxins, but only tetra- and penta-chlorinated furans (Table 1).

Table 1 also shows values of 2,3,7,8-TCDD and of Penta CDD for samples of ash from wood stoves and fireplaces. Those data are from Table 6 of the Draft Final Literature Review for the National Dioxin Study, Tier 4 (Keating, September 1985). The values for wood stoves and fireplaces are included in the table to provide perspective for the values from STC's facilities.

AMBIENT SOILS, SEDIMENT, AND SLUDGE AT THE CITY OF SHELTON LANDFILL

One or more homologues of chlorinated dioxins or furans were found in very small amounts in all samples of ambient soils and sediment, except for the sample from the Hillcrest area where no chlorinated dioxins or furans were found (Table 2).

Table 2
PRELIMINARY^e REPORTED CONCENTRATIONS (PARTS PER BILLION) OF CHLORINATED DIOXINS AND FURANS
IN SAMPLES OF AMBIENT SOILS, SEDIMENT, AND SEWAGE SLUDGE FROM THE SHELTON AREA^a

Homologue or Isomer	C3 Performance Sample ^b	C4 Field Blank ^c	C5 Capitol Hill	C6 City Landfill	C7 New STP Sediment	C8 Old STP Sediment	C9 Control Area	C9 Control Area (duplicate)	C10 Hillcrest	C11 Shorecrest
Tetrachlorinated Furans (total)	0.053	ND ^d	0.59	16.7	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDF	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND
Tetrachlorinated Dioxins (total)	15.4	ND	0.28	59.8	ND	0.11	ND	ND	ND	ND
2,3,7,8-TCDD	8.0	ND	ND	0.17	ND	ND	ND	ND	ND	ND
Pentachlorinated Furans (total)	ND	ND	ND	9.8	ND	0.050	ND	ND	ND	ND
1,2,3,7,8-PDCP	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND
2,3,4,7,8-PCDF	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND
Pentachlorinated Dioxins (total)	5.2	0.80	0.34	155	0.046	0.80	ND	ND	ND	0.088
1,2,3,7,8-PCDD	0.42	0.23	ND	1.4	ND	ND	ND	ND	ND	ND
Hexachlorinated Furans (total)	1.1	ND	0.16	5.5	0.097	0.67	ND	ND	ND	ND
1,2,3,4,7,8-Hexa-CDF	ND	ND	ND	0.93	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-Hexa-CDF	ND	ND	ND	1.1	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-Hexa-CDF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,3,4,6,7,8-Hexa-CDF	ND	ND	ND	1.3	ND	ND	ND	ND	ND	ND
Hexachlorinated Dioxins (total)	181	5.6	0.30	152	0.65	0.98	0.086	ND	ND	0.12
1,2,3,4,7,8-Hexa-CDD	0.43	0.28	ND	2.7	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-Hexa-CDD	0.53	0.37	ND	4.8	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-Hexa-CDD	1.7	0.89	ND	2.8	ND	ND	ND	ND	ND	ND
Heptachlorinated Furans (total)	ND	ND	0.81	4.9	0.40	4.3	0.12	ND	ND	ND
1,2,3,4,6,7,8-Hepta-CDF	ND	ND	0.20	2.5	0.094	0.68	0.023	ND	ND	ND
1,2,3,4,7,8,9-Hepta-CDF	ND	ND	ND	0.49	ND	ND	ND	ND	ND	ND
Heptachlorinated Dioxins (total)	315	14.4	1.9	50.2	0.62	4.3	0.33	0.23	ND	0.36
1,2,3,4,6,7,8-Hepta-CDD	142	6.3	1.0	26.6	0.25	2.2	0.14	0.086	ND	0.17
Octachlorinated Furans (total)	0.30	ND	0.80	0.97	ND	6.2	ND	ND	ND	ND
Octachlorinated Dioxins (total)	178	86.8	6.4	19.3	1.4	13.8	0.85	0.56	ND	1.1

^aSee Figures 1 through 4 for location of sampling areas.

^bEPA No. V58WQ02K1.

^cEPA No. R19AD99R4.

se5685/050/1

^dND = not detected.

^ePreliminary pending completion of EPA quality review.

None of the samples of ambient soils and sediment contained any of the 2,3,7,8-substituted tetra- through hexa- isomers of dioxins and furans.

All homologues, and all but one of the specific isomers tested for were found in the sludge at the city landfill. The concentration of 2,3,7,8-TCDD was 0.17 parts per billion at the city landfill. The penta- and hexachlorinated dioxin homologues comprised 65 percent of the total dioxins and furans at the city landfill. The relatively more toxic 2,3,7,8-substituted tetra-through hexa-chlorinated isomers comprised 4 percent of the total chlorinated dioxins and furans, and the 2,3,7,8-substituted tetra- and penta-isomers were 1.2 percent of the total chlorinated dioxins and furans found at the city landfill.

The composite sample from the control area had only hexa-through octachlorinated dioxins and furans (duplicate analyses in Table 2).

LANDFILL SOILS CLASSIFICATION

The soils at the City of Shelton landfill were classified as gravelly sandy loams to very gravelly sands and contained about 25 percent gravel by volume. The fraction finer than

2-mm diameter consisted of about 77 percent sand, 19 percent silt, and 7 percent clay with an organic carbon (OC) content of about 0.35 percent (Table 3).

The Dayton landfill soils were higher in organic carbon (about 2.1 percent average) than were the other sites (Table 3). This probably is related to the relatively undisturbed surface horizons on this clear-cut site; whereas, the soils at the other two sites had been extensively disturbed by excavation and earthmoving. Leached organic matter from wood waste may also have contributed to the higher organic content of these soils. About 32 percent by volume of the Dayton soil samples were larger than 2 mm in diameter, i.e., gravel. The less than 2-mm fraction consisted of about 65 percent sand, 31 percent silt, and 4 percent clay. The textural class ranged from a gravelly loam to a very gravelly loamy sand.

The Mason County landfill had the coarsest soils with about 36 percent gravel by volume. The less than 2-mm fraction contained about 92 percent sand, 7 percent silt, and 1 percent clay. The texture ranged from gravelly loamy sand to a very gravelly sand. Organic carbon content was about 1.3 percent (Table 3). Soils analytical data are included in Appendix E.

Table 3
SOIL PROPERTIES AT LANDFILL SITES

Location	Sample Number	Depth Interval (inches)	Particle Size Distribution Percent Fraction Less Than 2 mm Diameter ^a			Course Material Greater Than 2 mm (percent of total volume)	USDA Textural Class	Total Organic Carbon (dry weight basis) (%)
			Sand (%)	Silt (%)	Clay (%)			
<u>Mason County Landfill (Figure 7)</u>								
SE corner of gravel pit	MLC-1	24-48	91	9	0	37	Very gravelly sand	1.44
SE corner of gravel pit	MLC-2	48-96	97	1	2	36	Very gravelly sand	0.29
SW corner of gravel pit	MLC-3	24-48	99	1	0	40	Very gravelly sand	0.19
SW corner of gravel pit	MLC-4	48-96	97	1.5	1.5	39	Very gravelly sand	0.11
SE side of new cut just east of trenches	MLC-5	24-48	82	14	4	26	Gravelly loamy sand	3.14
	MLC-6	48-96	84	15	1	31	Gravelly loamy sand	2.47
	means	24-48	91	8	1.5	35	Gravelly sand	1.59
	means	48-96	93	6	1	36	Very gravelly sand	0.96
<u>Dayton Landfill (Figure 6)</u>								
SE corner	DLC-7	0-3	69	30	1	32	Gravelly sandy loam	1.15
SE corner	DLC-8	3-6	80	15	5	33	Gravelly sandy loam	0.73
75 feet south of midpoint of road through landfill	DLC-9	0-3	75	24	1	33	Gravelly sandy loam	0.75
	DLC-10	3-6	71	27	2	37	Very gravelly sandy loam	5.11
NE side of landfill	DLC-11	0-3	55	40	5	25	Gravelly silt loam	3.29
150 feet north of road	DLC-12	3-5	44	48	8	30	Gravelly loam	1.65
	means	0-3	66	32	2	31	Gravelly sandy loam	1.73
	means	3-6	65	30	5	34	Gravelly sandy loam	2.50
<u>City of Shelton Landfill^b (Figure 5)</u>								
SW side of skid road below berms	CLC-13	0-3	89	10	1	36	Very gravelly sand	0.40
	CLC-14	3-6	82	18	0	27	Gravelly loamy sand	0.39
100 feet SSE of above; south of lush growth of clover	CLC-15	0-3	70	24	6	16	Gravelly sandy loam	0.38
	CLC-16	3-6	76	20	4	17	Gravelly sandy loam	0.40
150 feet SE of above	CLC-17	0-3	68	25	7	21	Gravelly sandy loam	0.32
150 feet SE of above	CLC-18	3-6	79	17	4	30	Gravelly sandy loam	0.20
100 feet south of CLC-13	CLC-19	60-72	95	5	0	24	Gravelly sand	0.12
	means	0-3	76	20	5	25	Gravelly sandy loam	0.37
	means	3-6	79	18	3	25	Gravelly sandy loam	0.33

^aUSDA classification: Sand = fraction between 0.05- and 2.0-mm diameter.
Clay = fraction less than 0.002 mm.

Silt = fraction between 0.002- and 0.05-mm diameter.

^bCLC-19 not included in calculation of means because the depth interval is different.

DISCUSSION

HOMOLOGUES AND ISOMERS OF DIOXINS AND FURANS

The samples collected for EPA from the high-pressure boiler system were analyzed for the tetra- through octa- homologues of dioxins and furans, but the only specific isomer analyzed was the 2,3,7,8-TCDD. The samples collected during this study were analyzed for as many of the more toxic 2,3,7,8-substituted isomers as feasible. Feasibility was determined by the availability of a laboratory standard for a particular isomer at the time of analysis. During analysis of the samples from STC facilities (Table 1), all of the isomers listed by Bellin and Barnes (1986) as being of most toxic concern were analyzed, except for 1,2,3,7,8,9-Hexa CDD. During analysis of ambient soils, sediment, and sludge (Table 2), all of the most toxic isomers were analyzed, including 1,2,3,7,8,9-Hexa CDD.

Knowledge of the specific isomers present allows the use of the toxic-equivalent calculations proposed by Bellin and Barnes (1986) without making unnecessarily conservative assumptions. Using the relative (to 2,3,7,8-TCDD) toxicity factors of Bellin and Barnes (1986) (Table 4), the residue from the low-pressure boiler baghouse (Table 1) had the highest total toxic equivalence of 16.4 ppb. The residue from the high-pressure boiler baghouse had a toxic equivalence of

Table 4
CDD/CDF ISOMERS OF MOST TOXIC CONCERN^{a,b}

Dioxin		Dibenzofuran	
Isomer	TEF ^c	Isomer	TEF
2,3,7,8-TCDD	1	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	0.5	1,2,3,7,8-PeCDF	0.1
		2,3,4,7,8-PeCDF	0.1
1,2,3,4,7,8-HxCDD	0.04	1,2,3,4,7,8-HxCDF	0.01
1,2,3,7,8,9-HxCDD	0.04	1,2,3,7,8,9-HxCDF	0.01
1,2,3,6,7,8-HxCDD	0.04	1,2,3,6,7,8-HxCDF	0.01
		2,3,4,6,7,8-HxCDF	0.01
1,2,3,4,6,7,8-HpCDD	0.001	1,2,3,4,6,7,8-HpCDF	0.001
		1,2,3,4,7,8,9-HpCDF	0.001

^aIn each homologous group the relative toxicity factor for the isomers not listed above is 1/100 of the value listed above.

^bTable II of Bellin and Barnes (1986).

^cTEF = toxic equivalence factor = relative toxicity assigned.

3.8 ppb. The soil-sludge mixture from the city landfill (Table 2) had a toxic equivalence of 3.1 ppb, and the composite residue from the low-pressure boiler (Table 1) had a toxic equivalence of 0.7 ppb. Assuming that the proportion of 2,3,7,8-chlorine substituted isomers within each homologue is similar to that in the baghouse residue and boiler residue, the toxic equivalence of the soil at STC would be about 0.2 ppb. All of the other samples had a toxic equivalence of zero to 0.02 ppb.

HOMOLOGUE COMPOSITION OF RESIDUES, SLUDGE, AMBIENT SOILS,
AND SEDIMENT

The percent homologue compositions of the residues from the baghouses and the sludge-soil mixture from the city landfill were quite similar (Figure 9). The percent distribution of homologues observed during the National Dioxin Study in the outlet of the baghouse for the high-pressure boiler is also shown in Figure 9, and is very comparable to the distributions observed in the samples collected during this study. Variations were observed in the composition of baghouse residue. For example, the homologue composition of baghouse residue from the high-pressure boiler in the EPA study (Keller, et al., 1986) differed from this study (Figure 9). Such differences, and the absence of 2,3,7,8-TCDD from the

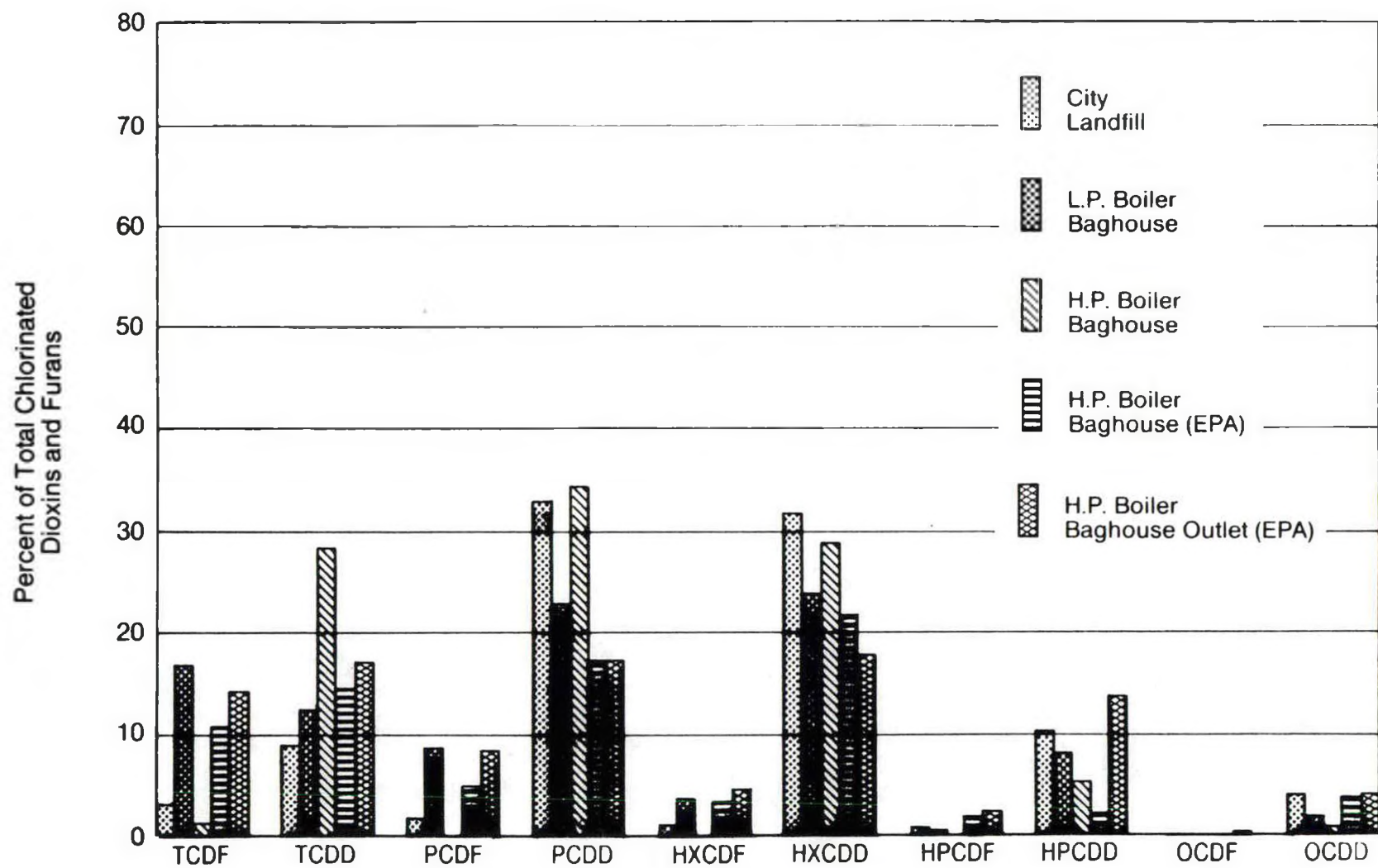


Figure 9
Percent Homologue Composition
of Baghouse Residue and Outlet
Emissions, and of Sludge at the City of
Shelton Landfill

baghouse of the high-pressure boiler in our study, probably reflect variations over time in the composition of the combustion or condensation products.

Tetra-, penta-, and hexachlorinated dioxins were the prevalent homologues in the baghouse residues and sludge at the city landfill (Figure 9). There were lesser amounts of tetra- and pentachlorinated furans, and heptachlorinated dioxins. The hexa- through octachlorinated furans, and octachlorinated dioxins comprised a very small proportion of the samples.

Most soil and sediment samples did not have sufficient amounts of chlorinated dioxins and furans to determine their homologue composition. The percent homologue compositions of the one sample of ambient soil (Capital Hill), and one sample of ambient sediment (old wastewater treatment plant) were quite different from those of the sludge and baghouse residue shown in Figure 9.

In those two samples, the octa- and heptachlorinated homologues predominated (Figure 10). The percent homologue composition in samples of ambient soil and sediment from the Shelton area were very similar to the composition reported by Czuczwa, McVeety, and Hites (1985), in sediment from Siskiwet Lake in Isle Royal National Park, and in atmospheric particulate matter in two United States cities. Percent

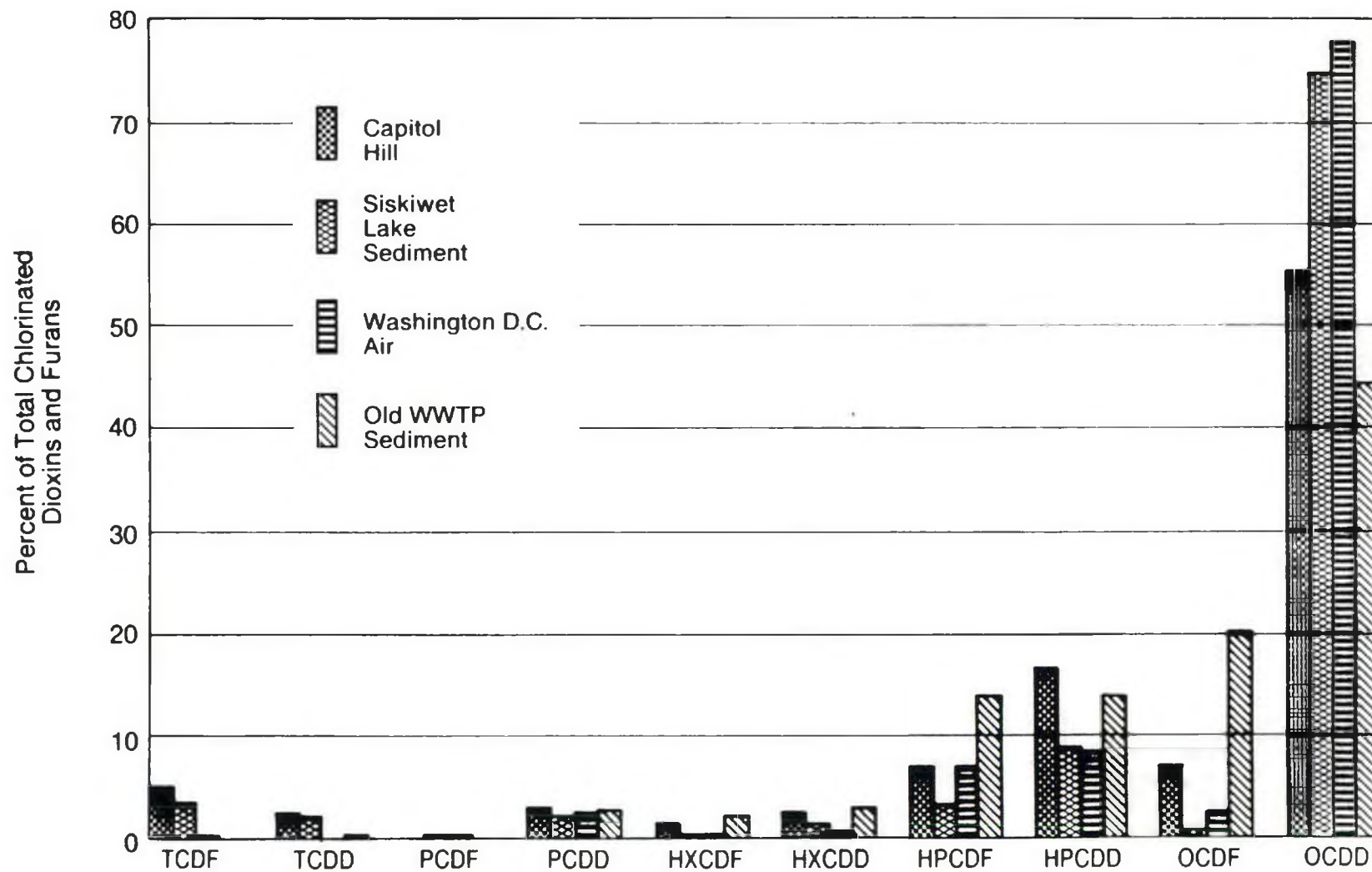


Figure 10
Percent Homologue Composition
of Ambient Soil and Sediment in the
Shelton Area, and of Sediment from
Lake Siskiwet (Isle Royal) and Air
Particulates from Washington, D.C.

homologue compositions for one each of the sediment and air samples reported by Czuczwa, et al. (1985) are plotted for comparison with the samples from Shelton in Figure 10.

The percent homologue composition of sediment from near the outfall of the old (primary treatment) sewage treatment plant was slightly different from the other samples shown in Figure 10, having relatively more hepta- and octachlorinated furans, and less octachlorinated dioxin. The sampling location is immediately adjacent to another source of combustion products, motor fuels burned at the Port of Shelton Marina. There also may have been other industrial discharges through the sewer system, and directly to Oakland Bay. These may account for the presence of the hepta- and octachlorinated furans, which were notably low in concentration at the STC combustion source (Tables 1 and 2, Figure 9, and Keller, et al., 1986), and in the soil sample from Capitol Hill (Figure 10).

The differences in proportional homologue composition between particulates at the STC combustion source (Figure 9) and material in soil from Capital Hill and sediment from Oakland Bay (Figure 10) could be due to any of several causes, none of which can be demonstrated by studies to date. Several possibilities (in no particular order) are:

- o Emissions from the stack differ from baghouse residue.
- o Lower-chlorinated dioxins and furans are preferentially lost (destroyed?) in the atmosphere.
- o Lower-chlorinated dioxins and furans are preferentially destroyed in the soil and sediment environment.
- o Dioxins and furans deposited at Capitol Hill and the old wastewater treatment plant are the result of global or regional sources.
- o Other historical discharge sources.

EVALUATION OF SOIL PROPERTIES AND POTENTIAL FOR MIGRATION

Relatively few laboratory studies have dealt with TCDD attenuation in soils. There are more field studies, but they are concerned with spills or extremely heavy applications rather than with controlled studies. All studies show that TCDD is tightly bound in the soil matrix and that leaching to groundwater would not occur unless promoted by the presence of organic solvents.

Two field studies have been widely cited: DiDomenico et al's (1982) evaluation of an industrial accident in Seveso, Italy, which resulted in TCDD contamination of a large area, and the work by Young (1983) on the fate and transport of TCDD in a military test area (Eglin Air Force Base, Florida) that was sprayed with TCDD-contaminated herbicides for 8 years.

At Seveso the soil properties and TCDD concentrations in surface soils were highly variable. The highest TCDD was not in the upper 0.5 cm of soil but was usually found at 0.5- to 1.5-cm depth; this was interpreted to be a result of photogradation, volatilization, or penetration and binding of TCDD to the slightly lower soil layers. The amount of TCDD found at depths greater than 8 cm was at least an order of magnitude less than that found in the upper layers.

At the Eglin AFB test area about 70 g/ha of TCDD had been applied in one test grid between 1962 and 1964. When the soils were sampled 10 years later in 1974, about 99 percent of the TCDD was lost from the system via volatilization and/or photodegradation (according to Young, 1983). The 1 percent that remained in the soil was retained in the upper 15 cm. The soil was a sandy soil of the Lakeland association (92 percent sand, 3.8 percent silt, and 4.2 percent clay), an extremely permeable soil with very low organic carbon content (about 0.1 percent). The average annual rainfall at

Eglin AFB is about 60 inches. (Shelton averages about 56 inches of rainfall annually.)

The level of TCDD contamination and site characteristics of the Eglin AFB study site are compared with the three landfill sites in Table 5. The range in disposal area and net TCDD applied at the Mason County and Dayton landfills represents the range calculated from reasonable assumptions about the actual surface area over which sludges were placed (lower value for disposal area and higher value for net application) to the total area used for disposal (assumed distribution throughout disposal area). Note that the net TCDD applied at Elgin AFB, Grid I, was the same order of magnitude after an assumed 99 percent loss as the net applications at the landfills without assuming losses.

Numbers of laboratory studies indicate that there is little or no vertical movement of TCDD in soils.

- o In an aquatic ecosystem, TCDD added to the water was found in only the uppermost organic sediment layer after 2 years (Tsushimoto et al., 1982).
- o Using soil thin-layer chromatography, Helling (1970) found that the mobility of TCDD and DCDD (dichlorodibenzo-p-dioxin) using water as a solvent was zero. The five soils studied had a range of

Table 5
COMPARISON OF LANDFILLS WITH EGLIN AIR FORCE BASE TCDD STUDY SITE

Site	Total TCDD ^a Delivered [grams (g)]	Disposal Area [hectare (ha)]	Net TCDD Mass/Area (g/ha)	Application/ Disposal Method	Soil Texture	Organic ^b Carbon Content (%)
Mason County Landfill	0.9	0.4 to 1.8	0.5 to 2.2	Ash/sludge mixture buried in trenches	Very gravelly sand to gravelly loamy sand	0.11 to 3.14 (>1.3)
Dayton Landfill	0.3	0.7 to 7.4	0.04 to 0.4	Ash covered by wood waste	Gravelly loamy sand to gravelly loam	0.73 to 5.11 (>2.1)
City of Shelton Landfill	2.2	0.9	2.4	Ash/sludge mixture surface dumped	Very gravelly sand to gravelly sandy loam	0.12 to 0.40 (>0.35)
Eglin AFB, Grid I ^c	2,613	37	70.6 (0.7) ^d	Herbicide trials (2,4,5-T)	Sand	(0.17)

^a Assumes baghouse ash has 1 µg/kg (ppb) TCDD.

^b Contribution of sludge and wood waste to soil organic carbon pool at landfills not included. Values shown are the range of six or seven samples and averages in parenthesis.

^c Young, 1980.

^d Assumes 99 percent photodegradation or volatile such loss of TCDD at Eglin AFB (see text).

organic carbon content of 0.08 percent to 52.4 percent, and clay content ranged from zero percent to 39.5 percent.

- o Jackson et al. (1985), analyzed soils from 10 sites contaminated with TCDD and other halogenated organics for extractable and leachable TCDD. The soil texture ranged from loamy sand to silt loam, and total organic carbon ranged from 1 percent to 4.5 percent (percent organic matter divided by 1.77). Their most contaminated site has 21.5 mg of solvent extractable organics (most phenols, analines, and neutral semivolatile organic compounds) and 26 ppb of 2,3,7,8-TCDD.

TCDD mobility as measured by the organic carbon partition coefficient (K_{oc}) was extremely low. Mean log K_{oc} values were greater than 7. This means that the proportion of TCDD adsorbed to soil (normalized for organic carbon content) to TCDD leached or extracted was greater than 10 million.

TCDD mobility was not correlated with any soil property. However, the concentration of halogenated organic co-contaminants in soil was positively correlated with TCDD mobility (as expressed by K_{oc}).

Jackson et al. (1985) also used a solute transport model to predict TCDD movement rates in water percolating through the sampled soils. They concluded that, even under the worst conditions they examined, TCDD was essentially immobile in soils. They suggested that dioxin might be more mobile at sites with greater amounts of cocontaminants than the sites they studied.

- o In a study by Matsumura and Benezet (1973) using a column of sand and soil, almost no TCDD leached from sand to soil in 7 days. However, Yockim et al. (1978) did report some desorption of TCDD into water from a silt loam soil (12.2 percent clay, 0.9 percent OC) after 1 day.

It should be noted that reported TCDD leaching (or desorption) in short-term studies is not representative of longer-term conditions. For example, Huetter and Philippi (1982) observed that TCDD becomes more difficult to extract with time during long-term incubations.

- o Nash and Beale (1980) found that 80 percent of applied 2,3,7,8-TCDD (as a contaminant in Silvex herbicide) was retained in the upper 2 cm of soil in a soil microcosm. During a period of 275 days

of simulated leaching they showed minor leaching of TCDD, which reached a concentration maximum of 0.06 ppt in leachate after 126 days and then declined.

The mechanisms of TCDD attenuation in the soil are not understood. The field and laboratory studies indicate almost complete soil immobilization of the nonvolatilized (or non-photodegraded) TCDD regardless of soil texture or organic carbon content. The lack of correlation with these soil factors may be because of experimental difficulties and interactions.

It is reasonable to assume that TCDD (like other chlorinated organics) is strongly sorbed to humic surfaces. If this is true, then the TCDD mixed with sewage sludge would be at least as immobile as the TCDD discussed in the various field and laboratory studies. As the proteinaceous material in the sludge degrades, the more resistant humic and fulvic substances will remain in the upper soil horizons, thus increasing the adsorptive capacity of these soils over time. The humic substances will bind to colloidal surfaces in the upper soil horizons. Some deeper translocation, possibly as much as several meters, will also occur through old root channels and macropores.

The sludge-disposal areas at the City and County landfills were not used for other wastes. Organic solvents are generally volatilized during either primary or secondary sewage treatment. In addition, there are no major industrial discharges to the City of Shelton sewer system. It is therefore unlikely that any potentially mobilizing solvents are present in the sludge area at either the City of County landfills, and almost certain that concentrations of organic cocontaminants are less than the worst sites studied by Jackson, et al. (1985).

At the Dayton landfill, the TCDD-contaminated ash is buried under wood waste that consists of about 50 percent soil and gravel and 50 percent bark and other woody debris. As the wood slowly decomposes, the soluble humic and fulvic acids will leach through the ash and into the upper soil horizons. This leaching of humic acids from the wood waste will increase the adsorptive capacity of the soil below the ash layer. No solvents have been disposed of at the Dayton landfill.

One other chlorinated dioxin, dichlorodibenzo-o-dioxin, has been found experimentally to be immobile in soils (Helling, 1970). Other polychlorinated dibenzo-p-dioxins and furans have similar physical properties and thus should also be relatively immobile in soil (Karickhoff, Brown, and Scott (1979)).

On the basis of the landfill soils data, the availability of organic carbon to increase the binding capacity of the soils, and the results of the cited TCDD mobility studies, the following conclusions can be drawn:

1. The landfill soils have at least as much adsorption capacity as the sandy soils at Eglin AFB where the vertical movement of TCDD was limited to about 6 inches.
2. The binding capacity of the landfill soils will increase over time as the organic material (sludge and wood waste) decomposes and enriches the upper soil horizons with stable organic compounds (e.g., humic and fulvic acids).
3. Leaching of TCDD into the groundwater below the landfills is extremely unlikely because of the following conditions:
 - o TCDD is extremely immobile, particularly in the presence of organic carbon.
 - o Very small amounts of TCDD were disposed of in the landfilled ash compared to other sites that have been studied.
 - o The depth to groundwater is about 35 and 70 feet at the Mason County and Dayton land-

fills, respectively. The depth to groundwater at the City of Shelton landfill is not known, but the site is 1/4 mile from Goldsborough Creek, which has an elevation 140 feet lower than the landfill. The creek is a logical discharge point for shallow groundwater. The operating gravel pits between the site and Goldsborough Creek are excavated well below the elevation of the city landfill, and show no evidence of discharge of shallow groundwater.

EXPOSURE AND RISK

STC FACILITIES

With the demolition of the old powerplant and boilers at STC in 1986, the potential for exposure at the site was reduced to onsite soils. Baghouse residue that was at the site at the time of demolition is in sealed steel containers awaiting a decision by EPA on a suitable disposal method.

Twenty-six of the 32 employees of STC that were exposed to baghouse residue during operation of the old powerplant have all had a health screening. (A follow-up program to screen the remaining six is in progress.) No adverse health affects

related to chlorinated dioxins and furans were noted (Jerry Soehnlein, STC, December 1986).

The new powerplant at STC has a more efficient boiler, with higher, more uniform combustion temperatures. It is equipped with a multicyclone emissions control device rather than a baghouse. Analysis of chlorinated dioxins and furans in the residue from the multicyclone system showed small amounts of the tetra- through hexa-substituted homologues, but no isomers with chlorine in the 2,3,7,8 positions. Concentrations of the homologues found were comparable to amounts reported in woodstove and fireplace ashes (Table 1).

LANDFILLS

Dayton Wood-Waste Landfill

The baghouse residues at the Dayton wood-waste landfill are buried under several feet of wood waste, dirt, and rocks. There is no present exposure of anyone to this material. Disposal of the baghouse residue at the Dayton landfill was by contract haulers. The residue was discharged by tipping the dumpsters as the trucks moved away from the dumped residue. Haulers had no reason to leave their trucks while dumping. Baghouse residue was covered with wood waste on the same day it was deposited. Employees of STC likewise had no reason to leave their vehicles while at the landfill.

The propensity of chlorinated dioxins and furans for binding to soil, and the greater than 50-foot depth to groundwater, indicate that chlorinated dioxins and furans should not reach regional aquifers. There should be no present or future exposure of the public or STC employees at the Dayton landfill as long as the covering material remains in place.

Mason County Landfill

The potentially contaminated sludge from the Shelton sewage treatment plant is buried in covered trenches on a dedicated portion of the landfill. Liquid sludge was discharged by gravity flow from haulers trucks into the trenches at the landfill. There were repeated applications until a particular trench was nearly full. The sludge was allowed to dewater until it was dry enough to support cover soil, at which time the trench was covered. Trenches that were not covered immediately developed dense vegetation covers. The generally wet conditions of the sludge, the method of dumping, and the use of mechanical equipment for placing cover soil indicate that there was little opportunity for exposure of workers during disposal and drying.

The Mason County landfill is scheduled to be closed under the minimum functional standards for solid waste facilities (State of Washington), and is presently secured by partial

fencing and security personnel. Soil cover over some trenches may be relatively thin.

The depth to shallow groundwater at the Mason County landfill is greater than 30 feet. The domestic well serving the landfill is completed in a deeper aquifer overlain by a silty clay layer. Binding to particles in soil and sewage sludge should prevent any migration of chlorinated dioxins and furans. There should be no present or future exposure of the public, or workers, at the landfill.

CITY OF SHELTON LANDFILL

The contaminated sludge at the City landfill is at the surface of the ground, but heavily vegetated, in an unfenced area. Security at the site consists of a locked gate on the access road, but there are several routes to the site created by persons using off-road vehicles, with general access from the adjacent powerline right-of-way and the gravel pits to the south of the landfill. There is no evidence of off-road vehicle traffic on the sludge-disposal area itself, perhaps because much of the area is surrounded by concrete rubble, tree trimmings, demolition debris, and other miscellaneous debris.

The City landfill is in a closed depression that would prevent any movement of contaminated material out of the depression by surface erosion. However, the lowest part of the depression is not City property, and there is potential for movement of contaminated material to lower elevations within the depression. The two berms containing the downhill end of the sludge area would have to be breached before surface movement could occur. The berms are presently intact, with no evidence of erosion or structural failure.

Binding of chlorinated dioxins and furans to soil particles and organic particles in sewage sludge should prevent migration of those contaminants downward through the soil to groundwater. Vegetation on the sludge-disposal area should minimize production and transport of dust from the sludge-disposal area. There does not presently appear to be any exposure to chlorinated dioxins and furans at the City landfill; however, the potential exposure remains because the material is at the surface.

The potential exposure at the City landfill cannot be quantified because the nature and frequency of any possible exposure is unknown. However, the potential risks at the City landfill can be placed in perspective by comparing them with the studies of Kimbrough, Falk, and Stehr (1984) related to contamination at Times Beach, Missouri, which have been used

by EPA to establish interim policies for cleanup of dioxin-contaminated sites. Kimbrough, et al. (1984) concluded that residential soils with a concentration of 2,3,7,8-TCDD greater than 1 ppb pose a concern. Exposure to dioxin was presumed to be primarily by dermal contact with, and ingestion of, soil over a persons lifetime.

The concentration of 2,3,7,8-TCDD in the composite sample from an area presumed to contain the most recent sludge at the City landfill was 0.17 ppb, and the total toxic equivalents of all chlorinated dioxins and furans was 3.1 ppb 2,3,7,8-TCDD equivalents.

Several factors suggest that potential exposure to chlorinated dioxins and furans would be much less at the City landfill than the exposures calculated by Kimbrough, et al. (1984) for Times Beach.

- o Residential use of the site is unlikely, and could easily be prevented, so the amount of time any person would be exposed to contaminated soil would be much less.
- o The area contaminated at the City landfill is only a small portion of the site, and far too small to constitute a lifetime exposure area.

- o There are indications that the soil ingestion rates used by Kimbrough, et al. (1984) may overestimate actual ingestion of soil (Schaum, 1984).
- o Studies related to Times Beach indicate that about 85 percent of the contamination in soil is bio-available when the soil is ingested (McConnell, et al., 1984). Dioxin mixed with other soils, particularly with higher organic content, or with charcoal, may be much less available (Umbreit, Hesse, and Gallo, 1986). The principal solid in STC baghouse residue after dissolution of the salt is partially burned wood, i.e., charcoal.
- o The action level of 1 ppb established for Times Beach was based on 2,3,7,8-TCDD alone irrespective of the amounts of other homologues and isomers that may be present.

Because the concentration of TCDD equivalents was 3.1 ppb, a three-fold reduction in exposure would be sufficient to reduce the magnitude of risk at the City landfill to the range of 10^{-6} to 10^{-5} excess lifetime cancers used to establish the 1 ppb 2,3,7,8-TCDD level for Times Beach. It is very likely that any potential exposure at the City landfill would be much smaller (in excess of three fold) than calculated exposure at Times Beach.

MUNICIPAL TREATMENT PLANTS

Primary Treatment Plant

All sludge has been removed from the closed primary treatment plant. Sewer lines and manholes have been cleaned of sludge and the residue disposed of in the sludge-disposal areas at the County landfill. The composite sample of sediment from Oakland Bay near the former discharge of the primary sewage treatment plant contained none of the more toxic tetra- through hexa-substituted isomers of chlorinated dioxins and furans.

There should be no exposure of the public to toxic chlorinated dioxins and furans associated with the closed primary treatment plant.

Secondary Treatment Plant

The sewage lines and sludge ponds at the secondary treatment plant have transported and contained large volumes of sewage and sludge that was not contaminated by chlorinated dioxins and furans since the last residue from STC was treated. Catch basins and manholes in the sewer system have been cleaned numerous times since the last STC residue passed through them. The composite sample of sediment from Oakland

Bay near the discharge from the secondary sewage treatment plant did not contain any of the more toxic isomers of chlorinated dioxins and furans.

There should be no exposure of the public to toxic-chlorinated dioxins and furans associated with the secondary treatment plant.

RESIDENTIAL AREAS

The U.S. EPA evaluated the gas emissions from the closed STC powerplant and determined that the excess lifetime cancer risks because of chlorinated dioxins and furans did not exceed 2×10^{-6} (Bill Kykendal, U.S. EPA personal communication, March 25, 1987. None of the most toxic isomers of chlorinated dioxins and furans were detected in the composite samples of ambient soil from the three residential areas.

There is no indication of exposure of persons in residential areas to chlorinated dioxins and furans from the closed STC powerplant. There is no indication that the new powerplant discharges more than trace amounts of any chlorinated dioxins and furans, and none of the more toxic isomers were detected in multicyclone residue. Therefore there is no indication of exposure to toxic amounts of dioxins and furans from the present facility.

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APPENDIX A

DRILLERS LOGS FOR MONITORING
WELLS AT THE DAYTON AND MASON
COUNTY LANDFILLS

Address

SE to NE 10 Dec 11 T 20 N R 5 W W M

...ing and distance from section or subdivision corner

(10) WELL LOG:

4) TYPE OF WORK: Owner's number of well is 1
(if more than one) ...

New well	☒	Method:	Dug	☐	Bored	☐
Deepened	☐		Cable	☐	Driven	☐
Reconditioned	☐		Rotary	☐	Jettied	☐

5) DIMENSIONS: Diameter of well _____ inches.
 Drilled _____ ft. Depth of completed well _____ ft.

6) CONSTRUCTION DETAILS:

Casing installed: _____ " Diam. from _____ ft. to _____ ft.
 Threaded ☐ _____ " Diam. from _____ ft. to _____ ft.
 Welded ☐ _____ " Diam. from _____ ft. to _____ ft.

Perforations: Yes ☐ No ☐

Type of performer used

SIZE of perforations _____ in. by _____ in.

_____ perforations from 85 ft. to 93 ft.

_____ perforations from 110 ft. to 113 ft.

_____ perforations from _____ ft. to _____ ft.

Screens: Yes ☐ No ☒

Manufacturer's Name

Type _____ Model No _____
 Diam. _____ Slot size _____ from _____ ft. to _____ ft.
 Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: _____
Gravel placed from _____ ft. to _____ ft.

Surface seal: Yes ☐ No ☒ To what depth? _____ ft.

Material used in seal

Did any strata contain unusable water? Yes ☐ No ☒

Type of water? _____ Depth of strata _____

Method of sealing strata off

(7) PUMP: Manufacturer's Name _____
Type: _____ HP 1

(8) WATER LEVELS: Land-surface elevation above mean sea level... 391
 Static level 34 ft. below top of well Date 9/7/71
 Artesian pressure _____ lbs. per square inch Date _____
 Artesian water is controlled by _____ (Cap. valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☐ If yes, by whom? _____

Yield: 90 gal./min with 41 ft. drawdown after 4 hr

" 100 " 47 " 4 "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
------	-------------	------	-------------	------	-------------

ate of last

Test _____ gal/min. with _____ ft. drawdown after _____ hr.

Artesian flow _____ g.p.m. Date _____

Temperature of water _____ Was a chemical analysis made? Yes ☐ No ☐

Formation Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation

MATERIAL	FROM	TO
Cemented gravel	1	46
Sand & Blue Clay	46	60
Blue Clay	60	75
Cemented Gravel	75	85
Gravel - (Water 35 ppm est)	85	87.5
Hard pan	87.5	100
Sand small gravel	100	105
small gravel	105	110
Sand - muddy formation	110	
Water 20 ppm at 113		
Sand & Mucky formation		120
Heavy gravel formation	120	124
Water		

Work started _____, 19____. Completed _____, 19____.

WELL DRILLER'S STATEMENT.

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME _____
(Person, firm, or corporation) (Type or print)

Address.....

[Signed] _____

License No. _____ Date _____ 19____

WATER WELL REPORT

STATE OF WASHINGTON

Application No.

Permit No.

(1) OWNER: Name Simpson Timber Co. Address _____
LOCATION OF WELL: County Mason 1/4 Sec. _____ T. _____ N. _____ R. _____ W. _____
ing and distance from section or subdivision corner (Dayton landfill #1)

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Monitor Well Irrigation ☐ Test Well ☐ Other ☒

(4) TYPE OF WORK: Owner's number of well #1
(if more than one) _____
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 80 ft. Depth of completed well 80 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: _____ " Diam. from _____ ft. to _____ ft.
Threaded ☐ _____ " Diam. from _____ ft. to _____ ft.
Welded ☒ 6 " Diam. from 0 ft. to 80 ft.

Perforations: Yes ☐ No ☒

Type of perforator used _____

SIZE of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

Screens: Yes ☐ No ☒

Manufacturer's Name _____

Type _____ Model No. _____
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: _____
Gravel placed from _____ ft. to _____ ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal _____

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? _____ Depth of strata _____

Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation _____
above mean sea level _____
Static level 62 ft. below top of well Date 7-24-84
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
------	-------------	------	-------------	------	-------------

Date of test _____
Bailer test 15 gal./min. with 275 ft. drawdown after _____ hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water _____ Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

	MATERIAL	FROM	TO
	Dirt & GR	0	2
	GR SAND	2	10
5'	Cem & GR	10	15
	GR SAND	15	42
9'	Cem GR	42	51
	GR SAND	51	53
22'	Cem GR	53	70
	Clay GR SAND	70	75
	GR SAND (water)	75	80

Work started 7-24 19 84 Completed 7-24 19 84

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Russell Drilling Co.
(Person, firm, or corporation) (Type or print)

Address P.O. Box 433 Skiaton WA
98584

[Signed] Bill Russell
(Well Driller)

License No. 0444 Date 8-2- 19 84

1) OWNER: Name Simpson Timber Co Address _____
LOCATION OF WELL: County MASON _____ 1/4 _____ 1/4 Sec. _____ T. _____ N. R. _____ W.M. _____
* and distance from section or subdivision corner Denton landfill #1

3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☒

4) TYPE OF WORK: Owner's number of well ~~2~~ 1
(if more than one).

New well	☐	Method:	Dug	☐	Bored	☐
Deepened	☒		Cable	☐	Driven	☐
Reconditioned	☐		Rotary	☒	Jetted	☐

(5) DIMENSIONS: Diameter of well 6 inches.
 Drilled 80' ft. Depth of completed well 106 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: _____" Diam from _____ ft to _____ ft
 Threaded ☐ _____" Diam from _____ ft to _____ ft
 Welded ☒ 6" Diam from 0 ft to 106 ft

Perforations: Yes ☐ No ☒

Type of perforator used _____
 SIZE of perforations _____ in. by _____ in.
 _____ perforations from _____ ft. to _____ ft.
 _____ perforations from _____ ft. to _____ ft.
 _____ perforations from _____ ft. to _____ ft.

Screens: Yes ☐ No ☒

Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: _____
Gravel placed from _____ ft. to _____ ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal _____
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name: _____
Type: _____ HP: _____

(8) WATER LEVELS: Land-surface elevation above mean sea level....
 Static level 72 ft below top of well Date 3-18-85
 Artesian pressure _____ lbs. per square inch Date _____
 Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☐ If yes, by whom? _____

Yield: gal./min. with _____ ft. drawdown after _____ hrs

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

[illegible]

Date of test _____
 Bailor test 35 gal./min. with _____ ft. drawdown after _____ hrs.
 Artesian flow _____ g.p.m. Date _____
 Temperature of water _____ Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
GR SAND	80	100
CLAY GR SAND	100	104
GR SAND (water)	100	106

Work started 3-18-85 Completed 3-18-85

WELL DRILLER'S STATEMENT

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Russell Drilling Co
(Person, firm, or corporation) (Type or print)

Address PO Box 433 Shelton Wash

[Signed] Bill Russell
(Wall Driller)

License No. 6644 Date 3-19 1955

WATER WELL REPORT

STATE OF WASHINGTON

Application No

Permit No

1) OWNER: Name Simpson Timber Co Address

2) LOCATION OF WELL: County Mason $\frac{1}{4}$ $\frac{1}{4}$ Sec. T. N. R. W. M.
and distance from section or subdivision corner Dayton landfill #3

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Water Well Irrigation ☐ Test Well ☐ Other ☒

(4) TYPE OF WORK: Owner's number of well # 3
(if more than one)
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 60 ft. Depth of completed well 60 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: " Diam. from ft. to ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ 6 " Diam. from 0 ft. to 60 ft.

Perforations: Yes ☐ No ☒

Type of perforator used

SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☐ No ☒

Manufacturer's Name

Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: Yes ☐ No ☒ Size of gravel
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.

Material used in seal

Did any strata contain unusable water? Yes ☐ No ☐

Type of water? Depth of strata

Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation
above mean sea level 8-30-84
Static level 48 ft. below top of well Date 8-30-84
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is
lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level
measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
------	-------------	------	-------------	------	-------------

Date of test 8-25-84

Ballot test 10 gal./min. with ft. drawdown after hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

	MATERIAL	FROM	TO
	SAND DIAT BIG ROCKS	0	3
	GR SAND	3	10
10'	GR SAND (HARD)	10	20
	GR SAND CLAY	20	30
	GR SAND	30	40
17'	CEM GR	40	57
	GR SAND (WATER)	57	60

Work started 8-30-84 Completed 8-30-84

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Russell Drilling Co
(Person, firm, or corporation) (Type or print)

Address P.O. Box 433 Shelton WA
98584

[Signed] Bill Russell
(Well Driller)

License No. 0444 Date 8-2-84

WATER WELL REPORT

STATE OF WASHINGTON

Application No

Permit No

1) OWNER: Name Simpson Timber Co Address _____

LOCATION OF WELL: County MASON 1/4 Sec. _____ T. _____ N. R. _____ W.M.

and distance from section or subdivision corner Dayton landfill #3

3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☒

4) TYPE OF WORK: Owner's number of well (if more than one) _____
New well ☐ Method: Dug ☐ Bored ☐
Deepened ☒ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

5) DIMENSIONS: Diameter of well 6 inches
Drilled 60 ft Depth of completed well 108 ft

6) CONSTRUCTION DETAILS:

Casing installed: _____" Diam. from _____ ft. to _____ ft.
Threaded ☐ _____" Diam. from _____ ft. to _____ ft.
Welded ☒ 6" Diam. from 0 ft. to 108 ft.

Perforations: Yes ☐ No ☒

Type of perforator used _____
SIZE of perforations _____ in. by _____ in.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.

Screens: Yes ☐ No ☒

Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: _____
Gravel placed from _____ ft. to _____ ft.

Surface seal: Yes ☐ No ☐ To what depth? 18 ft.
Material used in seal _____
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation above mean sea level _____
Static level 53 ft. below top of well Date 3-18-85
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap. valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
------	-------------	------	-------------	------	-------------

End of test

Baller test 40 gal./min. with _____ ft. drawdown after _____ hrs.

Artesian flow _____ g.p.m. Date _____

Temperature of water _____ Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG:

Formation Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
GR SAN	60	80
" "	80	90
Perm GR	90	100
GR SAN (Water)	100	108

Work started 3-18-85 Completed 3-18-85

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Russell Drilling Co
(Person, firm, or corporation) (Type or print)

Address P.O. Box 133 Shelton WA

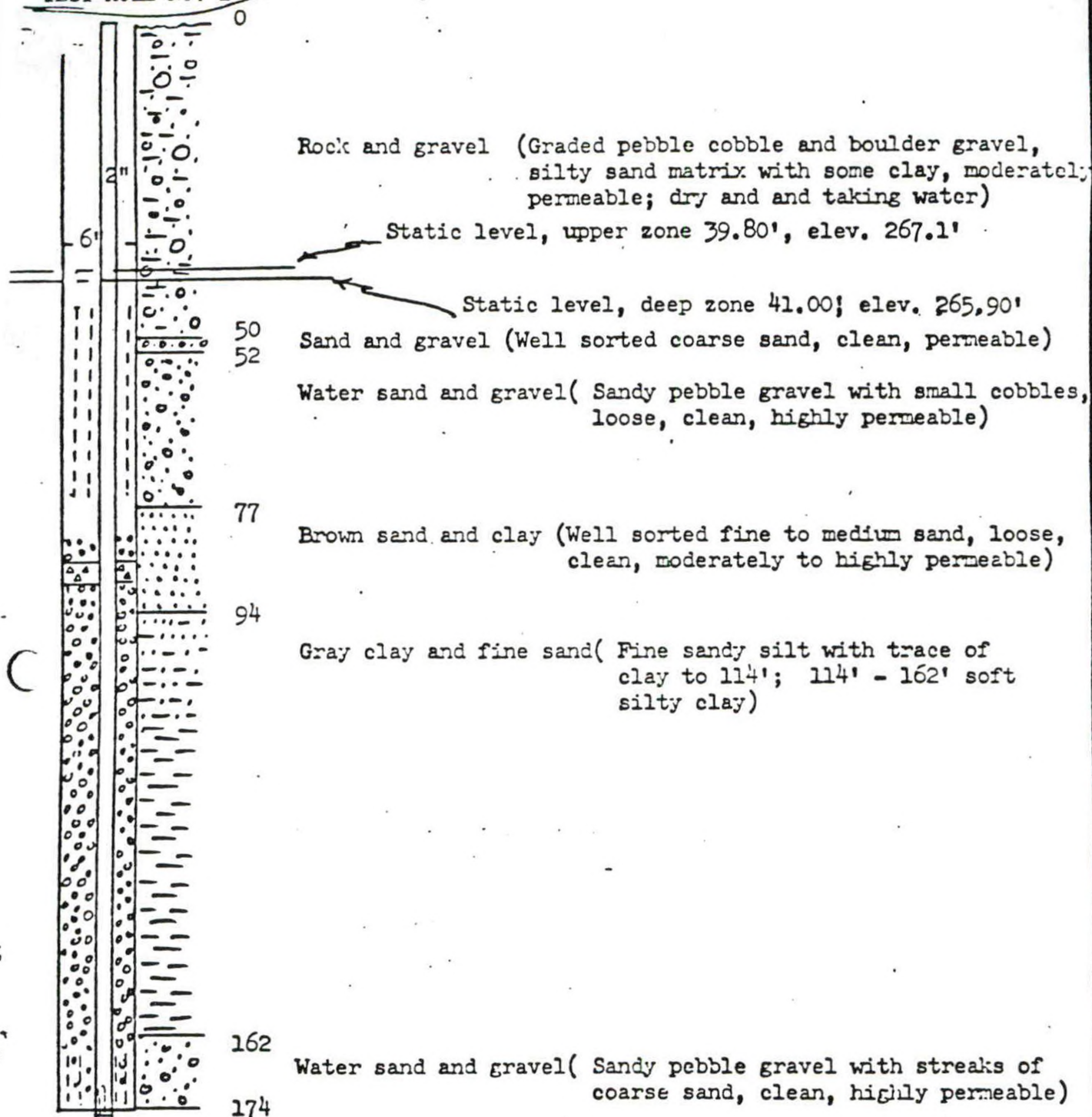
[Signed] Bill Russell
(Well Driller)

License No 6444 Date 3-18-85

casing, 306.05
pipe couplings 306.90
ground 306.7

Driller's Log (with geologist's notations)

TEST HOLE NO. 1



Knife perforated, 165' - 173',
75', 4 per round, one round per foot.
"galvanized piezometer to 175', torch
175' - 170'; gravel pack 175' - 90';
acker 90' - 86', pea gravel 86' - 82'

Ground-Water Investigations

MASON COUNTY

SOLID WASTE LANDFILL SITE

DATE 6/20/13

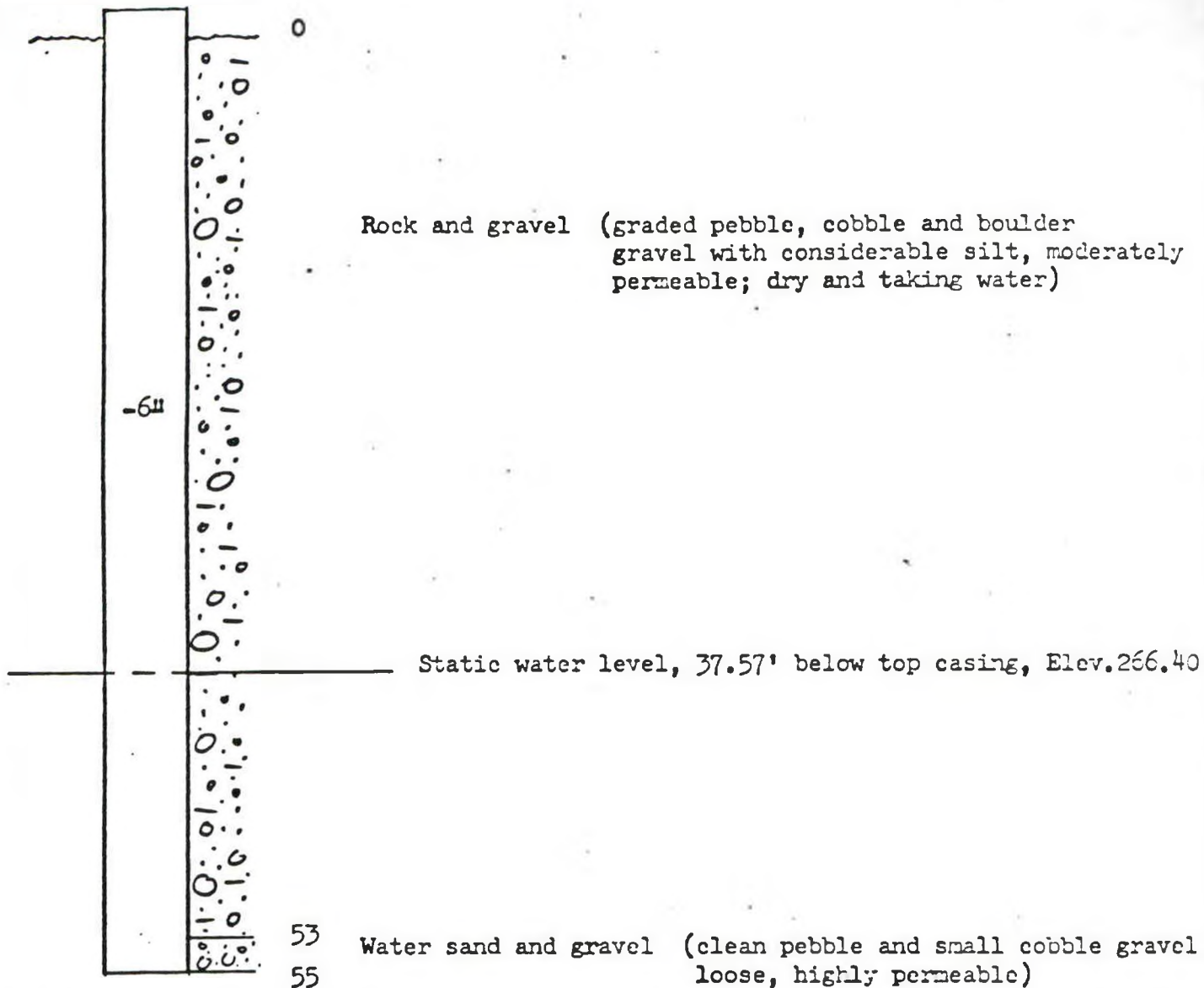
SCALE 1" = 25'

RICHARD J. RONGEY

CONSULTING GEOLOGIST

top casing, 303.97
avg. ground, 302.7
TEST HOLE NO. 2

Driller's Log (with geologist's notations)



pleted open bottom with no perforations.
l tested for 30 minutes at 15 gpm with
drawdown.

Ground-Water Investigations

MASON COUNTY

SOLID WASTE LANDFILL SITE

DATE

6/20/13

SCALE

1" = 10'

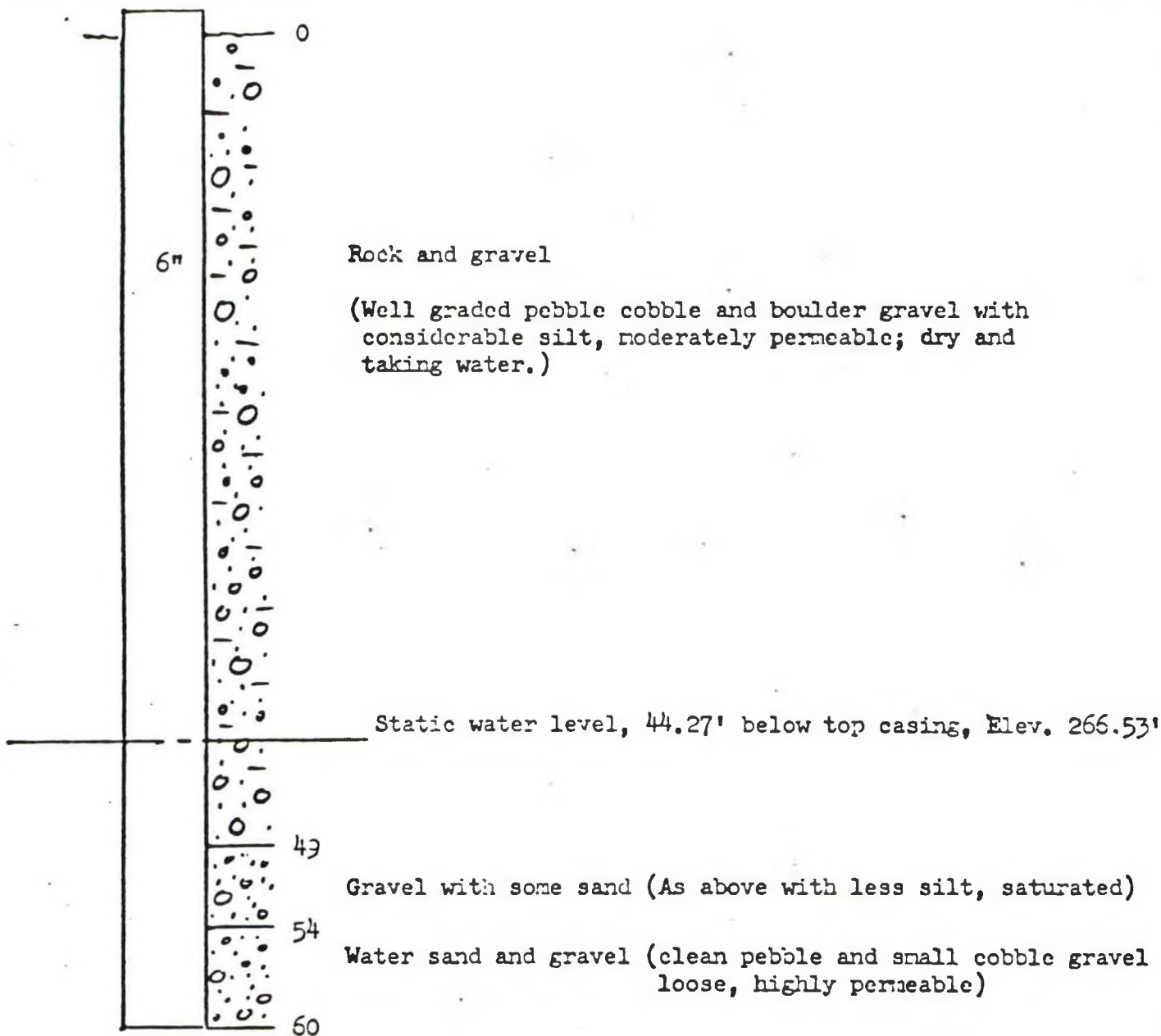
RICHARD J. RONGEY

CONSULTING GEOLOGIST

ev. top casing, 310.80
ev. av. ground, 308.9

Driller's Log (with geologist's notations)

TEST HOLE NO. 3



Completed open bottom with no perforations.
Pump tested for 15 minutes, no drawdown @ 15 gpm.

Ground-Water Investigations	
<u>MASON COUNTY</u>	
<u>SOLID WASTE LANDFILL SITE</u>	
DATE 6/20/73	SCALE 1" = 10'
RICHARD J. RONGEY	

APPENDIX B

WATER QUALITY DATA FROM MONITORING
WELLS AT THE DAYTON AND MASON
COUNTY LANDFILLS

**am test inc.**CH₂M-HILL

4900 9TH AVENUE N.W. • SEATTLE, WASHINGTON 98107-3697 • 206/783-4700

PLASMA SPECTROGRAPHIC

ANALYSES CERTIFICATE

P.O. Box 91500

Bellevue, WA 98009

DATE REPORTED: 6/30/86

Attention: Don Heinle

We hereby Certify that the following are the results of plasma spectrographic analyses made on Solution samples submitted.

Sample Identification	108365	108366	108367	108368		Detection Limit (mg/l)
Client Identification	STC-1-6/86 Filtered 1540	STC-2-6/86 Filtered 1425	STC-3-6/86 Filtered 1340	Pump Filtered 1547		
Aluminum	Al	L	L	L		0.15
Antimony	Sb	L	L	L		0.15
Arsenic	As	0.002	L	L		0.001
Barium	Ba	0.004	0.002	0.001	0.002	0.001
Beryllium	Be	L	L	L	L	0.003
Bismuth	Bi	L	L	L	L	0.5
Boron	B	L	L	L	L	0.01
Cadmium	Cd	L	L	L	L	0.025
Calcium	Ca	7.69	8.11	7.80	8.67	0.01
Chromium	Cr	L	L	L	L	0.025
Cobalt	Co	L	L	L	L	0.02
Copper	Cu	L	L	L	L	0.015
Iron	Fe	0.077	0.035	0.034	0.054	0.030
Lead *	Pb	L	L	0.001	L	0.001
Magnesium	Mg	3.00	2.32	2.96	3.58	0.001
Manganese	Mn	0.074	0.016	0.038	0.008	0.003
Mercury*	Hg	0.0017	0.0009	L	L	0.0004
Molybdenum	Mo	L	L	L	L	0.04
Nickel	Ni	L	L	L	L	0.025
Phosphorus	PO ₄	L	L	L	L	0.4
Potassium	K	0.24	0.26	0.32	0.21	0.01
Selenium	Se	-	-	-	-	-
Silicon	SiO ₂	1.04	0.54	0.98	18.8	0.08
Silver	Ag	L	L	L	L	0.03
Sodium	Na	3.52	3.55	3.62	3.23	0.1
Strontium	Sr	0.025	0.029	0.022	0.027	0.001
Tin	Sn	L	L	L	L	0.03
Titanium	Ti	0.012	L	L	L	0.006
Tungsten	W	-	-	-	-	-
Uranium	U	-	-	-	-	-
Vanadium	V	L	L	L	L	0.01
Zinc	Zn	0.021	0.034	0.022	0.027	0.015

All results expressed in parts per million.

L = less than.

AM TEST INC.

* Arsenic & Lead run by Graphic Furnace AA & Mercury by Cold Vapor Technique. Ann Reinhart



Engineers
Planners
Economists
Scientists

Environmental Laboratory

Date: November 12, 1984

Project No.: S18303.A6

Subject: Analysis of three water samples from Simpson Timber.
The samples were received September 24, 1984, and
assigned reference Nos. 4830-4832.

Parameter as mg/L	No. 1	No. 2	No. 3
Antimony, Sb	0.065	<0.005	<0.005
Arsenic, As	0.006	0.009	<0.005
Beryllium, Be	<0.01	<0.01	<0.01
Cadmium, Cd	0.0034	0.0510	0.0119
Chromium, Cr	<0.005	0.034	0.014
Copper, Cu	0.02	0.14	0.04
Mercury, Hg	0.00308	0.00711	0.00266
Nickel, Ni	<0.05	0.09	<0.05
Selenium, Se	<0.005	<0.005	<0.005
Silver, Ag	0.001	<0.001	0.001
Thallium, Tl	<0.1	<0.1	<0.1
Zinc, Zn	0.043	0.129	0.080
Sodium, Na	2.27	3.03	2.75
Lead, Pb	0.022	0.023	0.063
Chloride, Cl	2	4	3

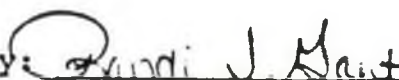
< Indicates "less than"

All tests are performed in accordance with current Environmental Protection Agency guidelines as published in the Federal Register.

The information shown on this sheet is test data only and no interpretation is intended or implied.

Samples will be retained 30 days unless otherwise requested.

Reported by:


Randi J. Gant

ct/CVLAB/090

(3256)

1977 12.05
1/21 8/19 12/6 | 6/12 12/4

F ¹¹	7.0 (umt)	8.0	6.5	6.4	6.5	6.3
Turbidity (NTU)	NTU	2.0	<1	2.0	NT	
Sp Conductivity (umhos/cm)		113	54	145	45	251
Total Hardness (as CaCO ₃)		211	14	66	NT	135
COD	mg/l	12	12	12	8.0	4.7
Chloride (as Cl)	mg/l	2.0	1.0	4.0	6.0	2.0
Sulfate (as SO ₄)	mg/l	NT	NT	NT	3.1	9.1
NO ₃ -N	0.1 mg/l	0.03	0.23	0.27	0.01	0.86
NO ₂ -N	mg/l	<0.02	<0.02	<0.02	<0.01	0.004
NH ₃ -N	mg/l	0.03	<0.02	<0.02	0.40	<0.2
C-J-PO ₄ -P Phosphate	mg/l	0.11	0.03	<0.02	<0.01	<0.2
Total Phos.-P	mg/l	0.13	0.02	<0.02	<0.01	<0.2
Copper	µg/l	NT	NT	NT	3.0	6.3
Zinc	µg/l	NT	NT	NT	49	1.1
Iron	200 µg/l	670	50	500	2,030	6,550
Nickel	µg/l	NT	NT	NT	4.0	<10
Chromium	µg/l	1	1	1	<1	4.0
Cadmium	µg/l	1	1	1	0.2	<10
Lead	µg/l	1	1	1	<1	2.00
Trisemic	µg/l				<1	<10
Selenium	µg/l	↓	↓	↓	1.0	<10

(Base line)

		1975			1977			1979	1981	1982	1984	1985
		8/22	8/24	11/12	1/24	5/11	10/21	2/3	3/11	2/3	1/10	6/13
4	8.1 (umib)	10.0	8.1	7.8	2.1	8.0	8.0	NT	3.1	8.2	7.8	7.1
Turbidity	(NTU)	1.0	10	13	1.0	2.0	5.0	22?	2.0	27	4.0	NT
Sp. Conductivity	(umhos/cm)	88	100	120	100	97	102	73	87	92	91	
Total Hardness	(as CaCO ₃)	19	NT	19	21	23	44	43	42	46	NT	
COD	mg/l	<4	4.0	4.0	12	12	4.0	NT	4.0	4.0	8.0	
Chloride	(as Cl)	mg/l	2.0	2.0	3.0	2.0	<1.0	2.0	1.0	2.3	2.8	1.7
Sulfate	(as SO ₄)	mg/l	NT	NT	NT	NT	NT	NT	NT	11	NT	1.5
NO ₃ -N	0.1 mg/l	0.02	0.06	0.02	0.04	0.23	0.03	0.05	0.06	0.04	0.03	
NO ₂ -N	mg/l	ND	ND	ND	<0.02	<0.02	<0.02	<0.01	<0.01	NT	0.01	
NH ₃ -N	mg/l	NT	NT	NT	0.02	<0.02	<0.02	<0.01	<0.01	<0.01	0.67	
O-PO ₄ -P	Phosphate 0.55 mg/l	ND	0.04	0.01	0.11	0.06	0.02	0.05	0.06	0.06	0.02	
Total Phos.-P	mg/l	0.02	0.05	0.05	0.11	0.07	0.02	0.05	0.03	0.03	0.02	
Copper	µg/l	NT	NT	NT	NT	NT	NT	110	9.0	<10	<1.0	
Zinc	µg/l	NT	NT	NT	NT	NT	NT	110	150	200	201	
Iron	200 µg/l	<50	100	1000	120	270	600	130	180	320	150	
Nickel	µg/l	NT	NT	NT	NT	NT	NT	<50	<5	<50	<1.0	
Chromium	µg/l	1	1	1	1	1	1	<10	<5	<10	15	
Cadmium	µg/l	1	1	1	1	1	1	<10	<1	<10	3.3	
Lead	µg/l	1	1	1	1	1	1	<400	<5	<50	14	
Arsenic	µg/l	1	1	1	1	1	1	NT	NT	NT	11	
Selenium	µg/l	↓	↓	↓	↓	↓	↓	NT	NT	NT	20	
Manganese	mg/l	NT	NT	NT	NT	NT	NT	NT	<10	<20	NT	

1925
6/12

r 4	1.0 (unit)	6.2
Turbidity	(NTU)	NT
Sp Conductivity	(µmhos/cm)	45
Total Hardness (as CaCO ₃)		NT
COD	mg/l	8.0
Chloride (as Cl ⁻)	mg/l	1.6
Sulfate (as SO ₄)	mg/l	0.8
NO ₃ -N	0.1 mg/l	0.04
NO ₂ -N	mg/l	<0.01
NH ₃ -N	mg/l	0.13
O-PO ₄ -P	mg/l	0.05
Total Phos.-P	mg/l	0.05
Copper	µg/l	<1.0
Zinc	µg/l	26
Iron	200 µg/l	500
Nickel	µg/l	1.0
Chromium	µg/l	12
Cadmium	µg/l	0.4
Lead	µg/l	<1.0
Arsenic	µg/l	1.0
Selenium	µg/l	2.0

APPENDIX C

FIELD NOTES (TRANSCRIBED) FROM SITE:
SOIL, SEDIMENT, AND SLUDGE SAMPLING
CHAIN-OF-CUSTODY FORMS

AMBIENT SOIL AND SEDIMENT

STC ambient soil sampling, July 22, 1986, Shelton, Washington, 1100.

Sample 1, Composite 1: Hillcrest ~150 west-southwest of intersection of Boundary and Ellinor Streets.

Photo 1: looking north from trail past sampling site.

Photo 2: looking east toward house at southeast corner of Boundary and Ellinor Streets.

Sample 2, Composite 1: 1122. 1933 Summit Drive. Sample collected 12 feet northeast of northeast corner of woodshed on east side of house.

Photo 3: looking west toward house.

Sample 3, Composite 1: 1140. South of gravel pit on west side of Old Olympic Highway; ~75 feet west of highway.

Photo 4: looking north toward Ken's Auto Body.

Sample 4, Composite 1: Tom McKim's property south-southwest of house, 75 yards south-southwest of southwest corner and 125 feet west of driveway.

Photo 5: looking from corner of house to sampling point.

Sample 5, Composite 1: 1221. Behind Arcadia Secondhand Store.

Photo 6: from entrance to store toward sampling point.

Photo 7: from sampling point looking toward store.

(Completed C-1 Hillcrest)

July 22, 1986, STC, 1350. Area 2, Munson Point (Shorecrest).

Sample 1, Composite 2: East Skyline Drive west of Parkway North (0.1 mile west on East Skyline), south of road. Sample at north edge of first clump of cedar trees west of driveway at top of hill (south side of road).

Photo 8: looking east-southeast toward sample site.

Sample 2, Composite 2: 1400. Corner of Panorama and Crest-view on southeast side near first large cedar tree at edge of clearing (in line with stop sign).

Photo 9: from stop sign toward sample point looking east-southeast.

Some indication of previous spraying in ditch.

Sample 3, Composite 2: 1412. North-northwest of corner of Maple and Wood Lane at edge of woods 35 feet from pipe at corner (north of pipe).

Photo 10: toward west-southwest showing sample location and pipe.

Sample 4, Composite 2: 1420. 120 feet north of View and 33 feet east of East Parkway, northeast from swimming pool on opposite side of East Parkway.

Photo 11: shows sample point.

Photo 12: shows John on road directly adjacent to sample point.

Sample 5, Composite 2: 1431. West side of Lynwood at corner with Fir.

Photo 13: sample point 30 feet in from west side of
Lynwood.

Photo 14: John by side of Lynwood adjacent to sampling
point.

(Completed C-2 Shorecrest)

Quality control sample.

Performance sample, 1450, STC-C3-July 1986, EPA
No. V58WQ02K1.

Field blank, 1453, STC-C4-July 1986, EPA No. E19AD00R4.

Photo 15: compositing C-2.

(Completed C-3, C-4 QA)

Area 3, Composite 5, Capitol Hill.

Sample 1, Composite 5: 1530. On old road off corner of
Hazel and Elk Streets due south of brown house ~120 feet.

Photo 16: sampling site.

Photo 17: brown house 120 feet north.

Sample 2, Composite 5: first open area off corner of Hazel and Elk Streets. Sample at upper edge of small clearing at foot of fir tree.

Photo 18: sample location.

Sample 3: 15 feet west-southwest of Sample 2.

Photo 19: sample location.

Photo 20: brown house from sample location.

Sample 4, Composite 5: downhill off Hazel Street at top of stand of bigleaf maple, just west of rotten stumps.

Photos 21 and 22: looking downhill at site (sample location).

Sample 5, Composite 5: 1548. on north side of Hazel Road, 75 feet south of developed lot to north. Sample at east edge of lot covered with Scotch broom between two large fir trees (closer to northern tree).

Photo 23: John at edge of Scotch broom.

Photo 24: sample site looking southeast.

Photo 25: sample site looking east.

Photo 26: looking east-northeast toward large trees.

(Completed C-5 Capitol Hill)

Composite 6: 1700, city landfill.

Ten tulip bulb planter cores from area nearest dump zone.

Photo 27: looking west toward sample area.

Photo 28: looking north toward sampling area.

Photo 29: looking northwest toward entire site.

Field equipment decontaminated at site by TSP wash, triple rinse, with distilled H₂O.

(Completed C-6 city landfill)

STC Sediment sampling, July 23, 1986, new STP, 1050.

Sample 1, Composite 7:

Photo 1: new STP looking west.

Photo 2: Jacobys Shorecrest.

Photo 3: STC plant past Eagle Point.

Sample 2, Composite 7: just south of Eagle Point. Two photos (No. 4 and 5).

Sample 3, Composite 7: 1102.

Photo 6: marina.

Sample 4: immediately after Sample 3.

Sample 5: immediately after Sample 3, 1104. End of marina still in sight.

Photo 7: near first dock south of Eagle Point.

First photo on new roll is of dock--Photo 8.

(Completed C-7 new wastewater treatment plant)

Old STP.

Composite 8, Sample 1: Just off yacht club, 1120, Photos 9 and 10.

Sample 2.

Photo 11: drifting slowly eastward during Samples 2 through 5.

Sample 3.

Sample 4: 1125.

Sample 5: 1126.

Last three photos, Photos No. 12, 13, and 14, taken at Sample 5.

(Completed C-8 new wastewater treatment plant)

STC ambient soil sampling, July 23, 1986.

STP Composite 9: 1340. Background sample, five tulip bulb cores; field south of C Street on left past cemetery.

Four samples collected at corners of a square 10 yd/side southwest of entry point to field off C Street.

One in center.

Approximately 150 feet west-southwest of edge of field at entry point.

Three photos, No. 15, 16, and 17, showing sampling area in perspective with point of access. Some buildings in background through trees to east-northeast.

STC ambient soil sampling--resampling of Hillcrest and Shorecrest areas, October 21, 1986. STC Hillcrest resample (Area 1).

Sample 1: same location as July 22 Sample 1. 1300. One bulb planter (Photo 1).

Sample 2: vacant house next to 1933 Summit Drive (new location). Address 1929 or 1931 Summit Drive (west side of house) (Photo 2). 1309.

Cool and cloudy.

Sample 3: same as July 22, Sample 3. 1314. Photo 3.

Sample 4: McKim, 1323. Same location as July 22 Sample 4. Photo 4.

Sample 5: Arcadia Secondhand Store. Same location as July 22 Sample 5. 1430. Photo 5.

Sample composited with 1 to 4 and placed in sample jar.
Photo 6 looking toward store from sample location.

(Completed C-10 Hillcrest)

October 21, 1986, STC Jacobys Shorecrest.

Sample 1: Munson Point. Same location as Sample 1 on
July 22. 1435. Photo 7.

Sample 2: new location. 1439. Lot 5, Block 3, Shorecrest
third addition. 310 feet down (south) Panorama Drive off
Crestview (fifth lot on Panorama). Old sample was on corner
of Panorama and Crestview. Gunter property.

Photo of site (Photo 8) and photo looking west across Pan-
orama to trailer (Photo 9).

Sample 3: same as Sample 3 on July 22. 1448. Photo 10.

Sample 4: same as Sample 4 on July 22. 1445. Photo 11.

Sample 5: same as Sample 5 on July 22. 1500. Composite.
Photo 12.

(Completed C-11 Shorecrest)

LANDFILL SOILS

STC soil sampling (landfill) Mason County landfill, July 29, 1986, start 1105.

Sample 1: composite from 2 to 4 feet at southeast corner of gravel pit. Sample No. MLC-1 (MLC-1).

Sample 2: MLC-2 composite from 4 to 8 feet (5, 6, 7, and 8 feet); Photo 1 same location as Sample 2.

Some large rocks discarded.

Tulip bulb planter diameter restricts particle size--samples taken in part with shovel.

Sample 3: July 29, 1986, MLC-3 composite from 2 to 4 feet, surface soil excluded surface soil 2 feet thick; Photo 2: looking east at sampling location.

Photo 3: looking northwest at west side of borrow pit showing some layering.

Sample 4 MLC-4: same location as Sample 3, 4- to 8-foot composite.

Photo 4: layer of buried natural organic matter 15 feet from east side of southeasternmost sludge trench in new borrow pit just east of trenches. Reworked material?

Sample 5 MLC-5: composite from 2 to 4 feet on southeast side of new cut just east of trenches.

Photo 5: sample location.

Photo 6: looking across sludge trench at location of MLC-5 and MLC-6.

Sample 6 MLC-6: 4- to 8-foot composite--same location as Sample 5. Encountered relatively fresh bark of Douglas fir.

Photo 7: closeup of cut for Sample MLC-6. Finished site at 1202.

Dayton landfill, July 29, 1986, DLC-7, 1300: surface 3 inches between rows of fill just west of stump pile near southeast corner. One fill row, rocks and dirt (east); other, rocks, dirt, bark, wood (west).

Photo 8: location before sampling.

Photo 9: looking east-southeast from debris pile just east of sample location.

DLC-8: 3 to 6 inches at same spot as DLC-7.

DLC-9: 75 feet south of road through landfill near middle zero to 3 inches of soil from below turf. Attempted to exclude roots and stems. May have included some and some seeds (Photo 10).

DLC-10: 3 to 6 inches same spot as DLC-9.

DLC-11: zero to 3 inches. West side of waste piles on northeast side of landfill 150 feet (north of road) in uncovered area.

Photo of sample location looking east-southeast toward cut on east side of landfill (Photo 11).

DLC-12: 3 to 6 inches same location as DLC-11.

City landfill: start 1457

CLC-13: zero to 3 inches deep on southwest side of skid road below berms. Location had 6 inches of overburden over compacted outwash gravel.

CLC-14: 3 to 6 inches.

Same location: one photo of false start (Photo 12) and one photo of sample location (Photo 13).

July 29

CLC-15: zero to 3 inches. 100 feet south-southeast of CLC-13 and CLC-14 on disturbed material south of lush growth of clover (compact gravelly sandy loam).

Photo 14: looking north northwest.

CLC-16: 3 to 6 inches same location.

CLC-17: 150 feet southeast of previous two samples. More gravel than other sites (more like the material under the sludge that John showed me). Zero to three inches deep.

CLC-18: 3 to 6 inches. Same location

Photo 15: looking northeast toward berms (berms out of sight). Closeup photo of sampling (Photo 16).

CLC-19: 100 feet south of CLC-13 and CLC-14 inside of cut--
native material from bottom edge of tree root zone. Sandy
gravel very much like material under sludge.

Photo 17: closeup of sample location.

Photo 18: showing log and willow sapling.

STC FACILITIES

STC, May 15, 1986.

STC NPP-1. Residue from cyclone on new powerplant; dry, dark, grey-black granular and powder. 1015.

STC BBH-2. 1045. Residue from burned baghouse sample taken from header over screw to slurry tank or dumpster Photos 1 through 4.

STC ABH-3. 1050. Intact baghouse (high-pressure boiler) (tested by EPA). Collected from dumpster.

STC HPB-4. 1055 to 1110. Composite from four locations in the high-pressure boiler top to bottom (not including bottom ash).

STC LPB-5. 1115 to 1130. Composite from various locations in the six low-pressure boilers (one sample from each boiler plus a sample of external soot outside combustion chamber).

24832



CHAIN OF CUSTODY RECORD

PROJECT NUMBER S18303.B6		PROJECT NAME SIMPSON Timber				NUMBER OF CONTAINERS	Analyze for Chlorine, Hexins and Butans can firm positive determine isomeric composition to extent possible, special eA for on 2379 TDD penta TCDD's (2379 position and TCDF's and PC 1,2,3,6,7 and 2,3,4,6,7 Pe CDF										REMARKS
LABORATORY CAL ANALYTICAL																	
STA. NO.	DATE	TIME	COMP	GRAB	SAMPLE IDENTIFICATION												
ST-1	5/15/82	1015		X	ST-NPP-1	1	X	X	X								Matrix is boiler residue and baghouse dust from a wood-b boiler - may have soluble inorganic salt wood residue and carbon particles
ST-2	5/15/82	1045		X	ST-BBH-2	1	X	X	X								
ST-3	5/15/82	1050		X	STC-ABH-3	1	X	X	X								
ST-4	5/15/82	1110		X	STC-MPB-4	1	X	X	X								
ST-5	5/15/82	1130		X	STC-LPB-5	1	X	X	X								

SAMPLED BY AND TITLE (SIGNATURE) <i>John R. Polk</i>		DATE/TIME 5/15/82 V600	RELINQUISHED BY: (SIGNATURE) <i>John R. Polk</i>		DATE/TIME 5/15/82 V600	RECEIVED BY: (SIGNATURE) <i>Chris Johnson</i>	
RELINQUISHED BY: (SIGNATURE) <i>John R. Polk</i>		DATE/TIME 1	RECEIVED BY: (SIGNATURE) <i>Chris Johnson</i>		DATE/TIME 1	RECEIVED BY LAB: (SIGNATURE) <i>Chris Johnson</i>	
REMARKS					SAMPLE SHIPPED VIA ☐ UPS ☐ BUS ☐ FEDERAL EXPRESS		AIR BUS BILL NUMBER

CHAIN OF CUSTODY RECORD

PROJECT NUMBER		PROJECT NAME		LABORATORY		NUMBER OF CONTAINERS	REMARKS
STA. NO.	DATE	TIME	COMP				
518303.B6 SIMPSON TIMBER CO						CAL ANALYTICAL	Analyze for chlorinated dioxins and furans with determination of as many isomers as possible
C-1	7/23/86	1230	X		STC-C1-7/86		
C-2	↑	1430	X		STC-C2-7/86	1	" "
C-3	↓	1450	X		STC-C3-7/86	1	" "
C-4		1453	X		STC-C4-7/86	1	" "
C-5		1555	X		STC-C5-7/86	1	" "
C-6	7/23/86	1715	X		STC-C6-7/86	1	" "
C-7	7/23/86	1050	X		STC-C7-7/86	1	Matrix - Sediment
C-8	7/23	1120	X		STC-C8-7/86	1	" "
C-9	7/23/86	1345	X		STC-C9-7/86	1	Matrix - Soil
							(2) two - sec. w. 2 sec. clon + 2 sec. jars received with this STC-C7-7-86 + Time of 1000 + STC-C8-7-86 + Time of 1120 + This sample was not received
							All other sec Sample Samples received in good in good condition

SAMPLED BY AND TITLE (SIGNATURE) <i>John Galk</i>	DATE/TIME 7-31-80 1500	RELINQUISHED BY: (SIGNATURE) <i>John Galk</i>	DATE/TIME 7-31-80 1600	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE) <i>[Signature]</i>	DATE/TIME 1	RECEIVED BY: (SIGNATURE)	DATE/TIME 07-23-80 1900	RECEIVED BY LAB: (SIGNATURE) <i>E. Ward C. Loper</i>
REMARKS			SAMPLE SHIPPED VIA ☐ UPS ☐ BUS ☐ FEDERAL EXPRESS	
			AIR BUS BILL NUMBER	

CHAIN OF CUSTODY RECORD

PROJECT NAME
 OBJECT NUMBER
 9303-B6
 SIMPSON TIMBER
 LABORATORY

QAL ANALYTICAL

DATE TIME COMP GRAB

NUMBER OF CONTAINERS

CHLORINATED DIOXINS + FURANS + AS MANY ISO. AS POSSIBLE

REMARKS

10/21/86 1330 X
 10/21/86 1500 X
 STC-C10-10/21
 STC-C11-10/21
 1 X X
 1 X X

SOIL SAMPLES
 SOIL SAMPLES

Note These samples STC-C10-10/21
 and STC-C11-10/21

Replace previous samples

STC-C1-7/86

and STC-C2-7/86

Phone Instructions to H. Chabonovsky

PREPARED BY AND TITLE (SIGNATURE)

DATE/TIME

RELINQUISHED BY (SIGNATURE)

DATE/TIME

RECEIVED BY (SIGNATURE)

LINQUISHED BY (SIGNATURE)

DATE/TIME

RECEIVED BY (SIGNATURE)

RELINQUISHED BY (SIGNATURE)

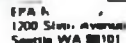
DATE/TIME

RECEIVED BY LAB (SIGNATURE)

MARKS

SAMPLE SHIPPED VIA
☐ UPS
☐ BUS
☐ FEDERAL EXPRESS

AIR BUS BILL NUMBER

☐ **Enforcement/Custody****Samplers:**

Project Code: _____ Account: _____

☐ Possible Toxic/Hazardous Notes: DIOXIN SAMPLES

Name/Location: SHELTON NOXAP SAMPLING

☐ Data Confidential FROM RESIDENTIAL AREAS

Project Officer: NEALIE VANAMOTO

☐ Data for Storet

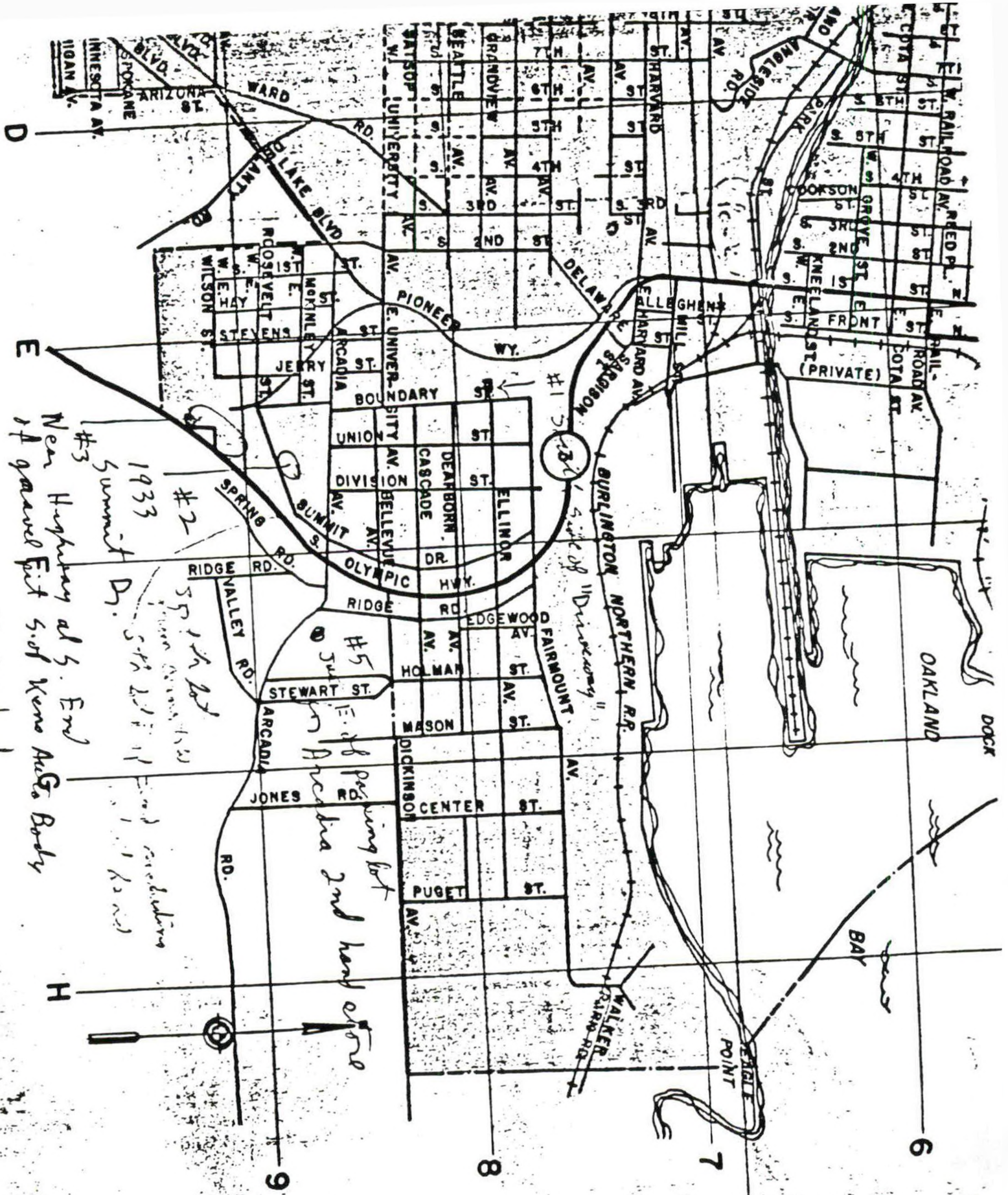
Recorder:

Glenn A. T.
1 Signature Required

SOURCE CODE	MATRIX					# CONTAINERS & PRESERV.					LAB NUMBER			STATION NUMBER			DATE				COMPOSITE ONLY					STATION DESCRIPTION	
	Water	Sediment	Tissue	Oil		Unpres.	H ₂ SO ₄	HNO ₃			Yr	Wk	Seq	Yr	Mo	Dy	Time	ENDING DATE			Type	Freq					
																		Mo	Dy	Time							
		X				X									86	07	22	1530	07	22	1530			HATZEL 5 Points Along St - Composite #STC-C5-7/86 CHARTER			
		X				X									86	07	22	1700	07	22	1715			City Landfill - Composite from 10 Points #STC-C6-7/86 - CHARTER			
		X				X									86	07	23	1050			1104			Newsp. Bt Comp - #STC-C7-7/86			
		X				X									86	07	23	1120			1126			off STC - Spr Comp - #STC-C8-7/86			
		X				X									86	07	23	1130						Background - Sat. St. - STC-C9-7/86 *Composite of 5 points			

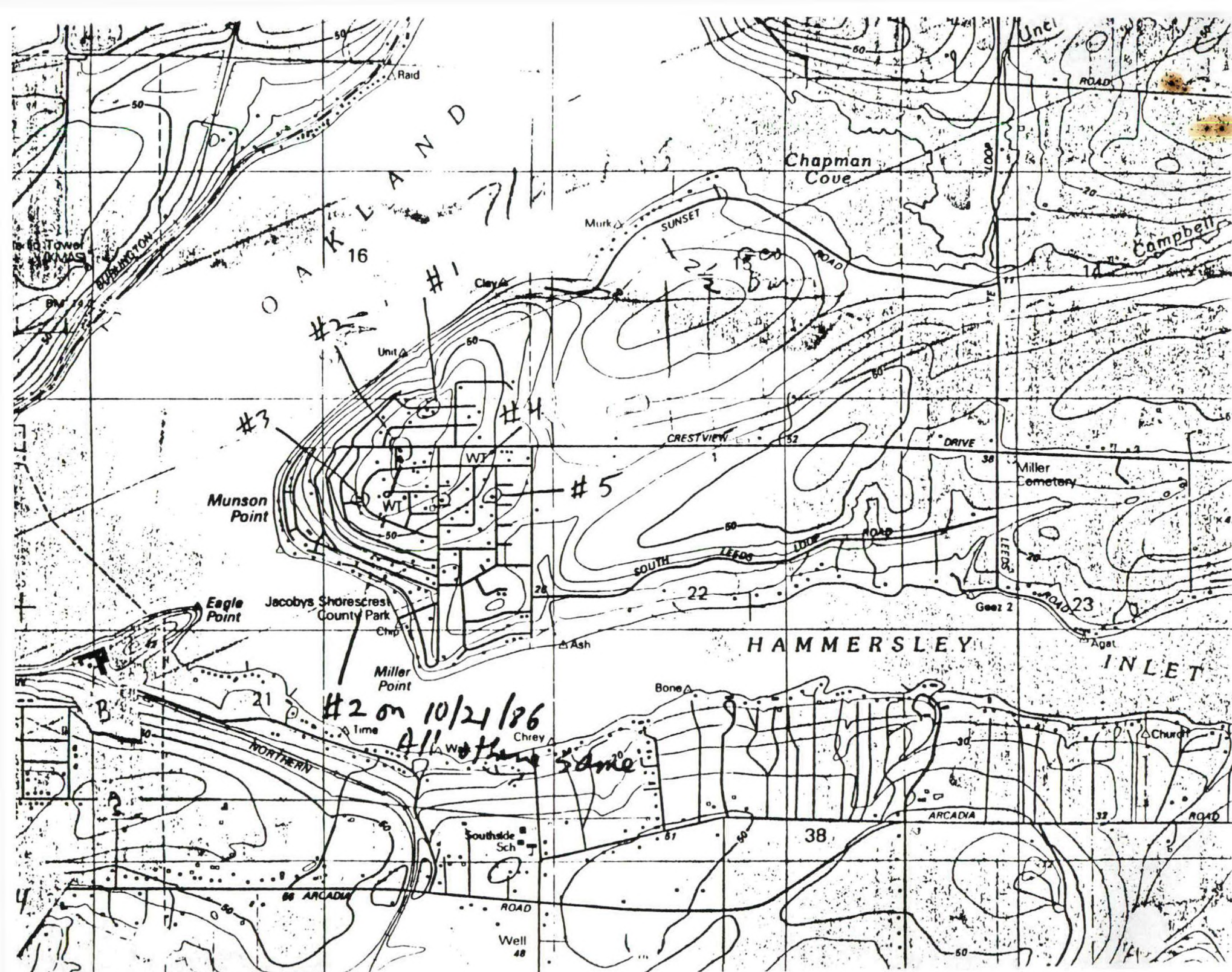
LAB NUMBER			DEPTH	UNIT TYPE	COL MTD CD	QA CODE	TEMP DEG C	pH	CNDCTVTY umho/cm	MISCELLANEOUS	CHAIN OF CUSTODY RECORD	
Yr	Wk	Seq									RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)
											RELINQUISHED BY: (Signature) <i>David A. Little</i> RECEIVED BY: (Signature) <i>Barbara Haynes</i> 7/28/60 12:40 DATE/TIME	
											RELINQUISHED BY: (Signature) <i>Barbara Haynes</i> RECEIVED BY: (Signature) <i>David A. Little</i> 7/28/60 14:30 DATE/TIME	
											RELINQUISHED BY: (Signature) <i>David A. Little</i> RECEIVED BY: (Signature) <i>David A. Little</i> 7/28 11:00 DATE/TIME	
											RELINQUISHED BY: (Signature) <i>David A. Little</i> RECEIVED BY: (Signature) <i>John P. ...</i> 7/28/60 DATE/TIME	
											DISPATCHED BY: (Signature) <i>John P. ...</i> 7/28/60 DATE/TIME	
											RECEIVED FOR LAB BY: (Signature) <i>Chris Rodriguez</i> 7/28/60 10:30 DATE/TIME	
											METHOD OF SHIPMENT <i>Fed Express</i>	

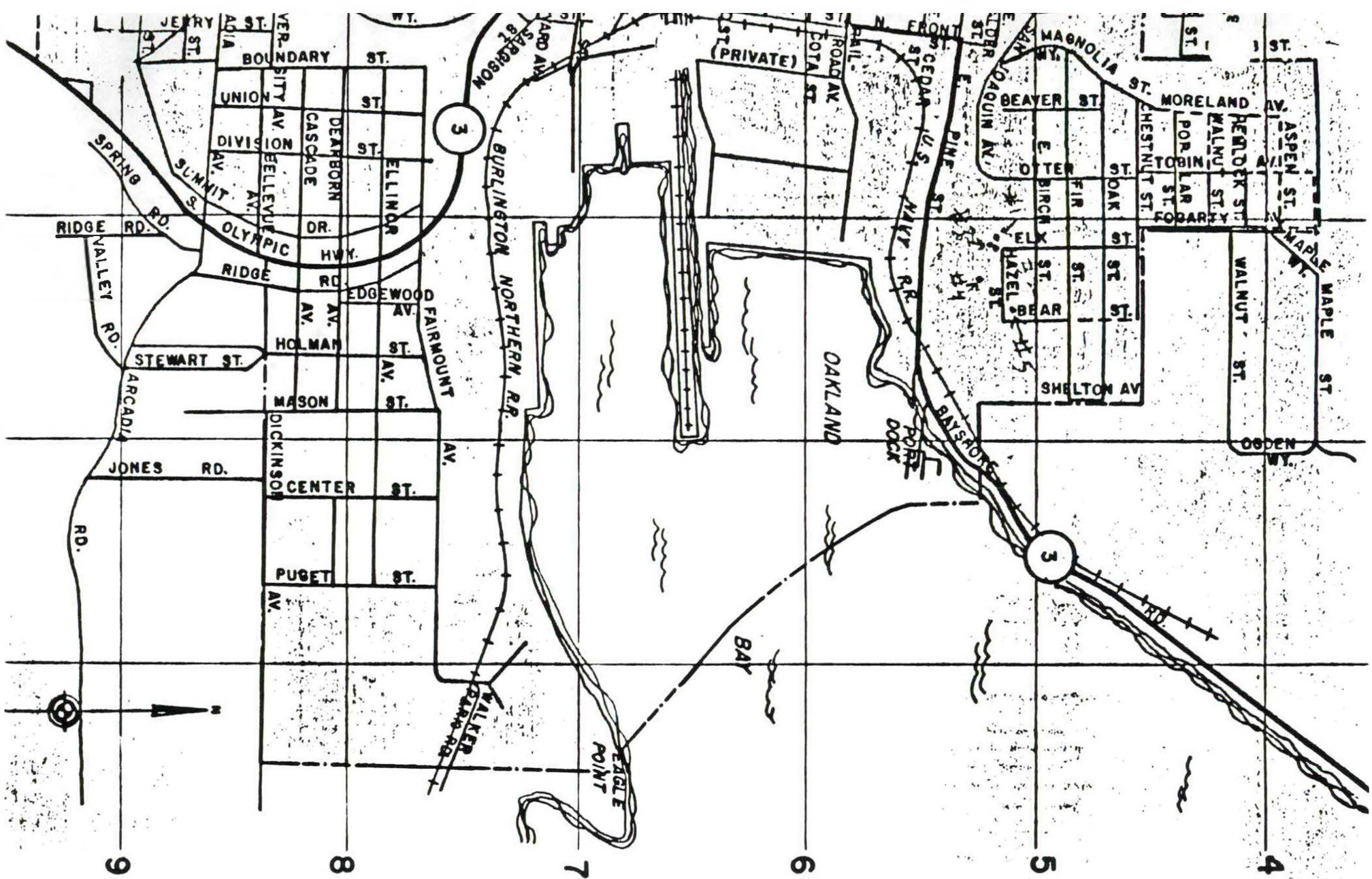
Laboratory Copy White	Project Office Copy Yellow	Field or Office Copy Blue
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1933
Summit Dr. 5th St
Near Highway 45. End
of gravel pit S. of Kemo Auto Body
#4 Tacoma
#5 1st St

1st St
Pioneer St
Division St
Olympic St
Ridge Rd
Stewart St
Jones Rd
Pugget St
Walker Rd
Point





APPENDIX D

SAMPLING PROCEDURES
SAMPLING HANDLING
SAMPLE PRESERVATION AND SHIPMENT

SAMPLE CONTAINERS AND SAMPLING EQUIPMENT

PRE-CLEANING

All sample containers were cleaned by California Analytical Laboratories before being sent to CH2M HILL. The cleaning procedure is as follows:

1. Wash with TSP (1 pound TSP to 10 gallons of water)
2. Rinse with clean tap water
3. Rinse with pesticide grade acetone
4. Rinse with pesticide grade hexane
5. Rinse with pesticide grade acetone
6. Rinse with deionized water
7. Air dry
8. Bake at 150°C for at least 2 hours

The tulip bulb planters, shelby tubes, and stainless steel scoops, mixing bowls, and measuring cups were cleaned in the same way at CH2M HILL except that they were air dried and then wrapped in aluminum foil. The ponar dredge was cleaned by rinsing with tap water before use and by rinsing with ambient water in the field. Sediment collected from the dredge had not been in contact with the dredge itself.

All samples were shipped in 1/2-quart wide-mouth glass jars. The jars had screw-type lids lined with either teflon or aluminum foil. Contact of the sample with a plastic or paper liner was avoided.

SAMPLE COLLECTION (AMBIENT SOIL AND SLUDGE)

At each location, vegetation was trimmed to a length of 1/2 inch or less with a hand clipper, or removed by hand. A plug of soil 2 to 3 inches long was extracted with a tulip bulb planter and placed into a stainless-steel mixing bowl. Large objects (sticks, roots, and rocks) were removed from the samples.

After combining the cores from all locations and obtaining a 1/2 quart sample, the surplus was returned to the last location sampled.

¹This procedure differs from the procedure described in the "Quality Assurance Plan" for the Tiers 3, 5, 6, and 7 National Dioxin Study (USEPA, July 23, 1984).

Soil was sampled using a directed approach. The U.S. EPA determined three areas where deposition of particulates is likely from the STC facilities (Figure 5). Within each of those areas, five soil samples were collected using a tulip bulb planter and combined in the field to obtain one composite sample. The specific locations sampled were selected on the following basis:

1. Elevation; higher elevations within the areas designed by EPA were preferred.
2. Vegetative cover and present and past use; areas likely to be contaminated from other sources (pesticides, fires, dust control) will be avoided. Given the natural and human history of the region, it cannot be determined that an area was never affected by fire, but sites showing evidence of recent fires were avoided.
3. Access, and presence of good landmarks.

CONTAINERS AND EQUIPMENT (SOIL AND SLUDGE)

Each sludge or soil site that is sampled will require the following pre-cleaned equipment:

- o One tulip bulb planter
- o One stainless-steel mixing bowl
- o One mixing spatula
- o Sample jars
- o One stainless steel plunger
- o One hand clipper
- o One sample jar (one-half quart, wide-mouth, glass)

SAMPLE HANDLING (SOIL AND SLUDGE)

During sample handling, exposure of personnel and the environment outside the immediate sampled area was avoided by conducting compositing and container filling at the sampling locations, and by ensuring that sample contact with the outside of the container was minimized. The latter was accomplished by securing a plastic bag around the container with a rubber band before it was filled. The container was then capped, the plastic bag removed, and the sample label applied to the clean exterior of the container. During sample handling, there was no transferring of samples from one container to another in order to reduce exposure of personnel and avoid potential loss of dioxin which readily adsorbs to the walls of glass containers.

Individual cores were forced from the Shelby tube into a stainless steel mixing bowl with a stainless steel plunger. During mixing of the samples and filling the sample jar exposure to direct sunlight was avoided. Large solid objects were removed from the sample.

SAMPLE PRESERVATION AND SHIPPING (SOIL AND SLUDGE)

Field data forms and sample labels were filled out at the sampling site. Sampling locations were documented on the field data forms by the use of landmarks (trees, buildings, etc.) and photographs of the sites that include reference landmarks (photographs are on file at STC). The sampling locations were described in sufficient detail that they can be re-visited at a later date, if necessary.

Chain-of-custody forms (Figure D-1) were filled out at the sampling site, but not necessarily at the immediate sampling area.

Sampling equipment was washed with TSP and water, and rinsed with tap water at the sampling location and the wash and rinse water disposed of at the site (on the gravel fill immediately adjacent to (southeast of) the sludge area at the City landfill).

Sludge and soil samples were shipped to the laboratory at ambient temperatures and kept in the dark, away from direct sunlight until they were prepared for analysis. Sample containers were sealed in the field with a tamper-proof seal.

Sample Collection (Sediment)

Sediment samples were collected from sub-tidal, soft-sediment, areas near both sewage plant outfalls. Areas of soft sediment nearest the outfalls were considered to be the areas of most likely deposition of particulates discharged from the sewage treatment plants.

Five samples were collected with a ponar dredge from each area sampled. A sub-sample of the sediment in the dredge was obtained by placing the sample in a wash tub and inserting a teflon coring tube. Material from near the sediment-water interface was obtained without sub-sampling sediment that had been in contact with the walls of the dredge. The subsample was extruded from the coring tube into a stainless steel measuring cup. Sufficient cores were taken from each dredge sample to fill an 8-ounce (237-cc) measuring cup.

SAMPLING EQUIPMENT (SEDIMENT)

Collection of sediment required the following pre-cleaned equipment.

- o One wash tub
- o One ponar dredge

- o Two 2-inch diameter teflon coring tubes
- o Two stainless steel mixing bowls
- o Two mixing spatulas
- o Two sample jars (1 quart, wide-mouth, dark glass)
- o Two pre-cleaned stainless steel plungers
- o One bucket (for pouring rinse water over the soiled equipment)
- o Sample jars (1/2-quart wide mouth glass)

SAMPLE HANDLING (SEDIMENT)

The sediment from the measuring cup was placed in a stainless-steel mixing bowl and combined with the 8-ounce samples from the other four dredge samples. The sediment from the five dredge samples was mixed in the mixing bowl to obtain a one-half quart sample. All transfer and mixing of sediment was done without exposing the sediment to direct sunlight.

Sample containers were kept clean as described above under "sludge." Samples were not transferred from one glass container to another.

The ponar dredge was washed with TSP and water and rinsed with ambient seawater after collecting each sample. A different pre-cleaned stainless-steel measuring cup and teflon coring tube was used at each location (outfall). Excess sediment was rinsed from all sampling equipment at the sampling location with ambient water which was discarded. The equipment was washed with TSP and water and rinsed with tap water. The wash and rinse water were also discarded at the site.

Field data forms and sample labels were filled out at the sampling site or while en route to the next site. Sampling locations were documented by sightings to at least two prominent shoreline landmarks. Photographs of the landmarks were taken from each sampling location to show the position and perspective of the landmarks as viewed from the sampling locations. Photographs are on file at STC. Chain-of-custody forms were filled out before sampling another location.

Sample Preservation and Shipping (Sediment)

Sediment samples were protected from light, shipped on ice, and stored at 4°C in the dark until extracted by the

laboratory. Sample jars were sealed in the field with tamper-proof seals.

Sample Handling (Soil)

The cores obtained with the tulip bulb planter were placed into a stainless steel mixing bowl to obtain a composite sample. The samples were kept out of direct sunlight during all collecting and handling procedures. The five cores were mixed in the bowl, and a one-half quart portion placed into the sample jar. The jar was kept clean as described under "sludge." Excess soil was returned to the last location sampled. Wash water and TSP, and rinsate (tap water) used to clean the sampling equipment was disposed of by pouring on the ground at the last sampling location.

Field data forms and sample labels were filled out at the sample locations. The chain-of-custody form was filled out before obtaining the next sample.

Sample Preservation and Shipping (Soil)

Soil samples were protected from light, shipped and stored in the dark until extraction for analysis. Sample jars were sealed in the field with tamper-proof seals.

Soil Blank Sample and Performance Sample

One soil blank sample was placed in a sample jar, numbered as an ordinary sample, and shipped to the laboratory for analysis. One performance sample with known amounts of dioxins and furans was also be shipped and analyzed.

The soil blank and performance samples were provided by the USEPA.

BOILER AND BAGHOUSE RESIDUE

STC facilities were sampled on May 15, 1986, prior to receipt of sampling and quality control procedures from EPA.

This was done to provide STC with information needed for prompt decisions concerning disposal of cyclone residue from the new power plant, and to provide information for planning the demolition of the old facilities.

Pre-cleaning of the sampling equipment differed from the procedure described by EPA in the Tier 4 and Tier 7 sampling plans in detail but not in effect. Sample jars were cleaned by California Analytical Laboratories and used as received by CH2M HILL (see the Sampling Plan, Appendices E and F). Field equipment (hand trowels) were cleaned by washing with TSP in water (1 pound per 10 gallons of water), rinsing with

tap water, rinsing with pesticide grade acetone, three rinses with deionized water, and air drying.

Sample Collection

Samples were collected as described in the text of this report.

Containers and Equipment

The following containers and equipment were used for collecting samples from STC facilities.

1. Hand trowels
2. One-quart wide-mouth sample jars provided by the laboratory (the sample jars had screw-cap lids lined with aluminum foil).

Sample Handling

The sample jars were capped at the sampling locations. The outside of the jars and the hand trowels were wiped clean of all visible contamination at the site. Closed sample jars may have experienced some brief (seconds to 3-minutes) exposure to sunlight during labeling. Sample jars were placed in steel cans with pressure lids. The lids were sealed with locking clips and the samples shipped to the laboratory at ambient temperatures in a cooler packed with vermiculite.

Jar labels and field notes were filled out at the site. Chain-of-custody forms were filled out at CH2M HILL's office on the day of sampling, at which time the shipping container was sealed with a tamper-proof seal.

QUALITY ASSURANCE/QUALITY CONTROL

QUALITY CONTROL

EPA's QA/QC procedures for the Tier 4 and Tier 7 dioxin study were reviewed and incorporated where feasible. Laboratory QC procedures have been supplied by California Analytical Laboratories (Sampling Plan, Appendixes E and F).

SAMPLE HANDLING

Sample containers, chain-of-custody, decontamination, packaging, and shipping are described previously.

Containers

All containers were provided by the laboratory. Container type conformed with the appropriate analytical methods for the parameters specified.

Documentation of Chain-of-Custody

All samples collected conformed to accepted chain-of-custody procedures. The elements of the chain-of-custody program used are as follows:

Sample Labels. Sample labels were necessary to prevent mis-identification of samples. All containers bore a label containing the following information:

- o Facility name
- o Sample identification number
- o Name of person collecting sample
- o Date and time of collection
- o Location of sample
- o Sample Matrix

Labels were affixed to sample containers prior to or at the time of sampling. The labels were filled out at the time of collection.

Field Logbook. All information pertinent to the field sampling was recorded in a field logbook. The field team manager was responsible for entering information into the logbook. At a minimum, the logbook included the following information:

- o Location of sampling point
- o Type of waste, process or media being sampled
- o Sample identification and estimated volume of sample
- o Description of sampling point and method of sample collection
- o Date and time of collection
- o Field observations of sample (e.g., color, odor, or other characteristics)
- o Results of any field measurements (e.g., pH, temperature, dissolved oxygen, conductivity, etc.)
- o Other relevant information, as appropriate

- o Signature of personnel responsible for observations

Security of the logbook was maintained by the field sampling manager.

Chain-of-Custody Record. Chain-of-custody records were maintained for every sample collected. Sample custody will be maintained until the samples were either shipped to or relinquished directly to the laboratory custodian. A sample of the chain-of-custody form used is illustrated in Figure D-1.

Decontamination

The following decontamination procedures were followed for all sampling equipment, except as described earlier:

- o Trisodium phosphate (TSP) solution wash. Wash mixture was one pound of TSP per 10 gallons of water and clean water rinse.
- o Pesticide-grade hexane rinse
- o Methanol rinse
- o Triple-distilled water rinse
- o Equipment allowed to air dry

Packaging and Shipping

Samples were placed inside a cooler. Void space was filled with vermiculite. As necessary for sample preservation, sample shipping containers (i.e., ice chests) were filled with an adequate quantity of dry ice or other cooling agent to ensure samples remained cold during shipment to the laboratory (see earlier sections).

Chain-of-custody forms accompanied the samples during shipment. All samples shipped to the laboratory were confirmed with the laboratory custodian prior to shipment as well as after receipt by the laboratory.

SITE SAFETY PLAN

The site safety plan to be followed during sampling is contained in Appendix D of the sampling plan (CH2M HILL, 1986).

LABORATORY QUALITY-CONTROL PROCEDURES

Quality-assurance and quality-control procedures supplied by California Analytical Laboratories are presented in Appendices E and F of the sampling plan (CH2M HILL, 1986).

APPENDIX E

SOILS LABORATORY DATA

Environmental Laboratory
Date: September 4, 1986
Project No.: S18303.B6
Page 1 of 1

CLIENT: Simpson Timber

Subject: Analysis of soil samples received August 12, 1986,
and assigned reference numbers 3343-1 through 3343-9.
Samples were analyzed on an as-received basis and
calculated to a dry basis.

<u>CVO Laboratory Identification</u>	<u>Soil Number</u>	<u>TOC as ppm</u>
3343-1	CLC-19	1,220
3343-2	CLC-13	4,020
3343-3	CLC-14	3,940
3343-4	CLC-15	3,770
3343-5	CLC-16	4,020
3343-6	CLC-17	3,220
3343-7	CLC-18	1,960
3343-8	DLC-7	11,500
3343-9	DLC-8	7,320
3343-10	DLC-9	7,460
3343-11	DLC-10	51,100
3343-12	DLC-11	32,900
3343-13	DLC-12	16,500
3343-14	MLC-1	14,400
3343-15	MLC-2	2,940
3343-16	MLC-3	1,950
3343-17	MLC-4	1,140
3343-18	MLC-5	31,400
3343-19	MLC-6	24,700

All tests are performed in accordance with current Environ-
mental Protection Agency guidelines as published in the
Federal Register. Samples will be retained for 30 days
unless otherwise requested.

The information shown on this sheet is test data only, and
no interpretation is intended or implied.

Lawrence J. Jacoby, Ph.D.
Environmental Laboratory Manager

<u>Sample Number</u>	<u>Gross Mass</u>	<u>Tare</u>	<u>Net Mass</u>	<u>Net Mass Through 2 mm</u>	<u>Percent Passing</u>
CLC-18	1,041.2	134.7	906.5	352.3	38.86
CLC-17	2,066.9	134.7	1,932.2	1,116.9	57.78
CLC-16	1,903.7	134.7	1,769.0	1,139.8	64.43
CLC-15	2,502.3	134.7	2,367.6	1,580.8	66.77
CLC-14	1,819.3	134.7	1,684.6	761.9	45.23
CLC-13	4,930.6	134.7	4,795.9	1,313.3	27.38
DLC-12	1,082.7	134.7	948.0	366.12	38.62
DLC-11	1,689.6	134.7	1,554.9	745.9	47.97
DLC-10	1,673.3	134.7	1,538.6	370.4	24.07
DLC-9	2,259.4	134.7	2,124.7	711.4	33.48
CLC-19	2,129.9	134.7	1,995.2	1,023.1	51.28
DLC-8	1,824.3	134.7	1,689.6	569.0	33.68
DLC-7	2,112.1	134.7	1,977.4	669.9	33.88
MLC-6	2,117.3	134.7	1,982.6	743.6	37.51
MLC-5	1,652.5	134.7	1,517.8	714.3	47.06
MLC-4	4,975.9	134.7	4,841.2	955.8	19.74
MLC-3	3,225.1	134.7	3,090.4	540.6	17.49
MLC-2	2,610.8	134.7	2,476.1	632.4	25.54
MLC-1	2,424.1	134.7	2,289.4	572.5	25.01

PROJECT DESCRIPTION: _____

MATERIALS LABORATORY: SEASAMPLE LOCATION: MLC-1

SAMPLE NO. _____

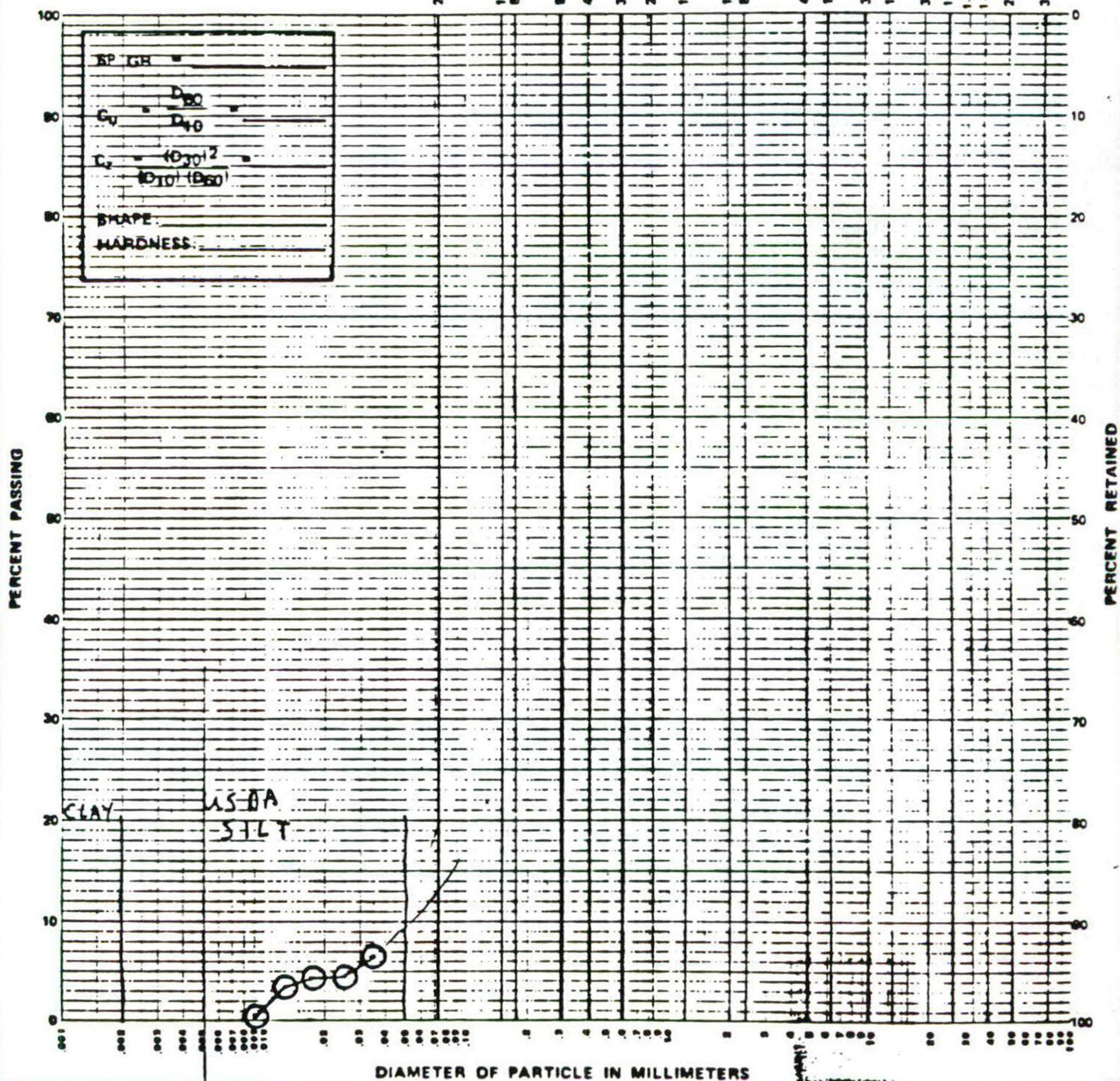
TYPE OF SAMPLE: BAG

HYDROMETER ANALYSIS

U.S. STANDARD SERIES

SIEVE ANALYSIS

CLEAR SQUARE OPENINGS



COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION: _____

TESTED BY: <u>L KANE</u>	DATE: <u>2/5/86</u>	COMPUTED BY: <u>L KANE</u>	DATE: <u>8/13/86</u>	CHECKED BY:	DATE:
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PARTICLE SIZE ANALYSIS

ASTM D422

PROJECT DESCRIPTION: _____
 MATERIALS LABORATORY: SEA
 SAMPLE LOCATION: MLC-2 SAMPLE NO. _____
 TYPE OF SAMPLE: ENG

HYDROMETER ANALYSIS		SIEVE ANALYSIS											
		U.S.A. STANDARD SERIES											
		CLEAR SQUARE OPENINGS											
		2 1/2" 2" 1 1/2" 1 1/4" 1" 3/4" 3/8" 1/2" 3/16" 1/4" 1/8" 1/16" 1/32"											
100	SP GR												
80	D ₈₀ C _u D ₄₀ C _c (D ₃₀) ² (D ₁₀) (D ₆₀)												
60	SHAPE												
40	HARDNESS												
20													
0													
100													
DIAMETER OF PARTICLE IN MILLIMETERS													

COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION: _____

TESTED BY: <u>L KANE</u>	DATE: <u>8/13</u>	COMPUTED BY: <u>L KANE</u>
DATE: <u>8/22</u>	CHECKED BY:	DATE:

PROJECT DESCRIPTION: _____

MATERIALS LABORATORY: SEASAMPLE LOCATION: MLC-3

SAMPLE NO. _____

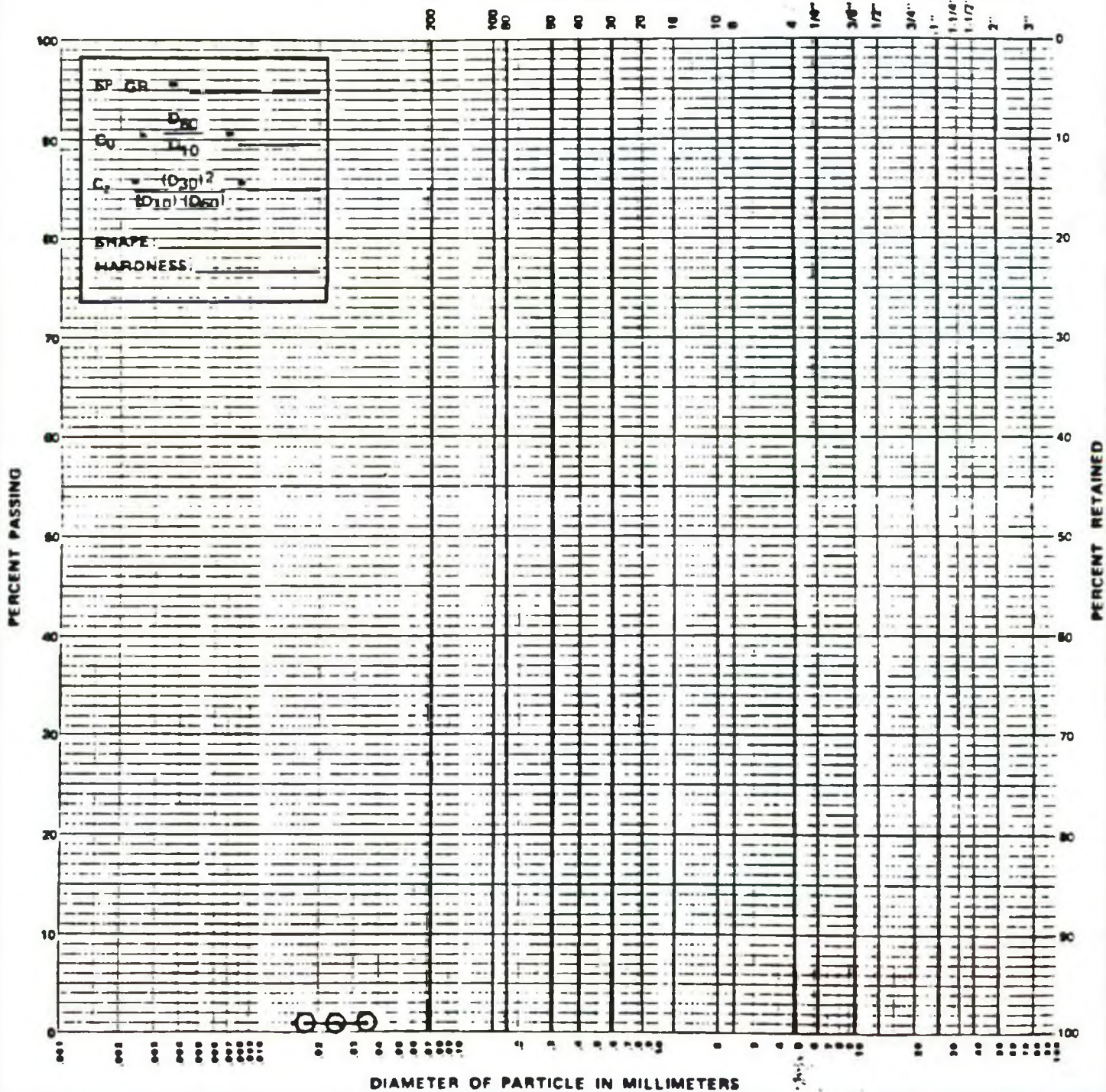
TYPE OF SAMPLE: BAG

HYDROMETER ANALYSIS

USA STANDARD SERIES

SIEVE ANALYSIS

CLEAR SQUARE OPENINGS

COL-
LOIDS

CLAY SIZE

SILT SIZE

SAND

FINE

MEDIUM

COARSE

GRAVEL

COBBLES

SAMPLE CLASSIFICATION _____

TESTED BY:

DATE:

COMPUTED BY:

DATE:

CHECKED BY:

DATE:

L KANE 8/12

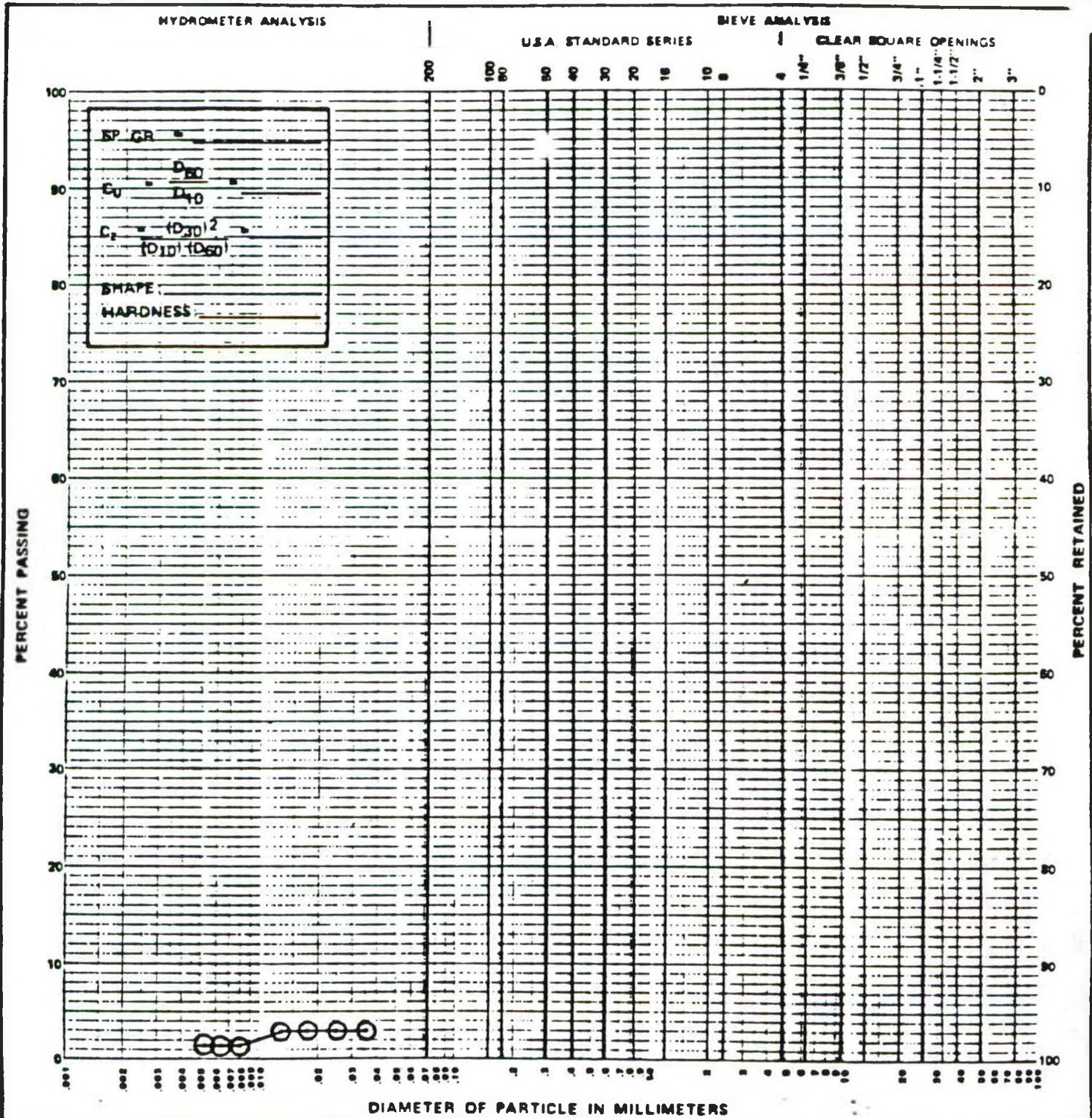
L KANE

8/12

PARTICLE SIZE ANALYSIS

ASTM D422

PROJECT DESCRIPTION: _____
 MATERIALS LABORATORY: SEA
 SAMPLE LOCATION: ULC-4 SAMPLE NO. _____
 TYPE OF SAMPLE: BAG



COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		
SAMPLE CLASSIFICATION _____							
TESTED BY: <u>L KANE</u>		DATE: <u>8/12</u>		COMPUTED BY: <u>L KANE</u>		DATE: <u>8/12</u>	
				CHECKED BY:		DATE:	

PARTICLE SIZE ANALYSIS

ASTM D422

PROJECT DESCRIPTION: _____

MATERIALS LABORATORY: _____

SAMPLE LOCATION: _____

SAMPLE NO. _____

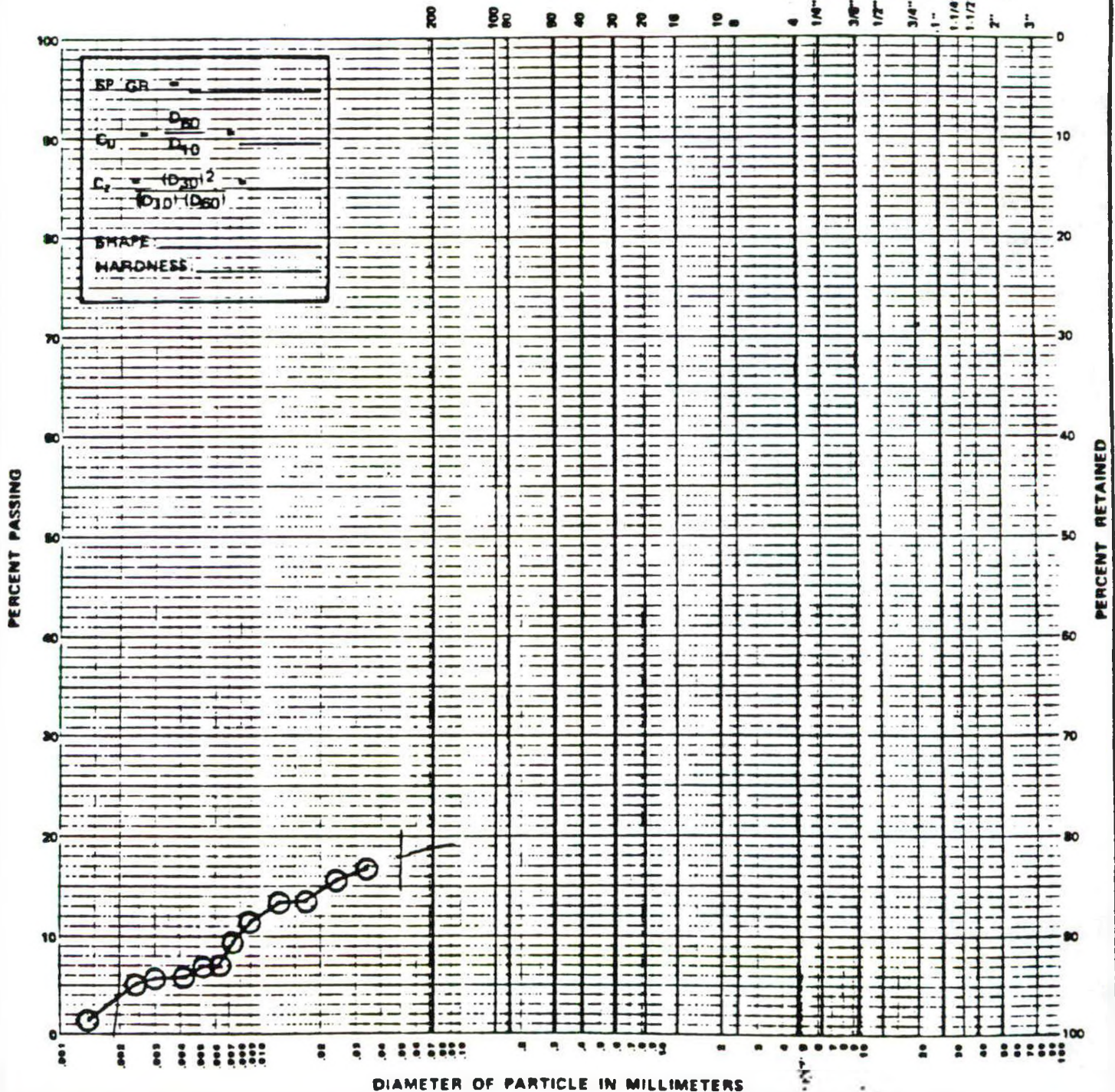
TYPE OF SAMPLE: _____

HYDROMETER ANALYSIS

SEVE ANALYSIS

USA STANDARD SERIES

CLEAR SQUARE OPENINGS

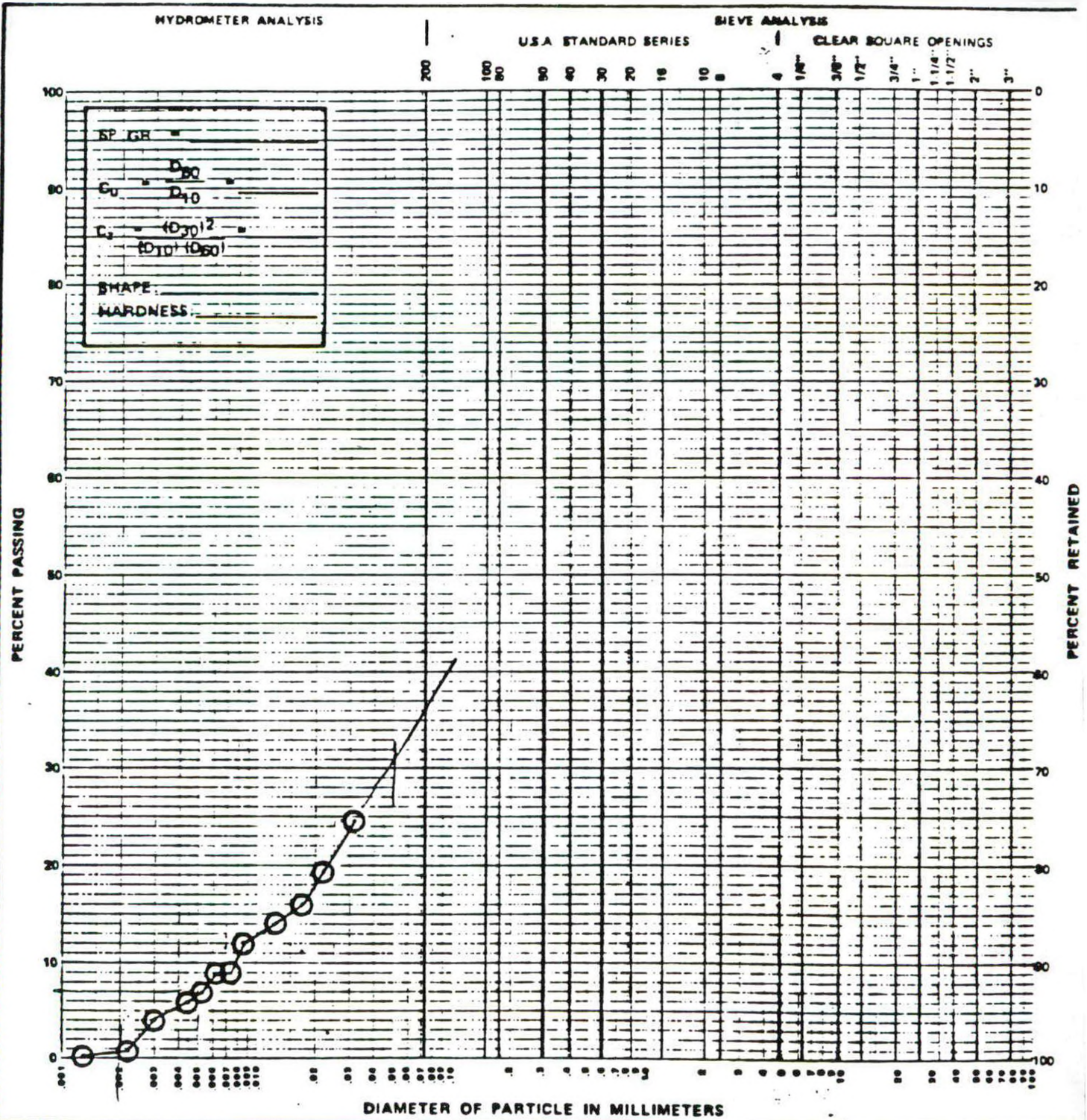


COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION _____

TESTED BY: LAURA KANE	DATE: 8/1	COMPUTED BY: L KANE	DATE: 8/22	CHECKED BY:	DATE:
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PROJECT DESCRIPTION: _____
 MATERIALS LABORATORY: SEA
 SAMPLE LOCATION: DLC-7 SAMPLE NO. _____
 TYPE OF SAMPLE: BAG



COLLOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		
SAMPLE CLASSIFICATION							
TESTED BY:	DATE:	COMPUTED BY:	DATE:	CHECKED BY:	DATE:		
L. KANE	8/5/86	L. KANE	8/13/86				

PARTICLE-SIZE ANALYSIS

ASTM D422

PROJECT DESCRIPTION _____

MATERIALS LABORATORY: SEA

SAMPLE LOCATION: DLC-8

SAMPLE NO. _____

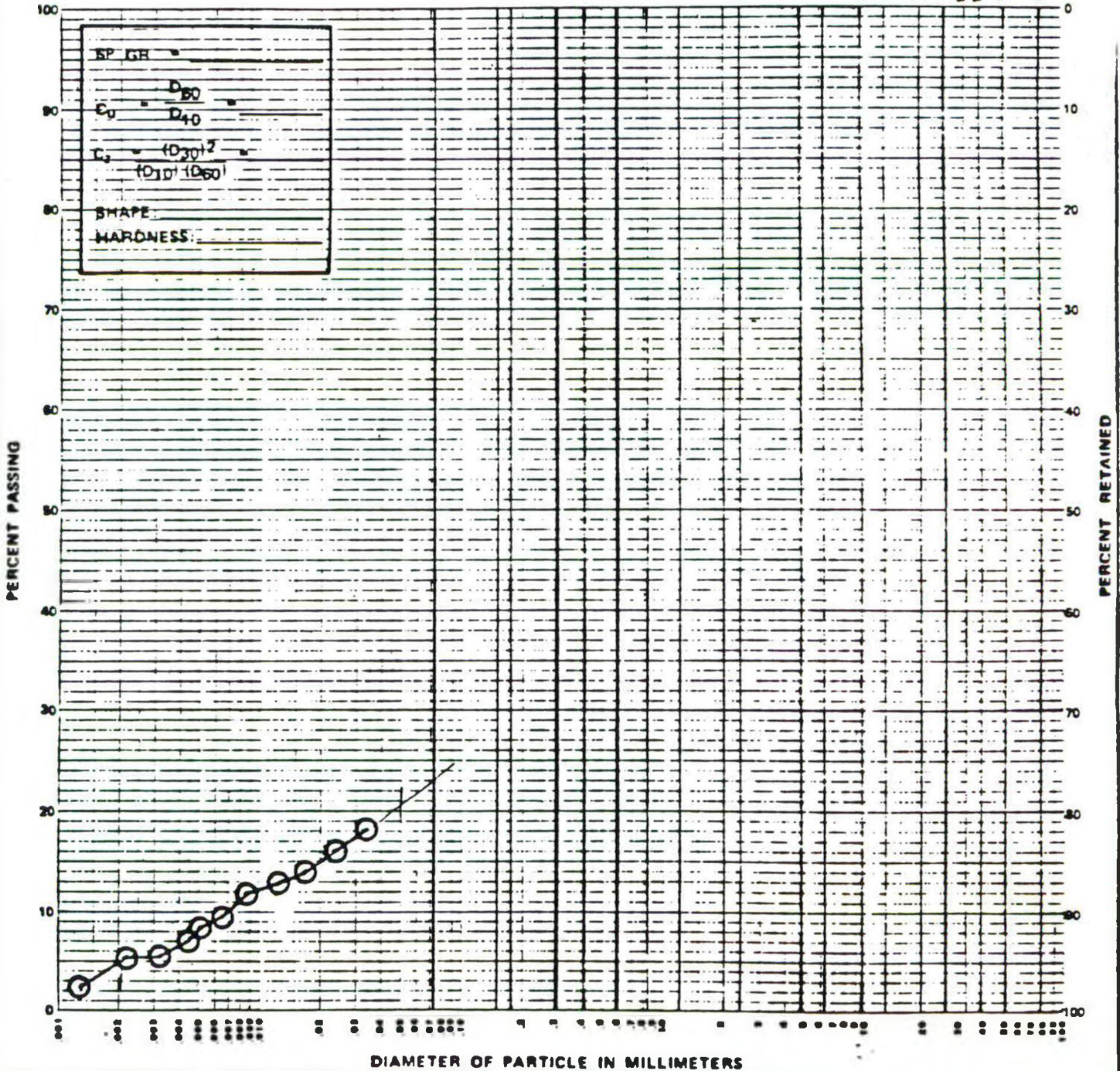
TYPE OF SAMPLE: BAG

HYDROMETER ANALYSIS

SIEVE ANALYSIS

U.S. STANDARD SERIES

CLEAR SQUARE OPENINGS



COLLOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

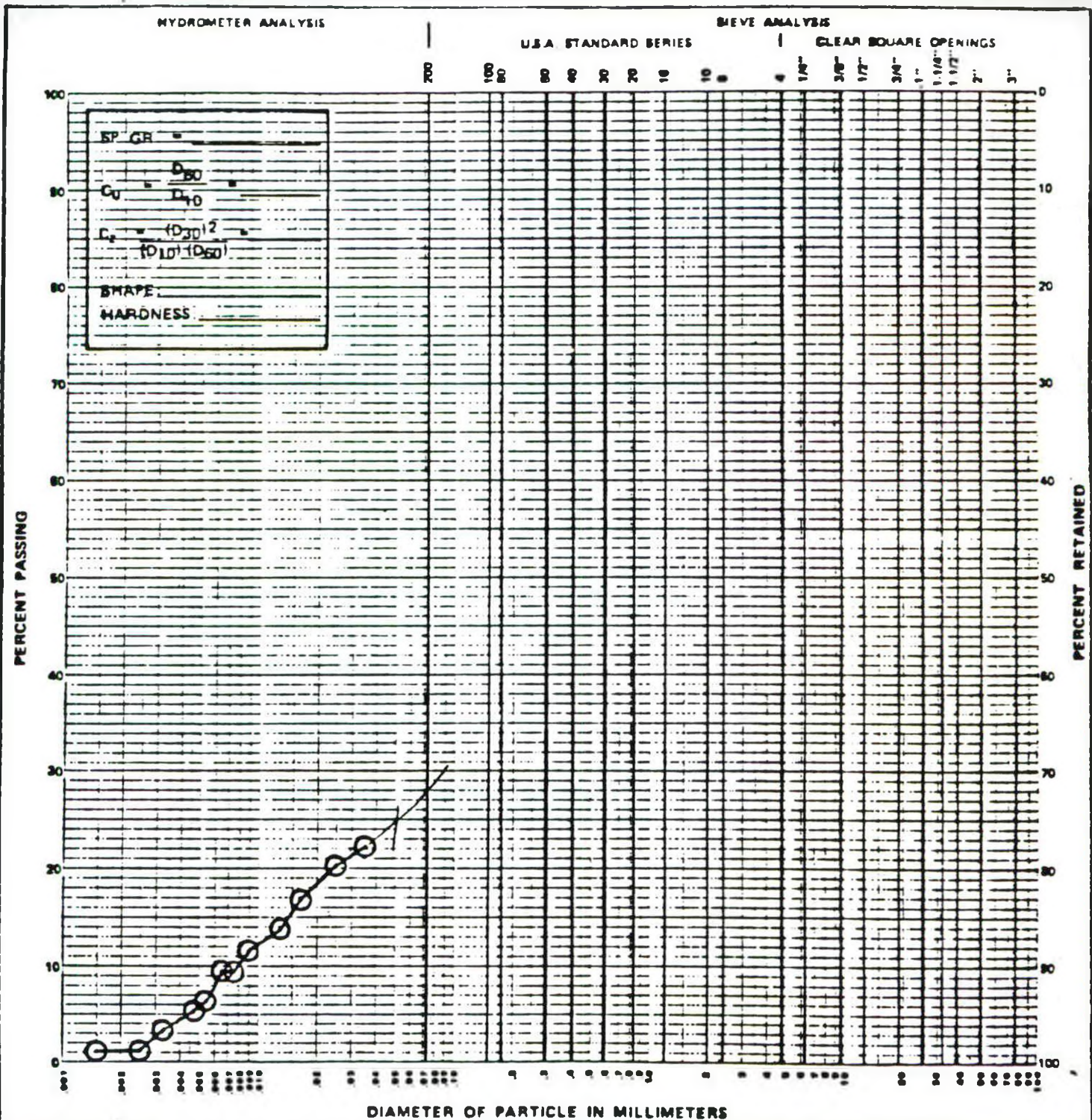
SAMPLE CLASSIFICATION _____

TESTED BY: <u>L KANE</u>	DATE: <u>8/4/86</u>	COMPUTED BY: <u>L KANE</u>	DATE: <u>8/13/86</u>	CHECKED BY:	DATE:
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PROJECT DESCRIPTION _____

MATERIALS LABORATORY: SEASAMPLE LOCATION: DLC-9

SAMPLE NO. _____

TYPE OF SAMPLE: BAG

COLLOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION _____

TESTED BY: <u>L KANE</u>	DATE: <u>8/7</u>	COMPUTED BY: <u>L KANE</u>	DATE: <u>8/22</u>	CHECKED BY:	DATE:
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PARTICLE-SIZE ANALYSIS

ASTM D422

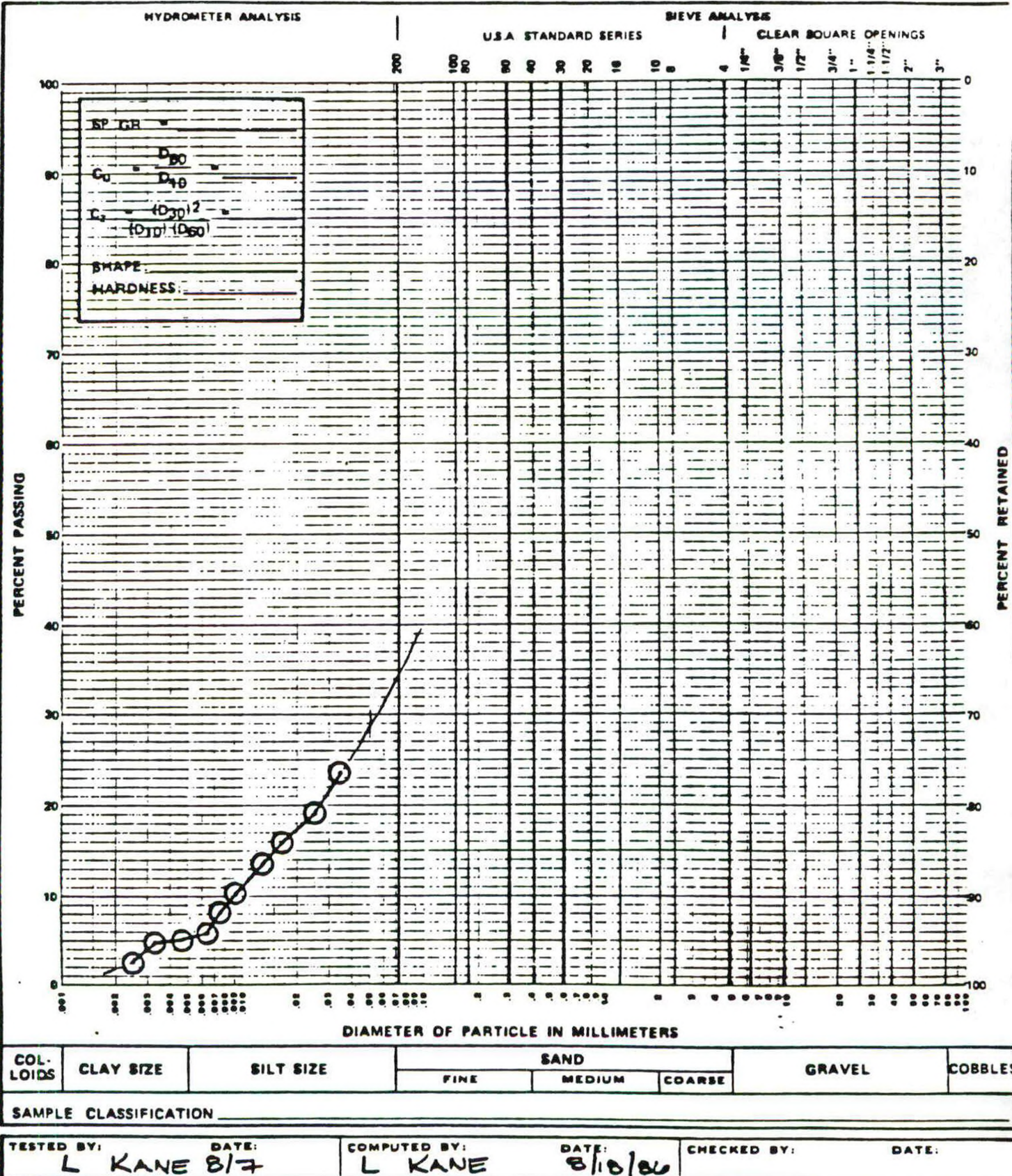
PROJECT DESCRIPTION _____

MATERIALS LABORATORY: SEA

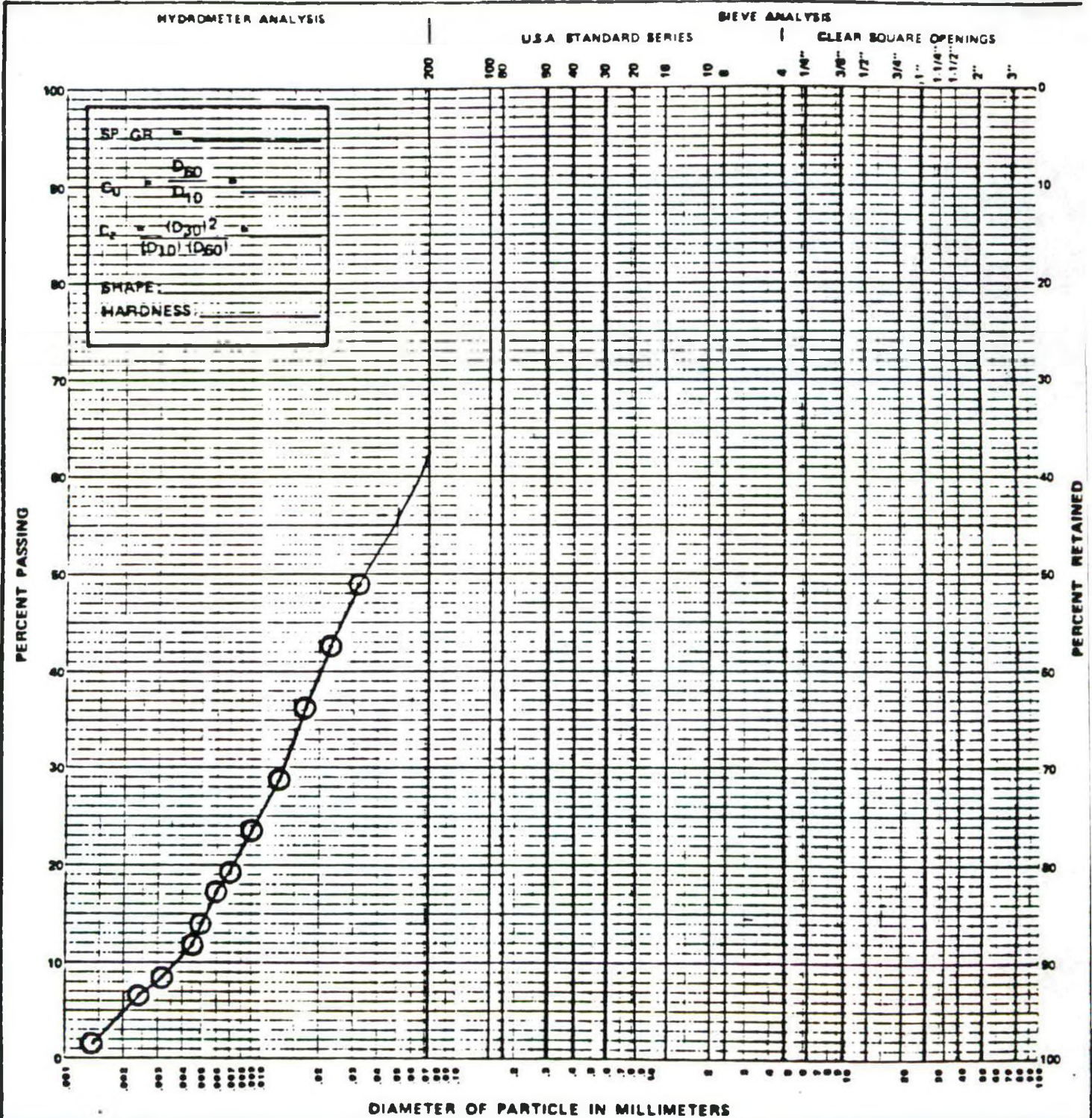
SAMPLE LOCATION: DLC-10

SAMPLE NO. _____

TYPE OF SAMPLE: BAG



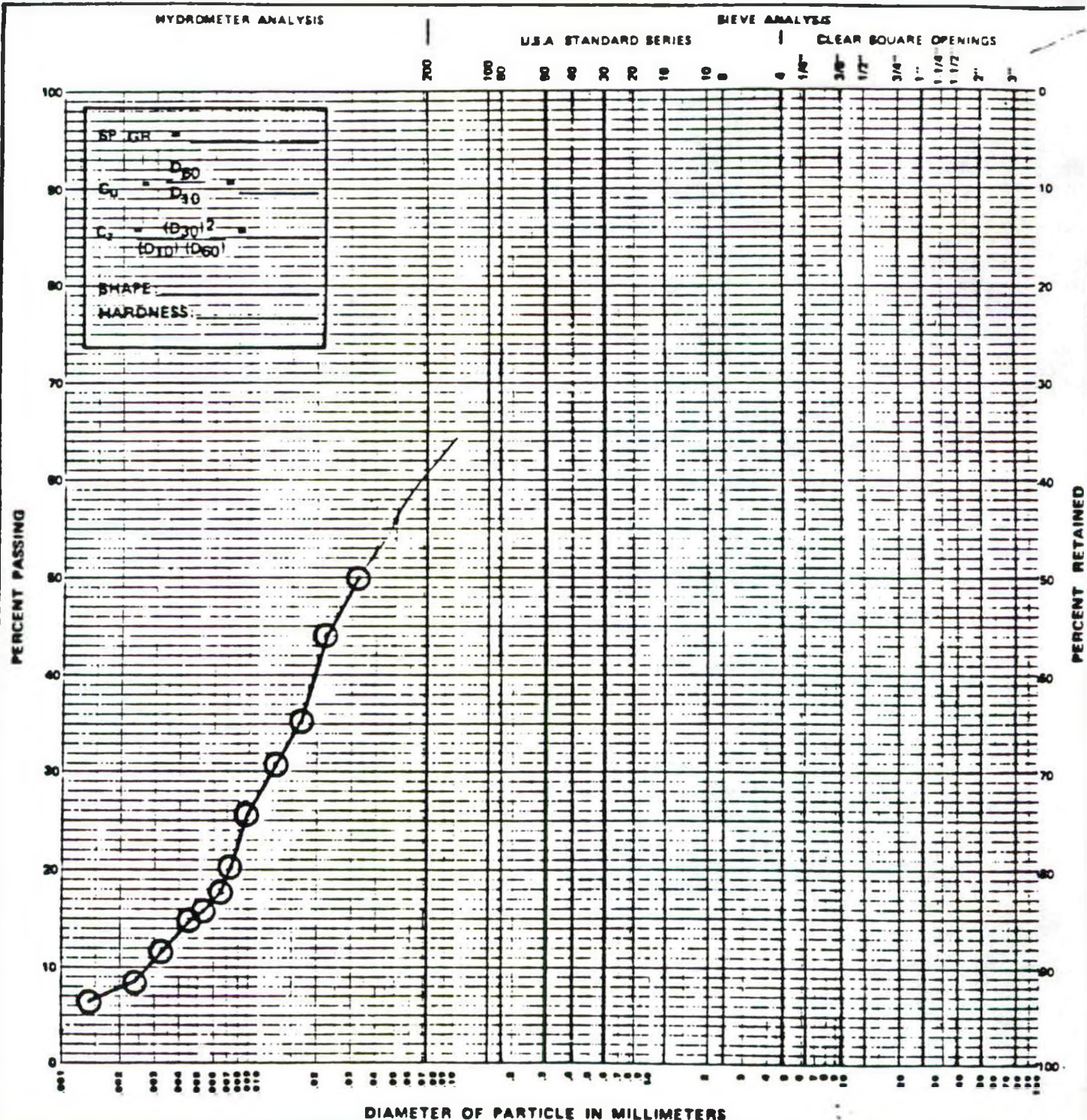
PROJECT DESCRIPTION _____
 MATERIALS LABORATORY: SEA
 SAMPLE LOCATION: DLC-11 SAMPLE NO. _____
 TYPE OF SAMPLE: BAG



PARTICLE-SIZE ANALYSIS

ASTM D422

PROJECT DESCRIPTION _____
 MATERIALS LABORATORY SEA
 SAMPLE LOCATION DLC-12 SAMPLE NO. _____
 TYPE OF SAMPLE BAG

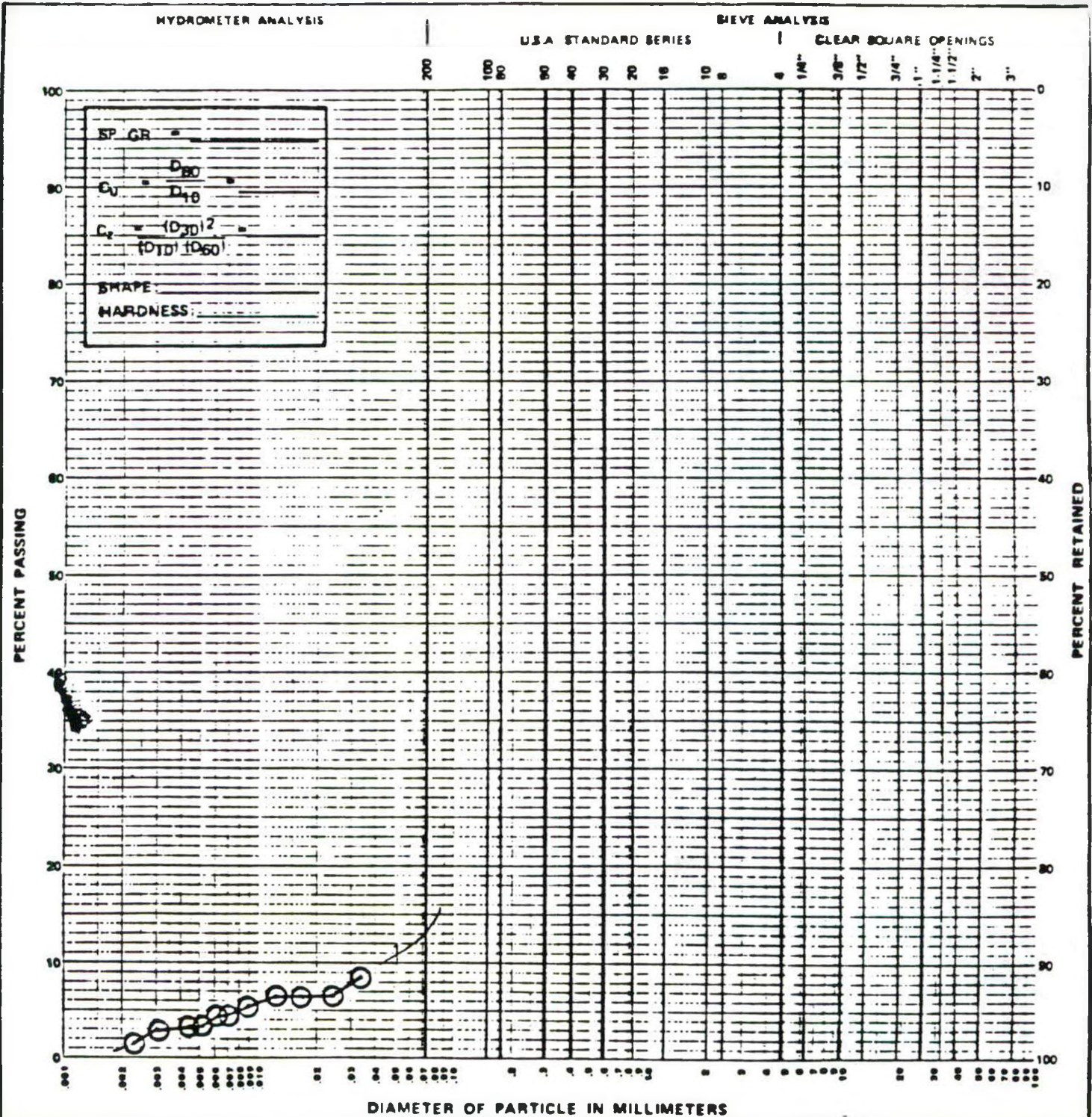


COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION _____

TESTED BY: L KANE DATE: 8/18/86 COMPUTED BY: L KANE DATE: 8/18/86 CHECKED BY: _____ DATE: _____

PROJECT DESCRIPTION: _____
 MATERIALS LABORATORY: SEATTLE
 SAMPLE LOCATION: CLC-13 SAMPLE NO. 1
 TYPE OF SAMPLE: BAG



COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION: _____

TESTED BY: LAVERA KANE DATE: 8/10/06 COMPUTED BY: L KANE DATE: 8/25/06 CHECKED BY: _____ DATE: _____

PARTICLE-SIZE ANALYSIS

ASTM D422

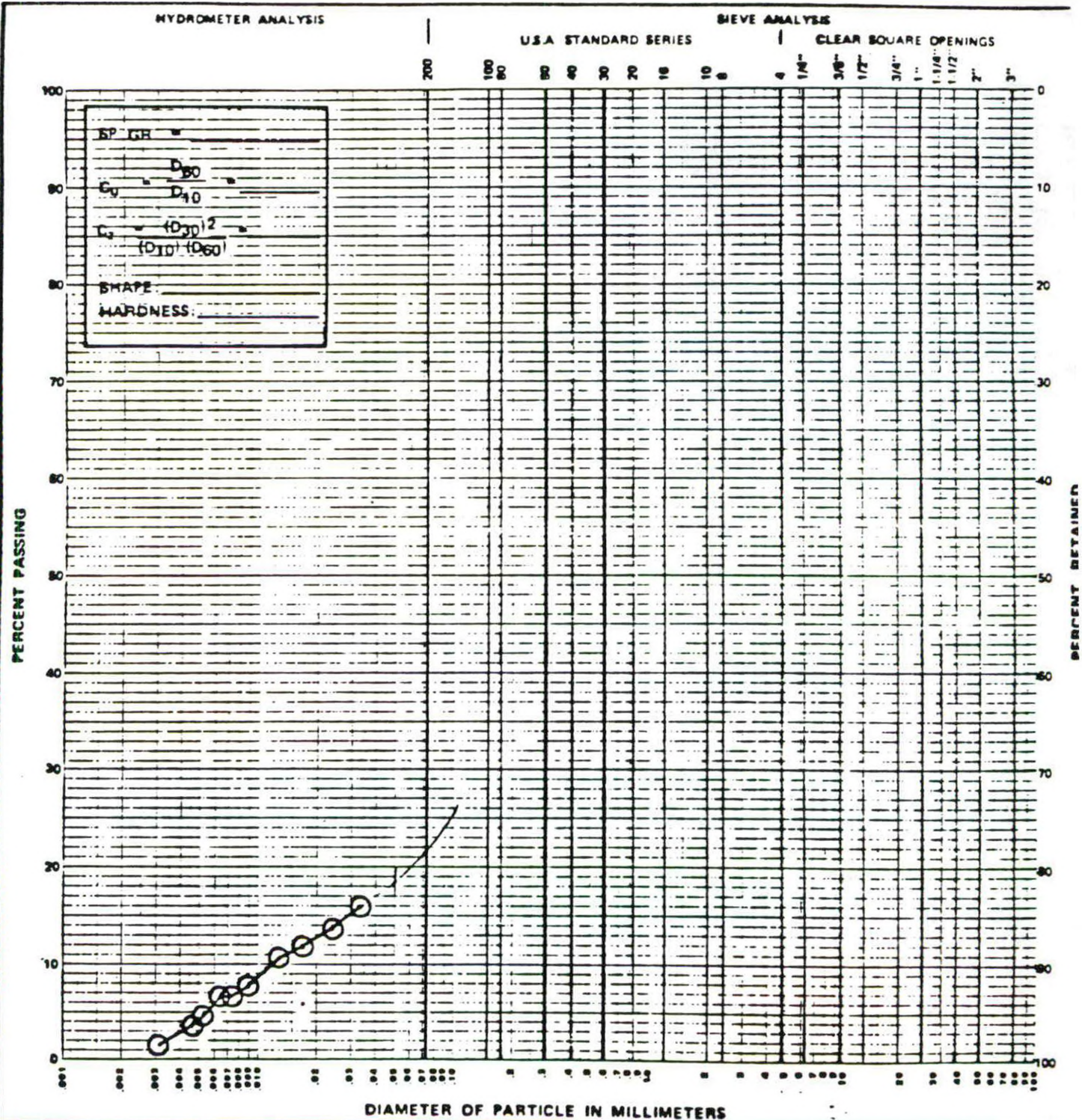
PROJECT DESCRIPTION: _____

MATERIALS LABORATORY: SEA

SAMPLE LOCATION: CLC-14

SAMPLE NO. _____

TYPE OF SAMPLE: BAG



COLLOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION: _____

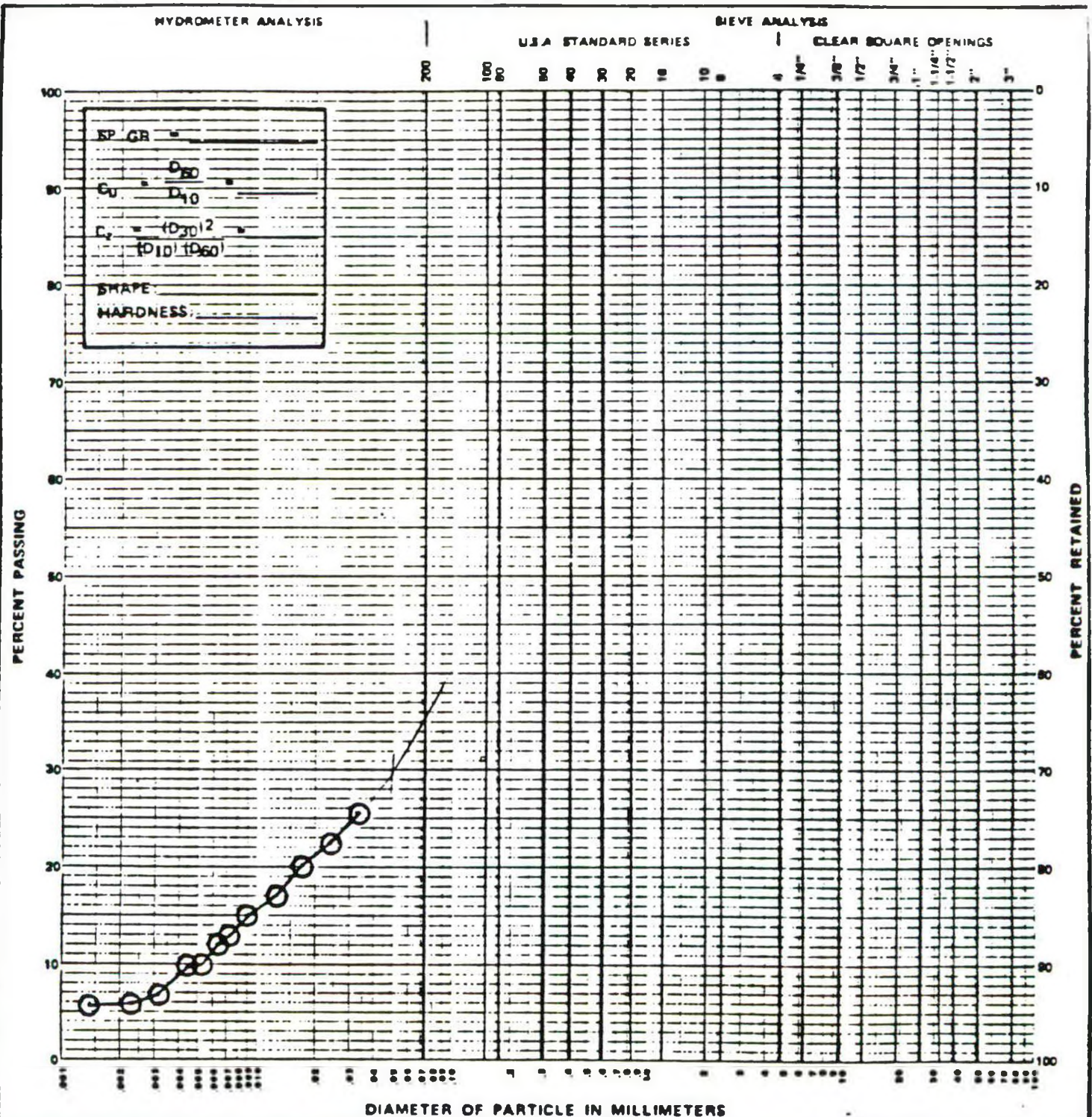
TESTED BY: L KANE DATE: 8/15

COMPUTED BY: L KANE DATE: 8/22

CHECKED BY: _____ DATE: _____

ASTM D422

TYPE OF SAMPLE: BAG



COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION

TESTED BY: L KANE DATE: 8/5/86

COMPUTED BY:
L KANE

DATE: 8/25/86

CHECKED BY:	DATE:
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PROJECT DESCRIPTION: _____

MATERIALS LABORATORY: SEATTLESAMPLE LOCATION: CLC-167

SAMPLE NO. _____

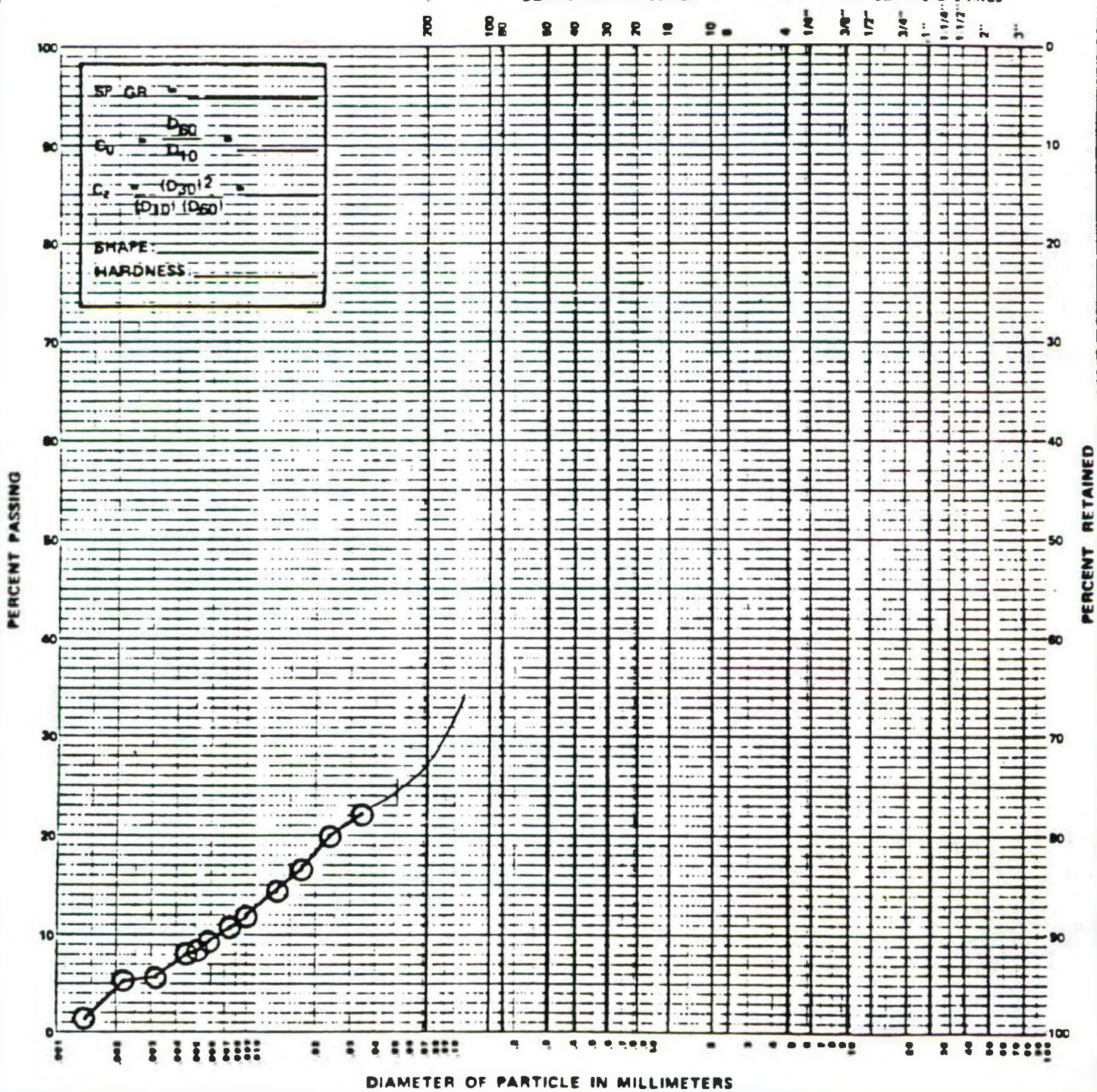
TYPE OF SAMPLE: BAG

HYDROMETER ANALYSIS

SIEVE ANALYSIS

U.S. STANDARD SERIES

CLEAR SQUARE OPENINGS



COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION: _____

TESTED BY: <u>LAURA KANE</u>	DATE: <u>8/4/86</u>	COMPUTED BY: <u>L KANE</u>	DATE: <u>8/25/86</u>	CHECKED BY:	DATE:
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PARTICLE SIZE ANALYSIS

ASTM D422

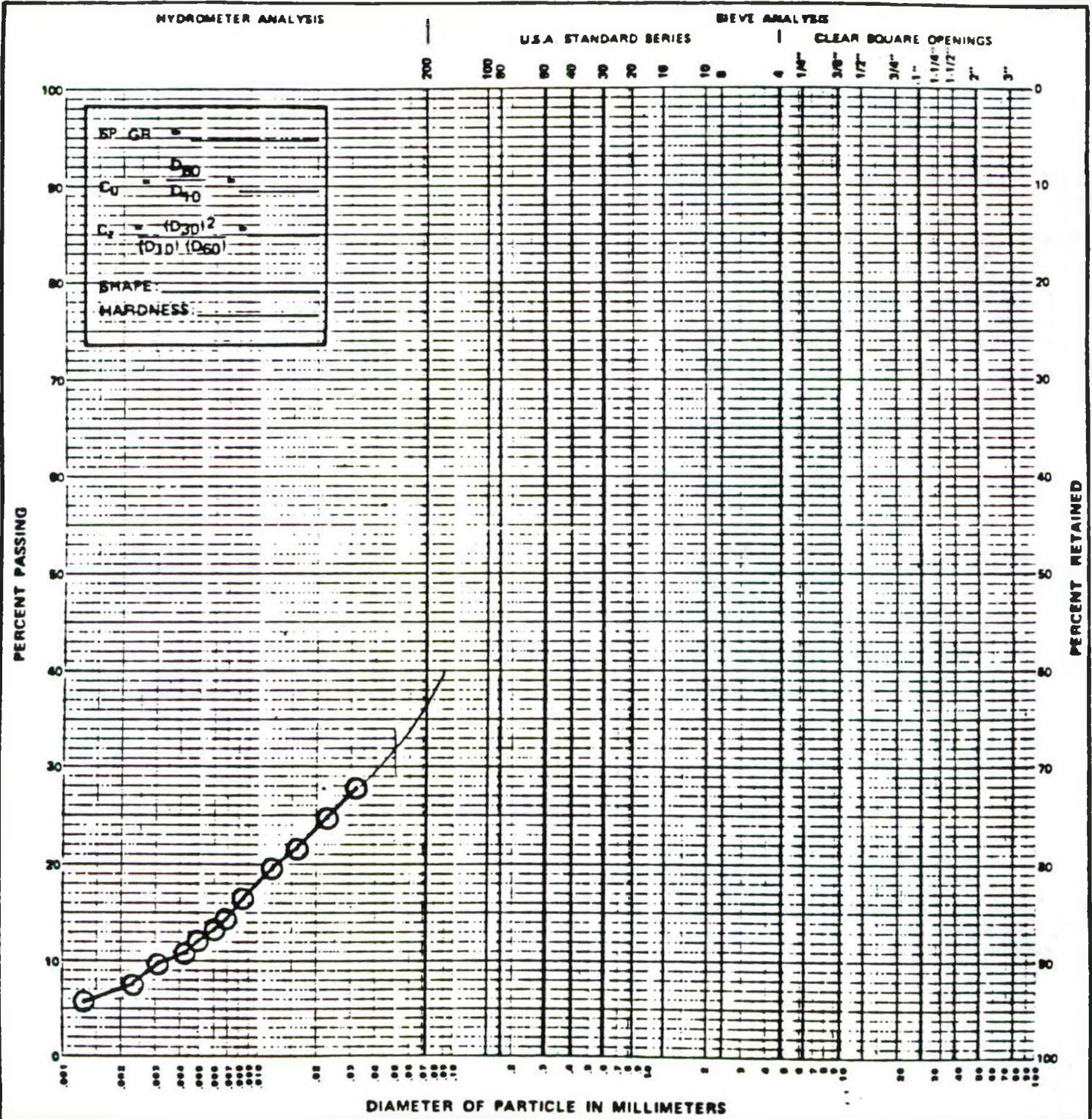
PROJECT DESCRIPTION _____

MATERIALS LABORATORY: SEATTLE

SAMPLE LOCATION: CLC-17

SAMPLE NO. _____

TYPE OF SAMPLE: BAG



COLLOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		

SAMPLE CLASSIFICATION _____

TESTED BY: <u>LAURA KANE</u>	DATE: <u>8/2/30</u>	COMPUTED BY: <u>L. KANE</u>	DATE: <u>8/25/30</u>	CHECKED BY:	DATE:
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PARTICLE-SIZE ANALYSIS

ASTM D422

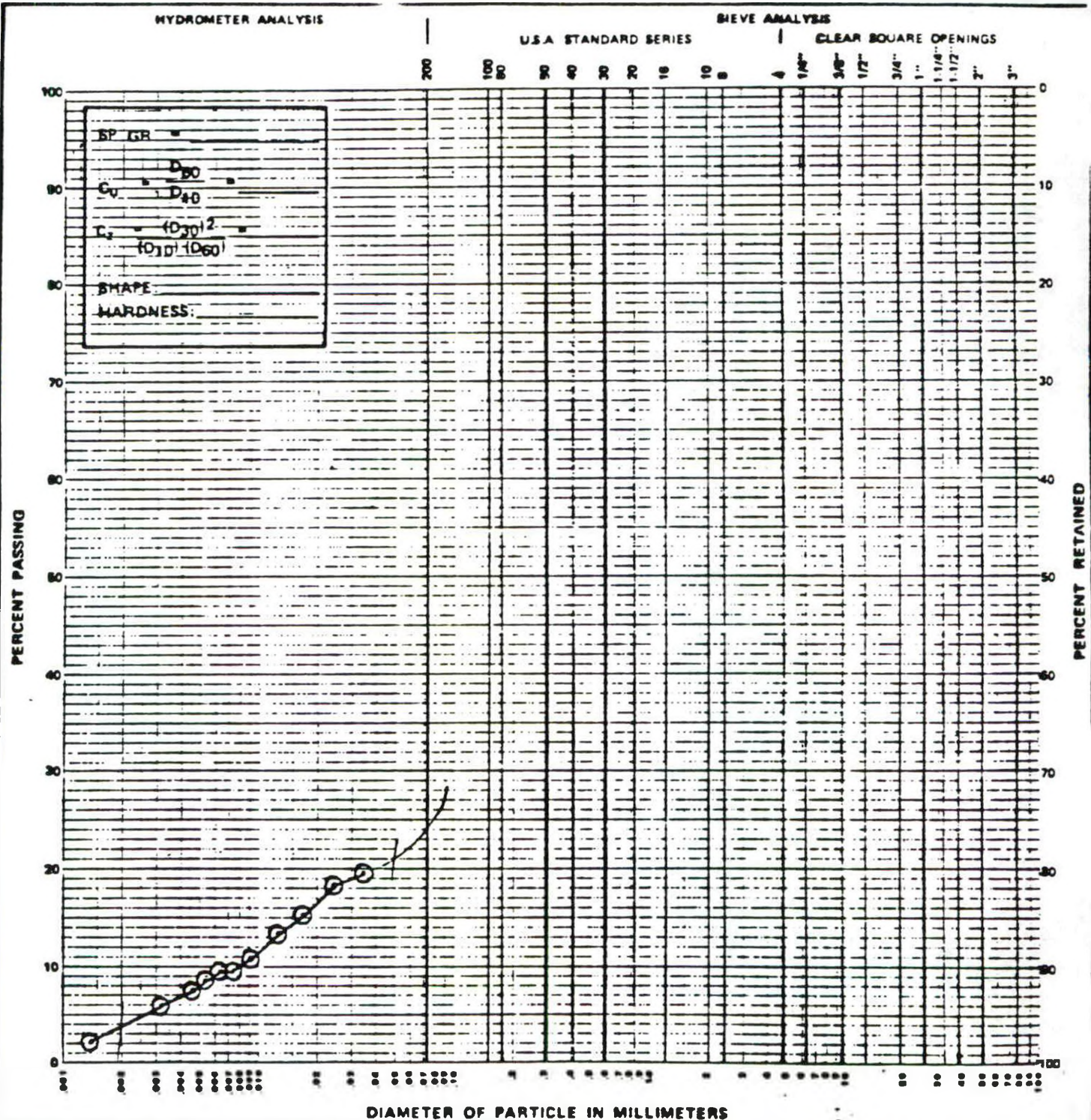
PROJECT DESCRIPTION: _____

MATERIALS LABORATORY: SEA

SAMPLE LOCATION: CLC-18

SAMPLE NO. _____

TYPE OF SAMPLE: BAG



COL- LOIDS	CLAY SIZE	SILT SIZE	SAND			GRAVEL	COBBLES
			FINE	MEDIUM	COARSE		
SAMPLE CLASSIFICATION: _____							
TESTED BY: <u>L. KANE</u>		DATE: <u>8/8</u>		COMPUTED BY: <u>L. KANE</u>		DATE: <u>8/8</u>	
CHECKED BY: _____				DATE: _____			



(CLC-19)

518303.26

PARTICLE SIZE ANALYSIS

ASTM D422

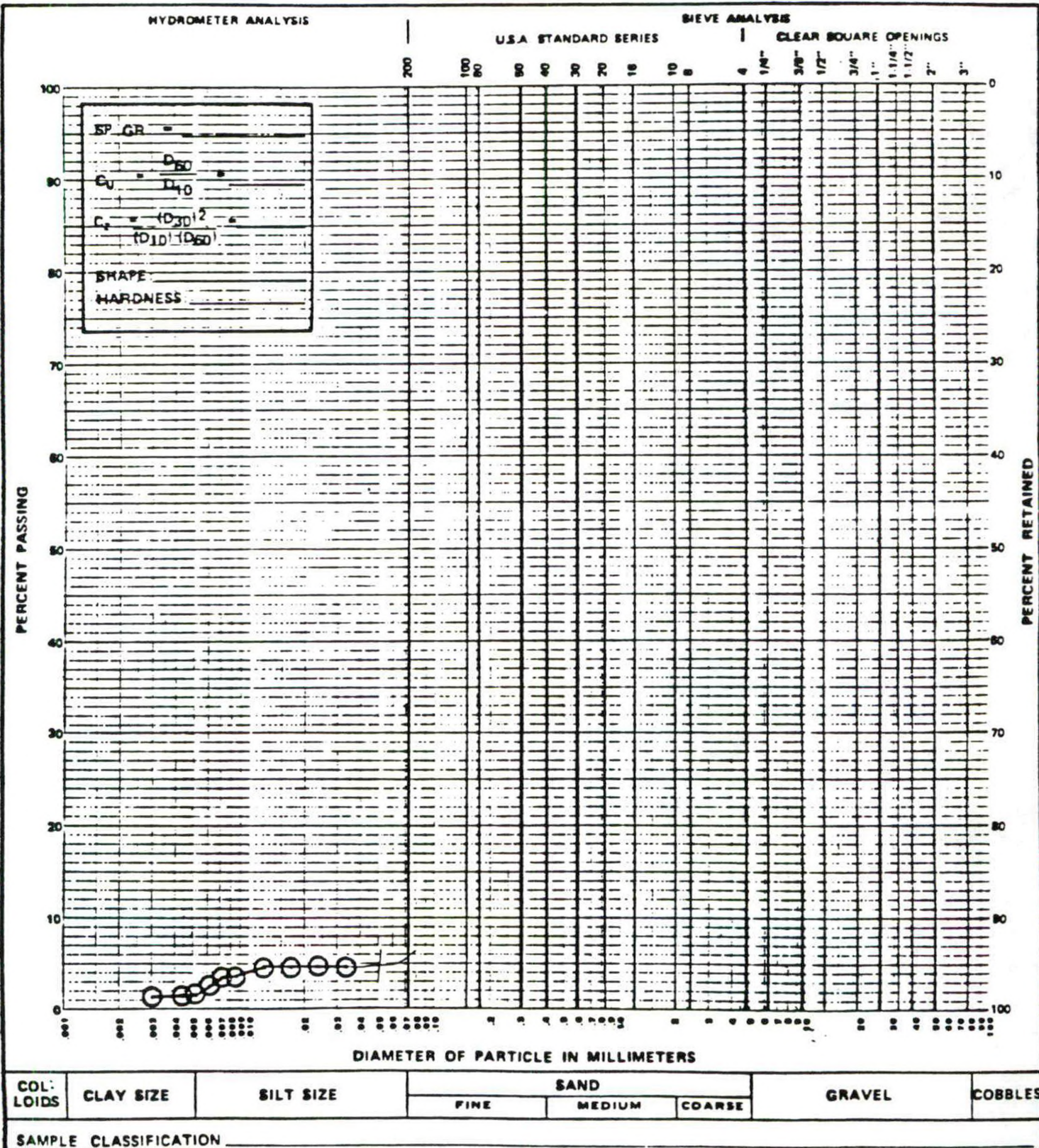
PROJECT DESCRIPTION

MATERIALS LABORATORY: SEA

SAMPLE LOCATION: CLC-9 CLC-19

SAMPLE NO. —

TYPE OF SAMPLE: BAG



TESTED BY: L KANE DATE: 8/17

COMPUTED BY: L KANE DATE: 8/22

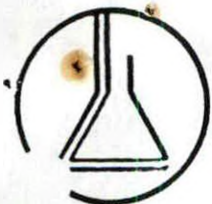
CHECKED BY: DATE:

APPENDIX F

QUALITY ASSURANCE, QUALITY CONTROL PROCEDURES
FOR DIOXINS AND FURANS FROM CALIFORNIA
ANALYTICAL LABORATORIES, INC.

Items:

1. Cover letter
2. List of isomers (standards)
3. Quality control requirements



California Analytical Laboratories, Inc.
2544 Industrial Boulevard • West Sacramento, CA 95691 • (916) 372-1393

July 7, 1986

Don Hinley
CH₂M Hill
1500 114th Ave. S.E.
Bellivue, WA 98009

Dear Mr. Hinley:

Enclosed is the QA/QC information you requested. Both the general lab QA/QC manual, version 3.3 and a list of more specific dioxin/furan QA requirements are included.

The native spike standard is made up of one isomer, 2,3,7,8 substituted, from each congener on the list dated 6/12/86. The spiking levels vary in according to deserved detection limits. The levels used during the analysis of your samples were as follows: Cl₄-Cl₇ dioxin and furans at 10ng and Cl₈ dioxin and furan at 50ng. These levels when used with a 10gm sample are 1.0 & 5.0 ppb respectively.

If you have any questions do not hesitate to call.

Sincerely,

Michael W. Orbanosky
GC/MS Lab Manager

MWO:mbj

6/12/86

ISOMER CLASS

1 - MCDD
2 - MCDD

16 - DCDD
23 - DCDD
27 - DCDD

124 - TriCDD

1234 - TCDD
1267 - TCDD
1278 - TCDD
1368 - TCDD
1478 - TCDD
2378 - TCDD

12378 - PeCDD
12478 - PeCDD

123478 - HxCDD
123678 - HxCDD
123789 - HxCDD

1234678 - HpCDD

12346789 - OCDD

13C-1234 - TCDD
13C-2378 - TCDD

13C-12378 - PeCDD

37CL-2378 - TCDD

13C-123478 - HxCDD
13C-123678 - HxCDD

13C-1234678 - HpCDD

13C-12346789 - OCDD

6/12/86

ISOMER CLASS

27 - DCCDF
28 - DCCDF

1236 - TCDF
1239 - TCDF
1247 - TCDF
1248 - TCDF
1267 - TCDF
1269 - TCDF
1278 - TCDF
1279 - TCDF
1346 - TCDF
1367 - TCDF
1368 - TCDF
1379 - TCDF
1467 - TCDF
1469 - TCDF
2346 - TCDF
2347 - TCDF
2348 - TCDF
2367 - TCDF
2368 - TCDF
2378 - TCDF
2467 - TCDF
2468 - TCDF

12348 - PeCDF
12367 - FeCDF
12378 - FeCDF
12378 - FeCDF
12389 - FeCDF
12468 - FeCDF
12478 - FeCDF
12479 - FeCDF
23467 - FeCDF
23468 - FeCDF
23478 - FeCDF

123468 - HxCDF
123478 - HxCDF
123479 - HxCDF
123678 - HxCDF
123689 - HxCDF
123789 - HxCDF
124678 - HxCDF
124689 - HxCDF
234678 - HxCDF

1234678 - HpCDF
1234679 - HpCDF
1234689 - HpCDF

6/12/86

ISOMER CLASS

1234789 - HpCDF

12346789 - OCDF

13C-2378 - TCDF

13C-12378 - PeCDF

13C-23478 - PeCDF

13C-123478 - HxCDF

13C-1234678 - HpCDF

13C-1234789 - HpCDF

13C-12346789 - OCDF

Quality Control Requirements

1. Each sample must be dosed with known quantities of internal standards (C14 [2.5 ppb], C15-C17 [5.0 ppb], C18 [12.5 ppb]) and surrogate standard (equivalent to 1.0 ppb). These values inevitably change depending on sample size and matrix. "Surrogate" spikes vary between 1 ng and 10 ng per sample. Internal standards similarly vary.

The action limits for surrogate standard results will be $\pm 40\%$ of the true value. Samples showing surrogate standard results outside of these limits must be reanalyzed, and valid explanations given.

2. A laboratory "method blank" must be run along with each set of samples or lab tickets with similar matrices. A method blank is performed by executing all of the specified extraction and cleanup steps, except for the introduction of the sample. The method blank is also dosed with the internal standards and surrogate standard.

3. The laboratory will perform evaluation samples (i.e., blind field spikes) on a periodic basis throughout the course of a given project. Further sample analyses will not be permitted if the performance criteria are not achieved. Corrective action must be taken and demonstrated before sample analyses can resume.

4. Qualitative Requirements. The following requirements must be met in order to confirm the presence of native C14 to C18 dioxins and furans (D/F).

a. The monitored mass ratio must be within $\pm 10\%$ of the standard ratio for each mass pair.

b. Ions must all be present and maximize together. The signal to mean noise ratio must be 2.5 to 1 or better for all ions. The level can be pre-determined by the instrument software.

c. The retention time of the native congener must be within ± 0.005 RRT units of the standard RRT. This relationship of native substituted CDD's and CDF's and their isotopically labelled I.S. must be maintained.

d. Isomer specificity must be demonstrated initially and verified once per 12-hour work shift. The verification consists of injecting a mixture containing TCDD isomers which elute close to 2,3,7,8-TCDD. This mixture will be provided by EPA. It contains seven TCDD isomers (2378, 1478, 1234, 1237, 1238, 1278, 1267) including those isomers which are known to be the most difficult to separate on SP2330/SP2340 columns and similar columns containing cyanoalkyl type liquid phases. The column performance solution must also contain both isotopically labeled 2,3,7,8-TCDD standards. The solution must be analyzed using the same chromatographic conditions and mass spectrometric conditions

as is used for other samples and standards. The 2,3,7,8-TCDD must be separated from interfering isomers, with no more than a 25% valley relative to the 2,3,7,8-TCDD peak.

Draw a baseline for the isomer cluster representing 1478, 2378, 1237, 1238, and 1234-TCDD. Measure the distance x from the baseline to the valley following the 2,3,7,8-TCDD peak. Distance x over distance y times 100 is the percent valley which must not exceed 25. An example is given in figure 1. Other criteria: 12348 and 12378 PnCDD; 123478 and 123678 HxCDD must be resolved on a 60 meter column. A 60% valley is attainable.

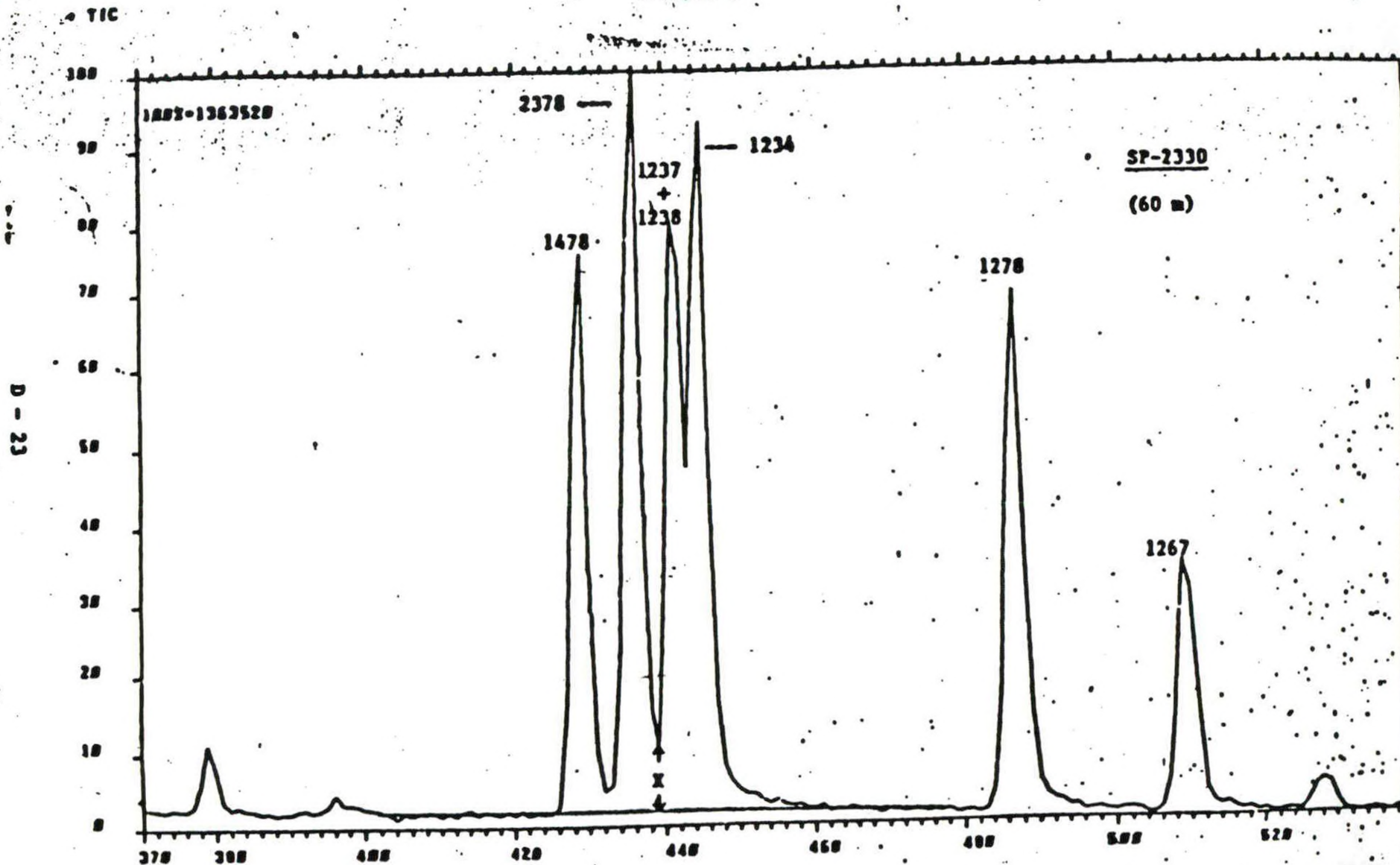
5. In cases where no native congeners are detected, the actual detection limit must be estimated and reported based on a signal to noise ratio of 2.5 to 1 at the appropriate mass range. Measure the mean noise for the retention window of each congener mass chromatogram. Multiply the noise by 2.5 and calculate the detection limit according to Equation 3. If an interfering signal is present in the mass window choose the ion not interfered with to calculate a detection limit using Equation 3. If both ions have interferences which are more than 2.5 times the noise, compute the detection limit using the mass which will give the most conservative result. (The 2.5 x noise level is indicated by a line on the mass chromatograms, and is controlled by the N command in chro).

The retention window is defined as the period of elution for each of the congener groups starting at the point where the first isomer elutes and ending at the point where the last isomer elutes. Retention time windows for each isomer group can be predetermined by shooting the complete C14-C18 dioxin and furan mix standard prior to sample analysis.

6. For each sample, the internal standard must be present with at least a 10 to 1 signal to noise ratio for both masses monitored. Also, the internal standard ratio's must be within $\pm 10\%$ of the X standard ratio.

7. Where appropriate, "field blanks" will be provided to monitor for possible cross contamination of samples in the field. The "field blank" will consist of uncontaminated sample (i.e., background soil taken off-site) and/or equipment rinsate.

FIGURE 1



Selected ion current profile for m/z 320 and 322 produced by MS analysis of performance check solution using a 60-m SP-2330 fused silica capillary column and conditions listed in Table 1.

Equation 3 (Calculation of concentration of native 2,3,7,8-TCDD)

$$\text{Concentration, ng/g} = (As)(Is)/(Ais)(RRF)(W)$$

where: As = SIM response for native ion at m/e (see Table III)
Ais = SIM response for the internal standard ion (see Table III)
Is = Amount of internal standard added to each sample (ng)
W = Weight of sample in grams, or liters if appropriate

Equation 4 (Calculation of amount of surrogate standard $^{37}\text{Cl}_4$ 2,3,7,8-TCDD)

$$\text{Amount in ng} = (Ass)(Is)/(Ais)(RRF)$$

where: Ass = SIM response for surrogate $^{37}\text{Cl}_4$ 2,3,7,8-TCDD ion at m/e 328*
Ais = SIM response for the internal standard ion at m/e 322 + 334
Is = Amount of internal standard added to each sample (ng)

*When using $^{37}\text{Cl}_4$ -TCDD, subtract 0.009 of any 322 response.

8. Co-eluting impurities are suspected if all criteria except the isotope ratio criteria are achieved. If broad background interference restricts the sensitivity of the GC/MS analysis, the analyst must employ additional cleanup procedures and reanalyze by GC/MS.

9. Calculation of Percent Accuracy of surrogate standard.

$$\% \text{ Accuracy} = (\text{amount measured in ng}/10 \text{ ng})(100)$$

APPENDIX G

ENGLISH - METRIC UNITS AND CONVERSION FACTORS

APPENDIX G

ENGLISH - METRIC UNITS AND CONVERSION FACTORS

<u>Unit</u>	<u>XFactor</u>	<u>Unit</u>	<u>XFactor</u>	<u>Unit</u>
feet	0.304	meters (m)	3.28	feet
inches	25.4	millimeters (mm)	0.0394	inches
inches	2.54	centimeters (cm)	0.394	inches
ounces	28.4	grams (g)	0.0352	ounces
pounds	0.454	kilograms (kg)	2.205	pounds
acre	0.405	hectare (ha)	2.47	acre