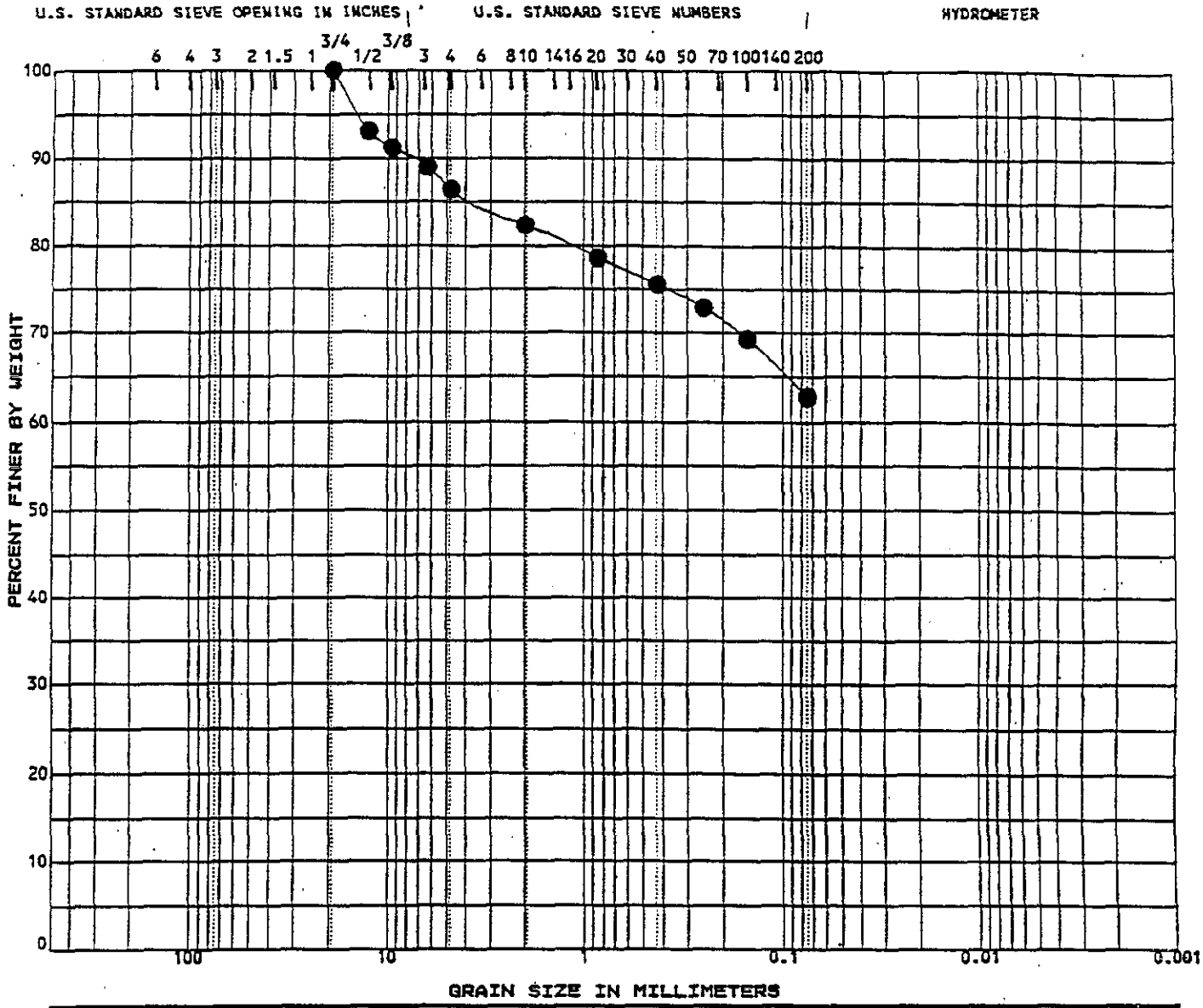
141873

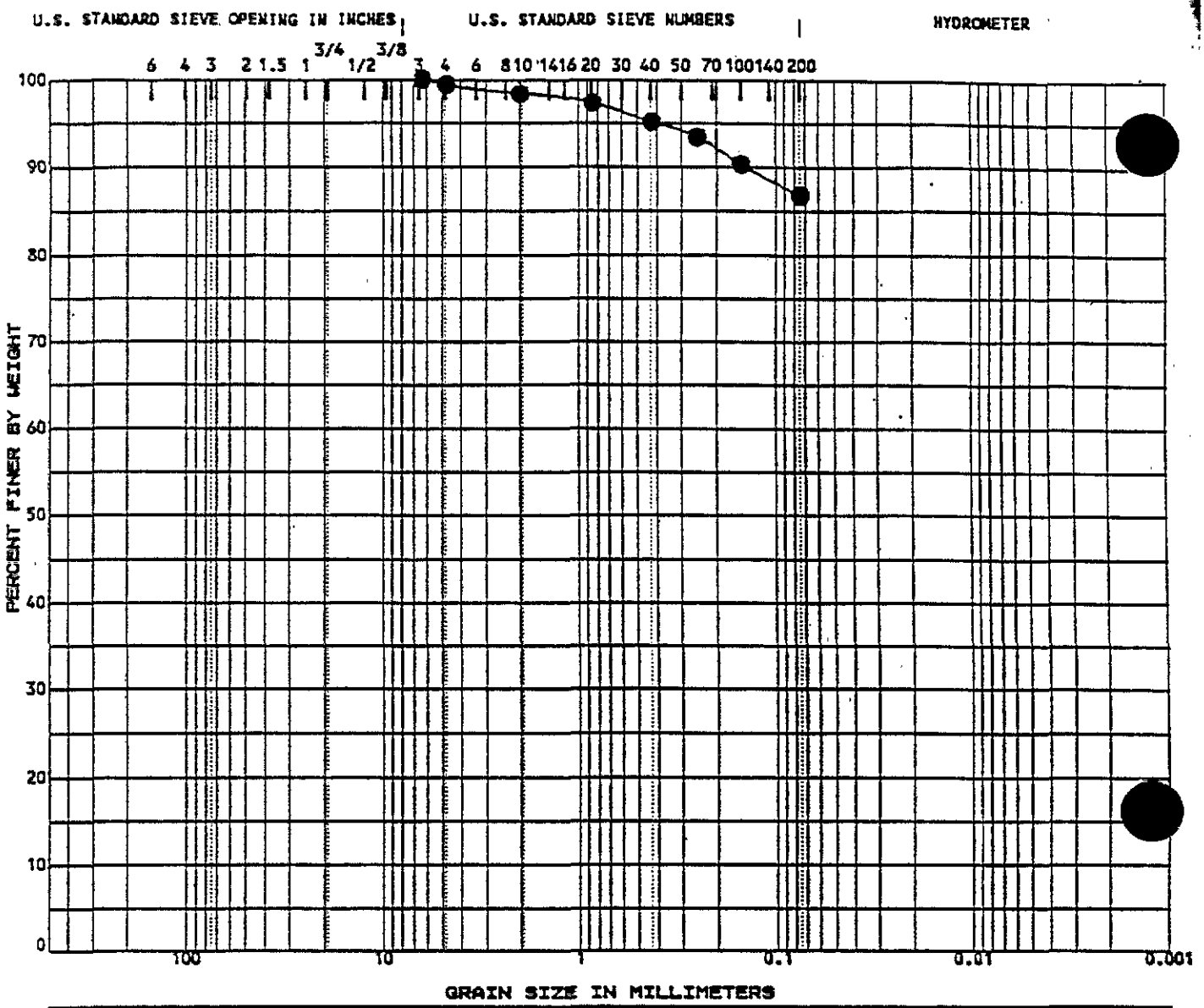


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA200002	SILT/CLAY; little fine gravel and fine sand;	20.3					
	trace medium and coarse sand.						
	Low plasticity.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA200002	19.10				13.6	23.6	62.8	

	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
AR302901	Date April 1996	GRADATION CURVES

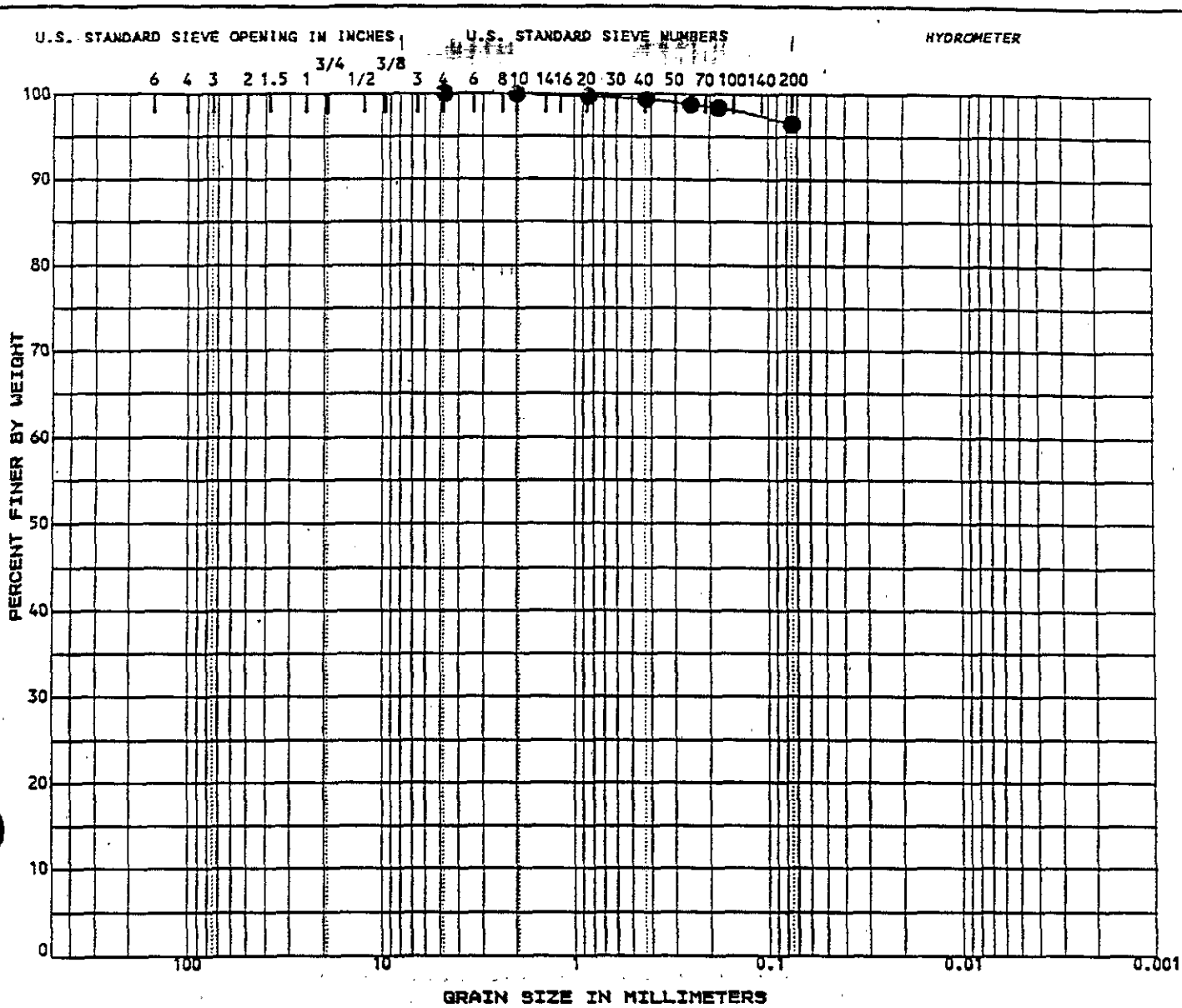


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA210204	SILT/CLAY; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	20.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA210204	6.30				0.6	12.6	86.8	

AR302902	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

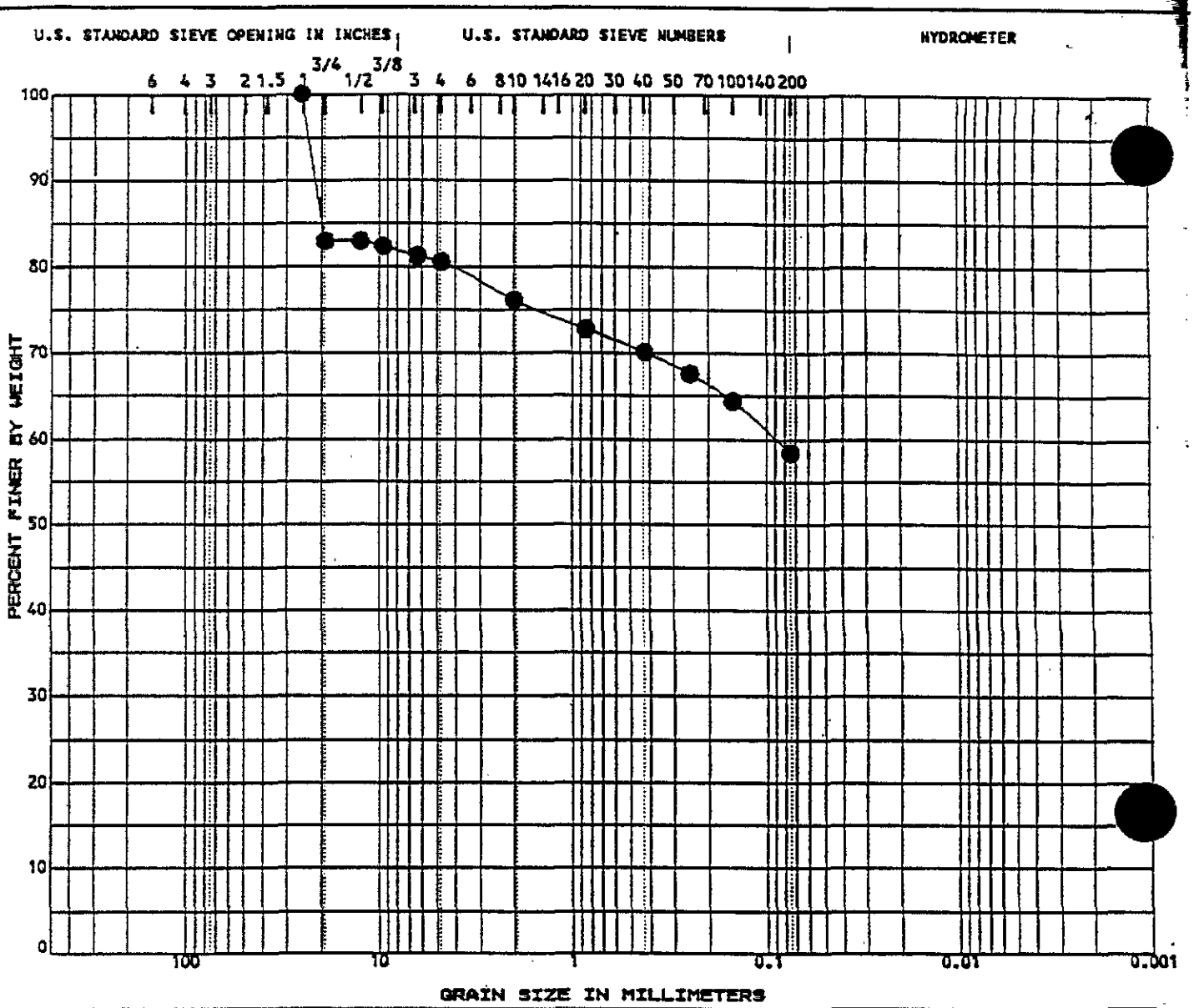


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA230204	SILT; trace fine, medium, and coarse sand.	24.8					
	With organics.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA230204	4.75				0.0	3.6	96.4	

AR302903	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

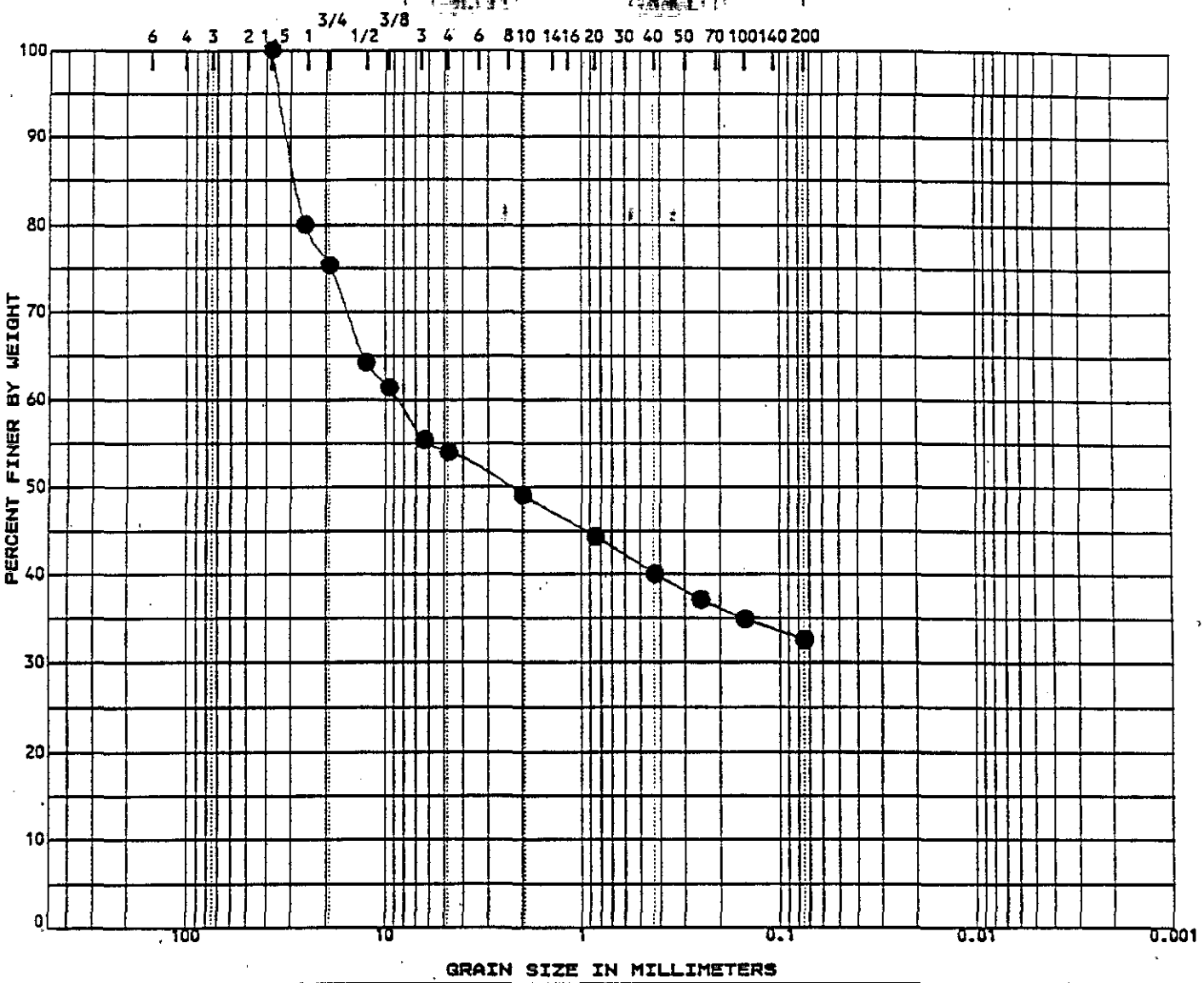


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA260204	CLAY; little coarse gravel and fine sand; trace medium and coarse sand and fine gravel. Moderately to highly plastic.	31.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA260204	25.40	0.09			19.5	22.0	58.5	

AR302904	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

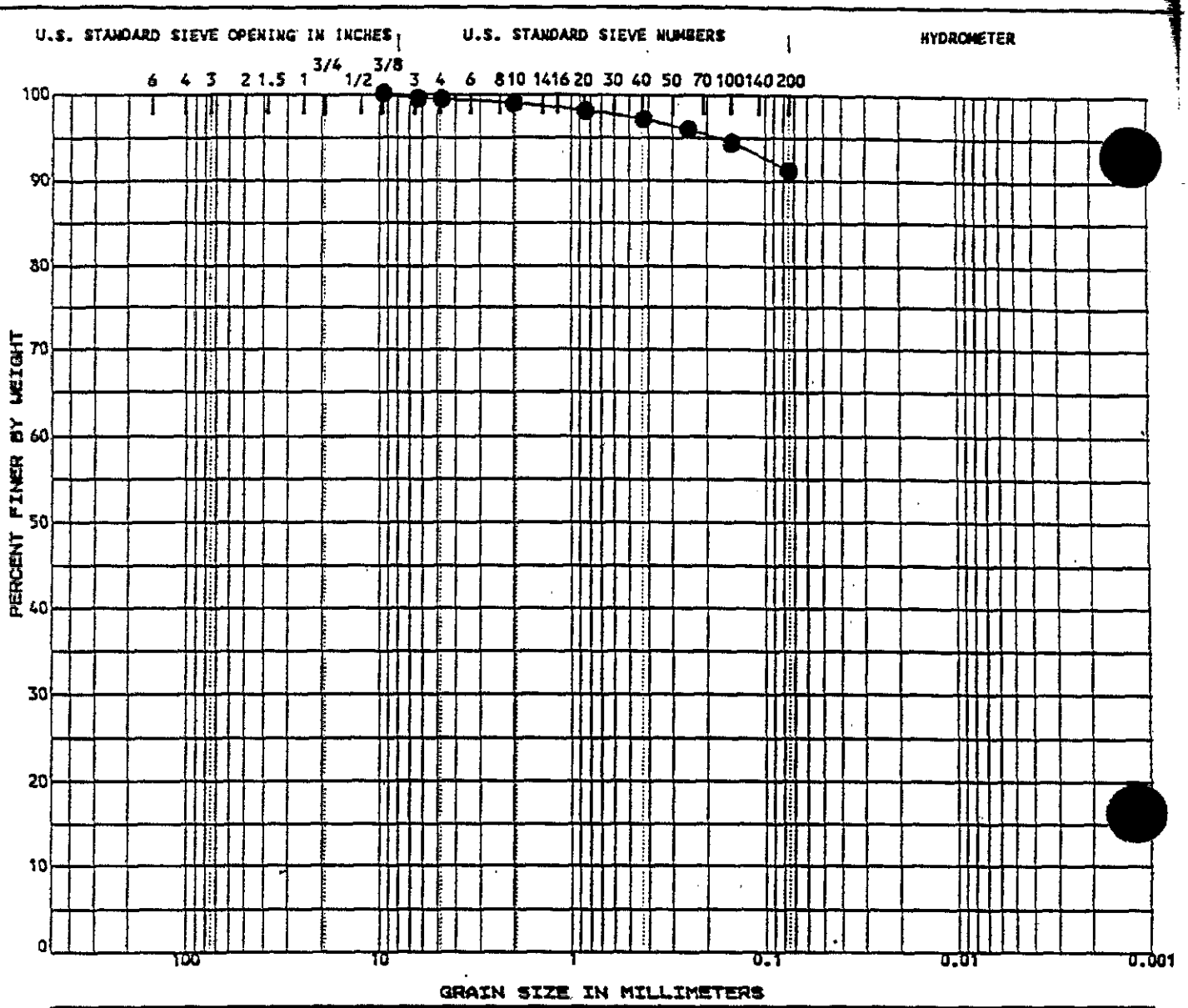


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA310002	Coarse to Fine GRAVEL; some silt; trace medium fine and coarse sand.	21					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA310002	37.50	8.64			46.0	21.4	32.6	

AR-302905	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes Large black charcoal pieces.
	Date April 1996	GRADATION CURVES

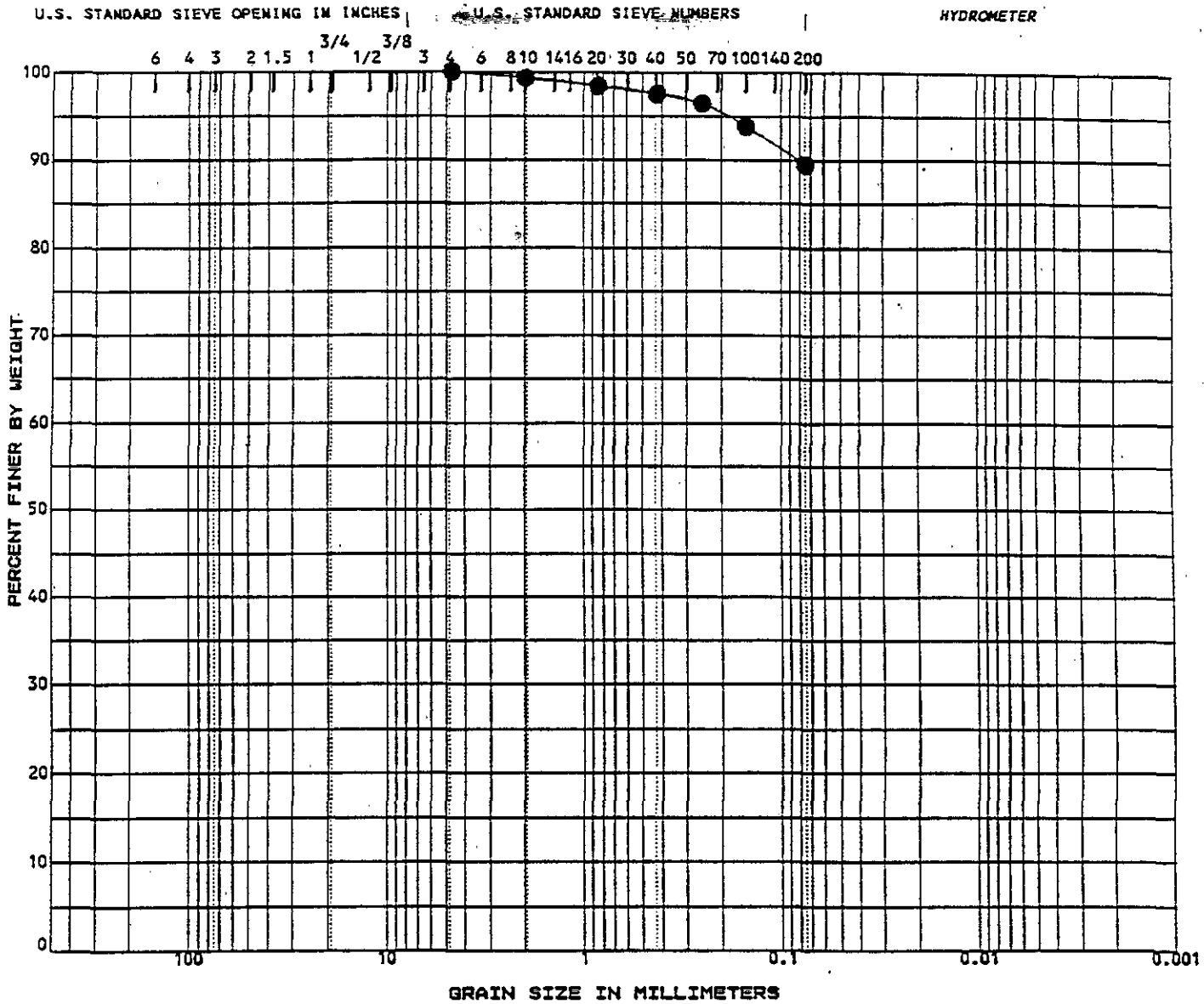


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA090004	SILT; trace fine, medium, and coarse sand and fine gravel. With organics.	31.2					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA090004	9.51				0.6	8.2	91.2	

AR302906	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

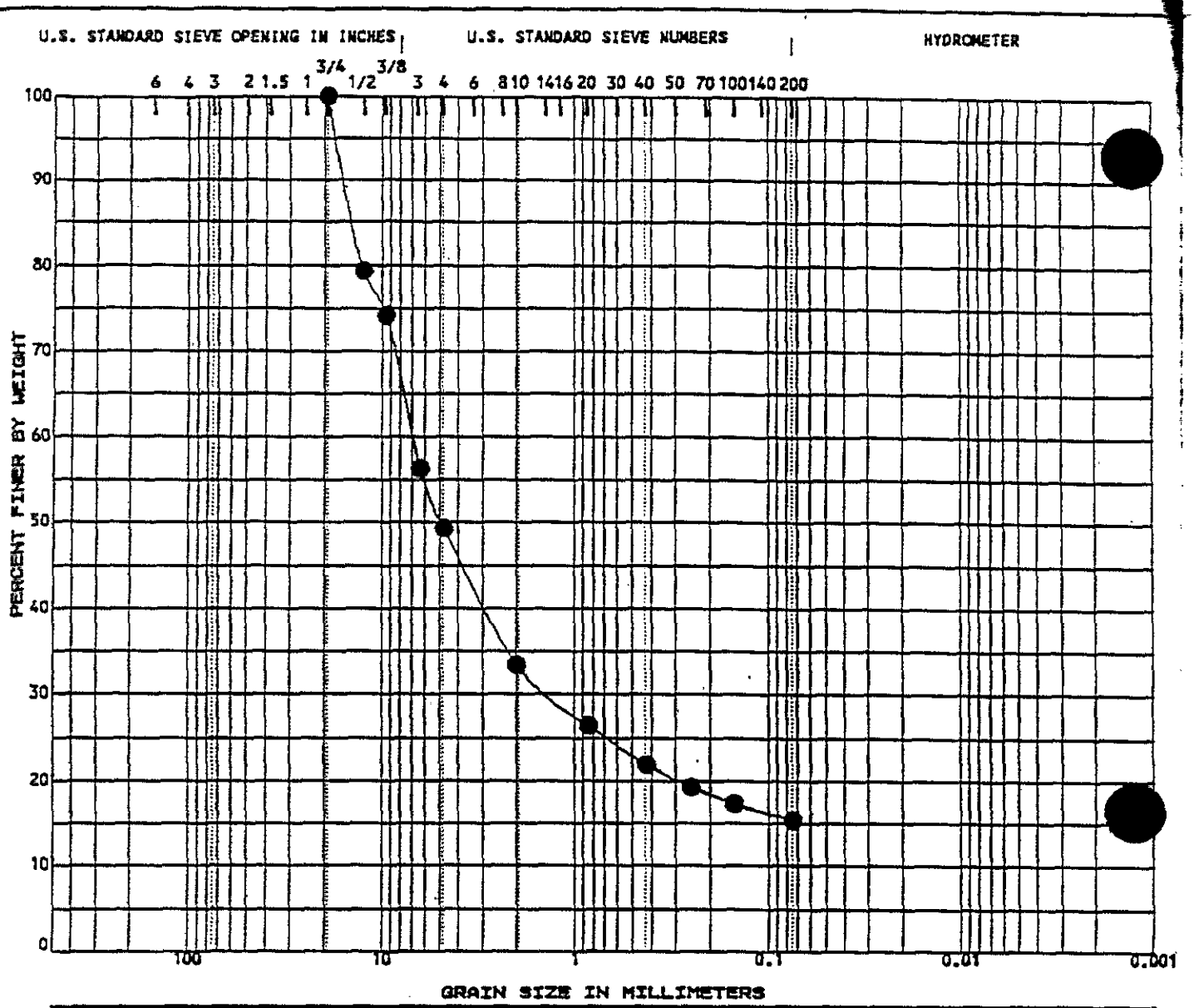


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA060004	SILT; trace fine, medium, and coarse sand.	27.7					
	Small amount of organics.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA060004	4.75				0.0	10.5	89.5	

AR302907	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



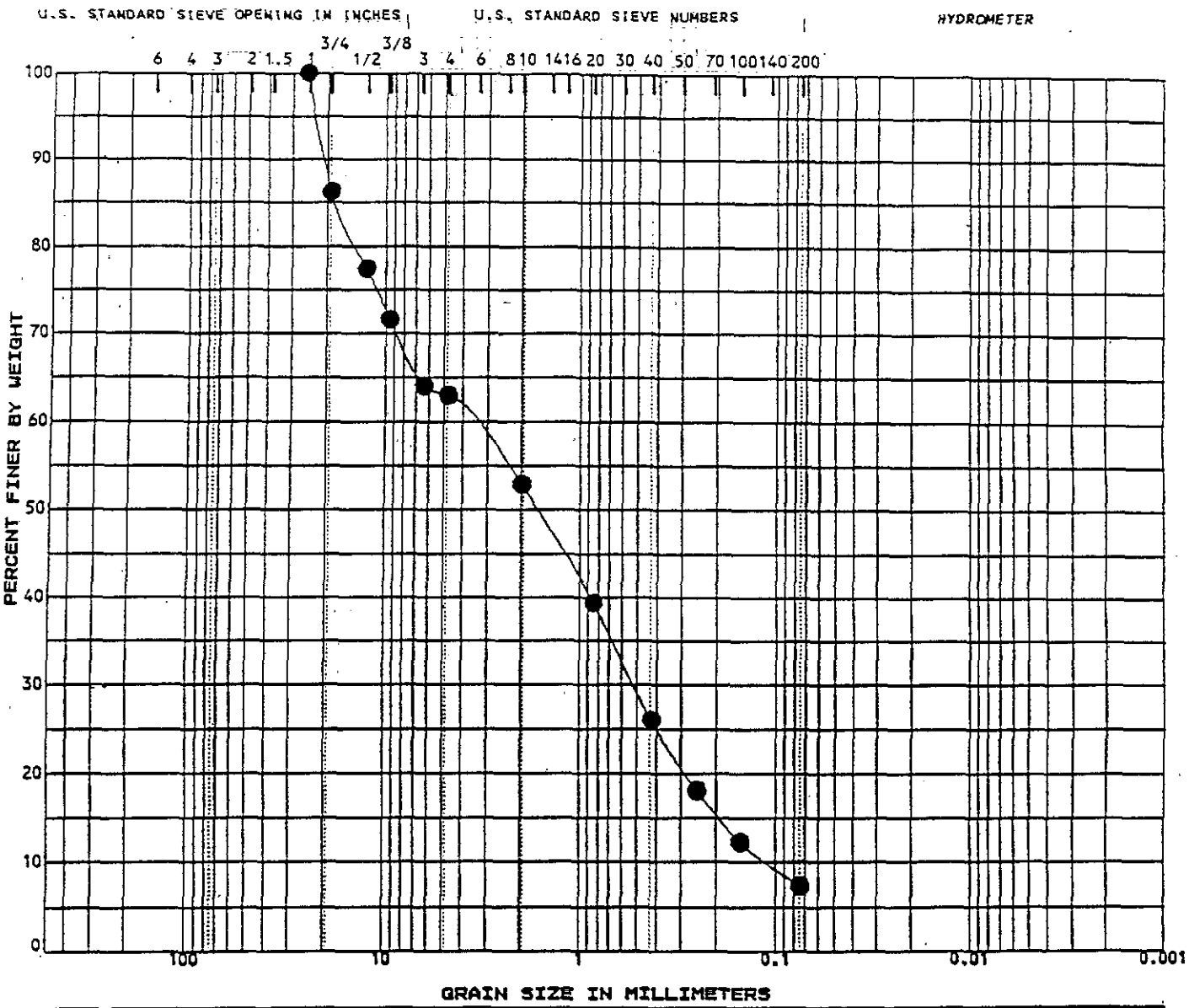
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SA340004	Fine GRAVEL; little silt and coarse and medium sand; trace fine sand.	32.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SA340004	19.10	6.86	1.320		50.7	33.9	15.4	

AR302908

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes Large charcoal pieces.
Date April 1996	GRADATION CURVES

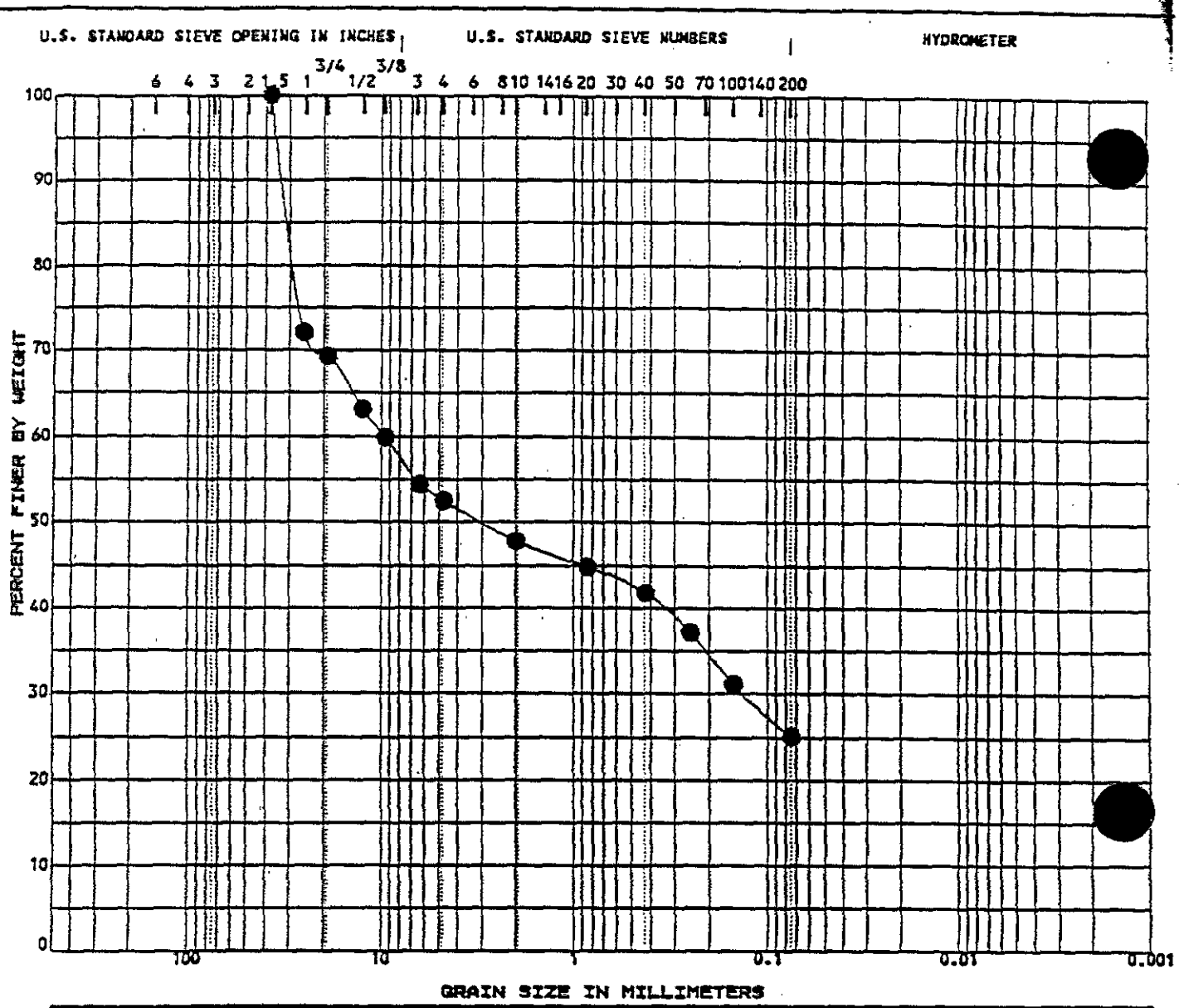


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA020004	Coarse to Fine Gravely Coarse to Fine SAND;	30.3				0.69	33.9
	trace silt.						
	Splotches of tar stuck to pan.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA020004	25.40	3.67	0.523	0.1083	37.0	55.6	7.4	

	Project OLIN MORGANTOWN	Location West Virginia	
AR302909	Area	Notes	
	Date April 1996	GRADATION CURVES	



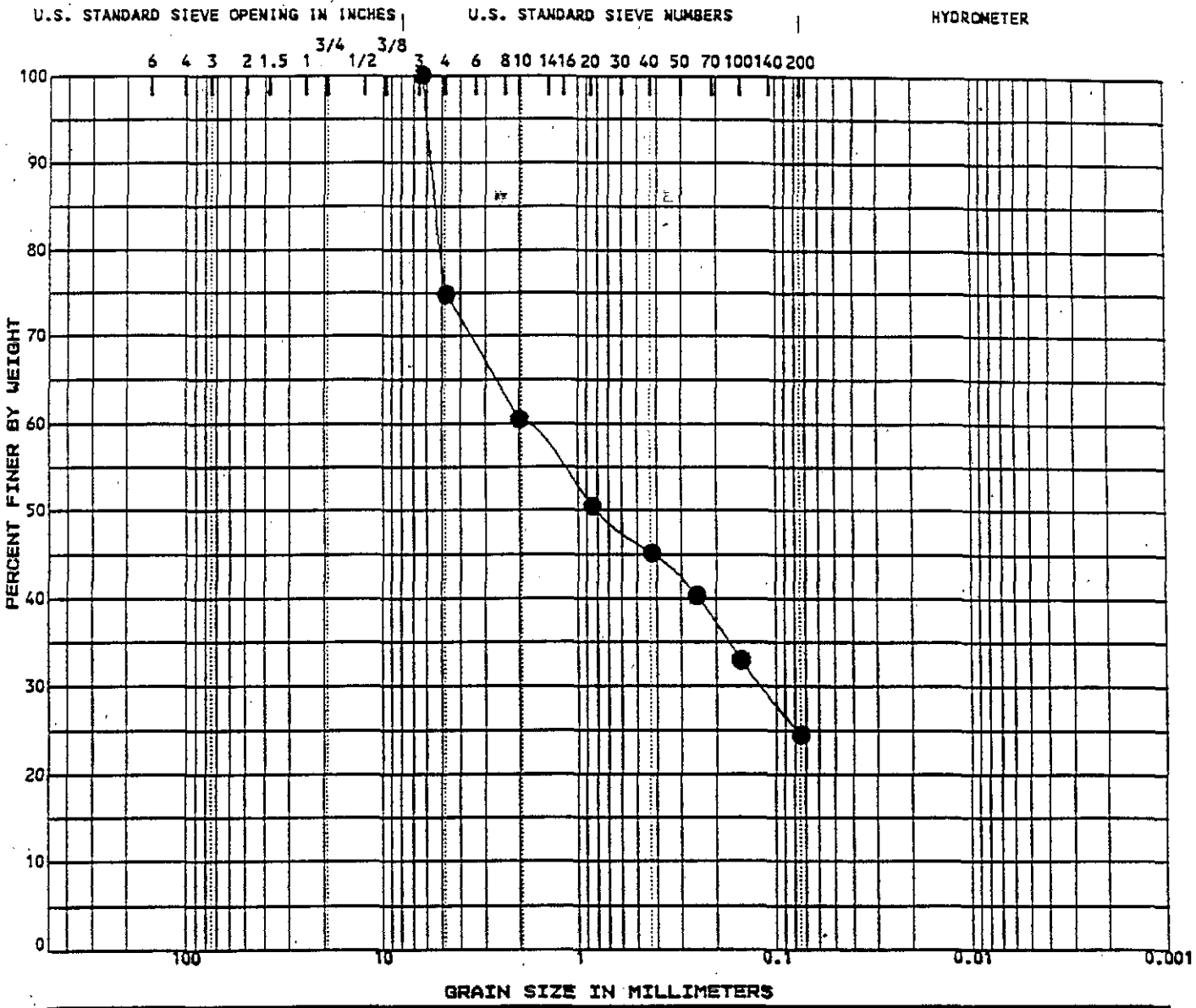
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA080004	Coarse to Fine GRAVEL; some silt; little. fine sand; trace medium and coarse sand.	18.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA080004	37.50	9.59	0.132		47.5	27.4	25.1	

AR302910

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes Large tar pieces in sample.
Date April 1996	GRADATION CURVES

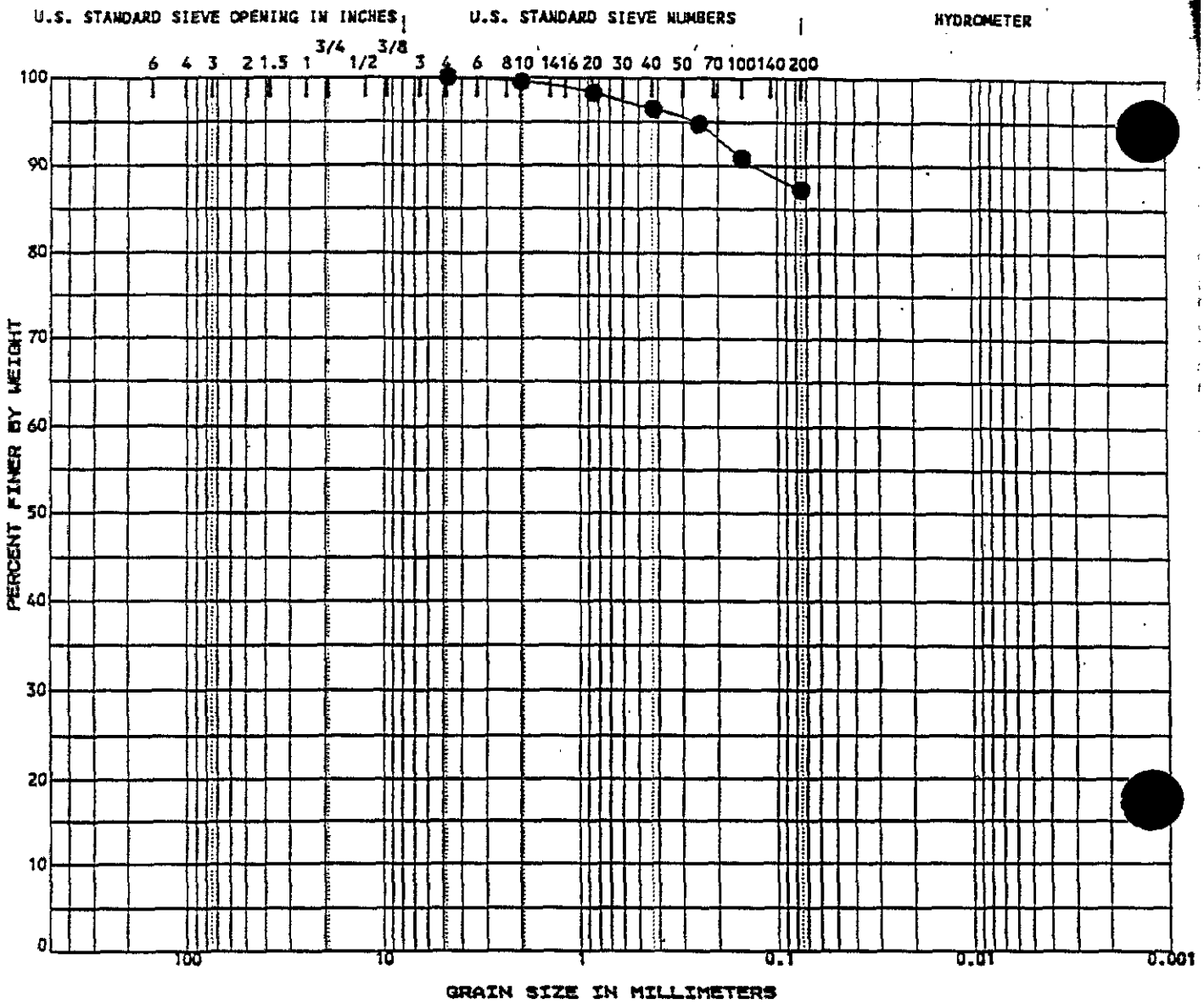


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA170002	Fine to Coarse SAND; some fine gravel and silt.	15.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA170002	6.30	1.93	0.117		25.2	50.3	24.5	

AR302911	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



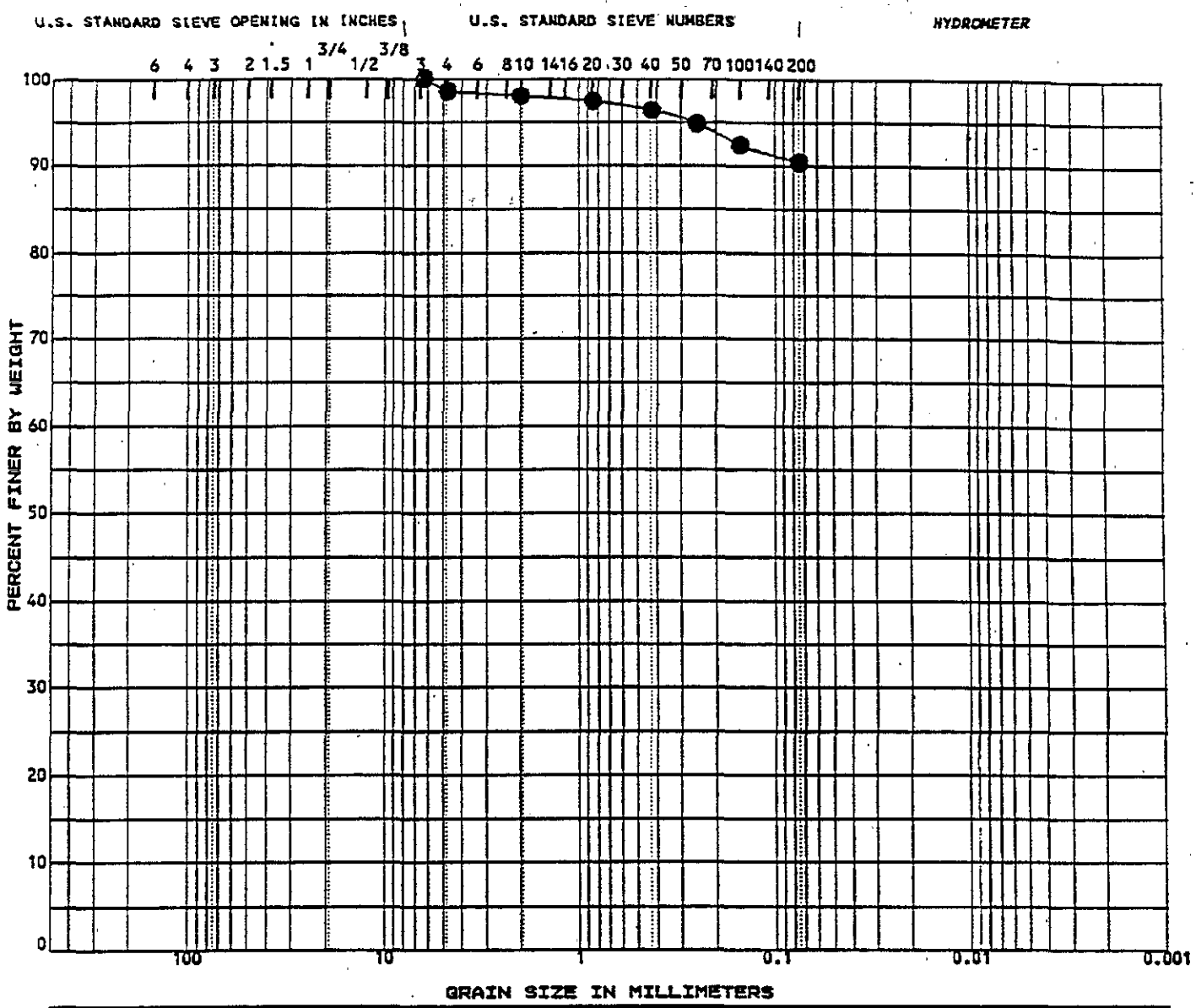
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA190002	SILT; trace fine, medium, and coarse sand.	20.5					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA190002	4.75				0.0	12.7	87.3	

AR302912

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

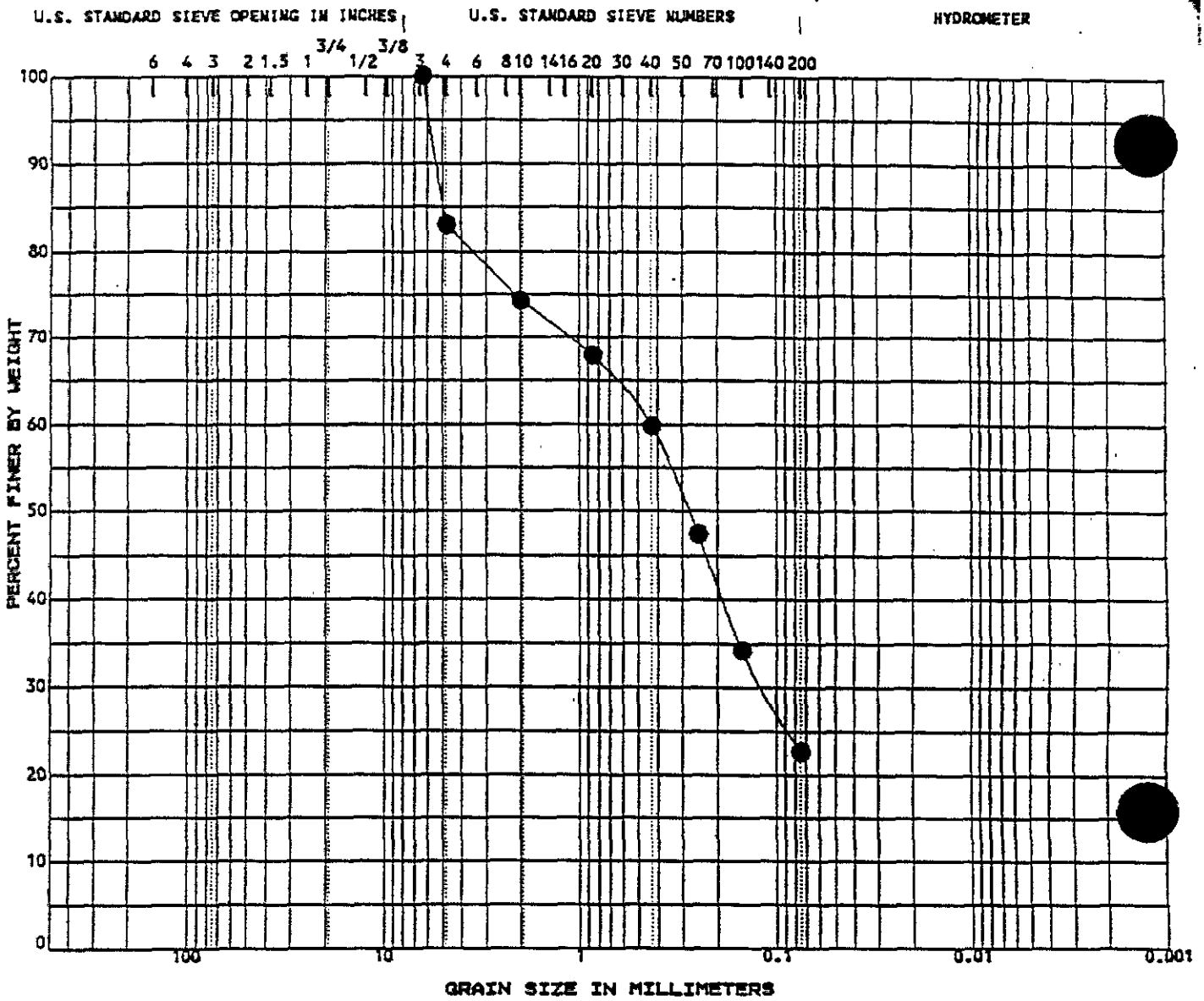


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA220408	CLAY; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	24.5					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA220408	6.30				1.5	8.1	90.4	

AR302913	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

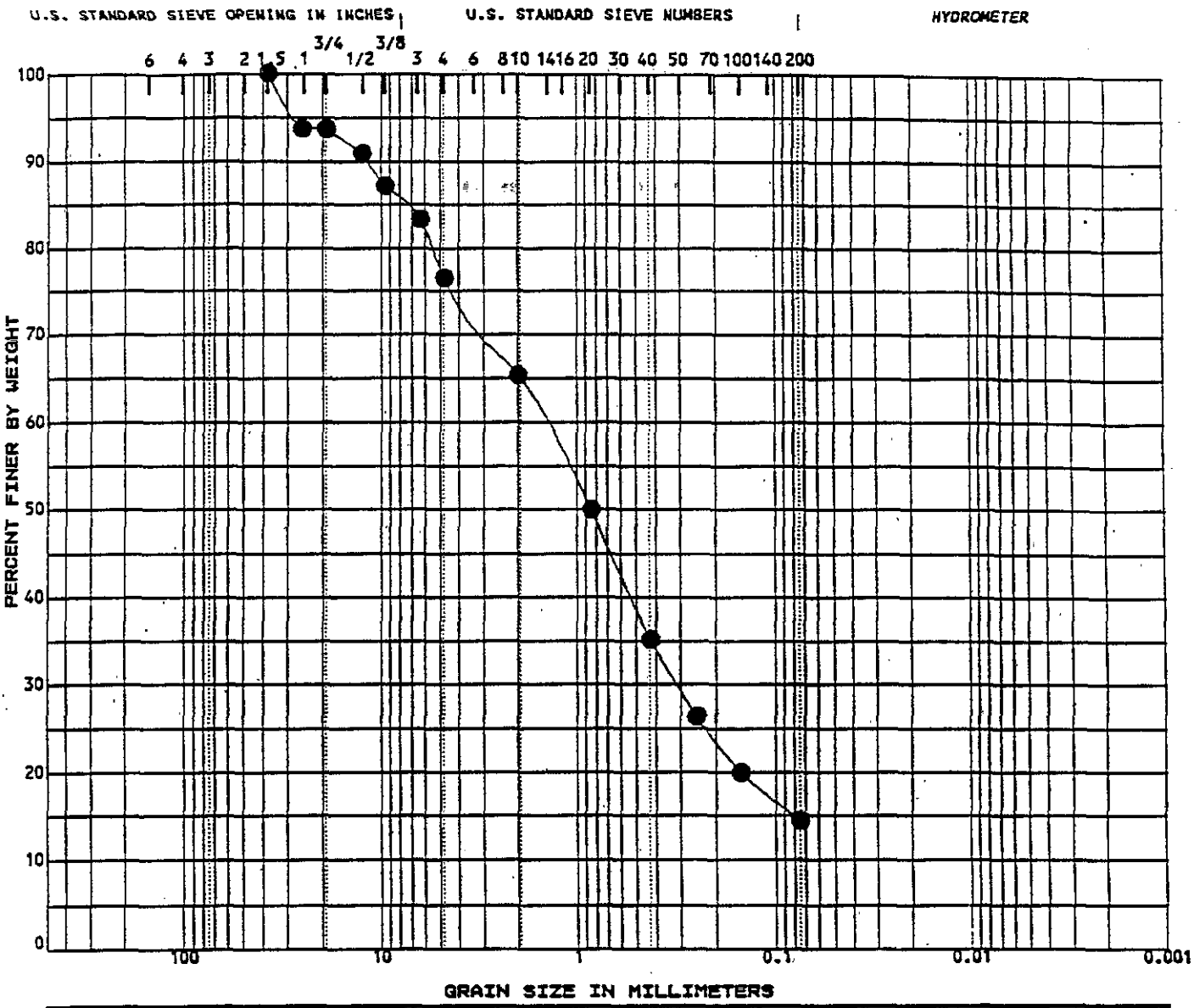


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA230204	Fine to Coarse SAND; some silt; little fine gravel.	21.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● LA230204	6.30	0.43	0.116		17.0	60.3	22.7	

AR302914	Project	OLIN MORGANTOWN	Location West Virginia
	Area		Notes
	Date	April 1996	GRADATION CURVES



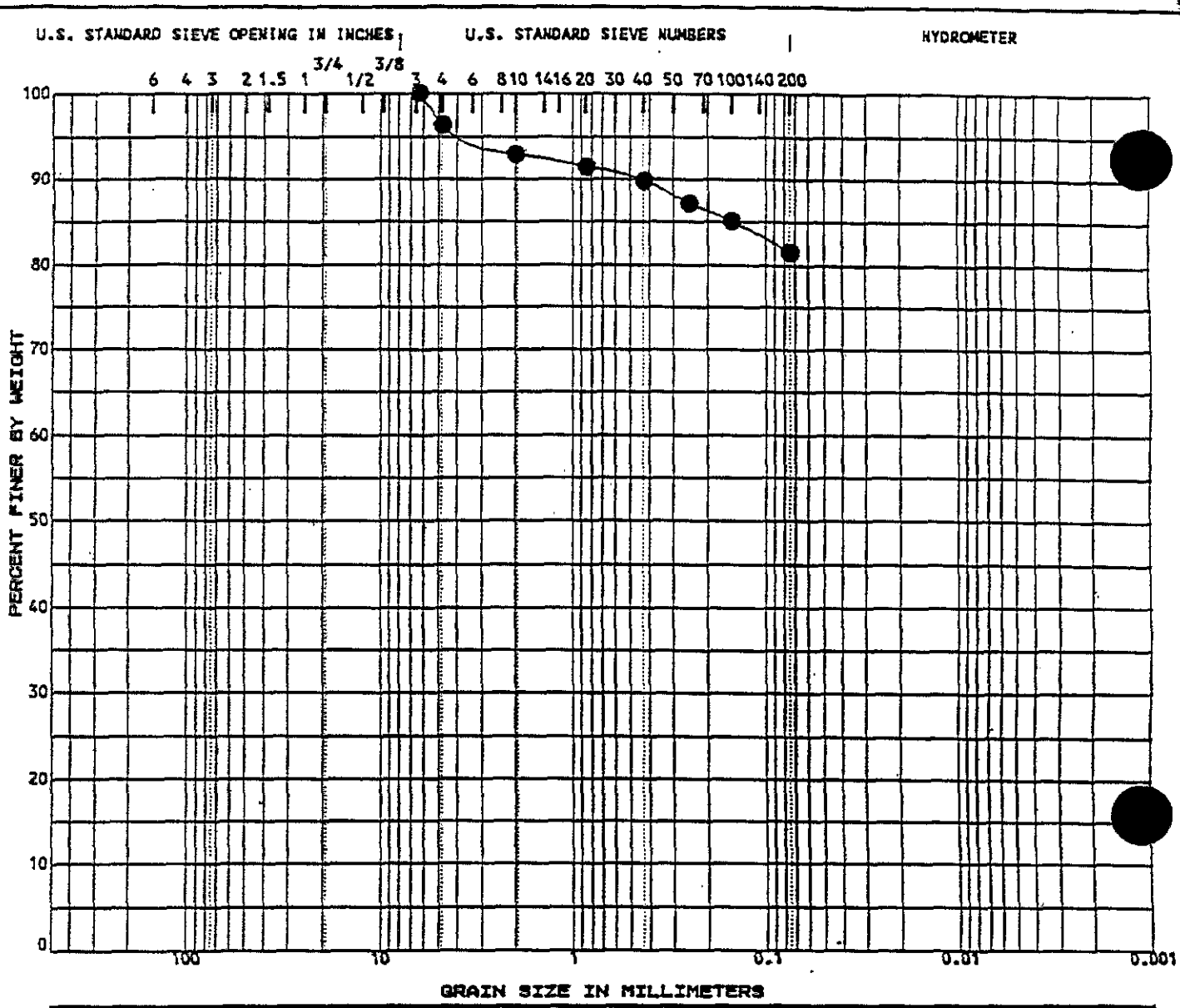
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA300002	Fine to Coarse SAND; litle fine gravel and silt; trace coarse gravel.	33					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA300002	37.50	1.48	0.311		23.5	62.0	14.5	

AR302915

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



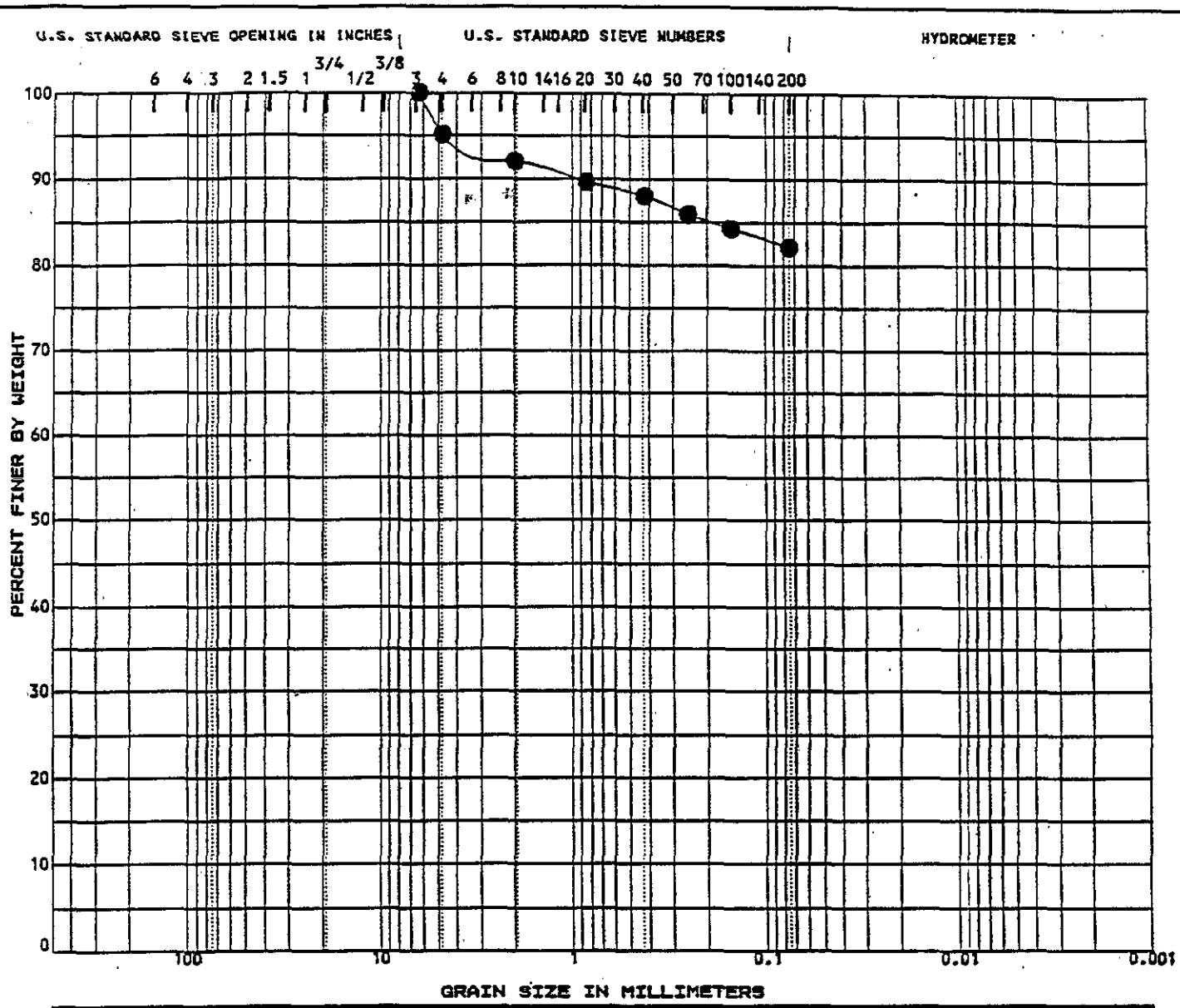
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA310406	SILT; trace fine, medium, and coarse sand and fine gravel.	26.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA310406	6.30				3.7	14.8	81.5	

AR302916

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996		GRADATION CURVES



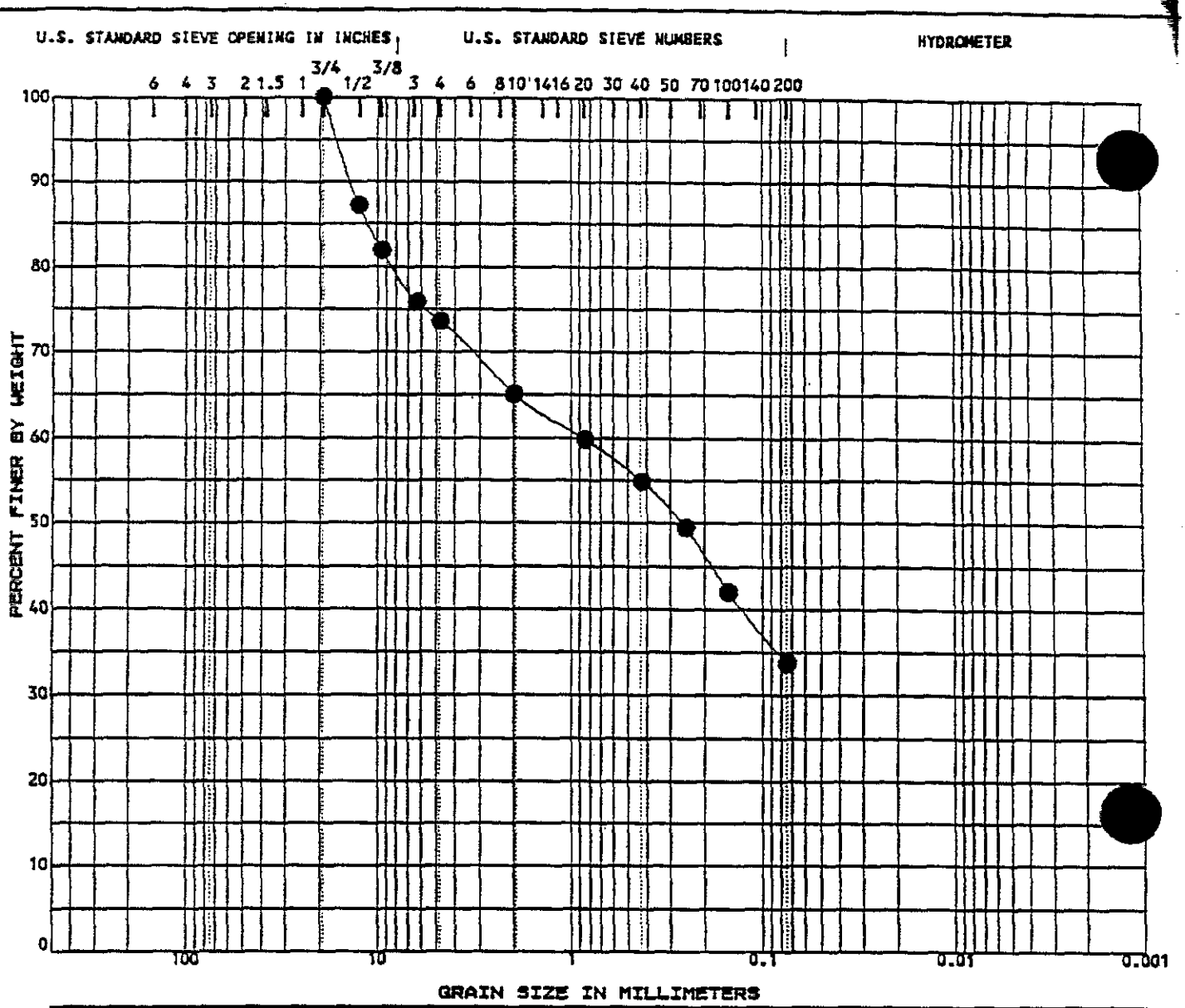
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
●	LA31406D	Silt; trace fine gravel and fine, medium, and coarse sand.	29.5					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	LA31406D	6.30				4.9	13.0	82.1	

AR302917

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



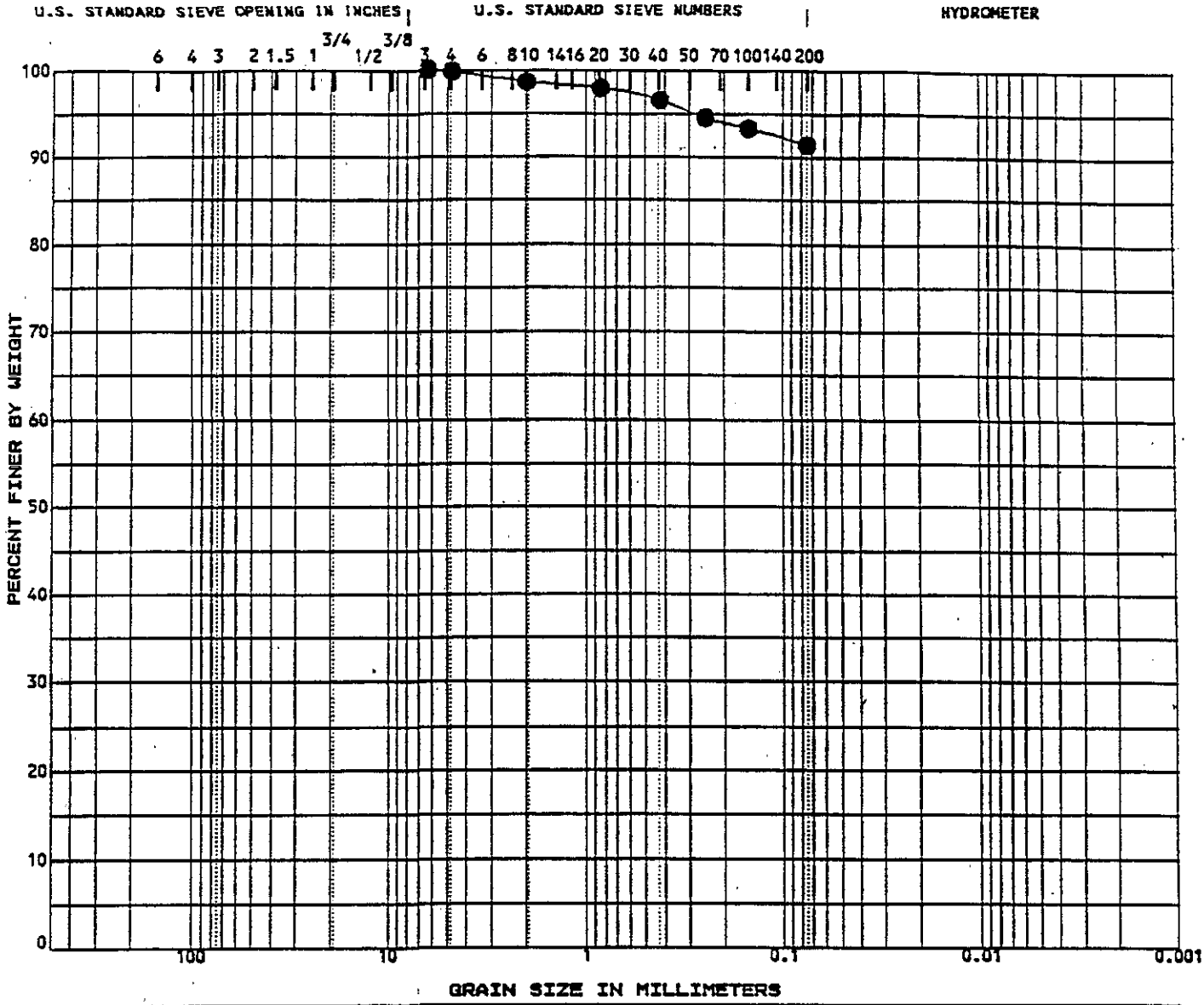
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA340004	Fine to Coarse SAND; some silt and fine gravel.	16.5					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA340004	19.10	0.88			26.4	39.8	33.8	

AR302918

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	Black charcoal pieces.
Date	April 1996		GRADATION CURVES



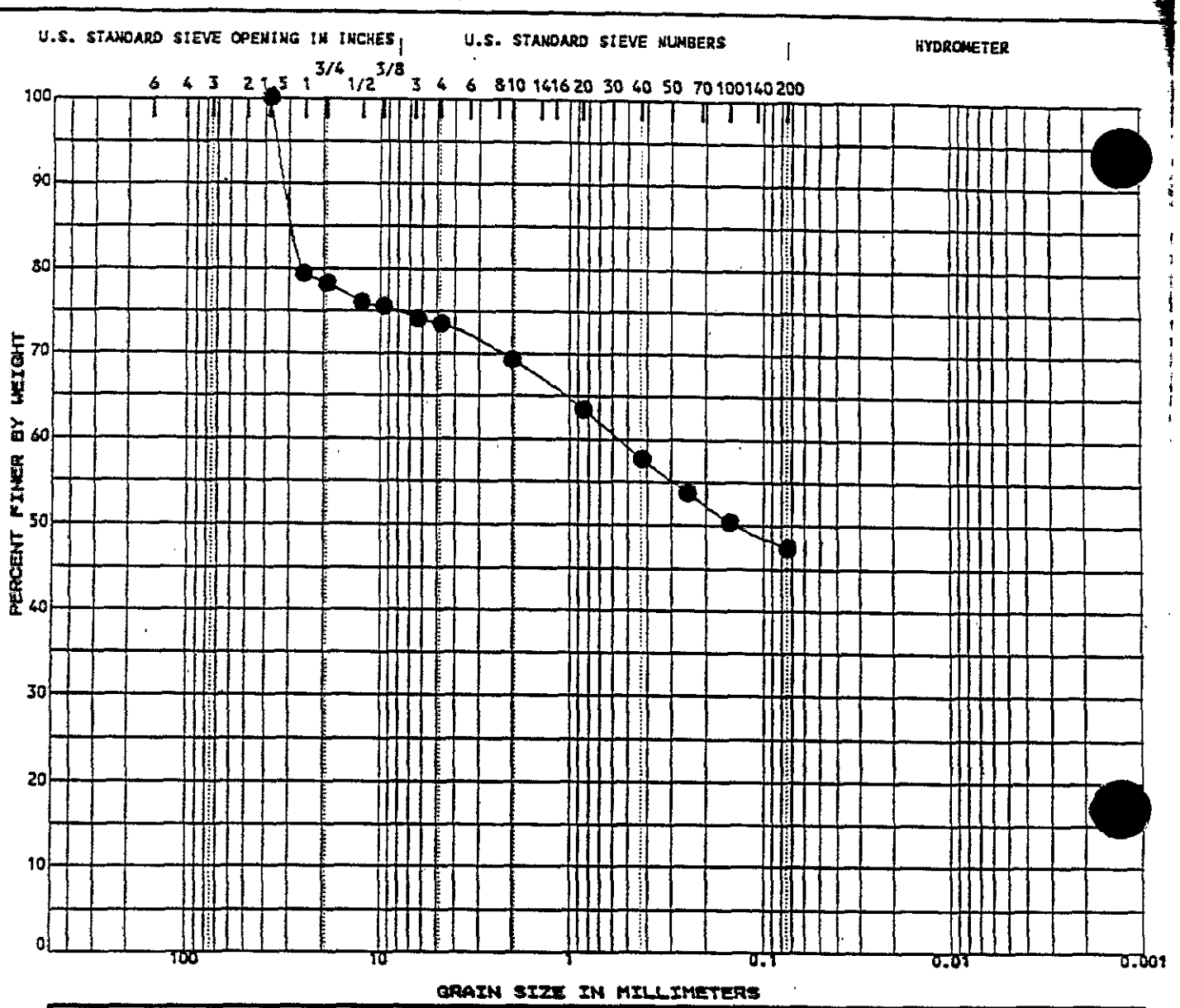
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA370305	CLAY; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	23.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA370305	6.30				0.2	8.4	91.4	

AR302919

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	



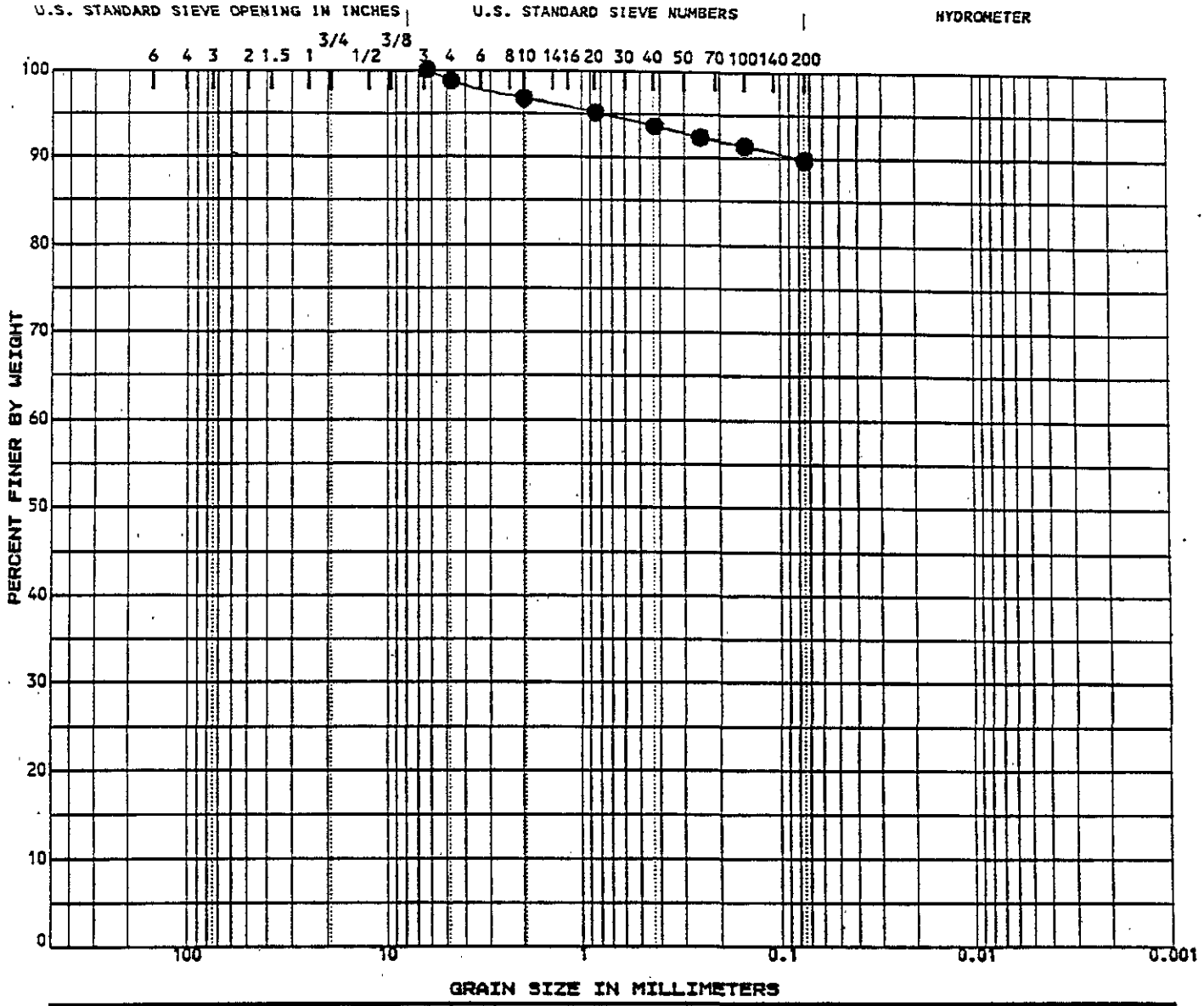
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA380304	SILT; some coarse gravel; little medium sand; trace fine and coarse sand and fine gravel.	30.8					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA380304	37.50	0.56			26.5	26.1	47.4	

AR302920

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes Large pieces of charcoal.
Date April 1996	GRADATION CURVES



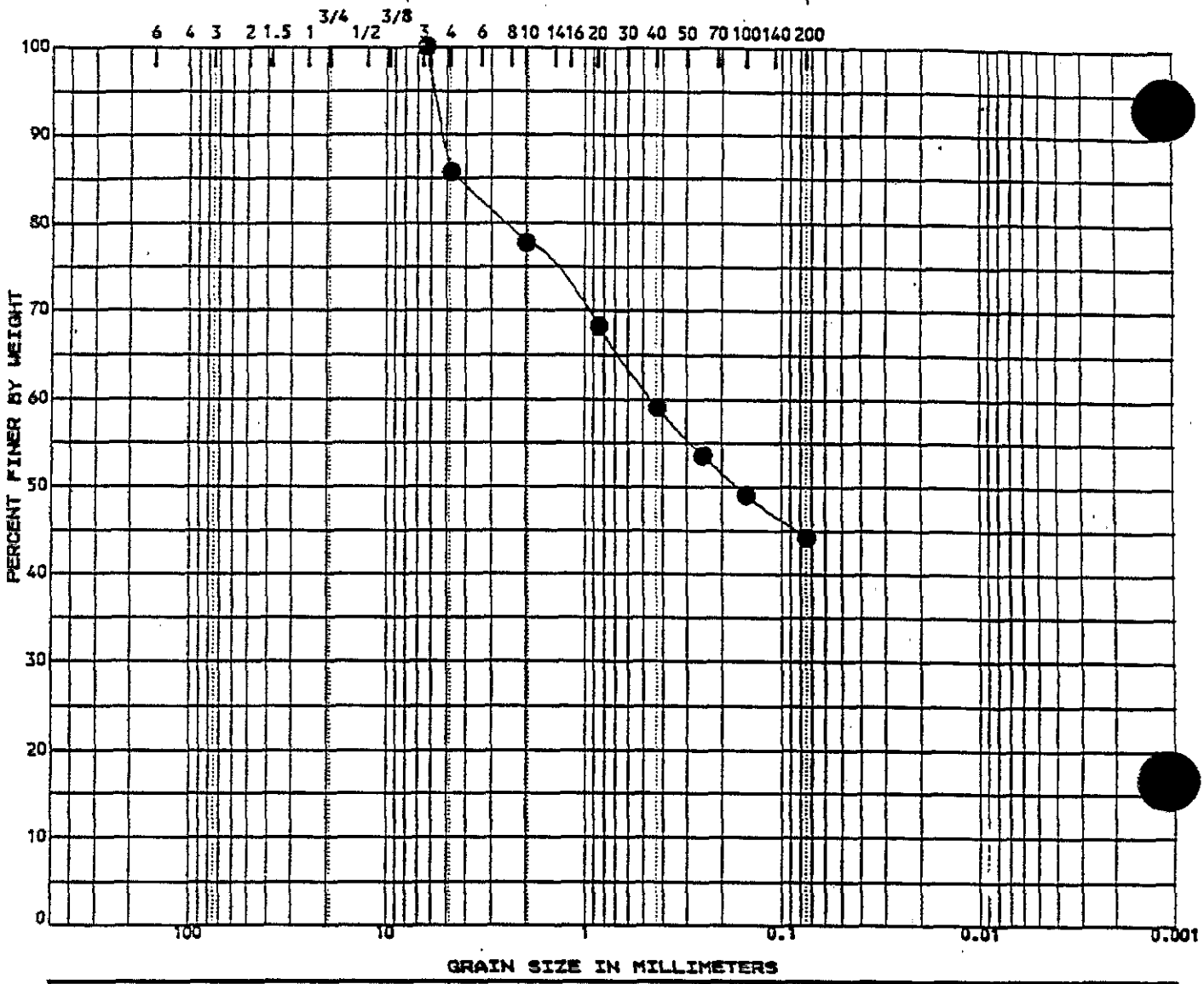
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
●	LA380506	CLAY; trace fine, medium, and coarse sand and fine gravel.	35.4					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	LA380506	6.30				1.3	8.9	89.8	

AR302921

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	



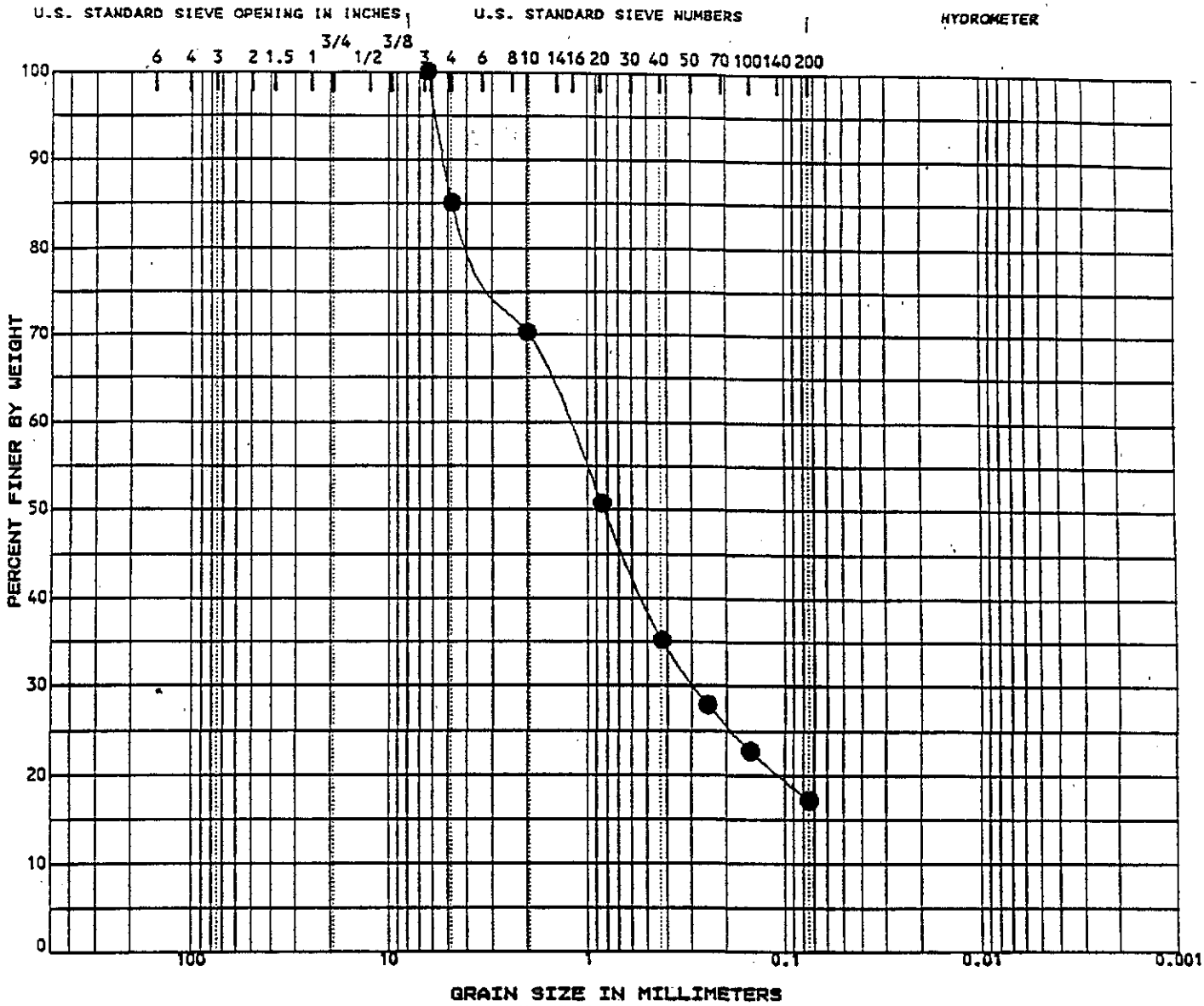
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA410204	Fine to Coarse Sandy SILT; little fine gravel.	30					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA410204	6.30	0.45			14.3	41.5	44.2	

AR302922

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	Black charcoal pieces.
Date	April 1996		GRADATION CURVES



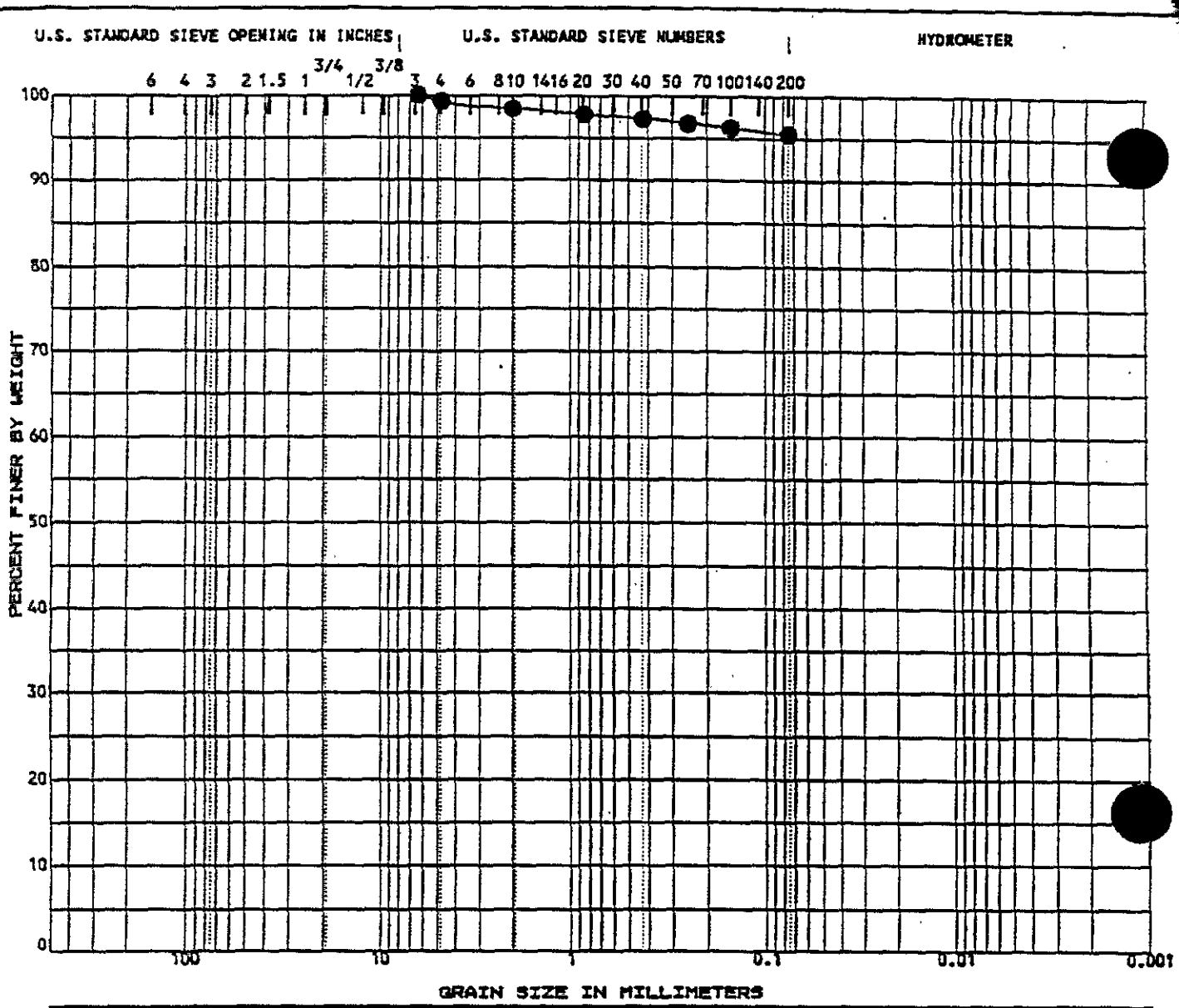
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA420408	Fine to Coarse SAND; little silt and fine gravel. Pan has noticible black blotches stuck to it. Heavy sheen and odor.	33.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA420408	6.30	1.28	0.291		14.9	67.9	17.2	

AR302923

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

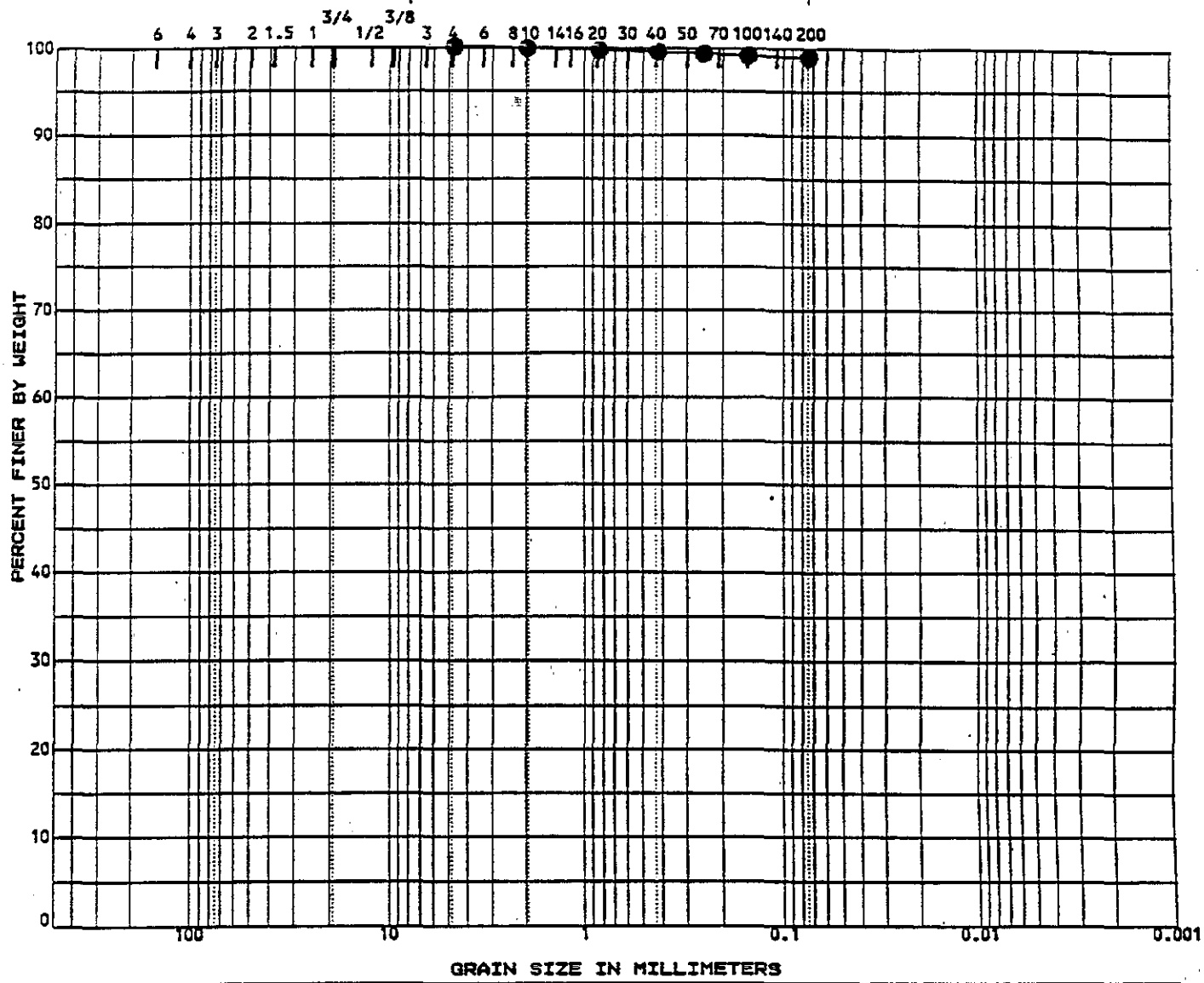


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA430608	SILT/CLAY; trace fine, medium, and coarse sand and fine gravel.	26.2					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA430608	6.30				0.8	3.8	95.4	

4R302924	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



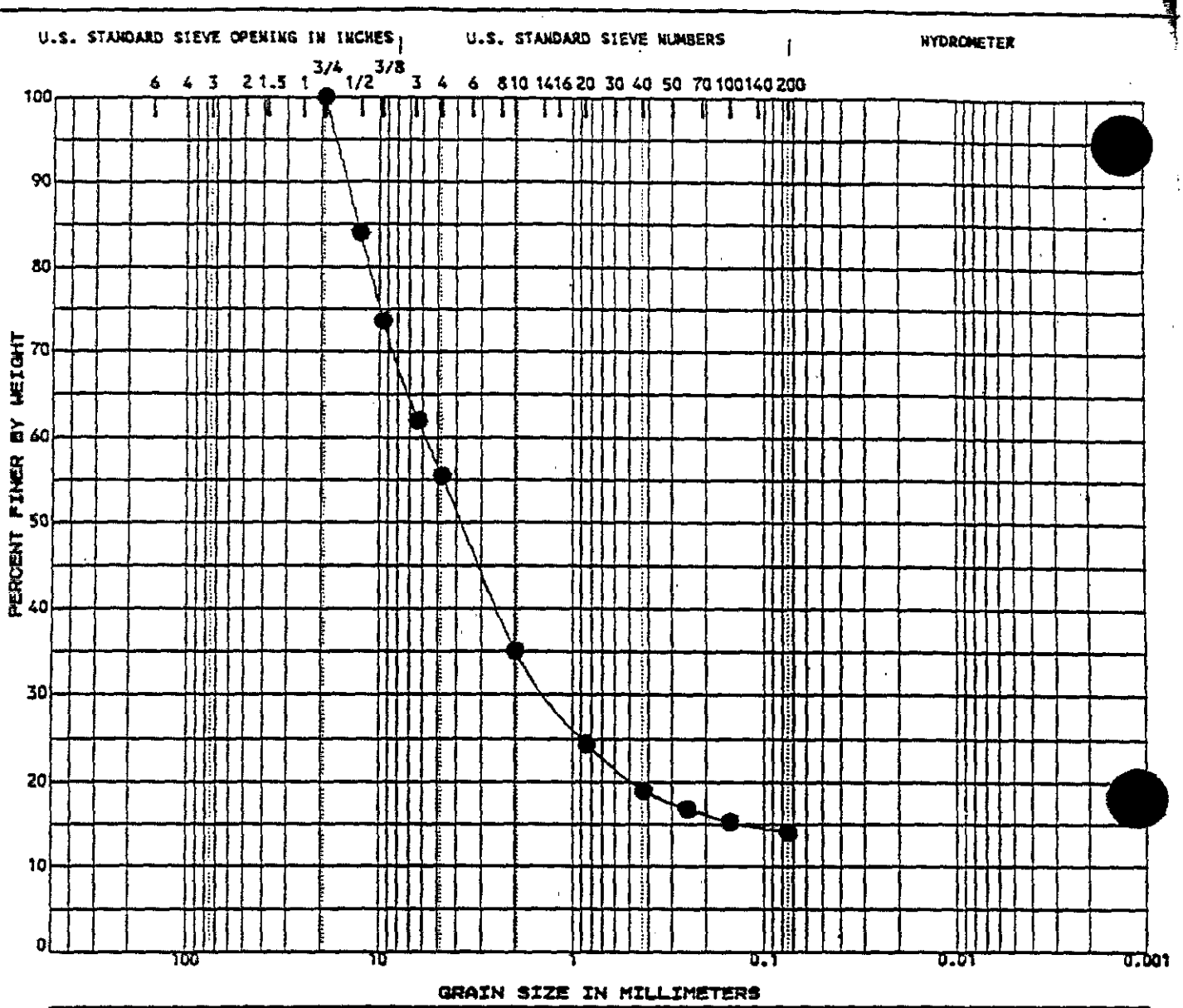
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA440408	CLAY; trace medium, and coarse sand.	30.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA440408	4.75				0.0	1.1	98.9	

AR302925

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	Highly plastic.
Date	April 1996	GRADATION CURVES	



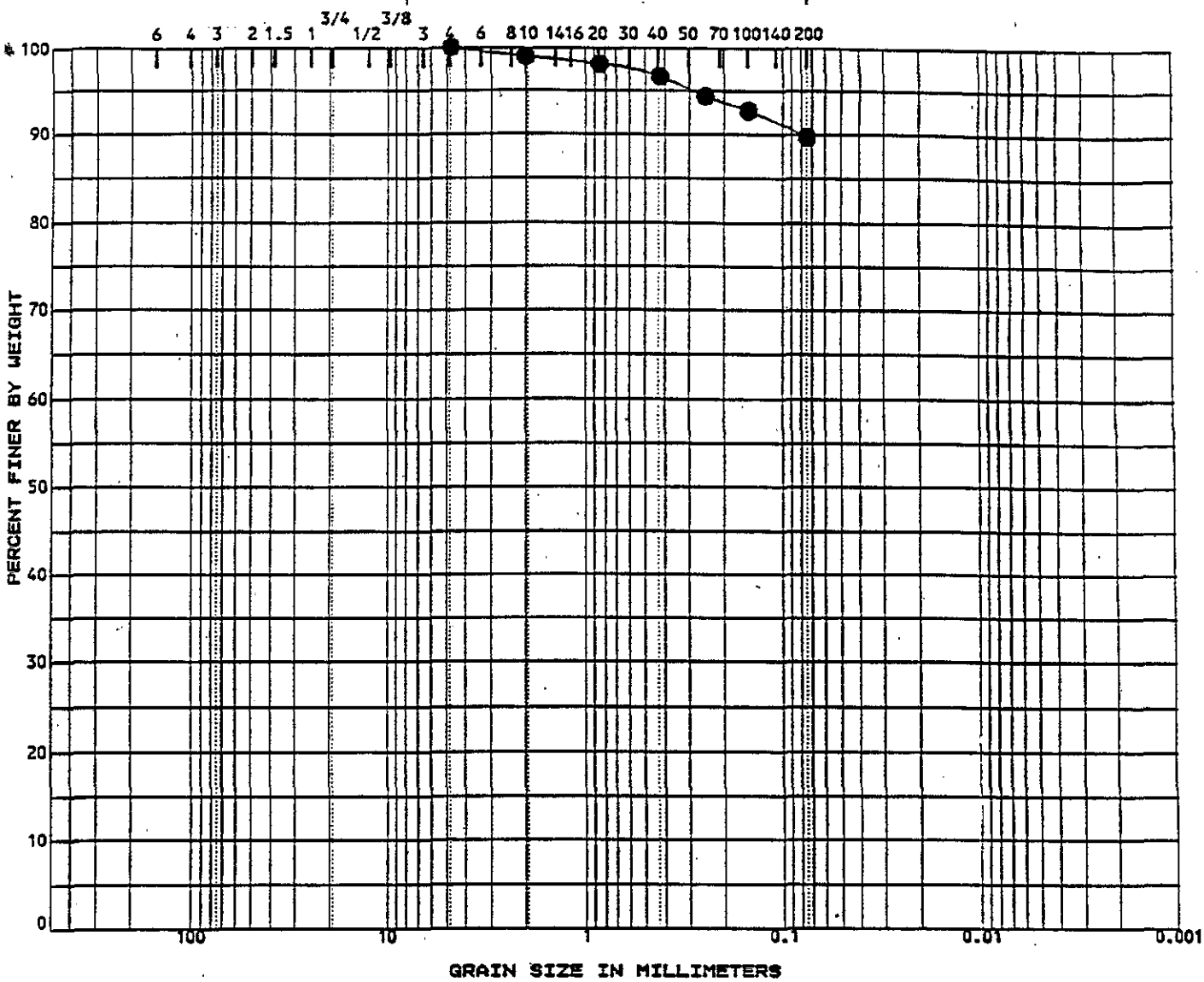
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA440812	Coarse to Fine Sandy Fine GRAVEL; little silt.	24.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA440812	19.10	5.78	1.330		44.5	41.4	14.1	

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302926



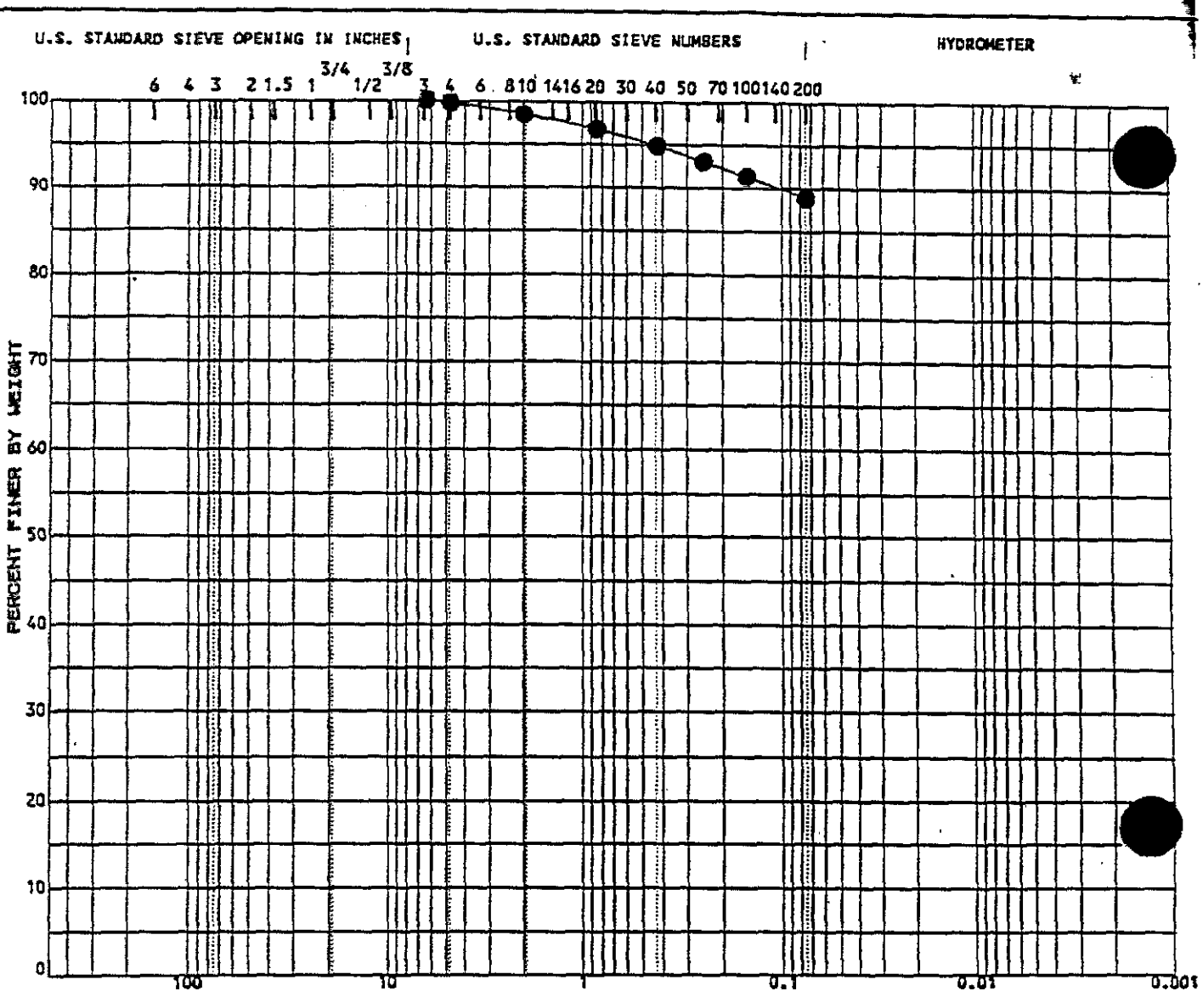
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA460910	CLAY; trace fine, medium, and coarse sand.	26.3					
	Moderately plastic.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA460910	4.75				0.0	10.3	89.7	

AR302927

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



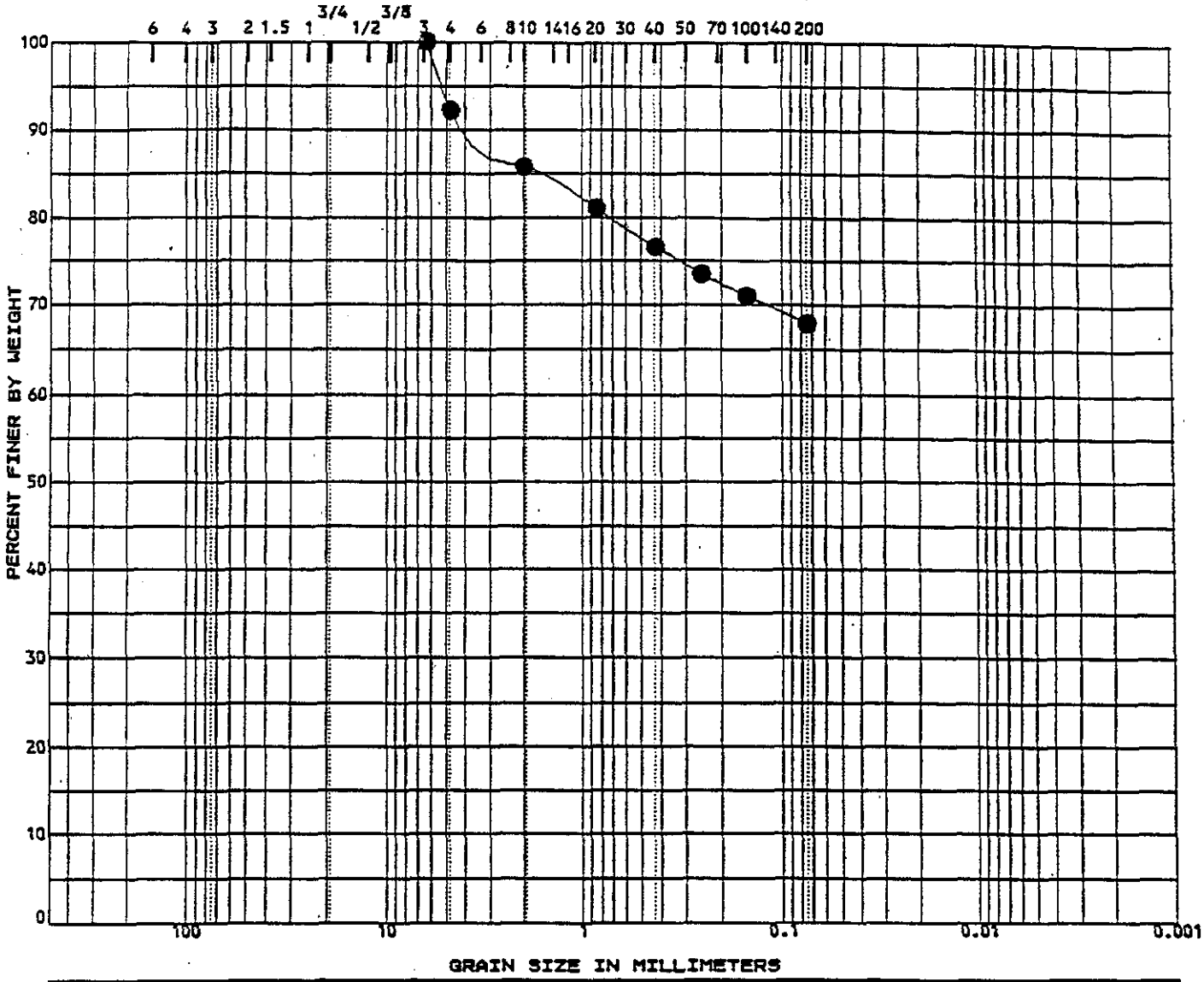
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA470002	CLAY; trace fine, medium, and coarse sand and fine gravel. Moderately plastic. With organics.	27.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● LA470002	6.30				0.3	10.8	88.9	

AR302928

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes Small amount of organics.
Date April 1996	GRADATION CURVES



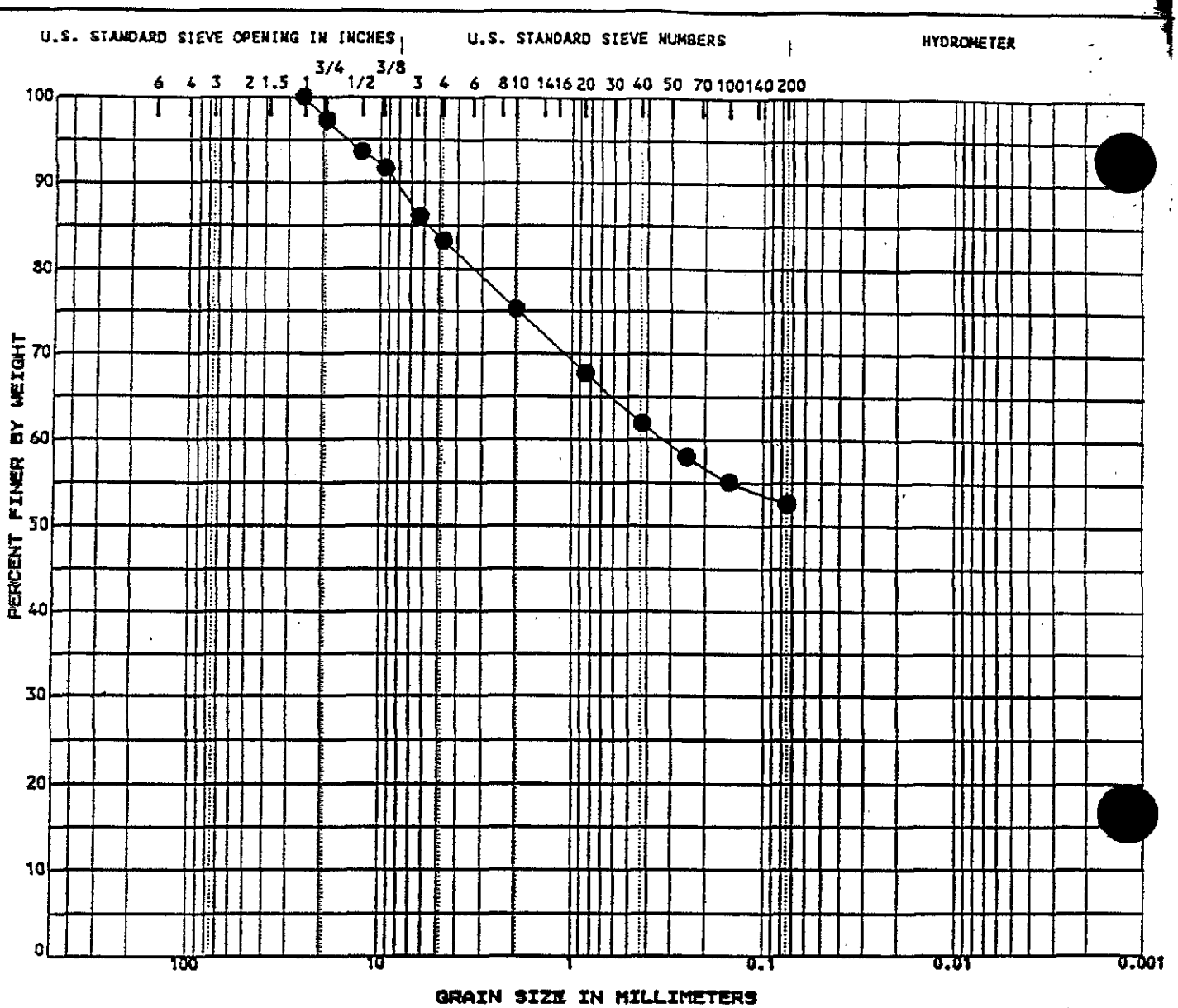
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
●	LA480203	SILT/CLAY; trace fine, medium, and coarse sand and fine gravel. Moderately plastic.	32.3					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	LA480203	6.30				7.8	24.3	67.9	

AR302929

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



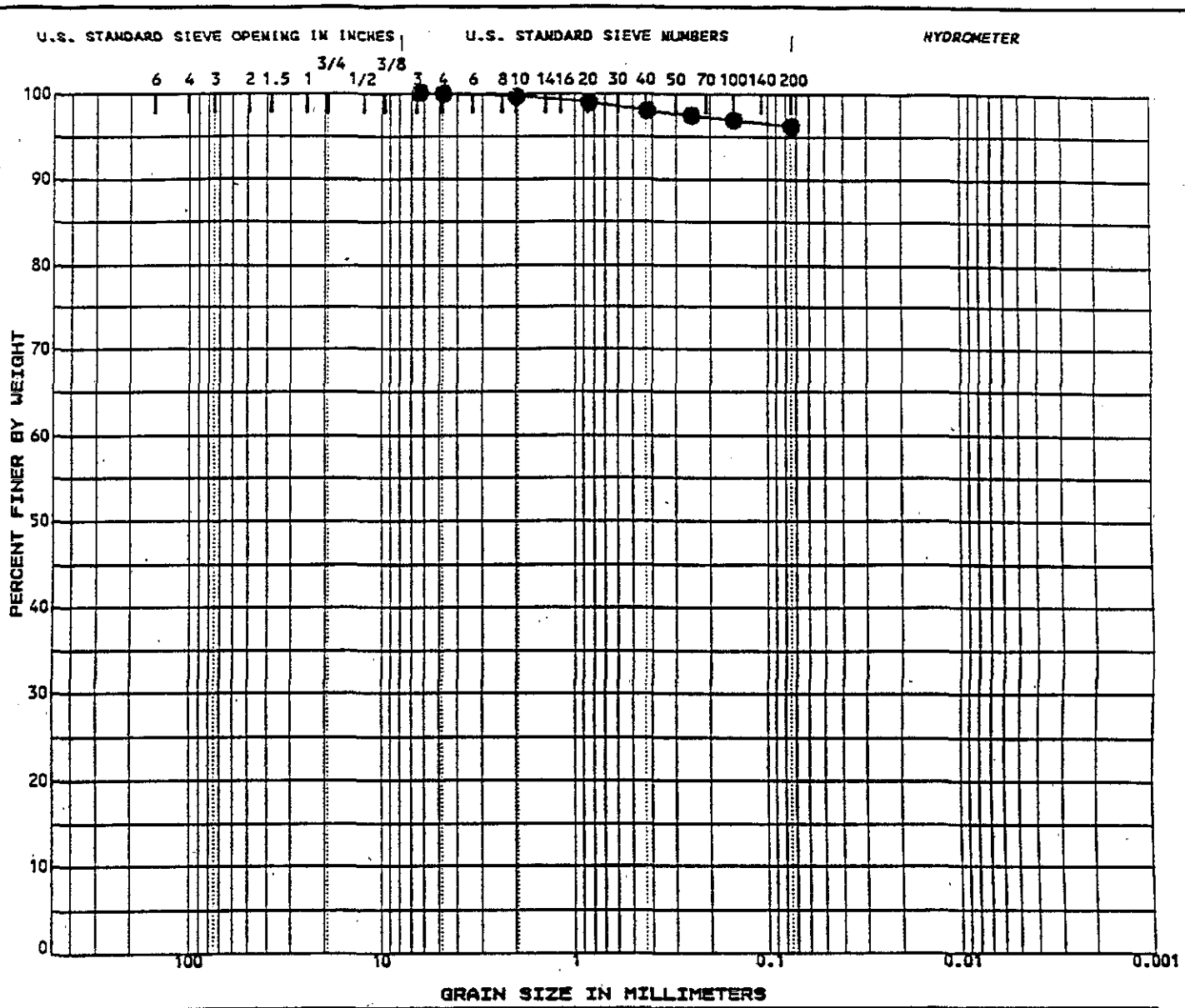
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA490002	SILT; little medium sand and fine gravel; trace fine and coarse sand and coarse gravel.	38.3					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA490002	25.40	0.33			16.7	30.7	52.6	

AR302930

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996		GRADATION CURVES



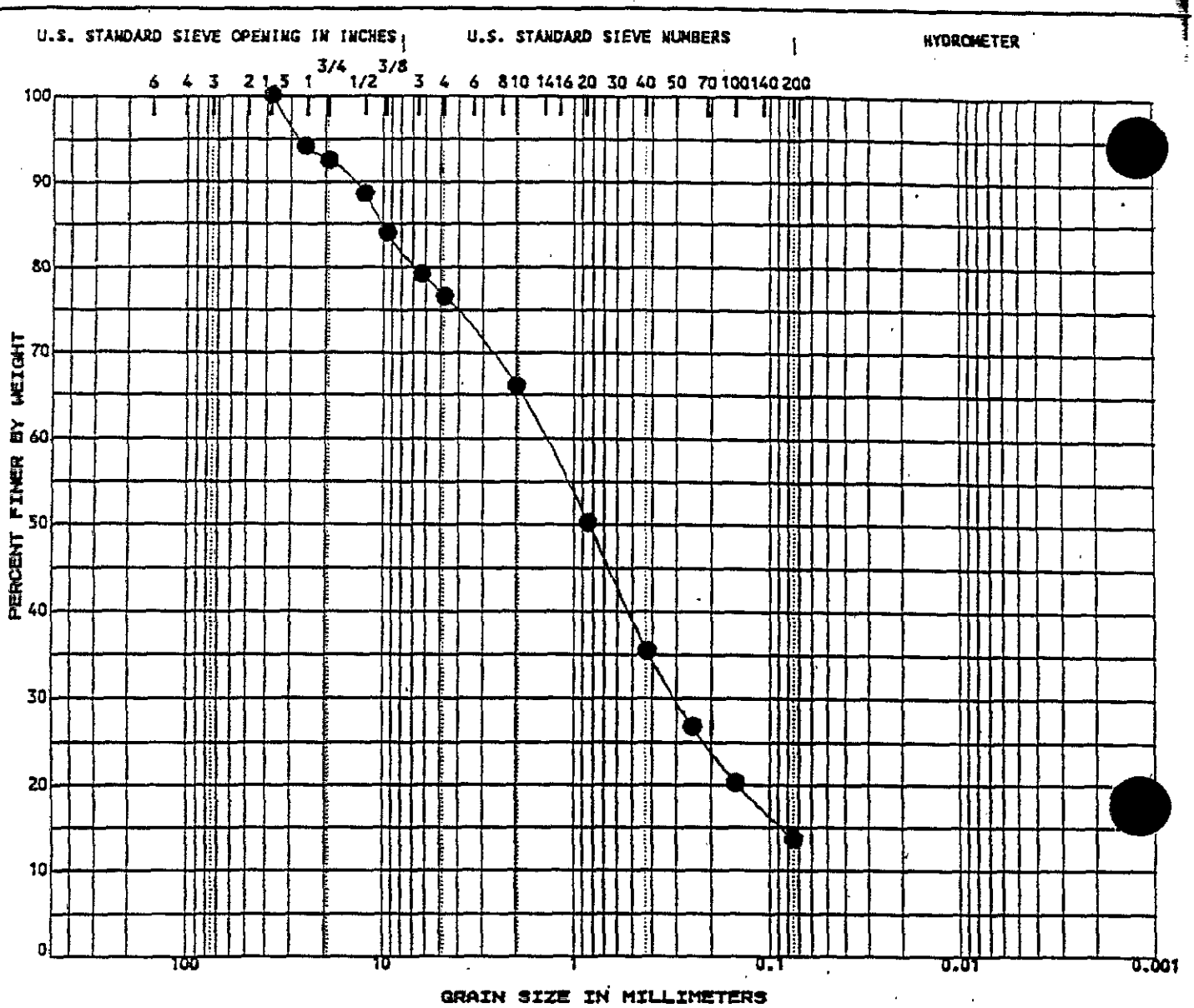
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA490204	SILT; trace fine, medium, and coarse sand	26.4					
	and fine gravel.						
	Entire sample was ash/charcoal.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA490204	6.30				0.1	3.7	96.2	

AR302931

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



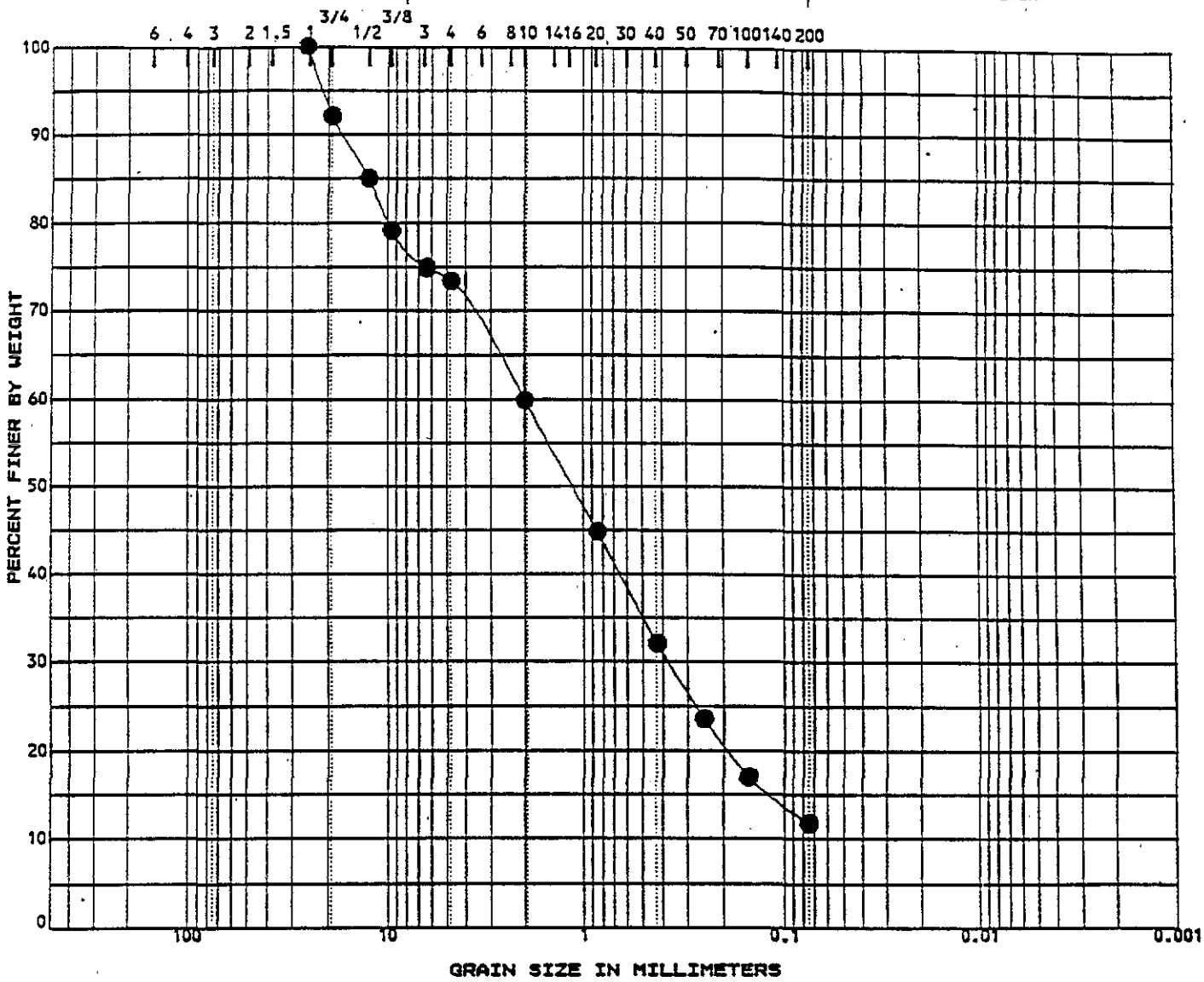
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA500004	Fine to Coarse SAND; little fine gravel and silt; trace coarse gravel.	39.3					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA500004	37.50	1.44	0.304		23.4	62.9	13.7	

AR302932

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



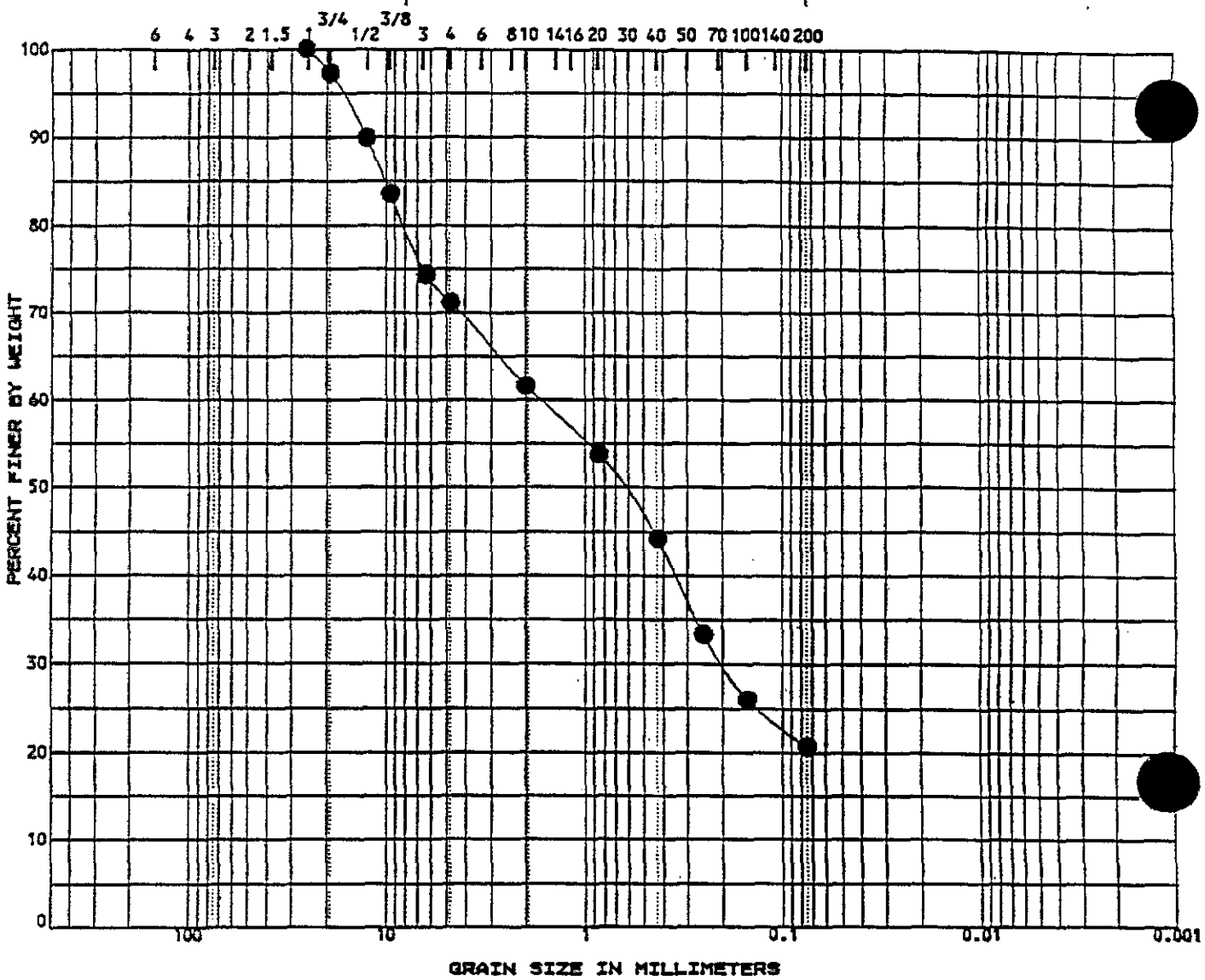
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA510204	Fine to Coarse SAND; little fine gravel and silt; trace coarse gravel.	51.3				0.99	28.8

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA510204	25.40	2.01	0.373		26.6	61.6	11.8	

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes Black tar like substance.	
Date April 1996	GRADATION CURVES	

AR302933

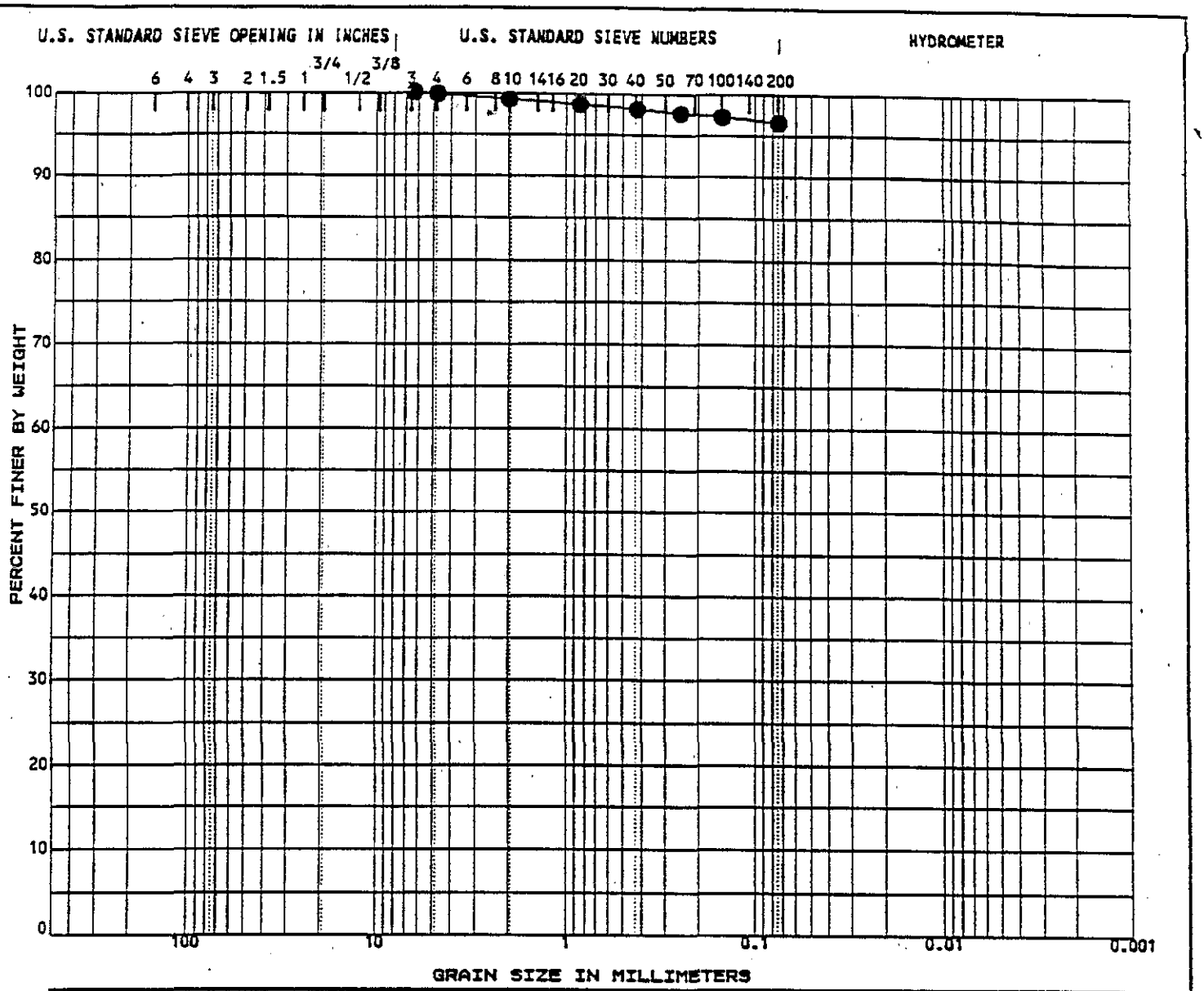


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA520004	Fine to Coarse SAND; some fine gravel and silt; trace coarse gravel.	26.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA520004	25.40	1.68	0.198		28.8	50.5	20.7	

AR302934	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



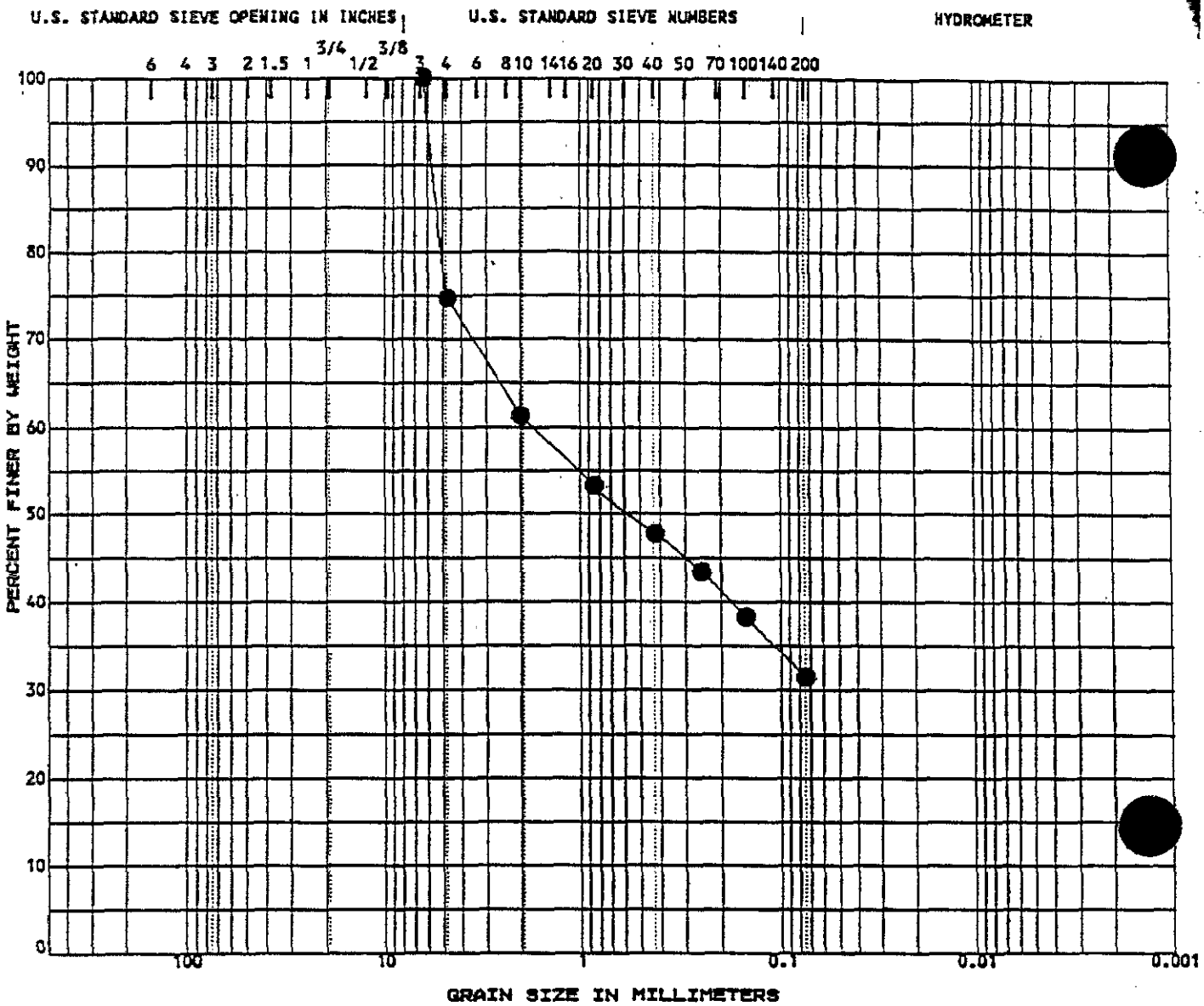
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA520708	Silty CLAY; trace fine, medium, and coarse sand and fine gravel. Moderately to highly plastic.	28.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA520708	6.30				0.2	3.3	96.5	

AR302935

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

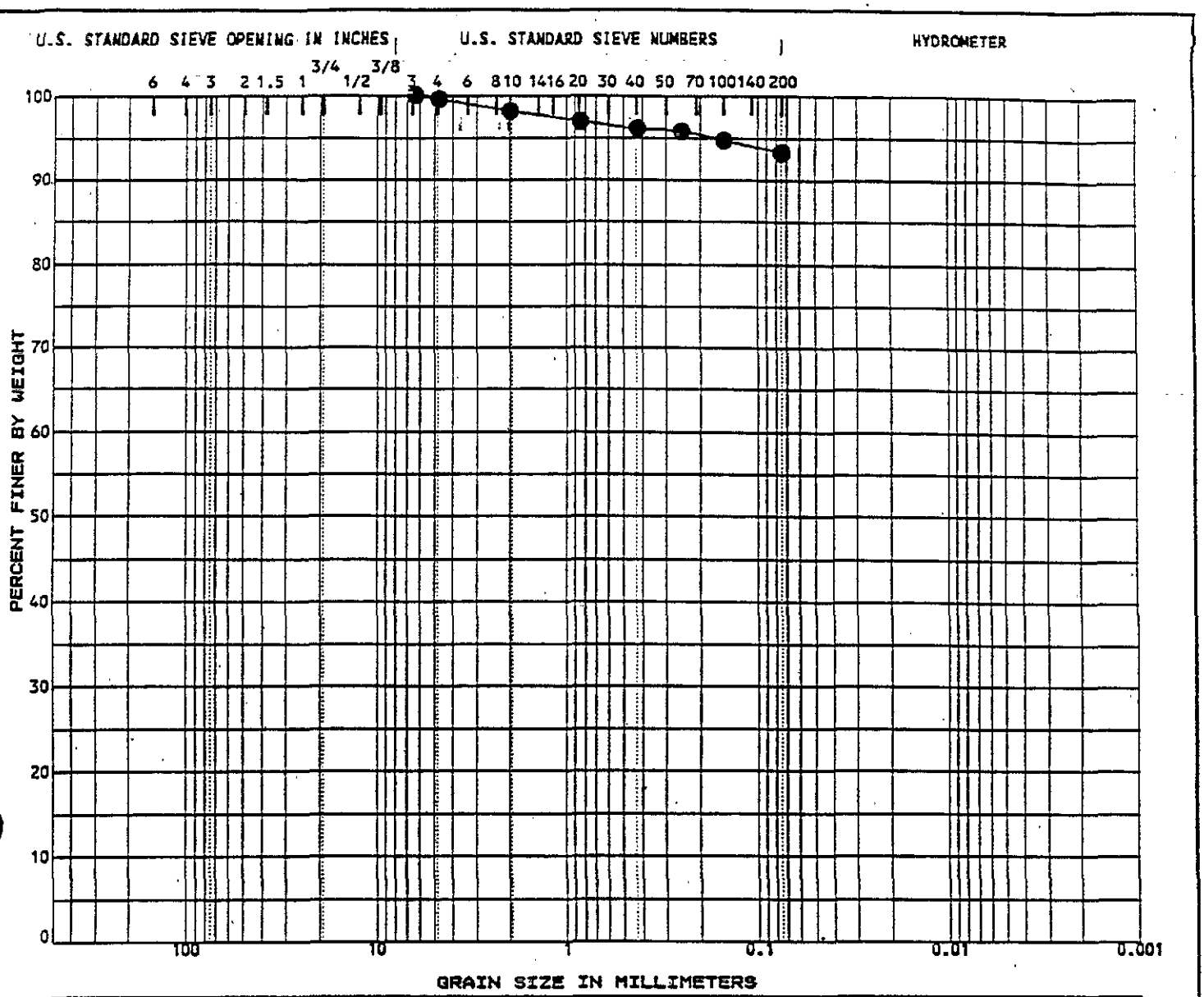


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA530408	Coarse to Fine SAND; some silt and fine gravel.	23.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● LA530408	6.30	1.74			25.3	43.2	31.5	

AR302936	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

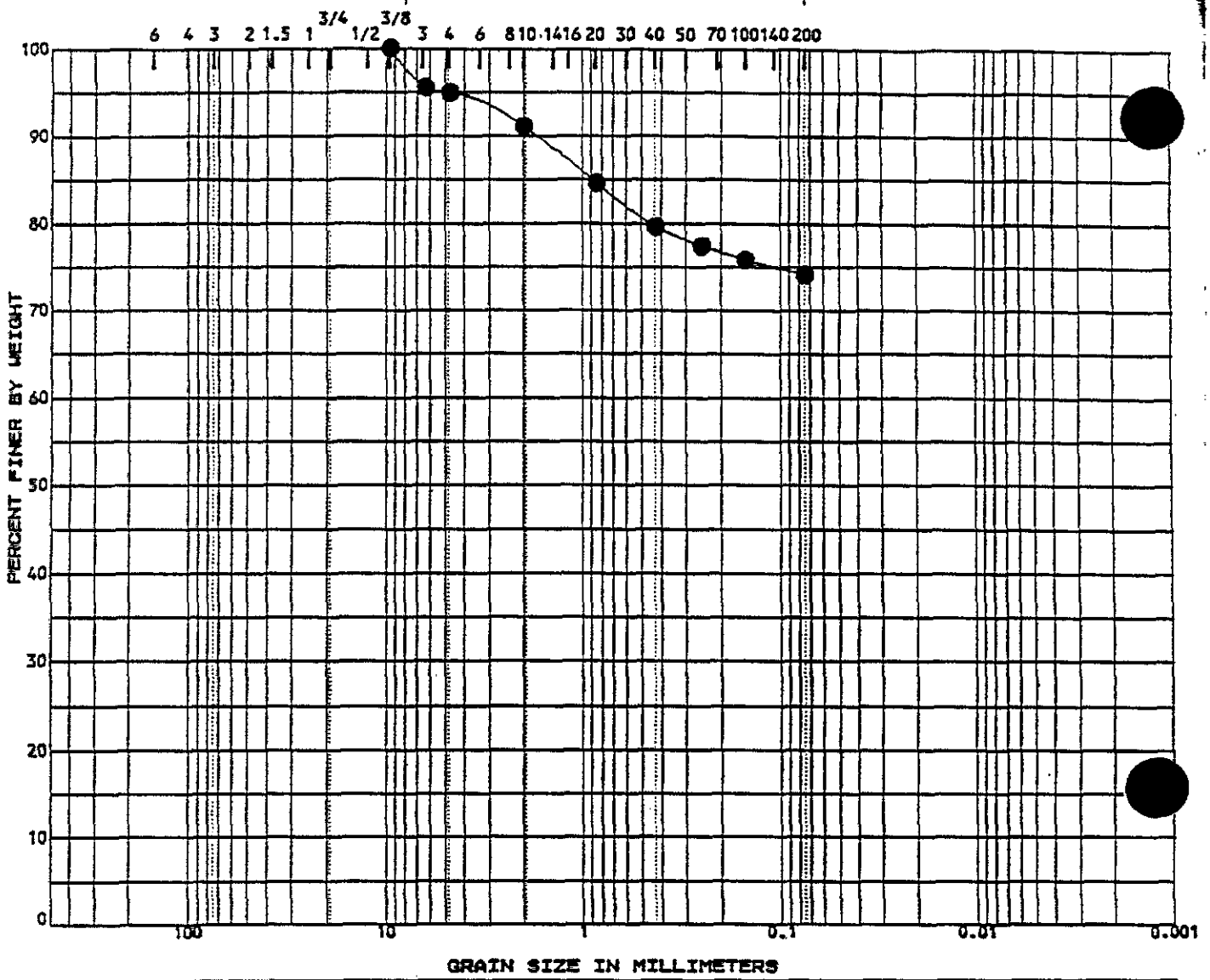


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA531012	Clayey SILT; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	28.5					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA531012	6.30				0.5	6.2	93.3	

AR302937	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

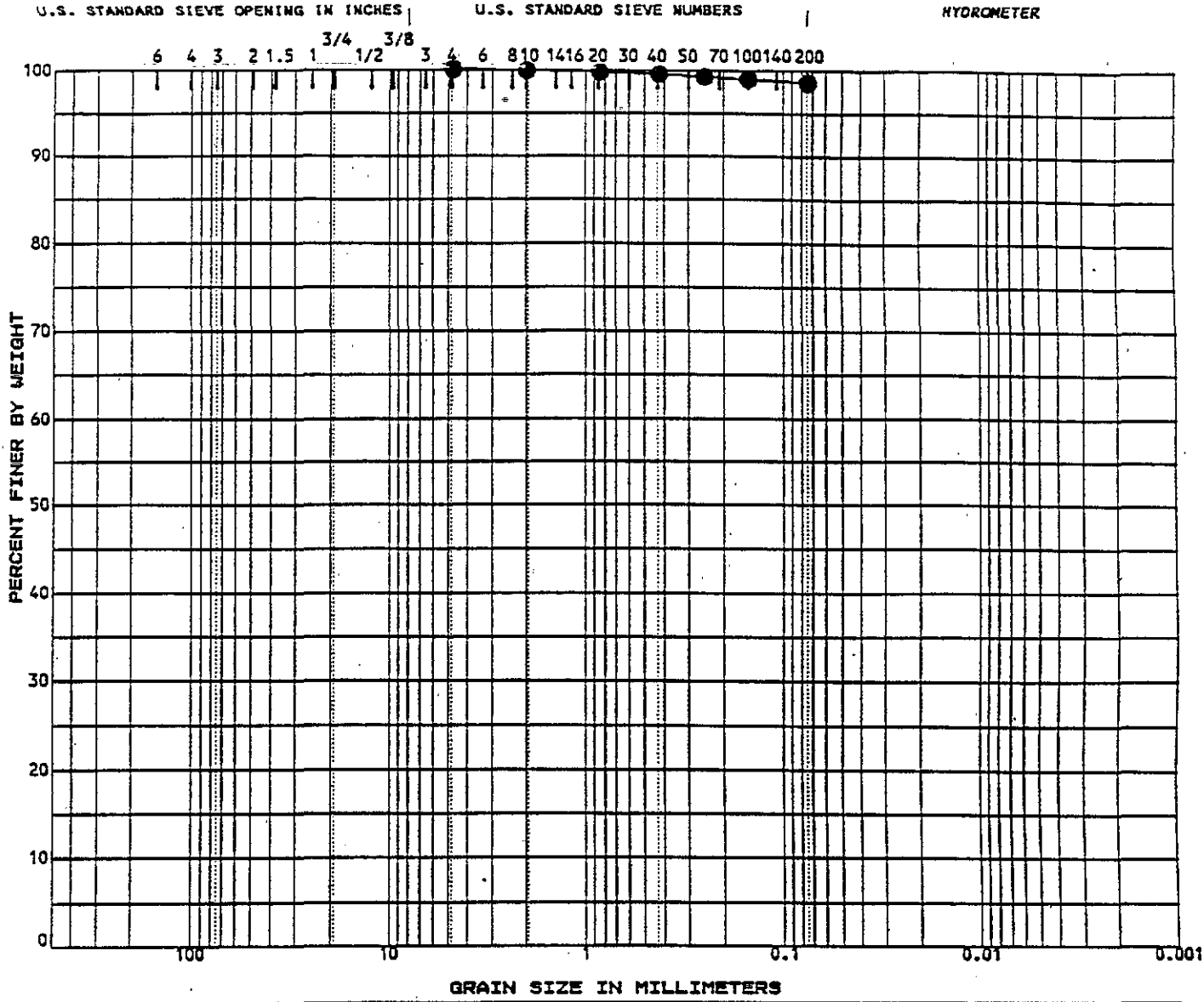


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA530810	SILT; little medium sand; trace fine and coarse sand and fine gravel.	33.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cla
● LA530810	9.51				5.1	20.8	74.1	

AR302938	Project	OLIN MORGANTOWN	Location West Virginia
	Area		Notes Black tar like substance.
	Date	April 1996	GRADATION CURVES

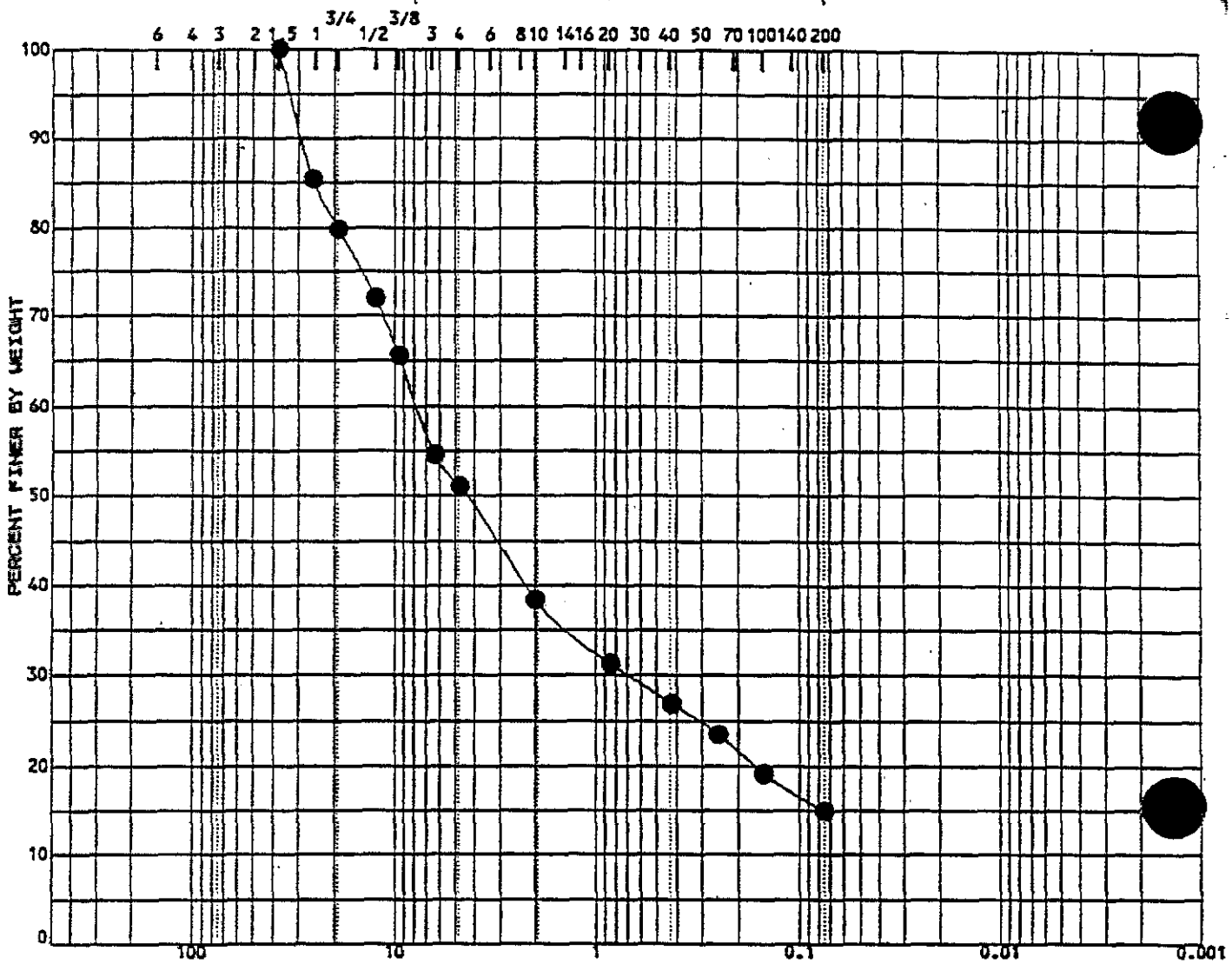


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA540708	CLAY; trace fine, medium, and coarse sand.	26.9					
	Moderately plastic.						

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA540708	4.75				0.0	1.5	98.5	

AR302939	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



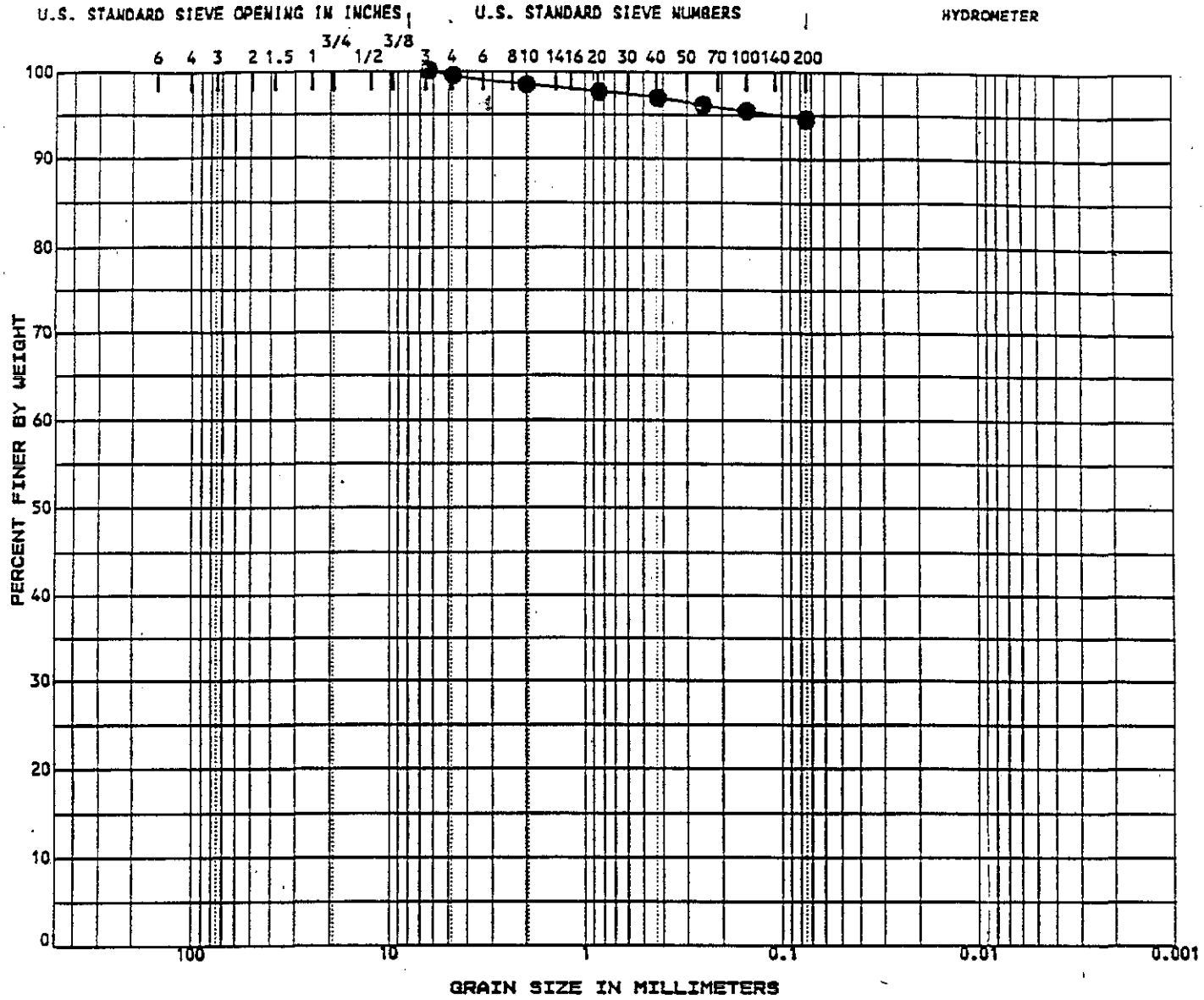
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA620002	Coarse to Fine Sandy Coarse to Fine GRAVEL; little silt/clay. Low plasticity.	21.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA620002	37.50	7.71	0.693		48.9	36.1	15.0	

AR302940

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



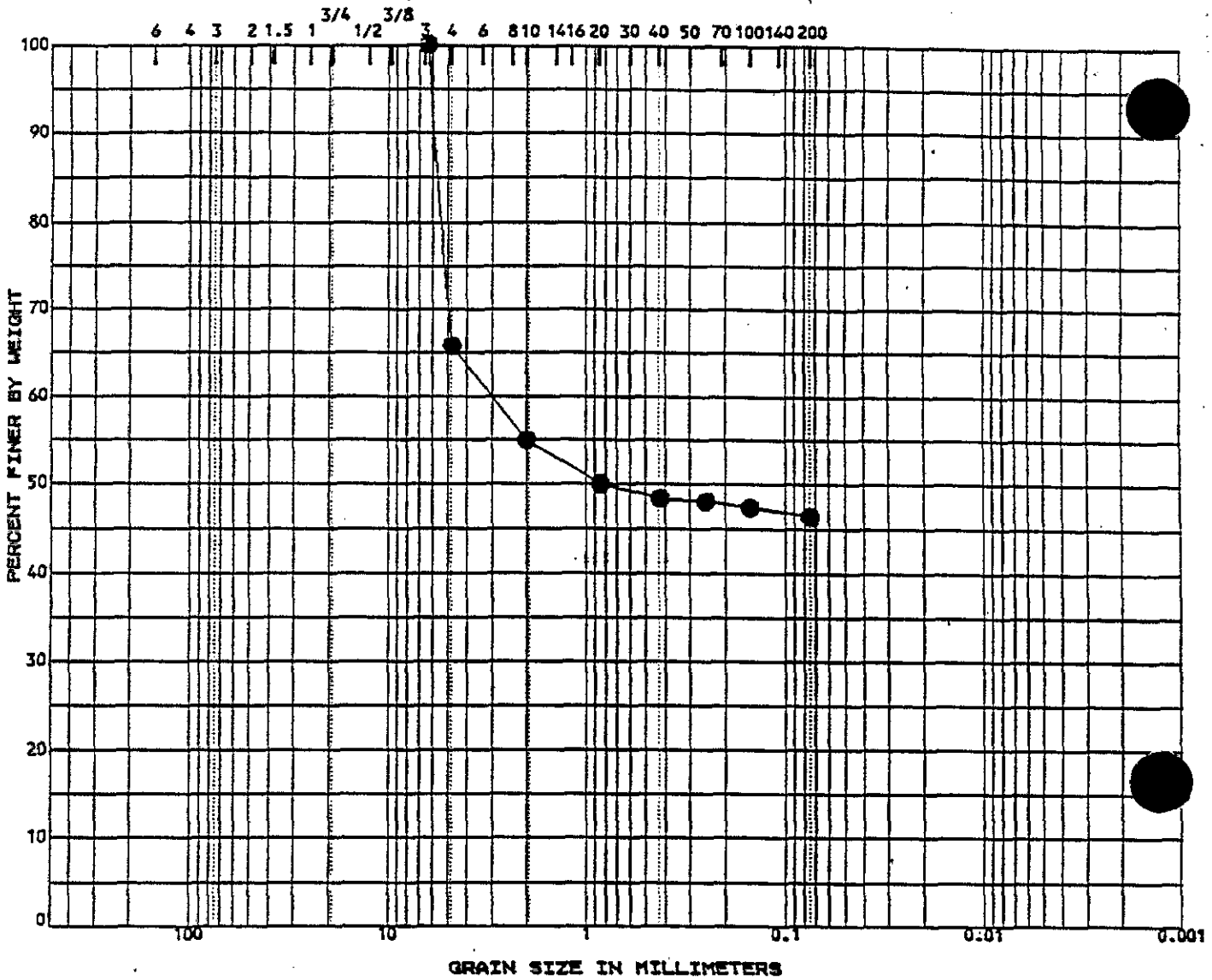
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
●	LA620204	Silt; trace fine, medium, and coarse sand and fine gravel.	33.7					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	LA620204	6.30				0.6	4.9	94.5	

Project OLIN MORGANTOWN		Location West Virginia
Area		Notes
Date April 1996		GRADATION CURVES

AR302941

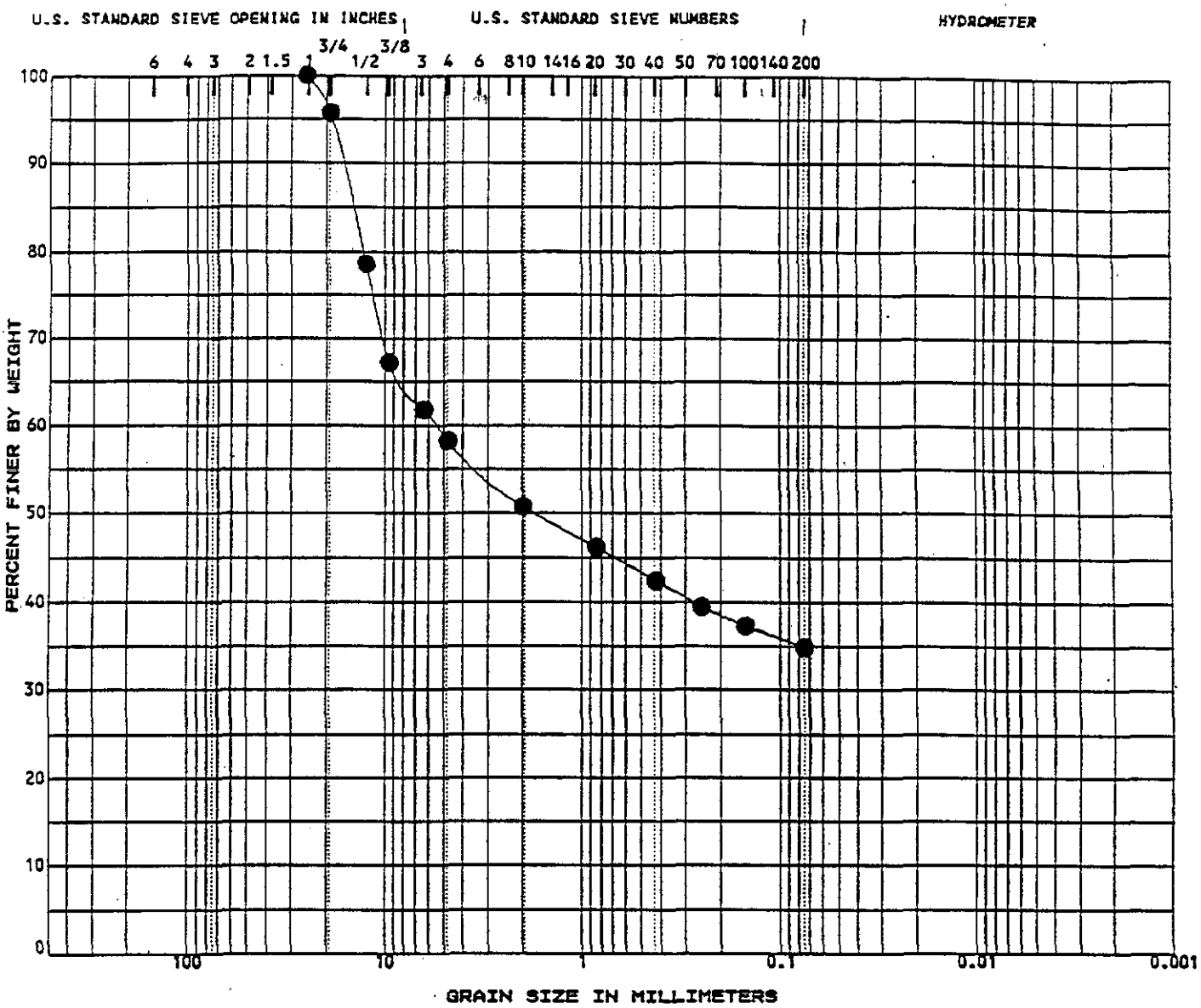


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA680506	SILT/CLAY; some fine gravel; little coarse sand; trace medium and fine sand. Low plasticity.	25.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA680506	6.30	3.00			34.2	19.4	46.4	

AR302942	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

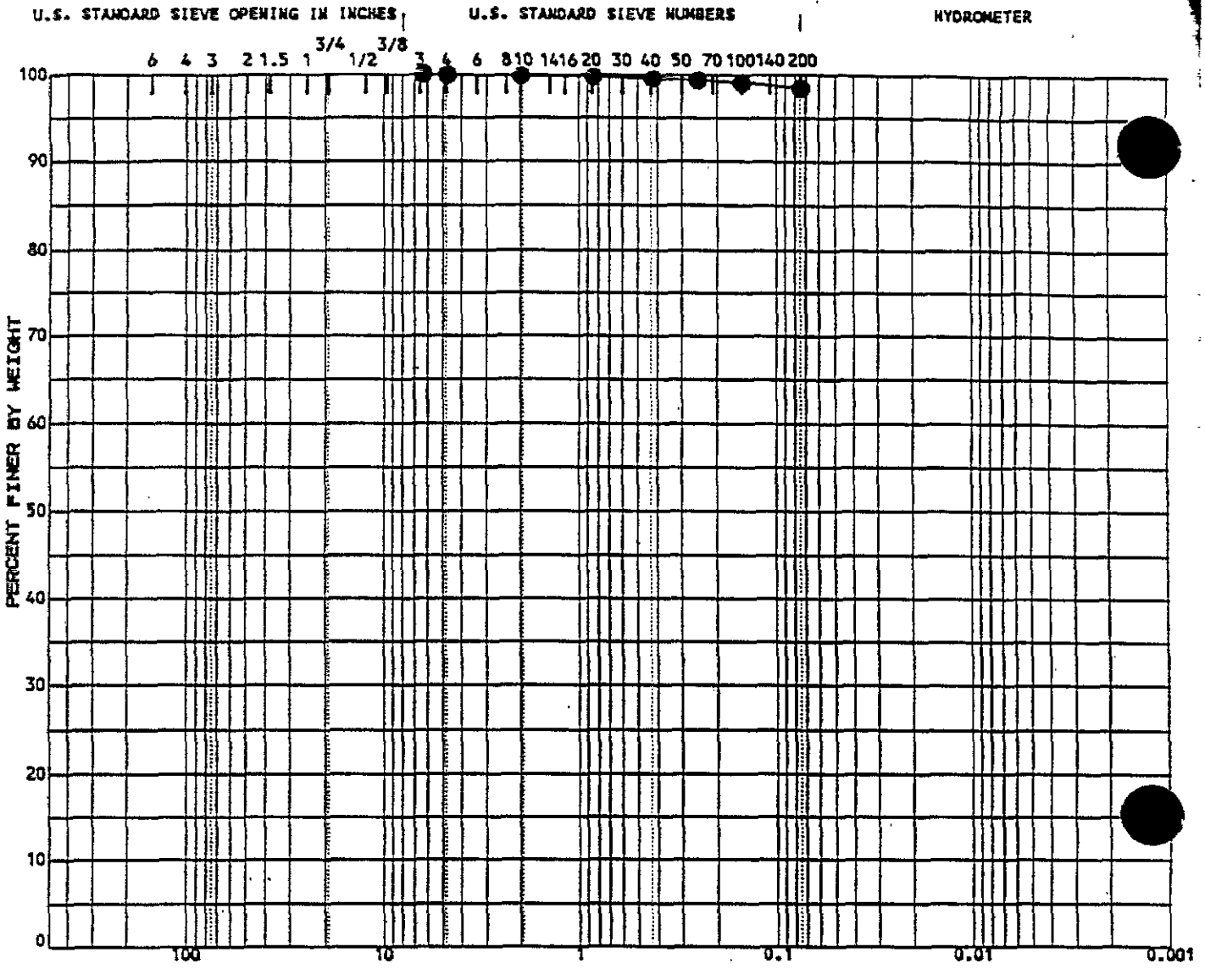


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA690002	Fine GRAVEL; some silt; trace coarse, medium, and fine sand and coarse gravel.	36.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA690002	25.40	5.47			41.8	23.3	34.9	

AR302943	Project	OLIN MORGANTOWN	Location West Virginia
	Area		Notes Black charcoal pieces.
	Date	April 1996	GRADATION CURVES

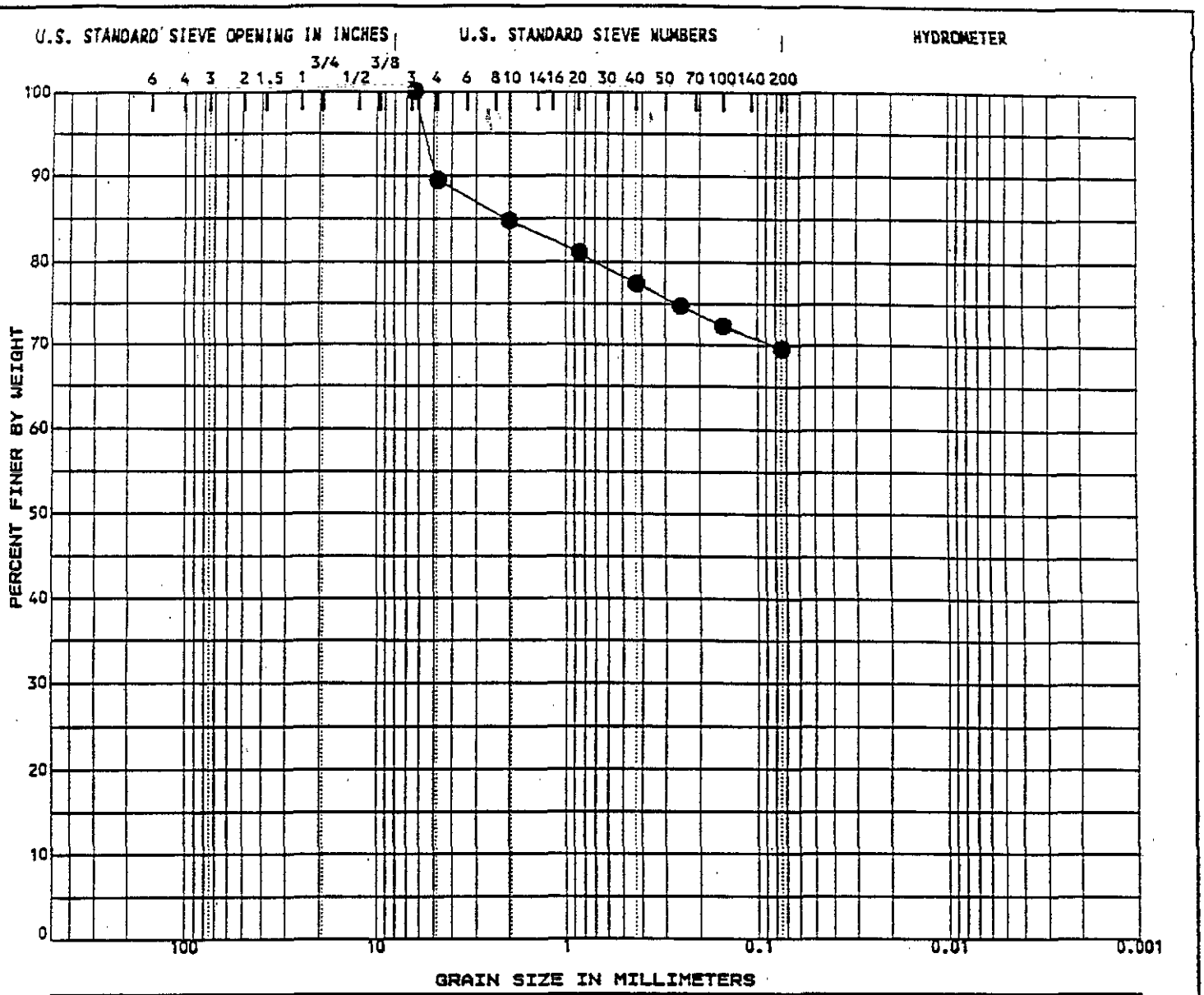


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA690204	CLAY; trace fine, medium, and coarse sand and fine gravel. Moderately plastic.	25.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA690204	6.30				0.1	1.6	98.3	

AR302944	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



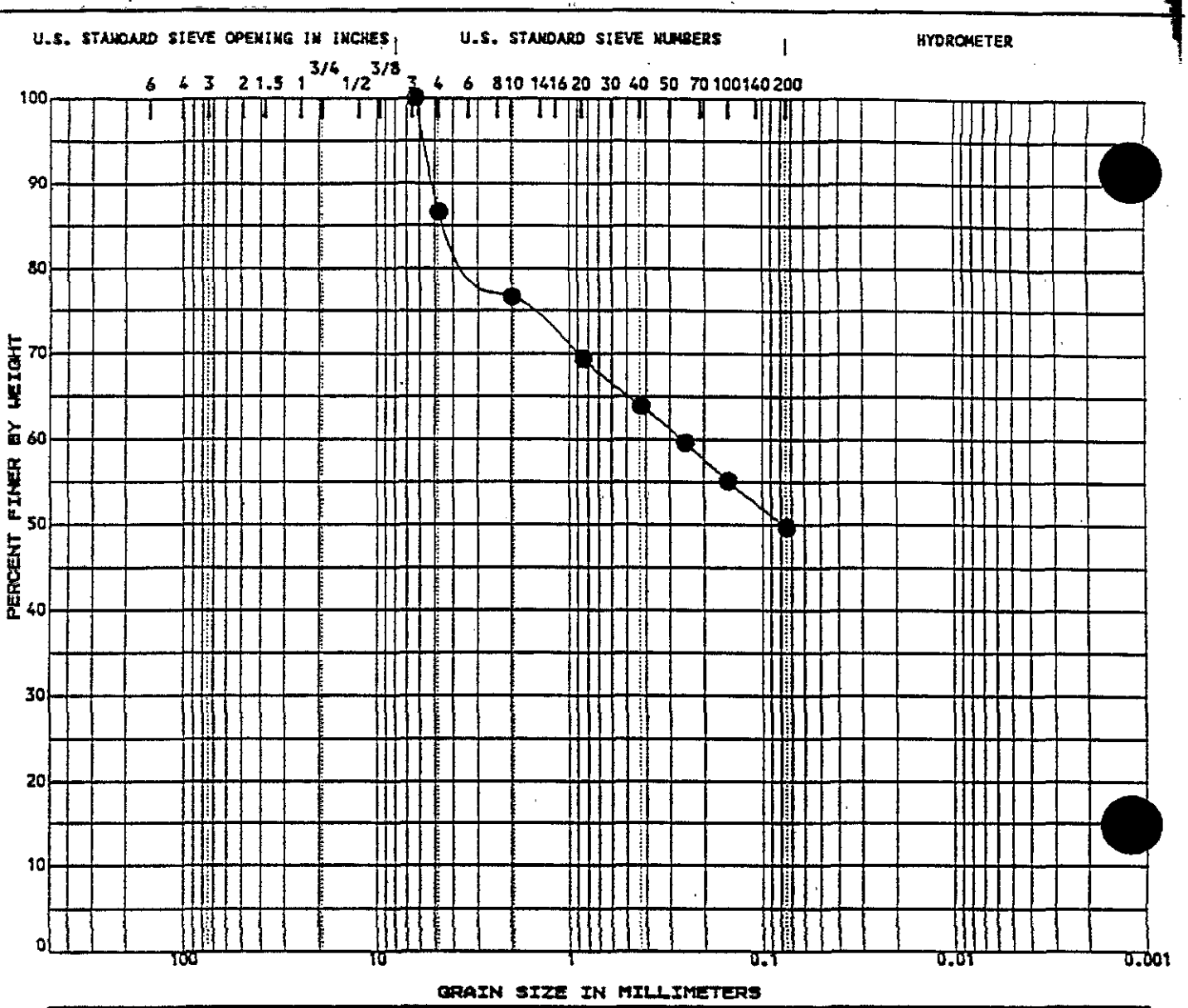
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA740002	SILT/CLAY; little fine gravel and fine medium and coarse sand. Moderately plastic.	23.8					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LA740002	6.30				10.5	19.9	69.6	

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302945

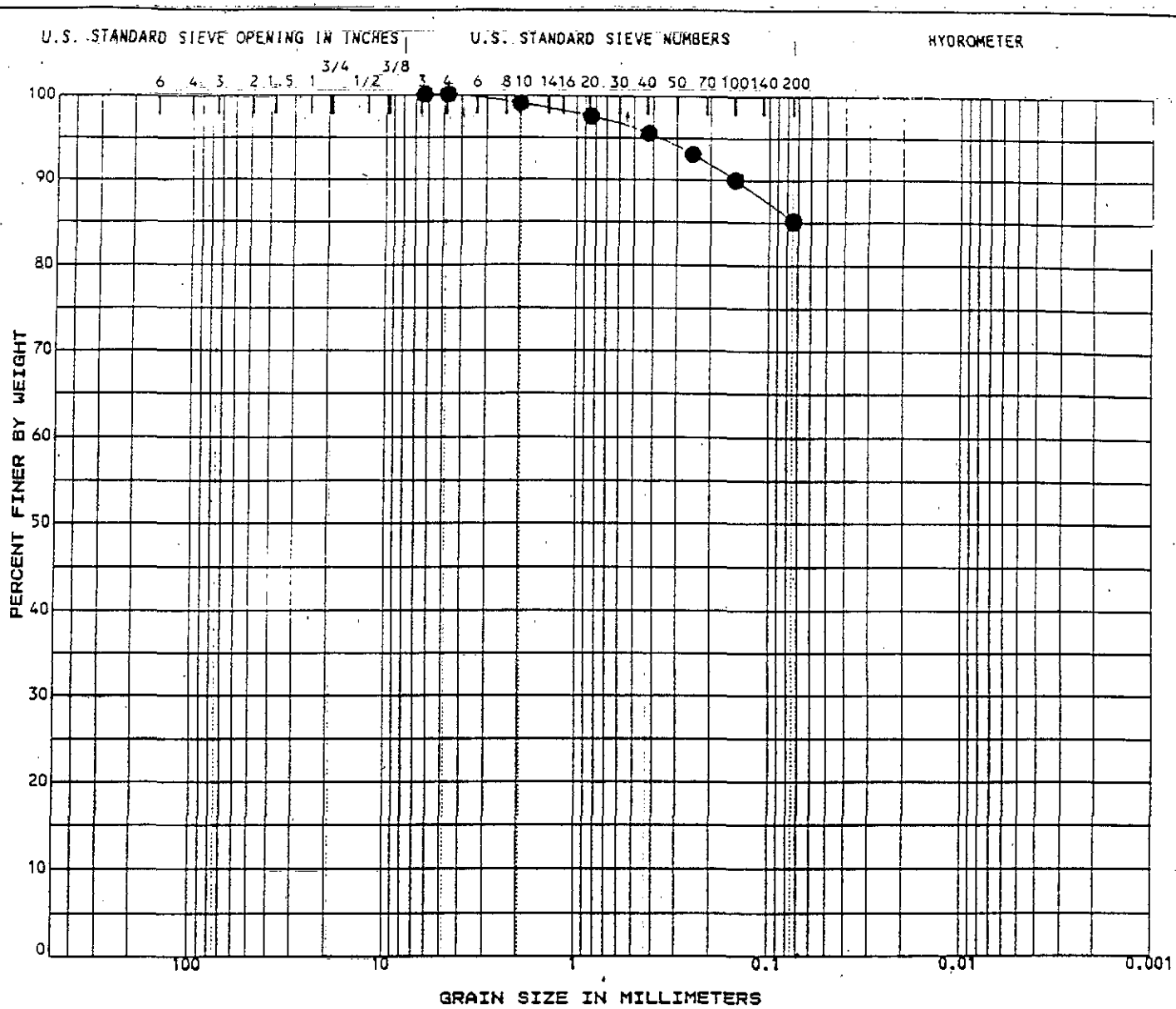


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● LA900002	Fine to Coarse Sandy CLAY; little fine gravel.	21.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cla
● LA900002	6.30	0.26			13.4	36.9	49.7	

AR302946	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	**GRADATION CURVES**



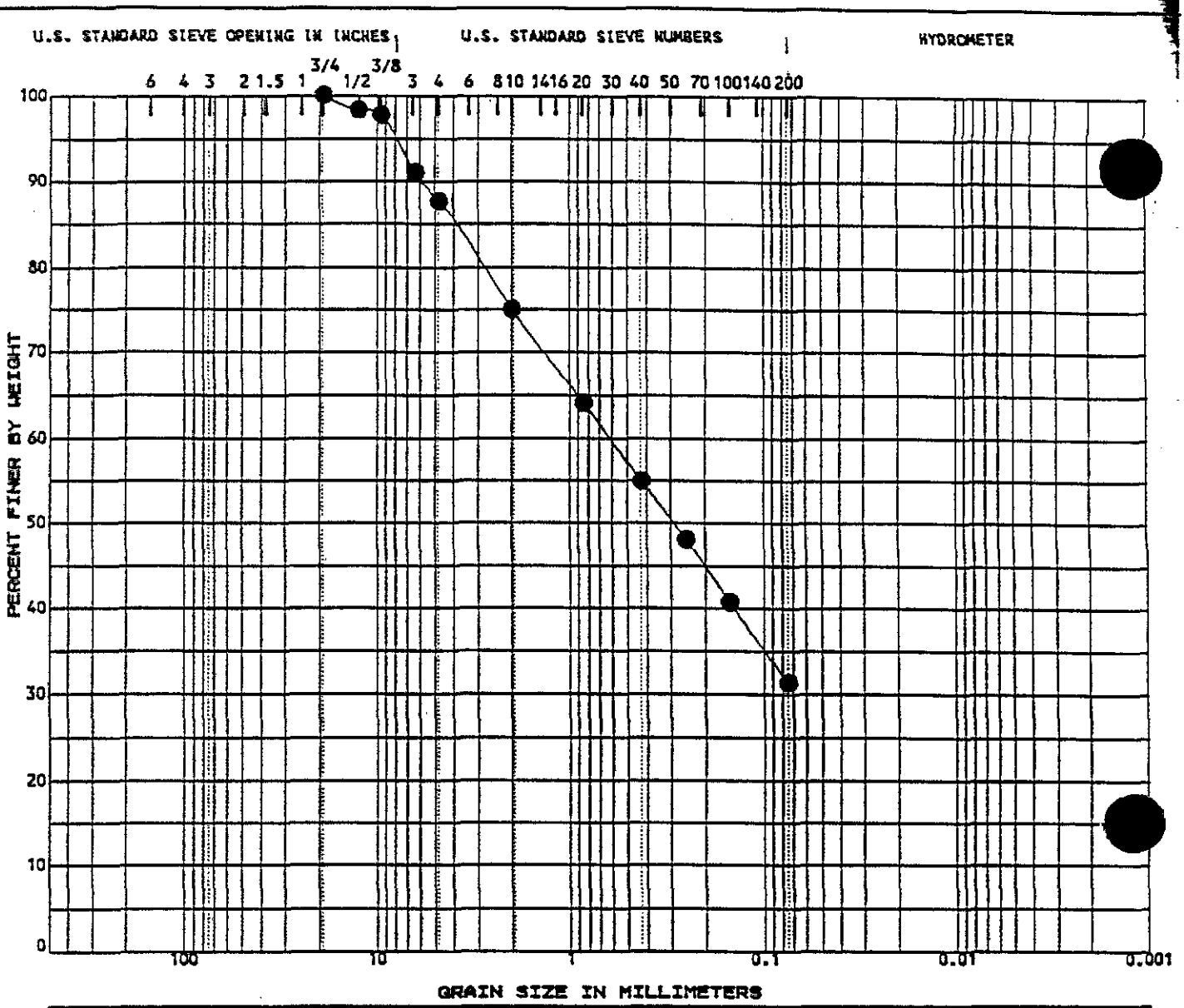
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-02	SILT; little fine sand; trace medium and coarse sand and fine gravel. With organics.	49.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-02	4.75				0.0	14.9	85.1	

AR302947

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	



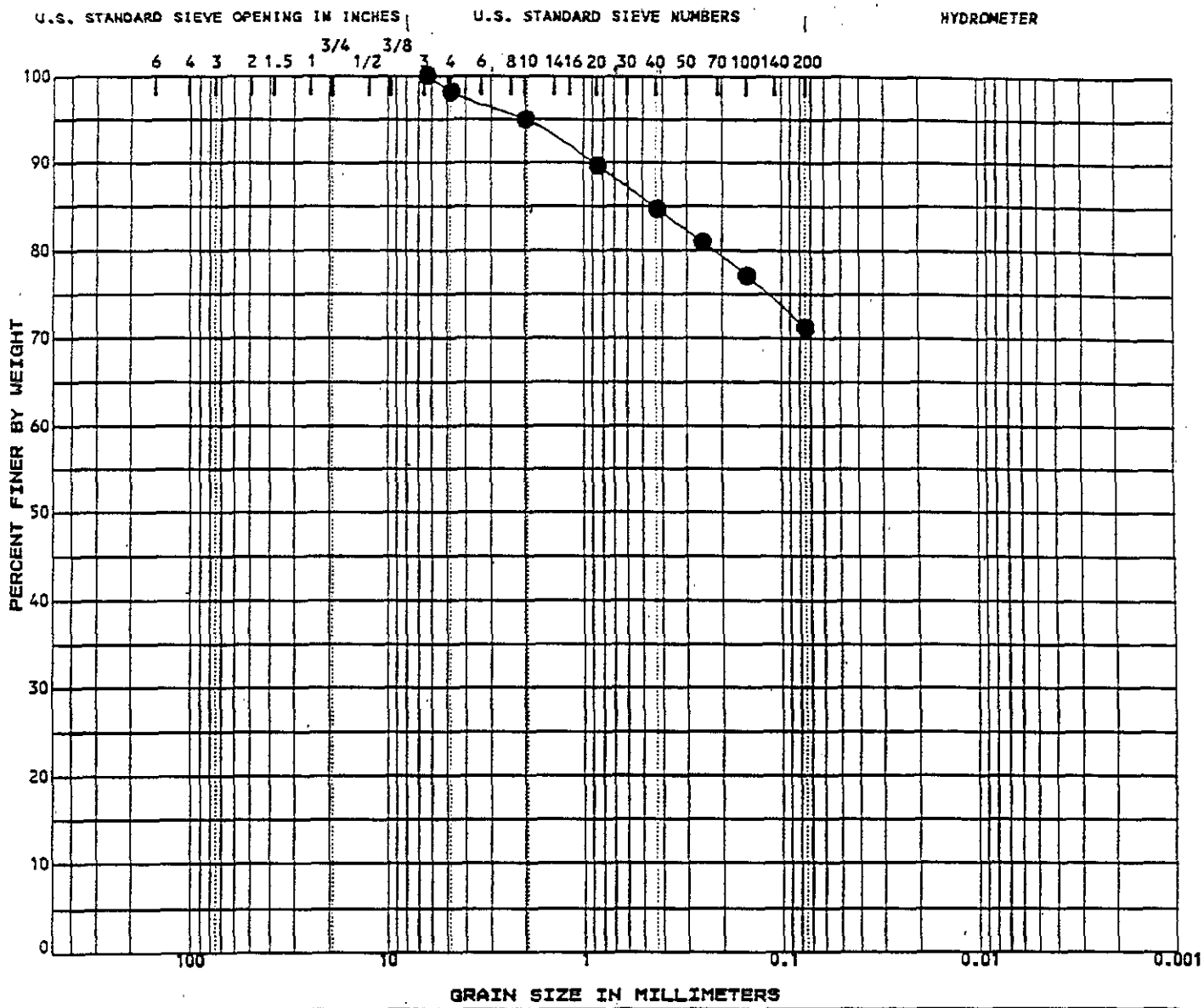
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-06	Fine to Coarse SAND; some silt; little fine gravel. With organics.	51.5					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-06	19.10	0.62			12.3	56.3	31.4	

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

AR302946

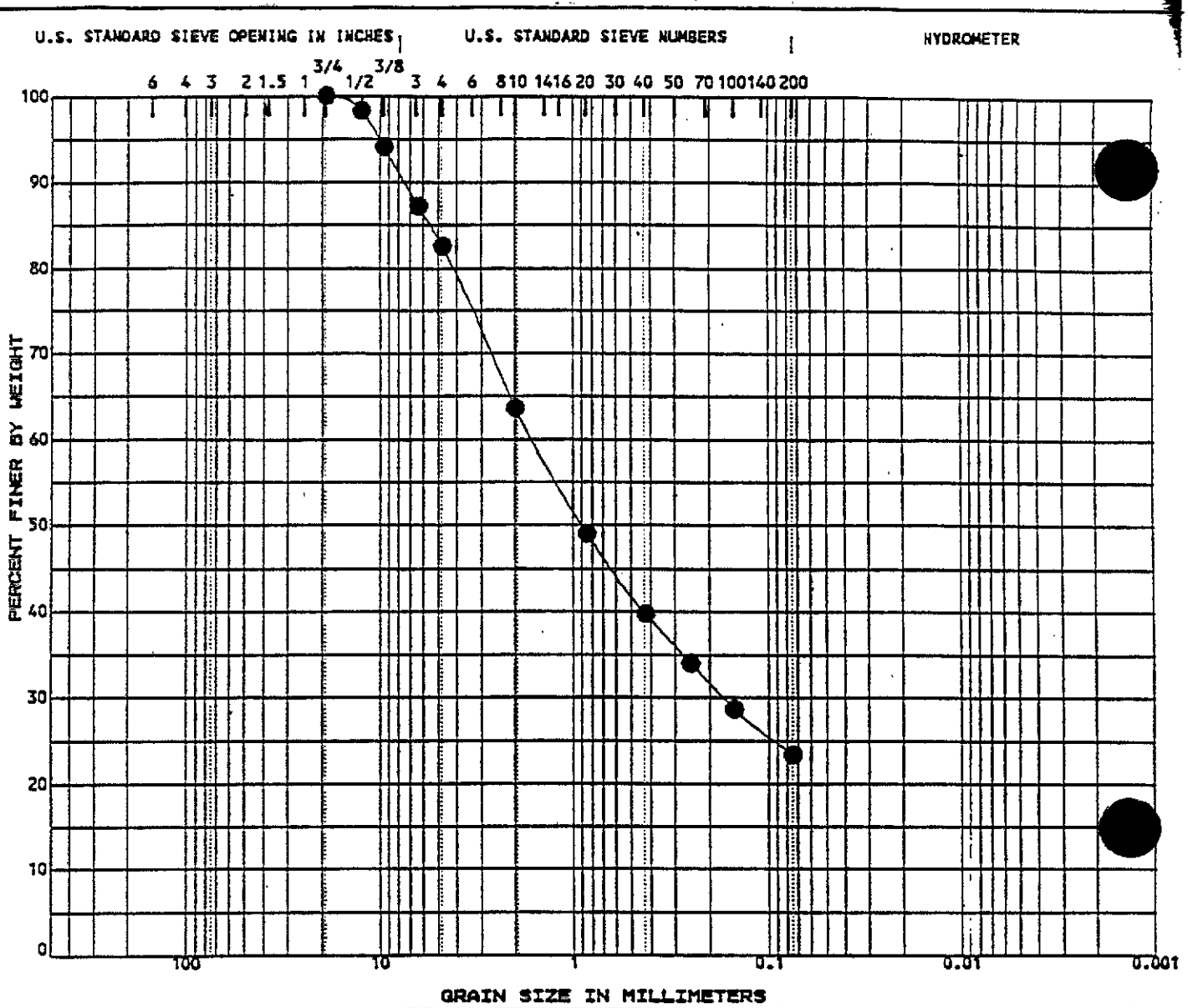


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-07	SILT; little fine and medium sand; trace coarse sand and fine gravel. With organics.	131					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-07	6.30				1.9	26.9	71.2	

AR302949	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

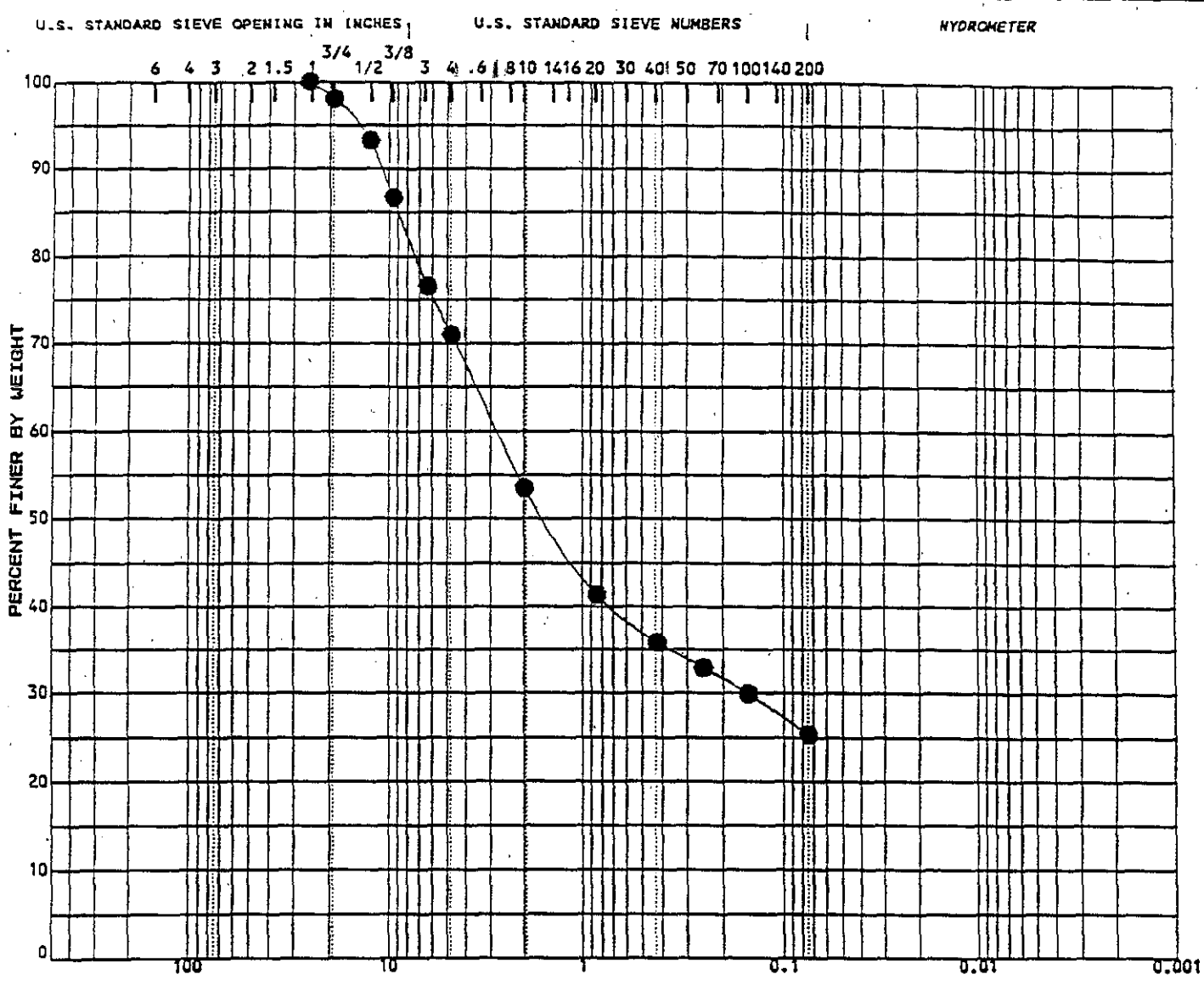


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-01	Fine to Coarse SAND; some silt; little fine gravel.	21.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-01	19.10	1.61	0.170		17.4	59.2	23.4	

AR302950	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

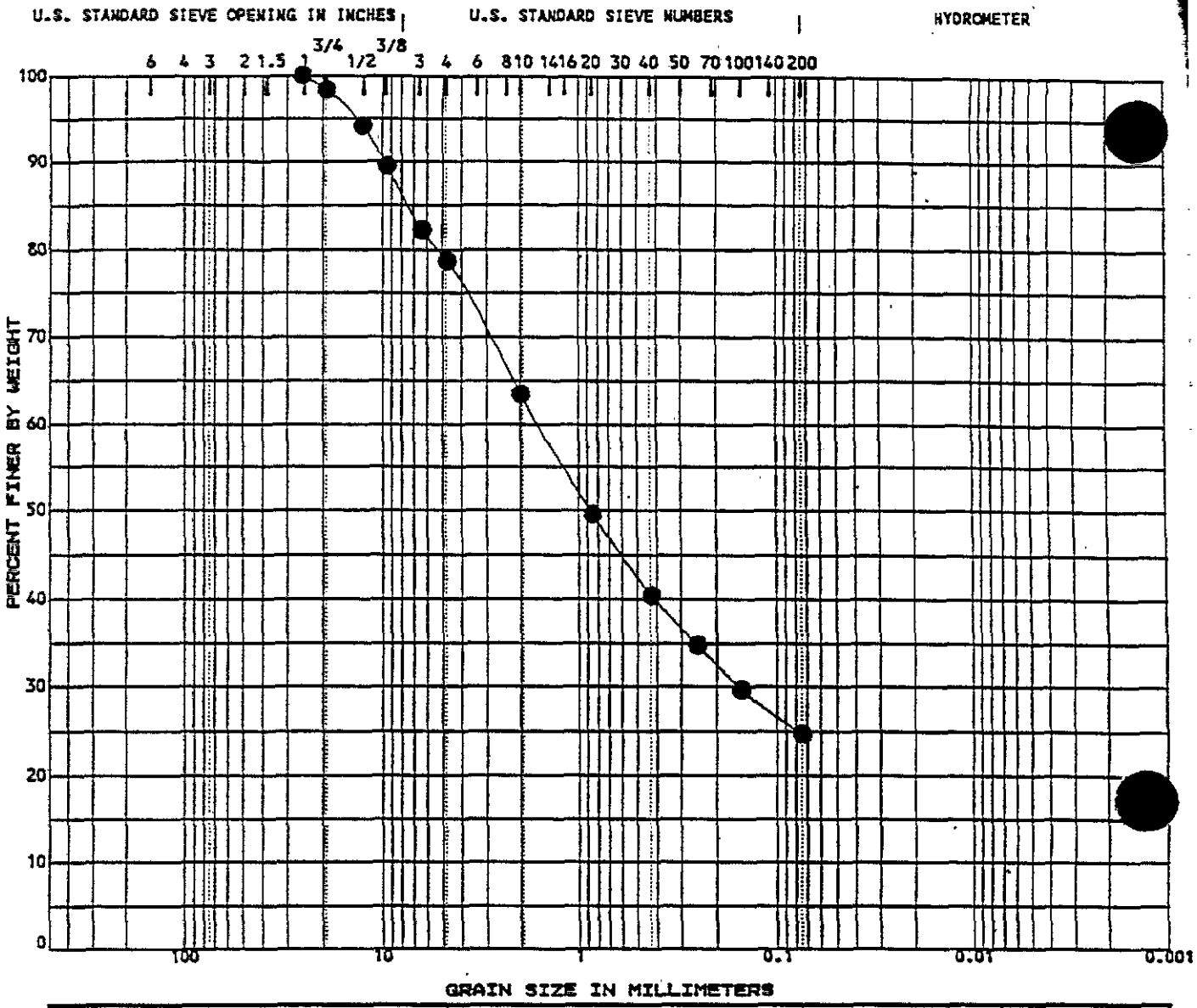


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-02	Coarse to Fine SAND; some fine gravel and silt; trace coarse gravel.	25.2					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-02	25.40	2.76	0.153		29.0	45.7	25.3	

AR302951	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



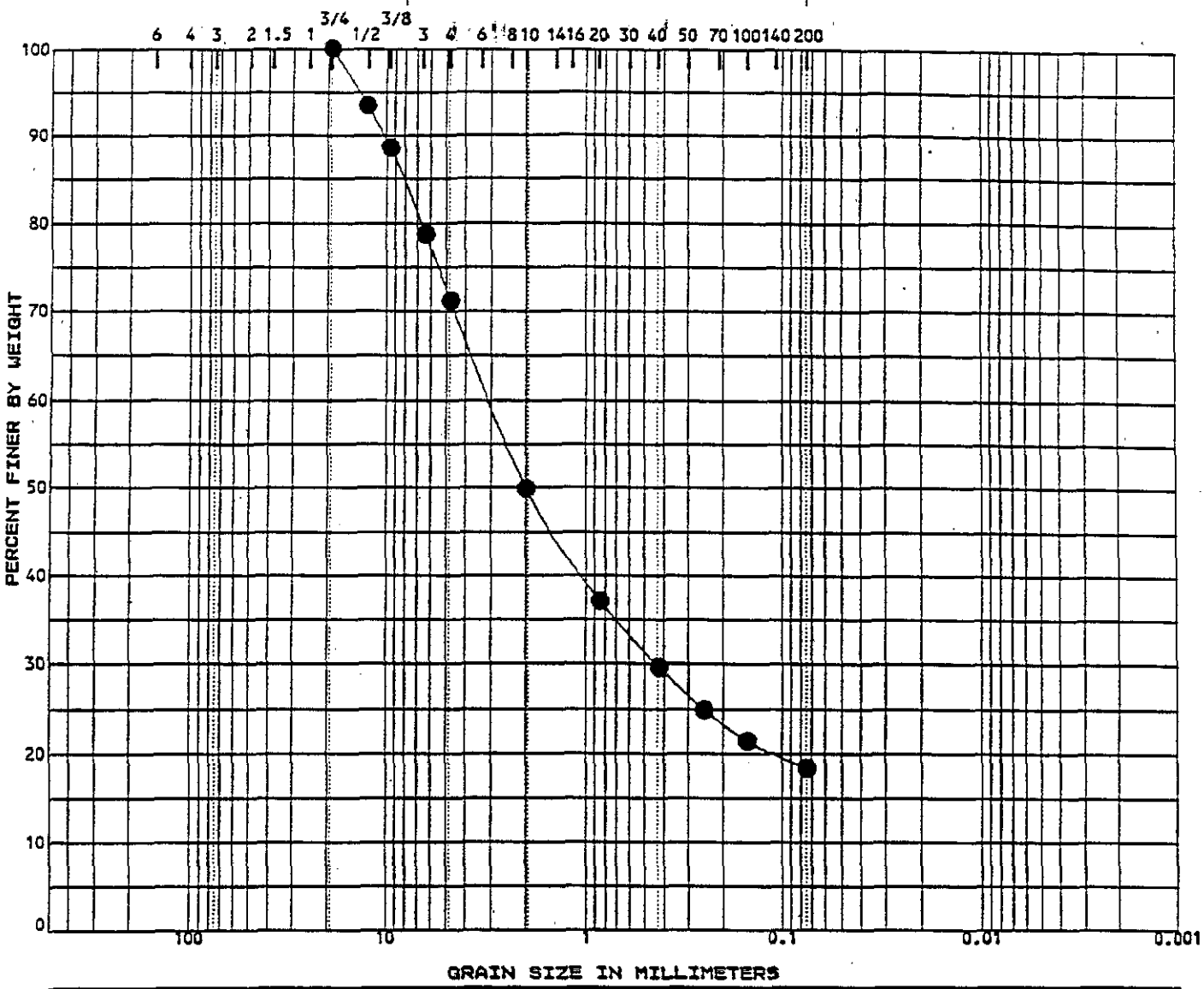
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-04	Fine to Coarse SAND; some silt and fine gravel; trace coarse gravel.	26.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cla
● DS2-04	25.40	1.61	0.155		21.3	54.0	24.7	

AR302952

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



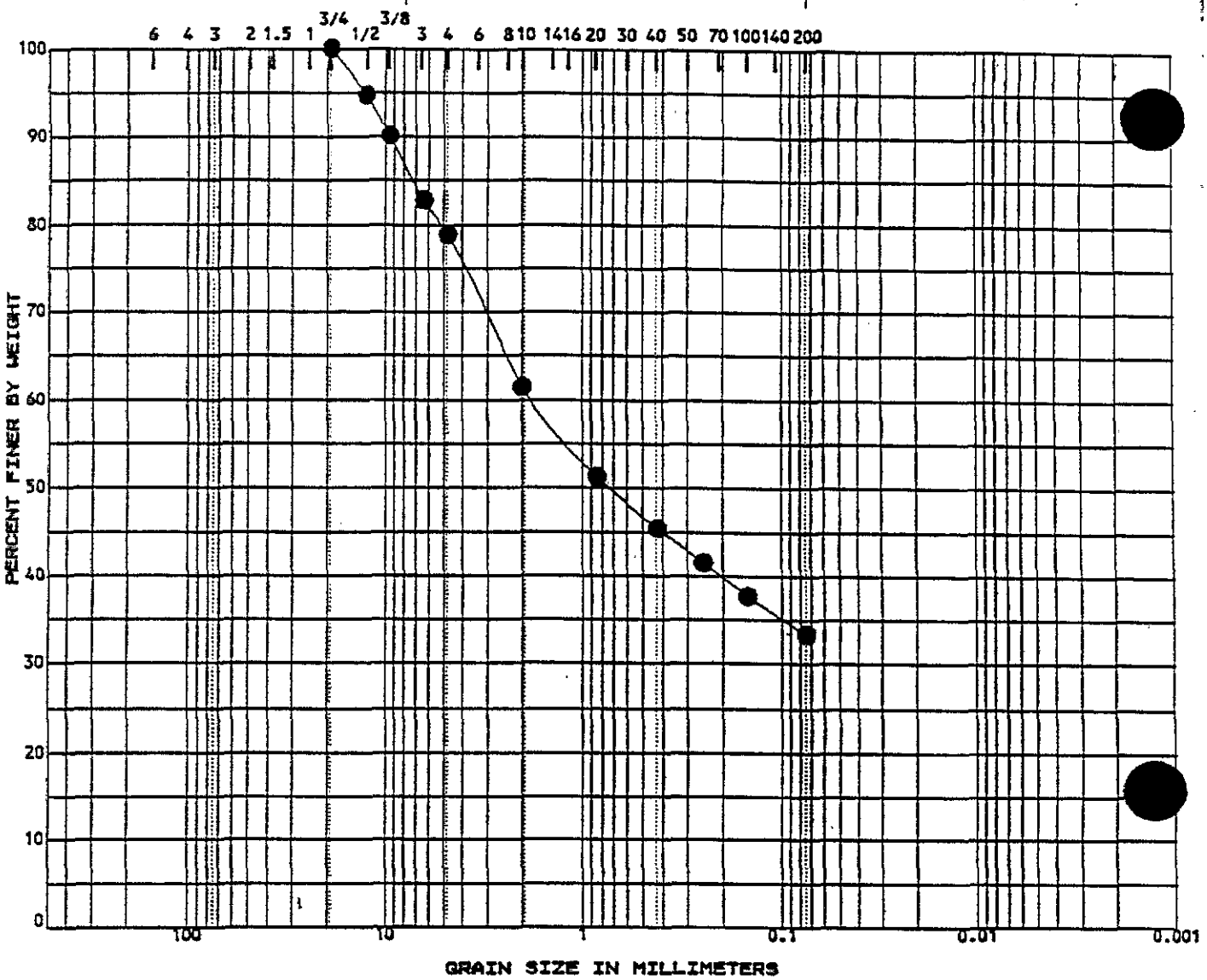
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-07	Coarse to Fine SAND; some fine gravel; little silt.	28					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-07	19.10	3.01	0.437		28.8	52.8	18.4	

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302953



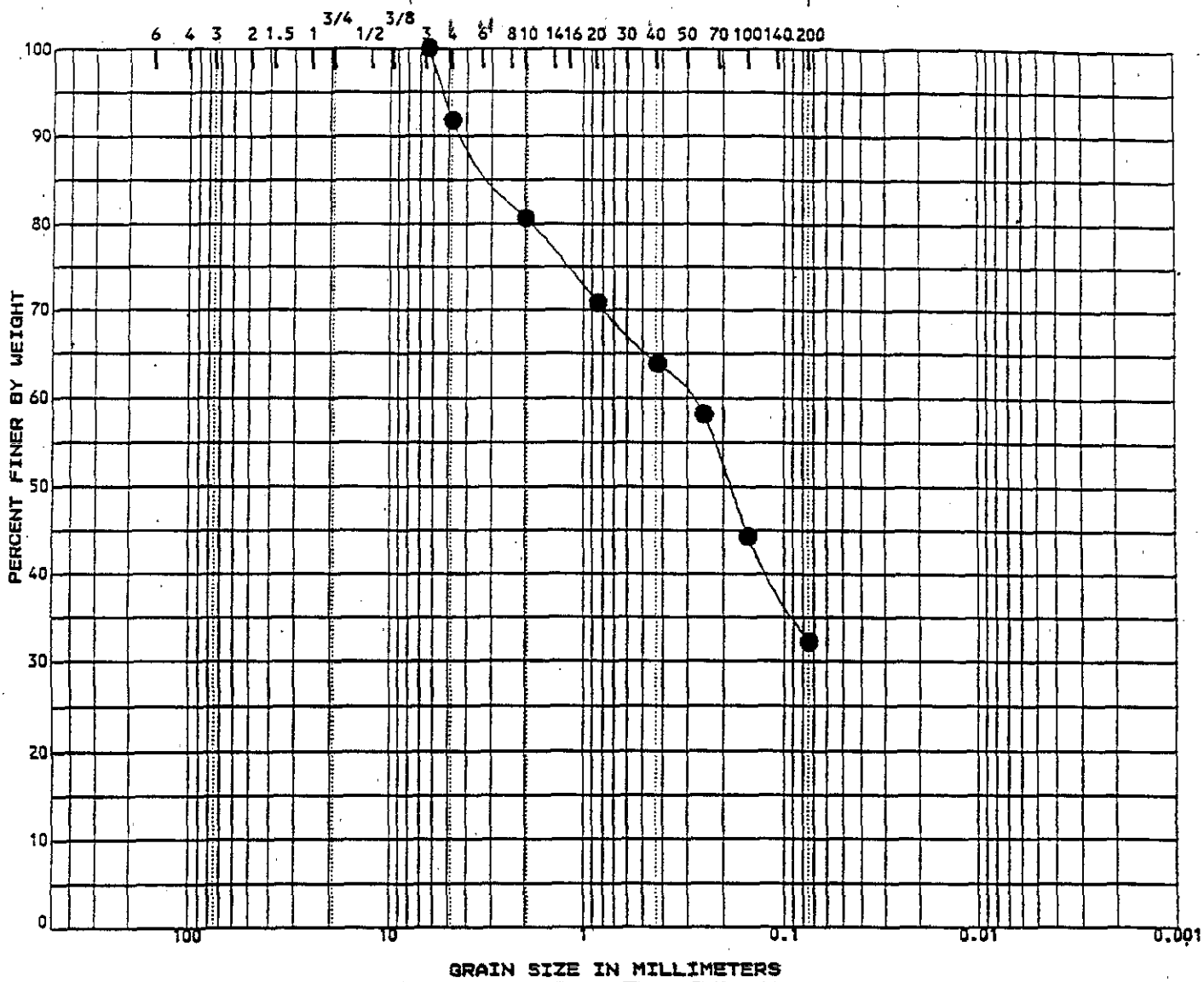
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-D7	Coarse to Fine SAND; some silt and fine gravel.	27.2					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-D7	19.10	1.76			21.1	45.5	33.4	

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302954



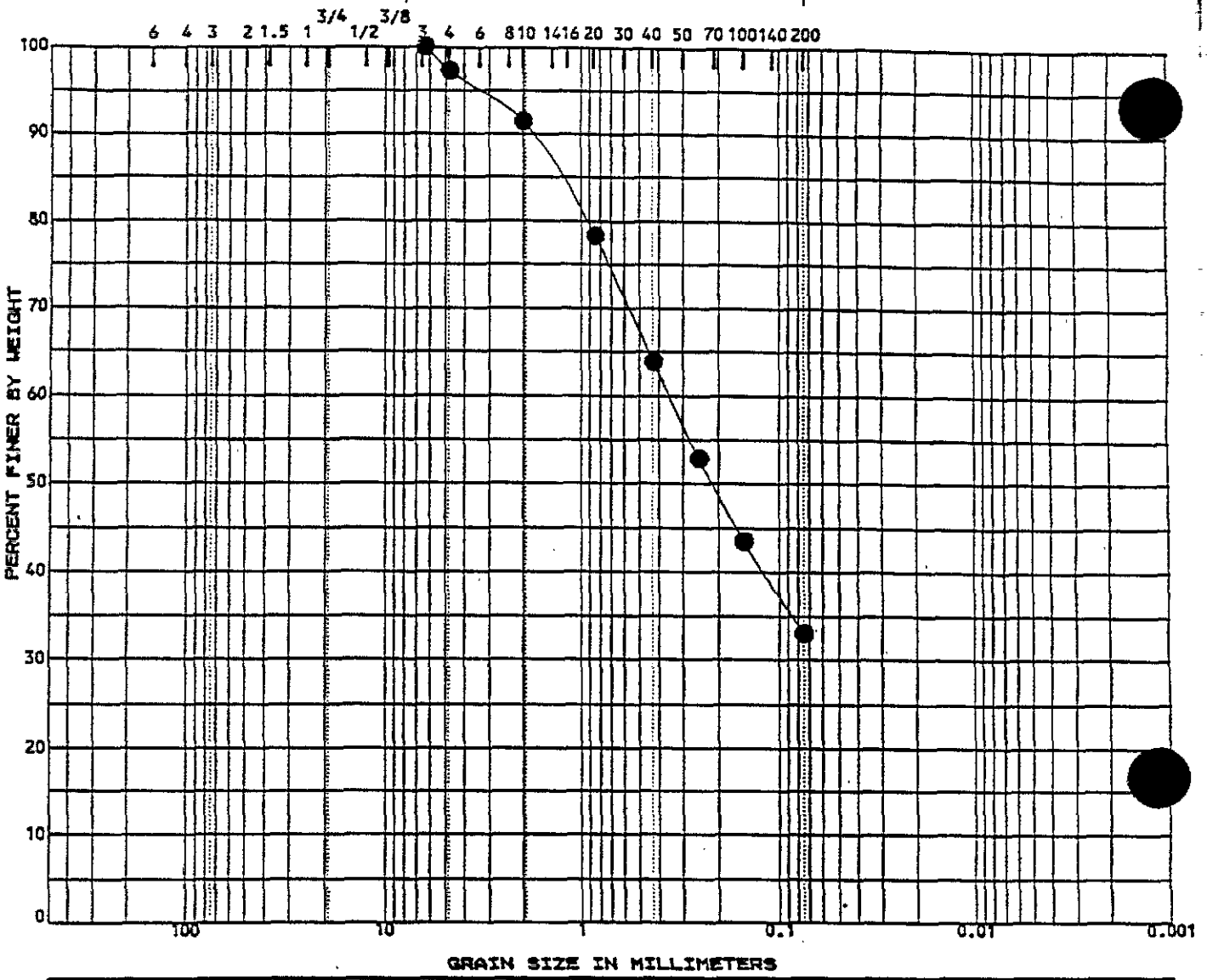
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-09	Fine to Coarse SAND; some silt; trace fine gravel.	9.3					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-09	6.30	0.30			8.2	59.6	32.2	

AR302955

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

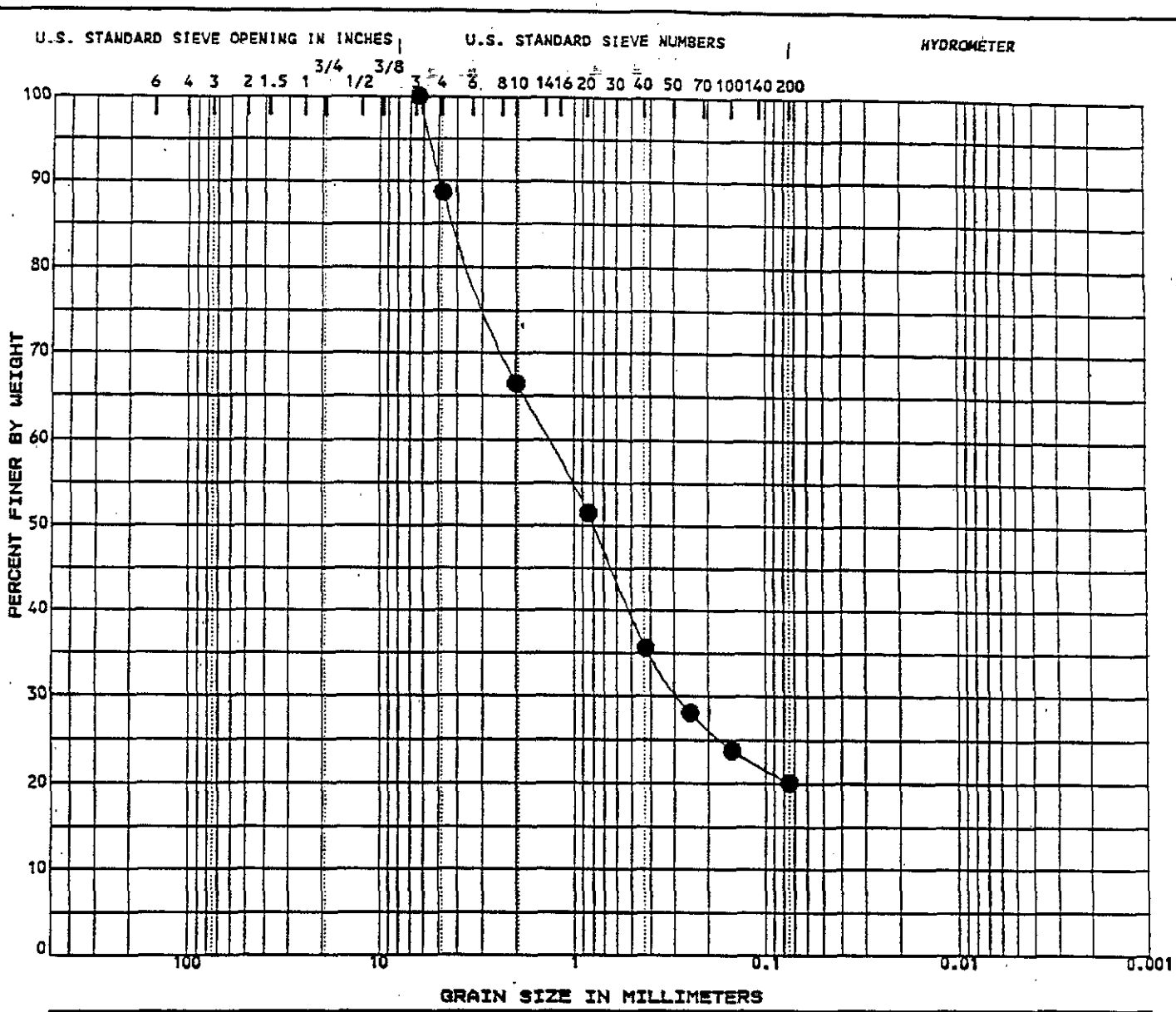


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS3-01	Fine to Coarse SAND; some silt; trace fine gravel. With organics. PEAT	223.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS3-01	6.30	0.35			2.7	64.2	33.1	

A-R302956	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes Grain size on dry weights.
	Date April 1996	GRADATION CURVES



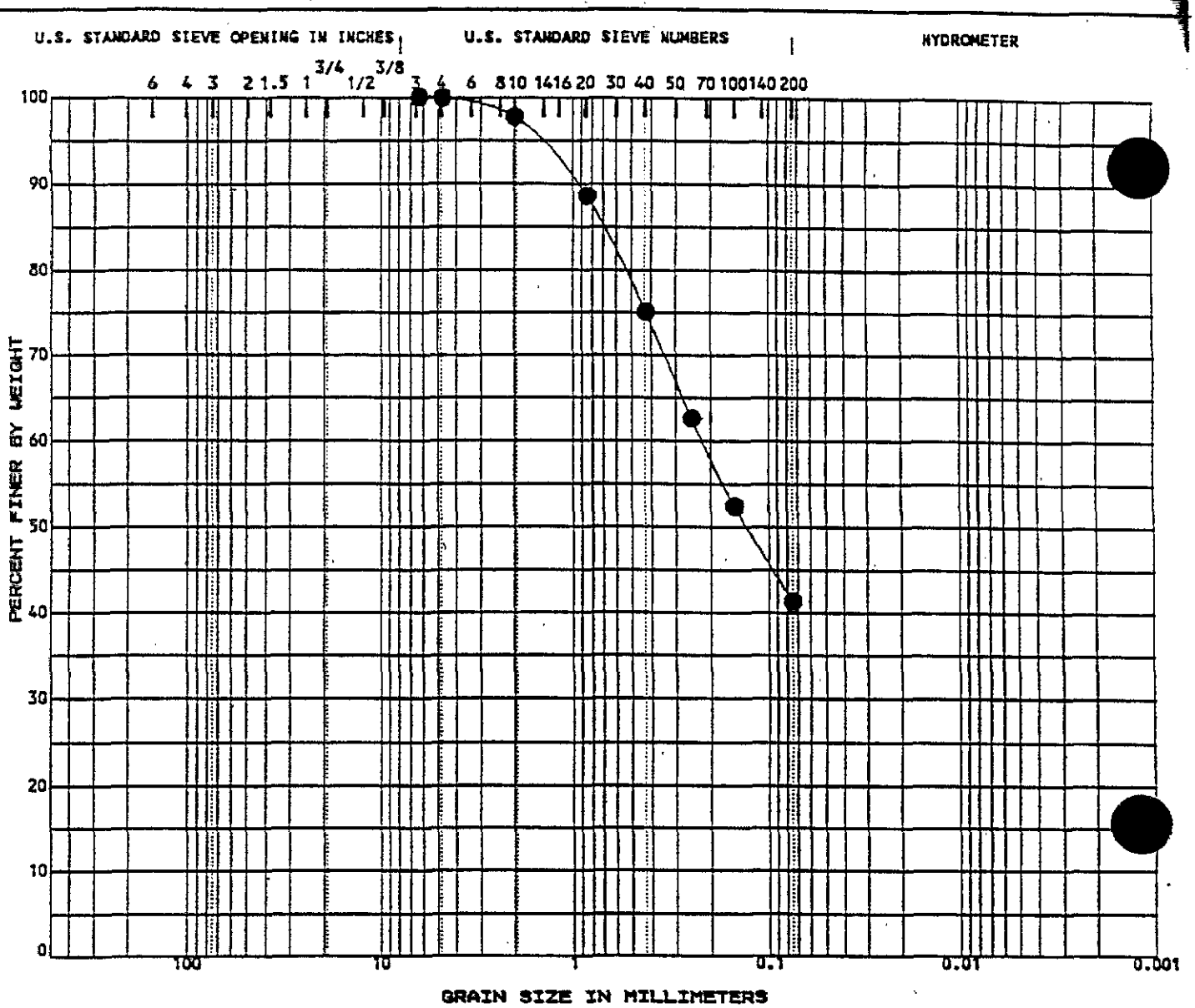
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS3-02	Coarse to Fine SAND; some silt; little fine gravel. With organics, PEAT	146.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS3-02	6.30	1.38	0.286		11.3	68.6	20.1	

AR302957

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes Grain size on dry weights.
Date April 1996	GRADATION CURVES

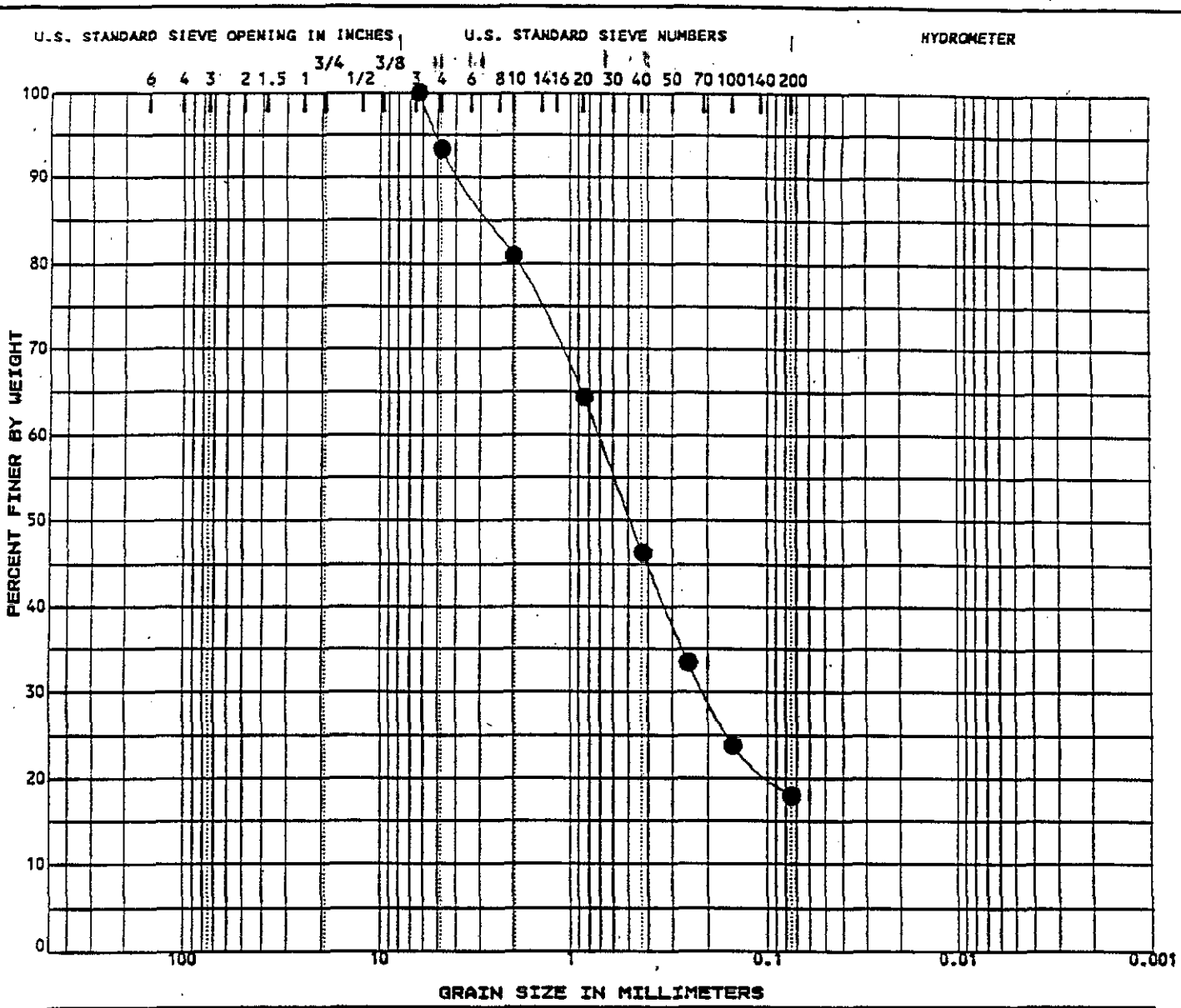


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS3-03	Silty Fine to Medium SAND; trace coarse sand and fine gravel. With organics.	116.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cla
● DS3-03	6.30	0.22			0.1	58.6	41.3	

AR302958	Project	OLIN MORGANTOWN	Location West Virginia
	Area		Notes
	Date	April 1996	GRADATION CURVES



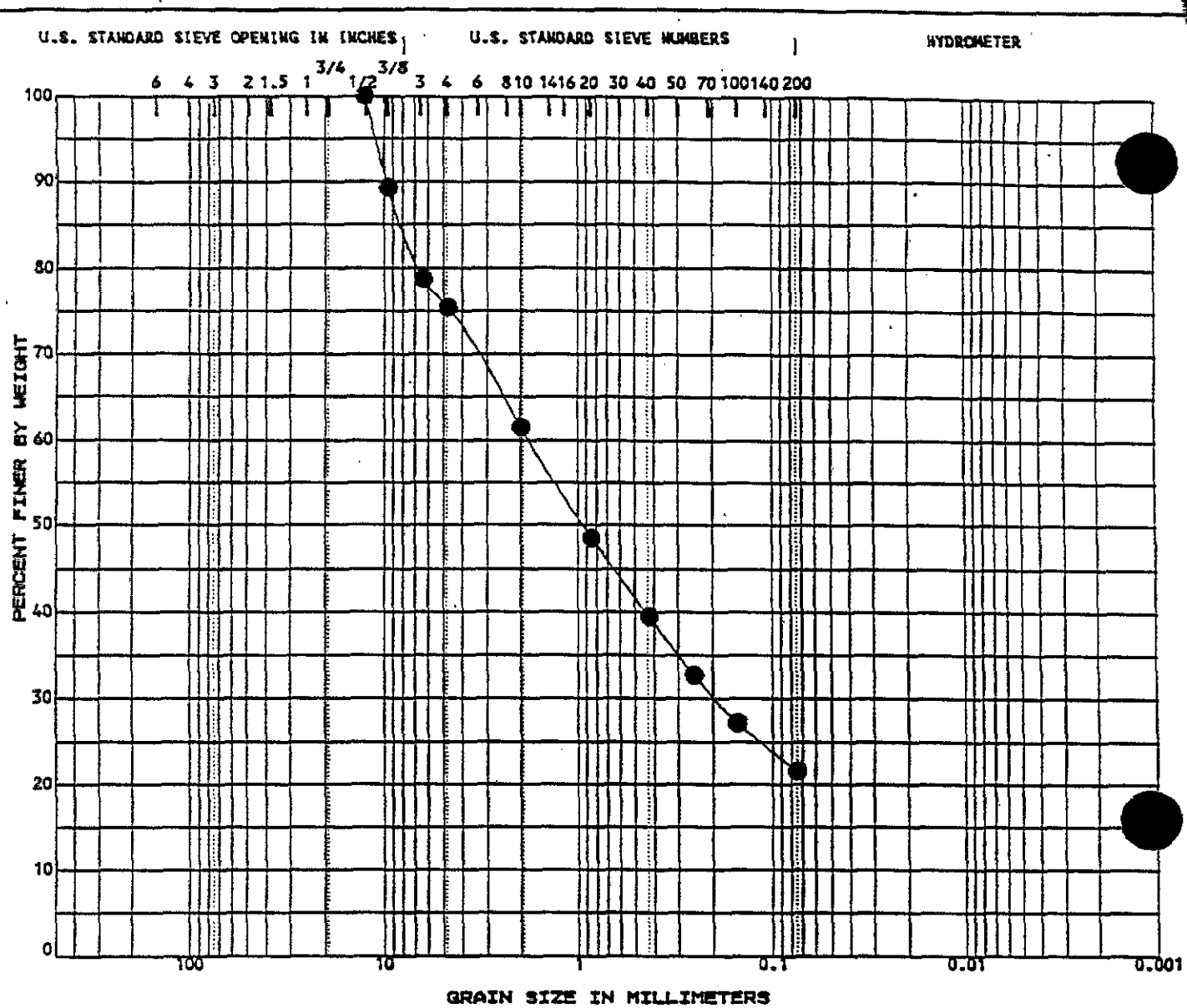
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS3-05	Fine to Coarse SAND; little silt; trace fine gravel. With organics.	72.8					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS3-05	6.30	0.72	0.208		6.7	75.3	18.0	

AR302959

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

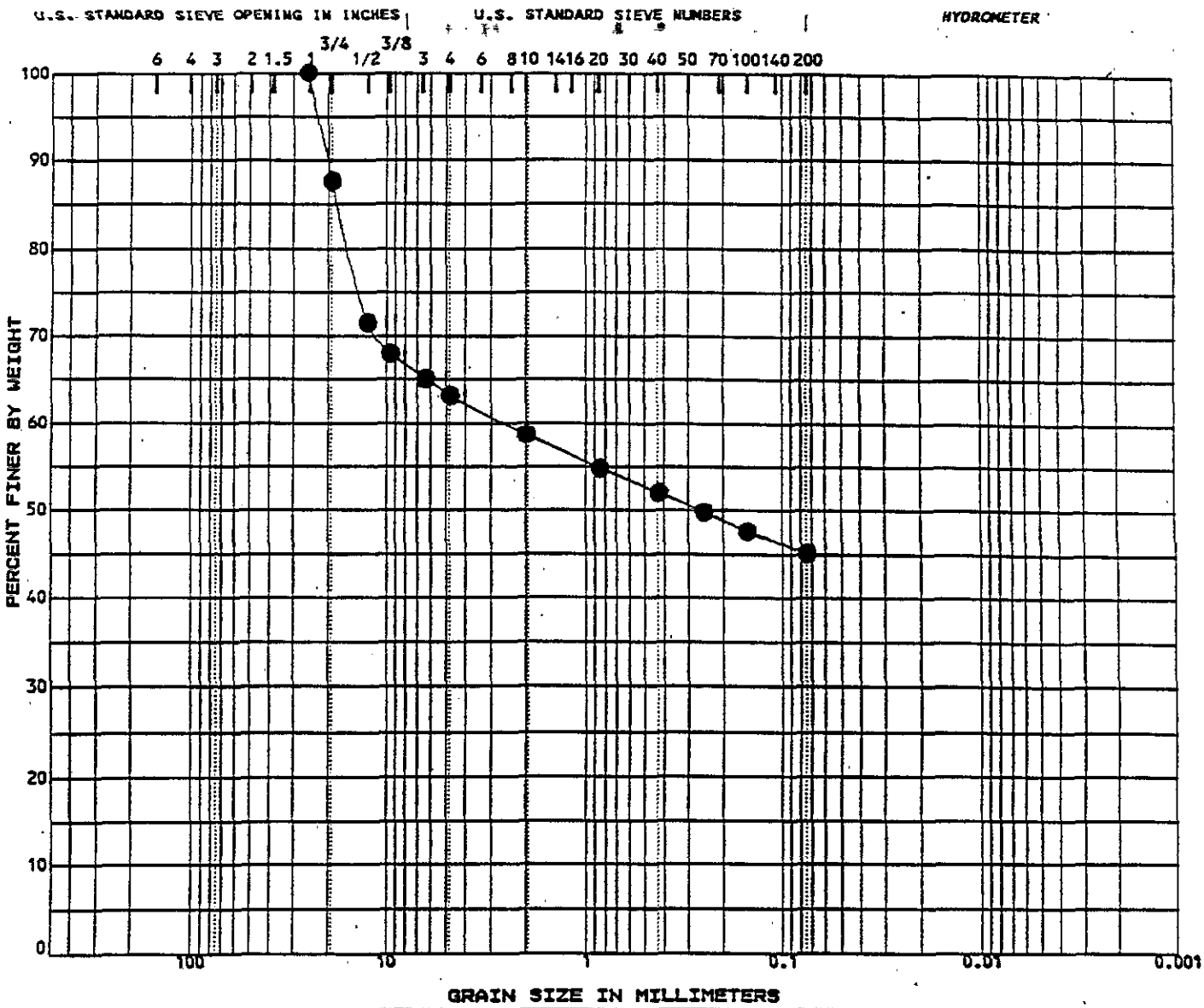


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS3-06	Fine to Coarse SAND; some fine gravel and silt. With organics.	109					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS3-06	12.50	1.81	0.195		24.6	53.8	21.6	

AR302960	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES

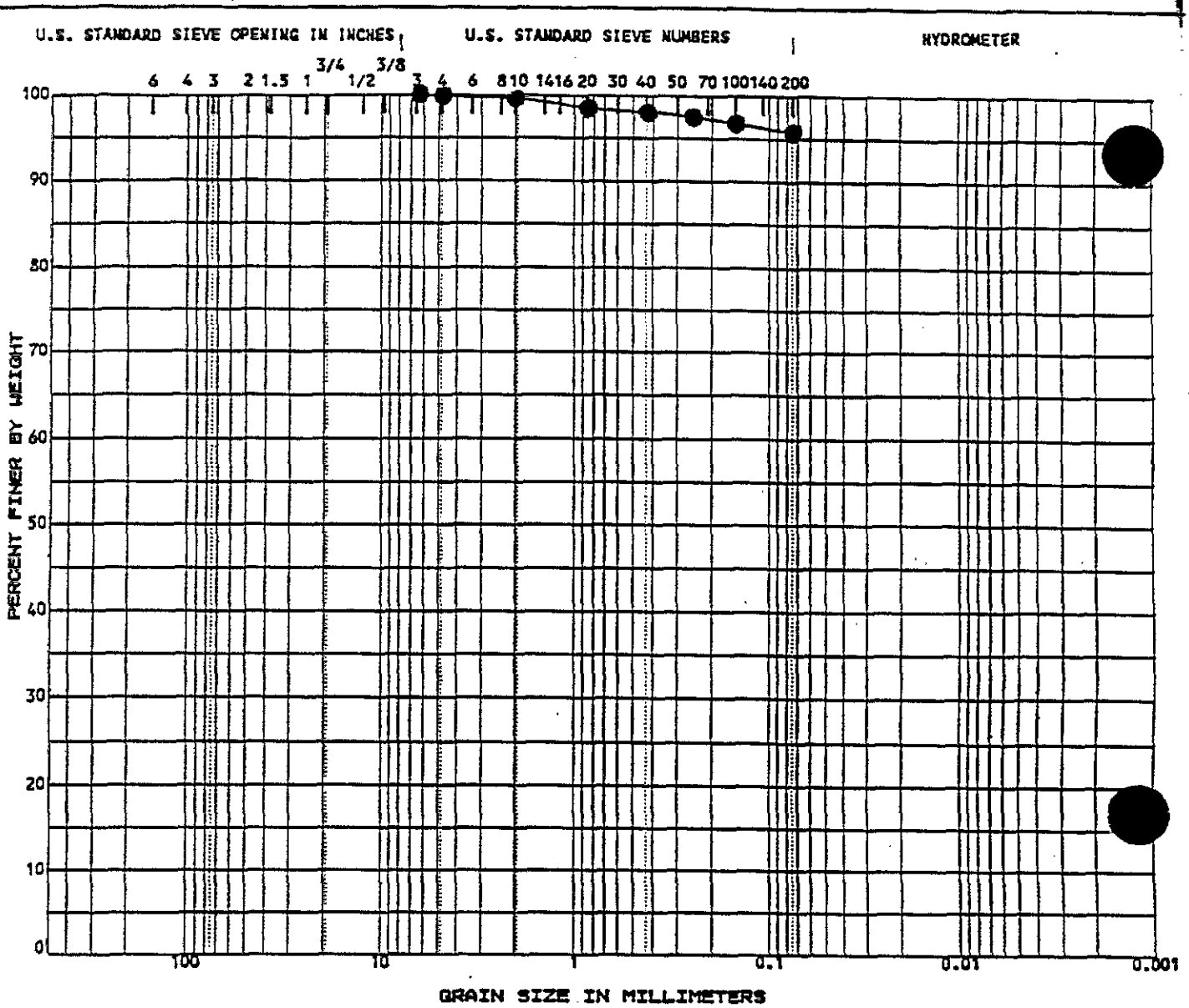


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SC020004	Fine to Coarse Gravely SILT; trace fine, medium, and coarse sand.	18.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SC020004	25.40	2.57			36.8	18.1	45.1	

AR302961	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



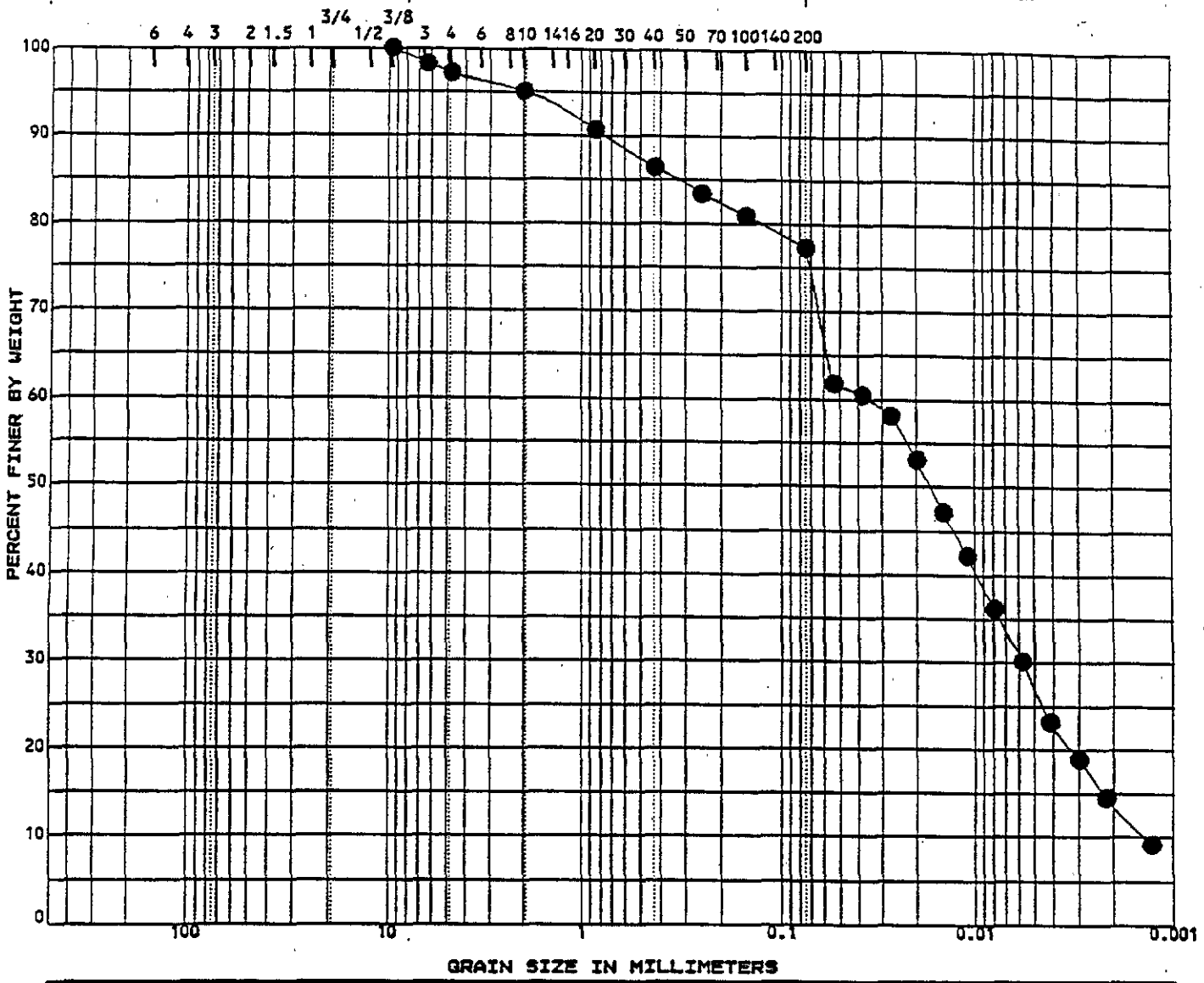
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● SC020408	CLAY; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	25.2					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● SC020408	6.30				0.2	4.1	95.7	

AR302962

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



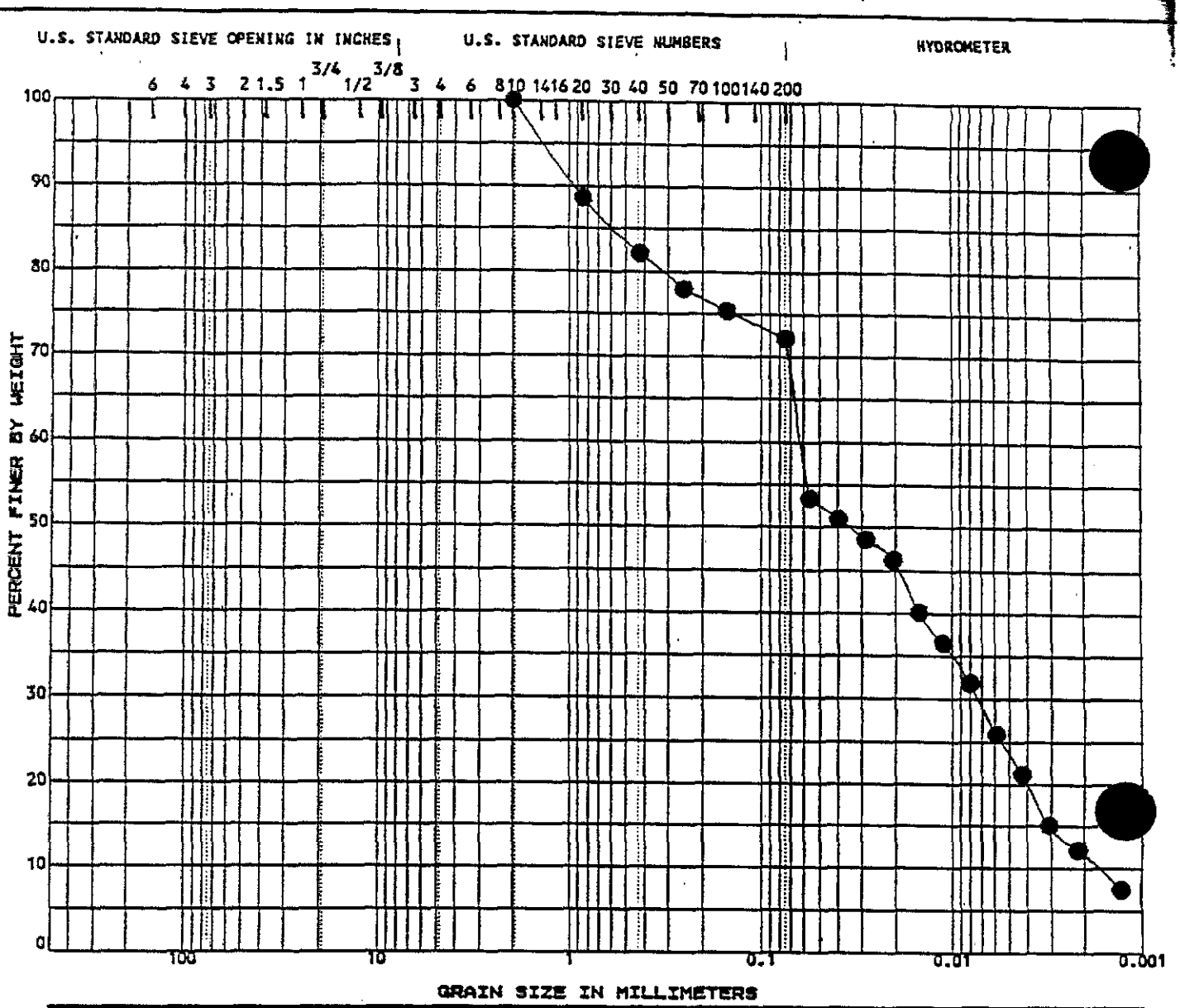
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-01	1.0	SILT; some clay; trace fine, medium, and coarse sand and fine gravel.	58.3					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-01	1.0	9.51	0.04	0.006	0.0014	2.9	19.8	50.3	26.9

AR302963

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



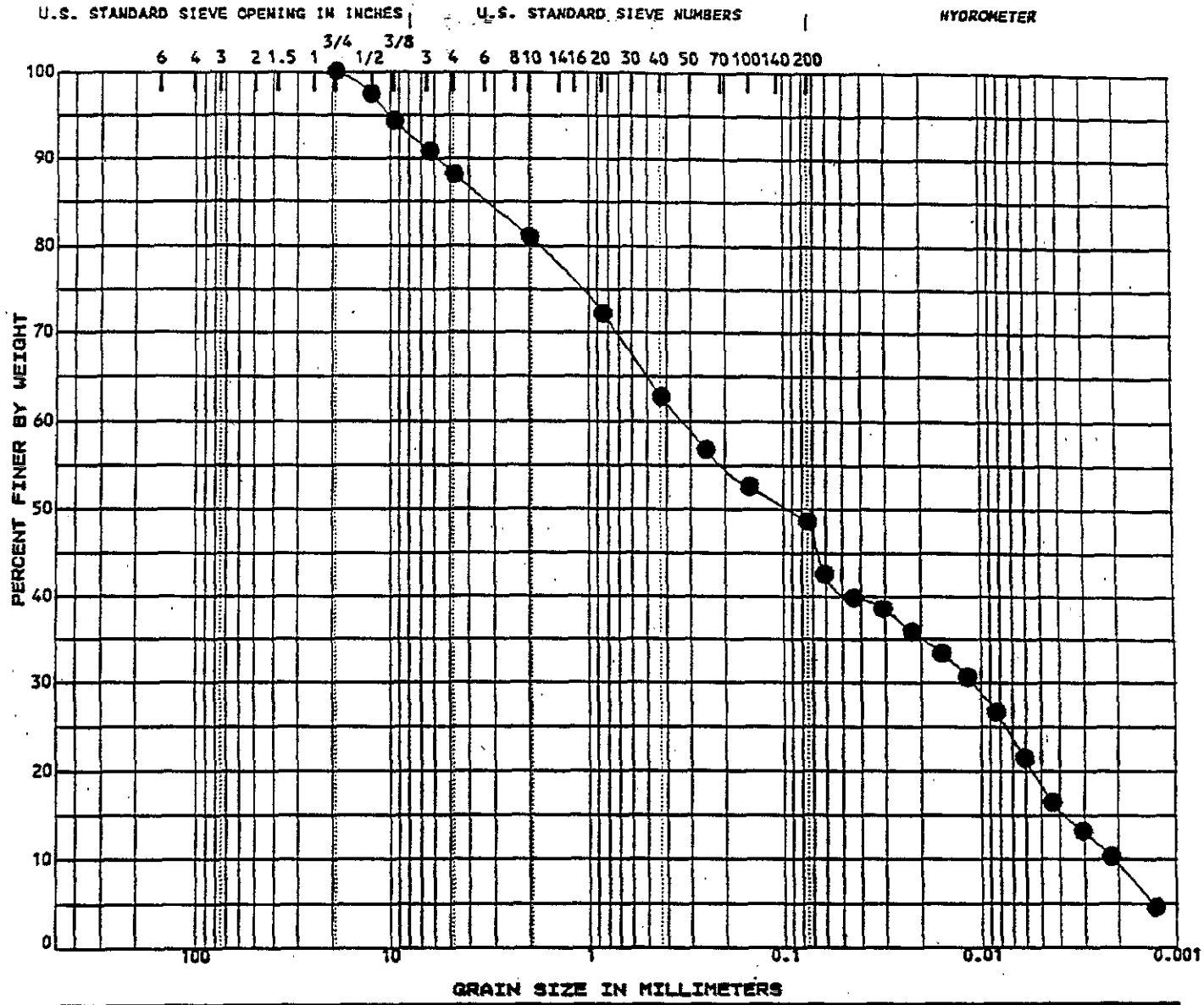
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	WC%	LL	PL	PI	Cc	Cu
DS1-04	1.0	Material greater than #10 Sieve was not sieved due to tar melting during drying of sample. Visual descrition indicates trace coarse sand .						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
DS1-04	1.0	2.00	0.06	0.007	0.0017	0.0	27.8	48.7	23.4

AR302964

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



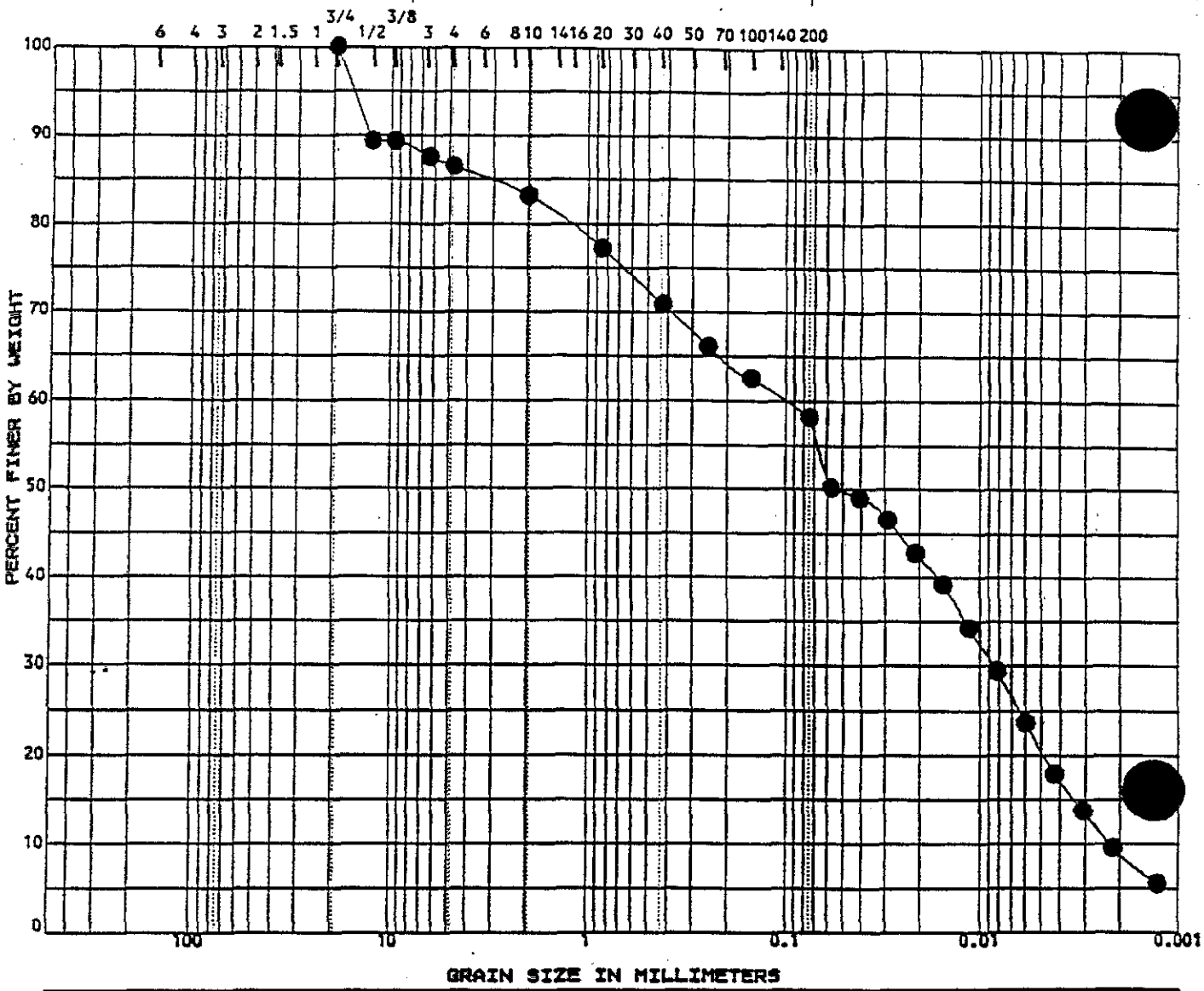
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-05	Fine to Coarse SAND; some silt; little clay and fine gravel.	41.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-05	19.10	0.33	0.011	0.0021	11.8	39.5	30.2	18.4

AR302965

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	



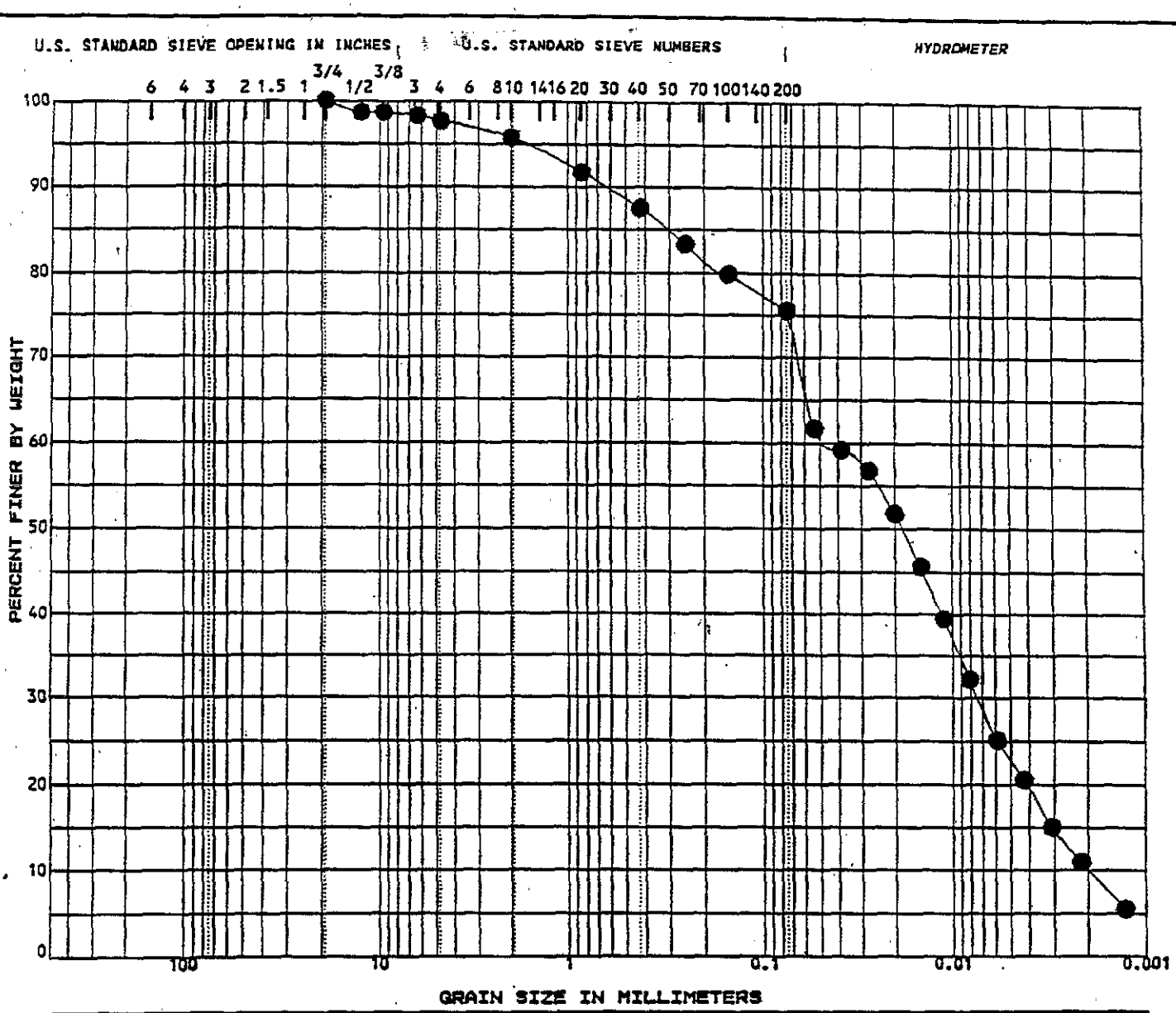
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-08	SILT; little clay, fine gravel, medium and fine sand; trace coarse sand.	81					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-08	19.10	0.10	0.009	0.0023	13.5	28.3	37.6	20.5

AR302966

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES

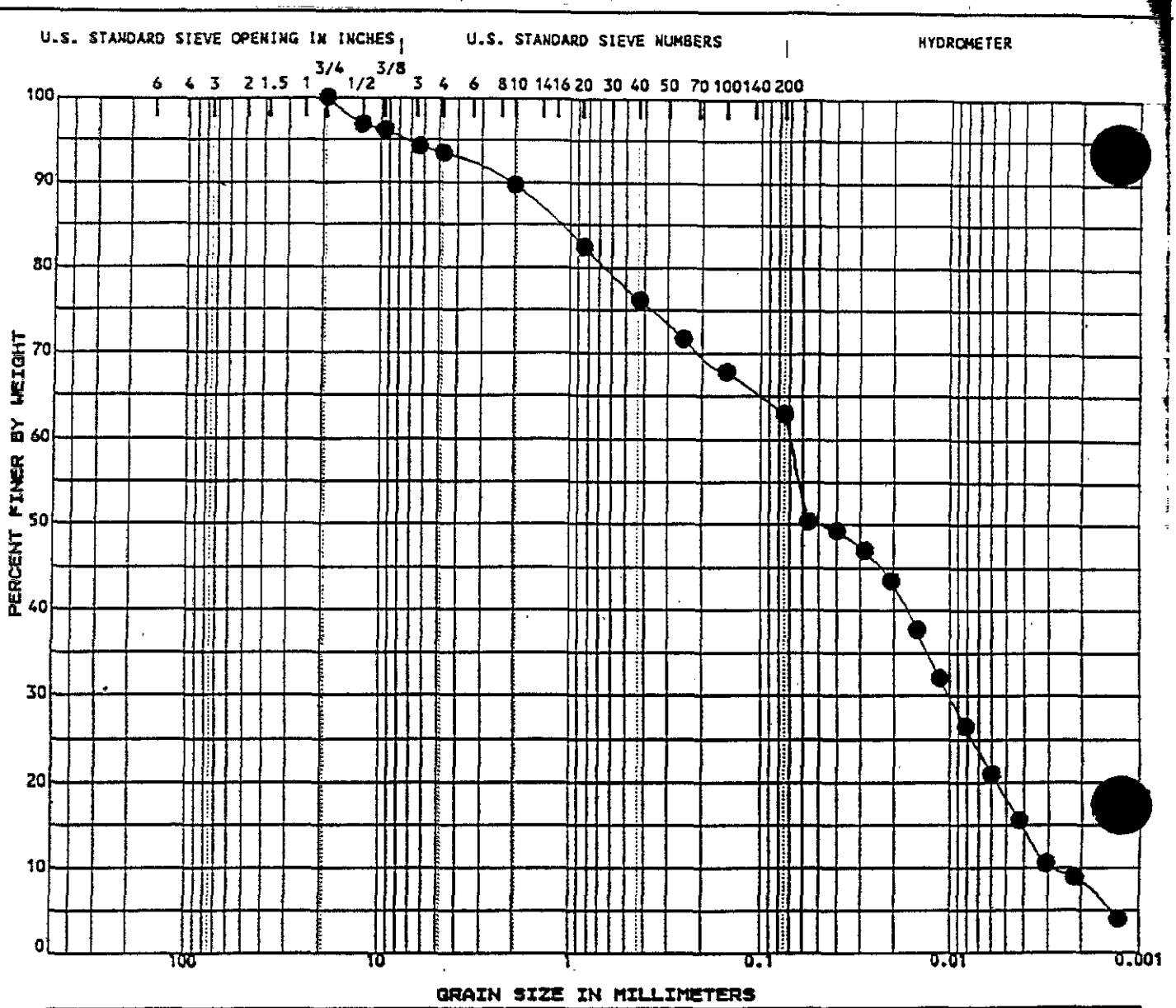


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-09	SILT; some clay; little fine sand; trace medium and fine sand and fine gravel.	55.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-09	19.10	0.04	0.007	0.0020	2.4	22.1	52.8	22.6

AR302967	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



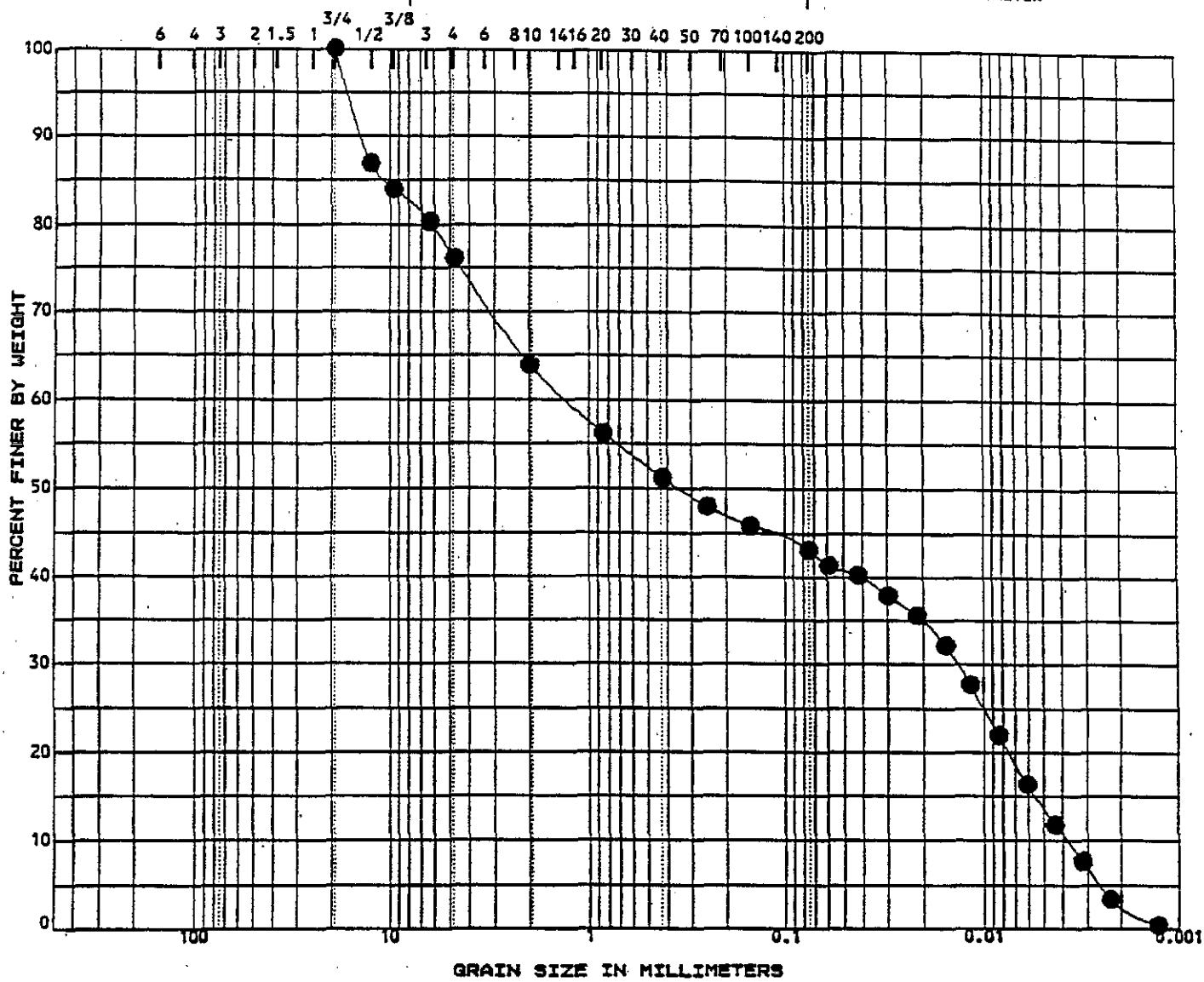
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	W/C%	LL	PL	PI	Cc	Cu
● DS1-10	SILT; little clay and medium and fine sand; trace fine gravel and coarse sand. With organics.	79.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-10	19.10	0.07	0.010	0.0027	6.6	30.4	44.9	18.0

AR302968

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES

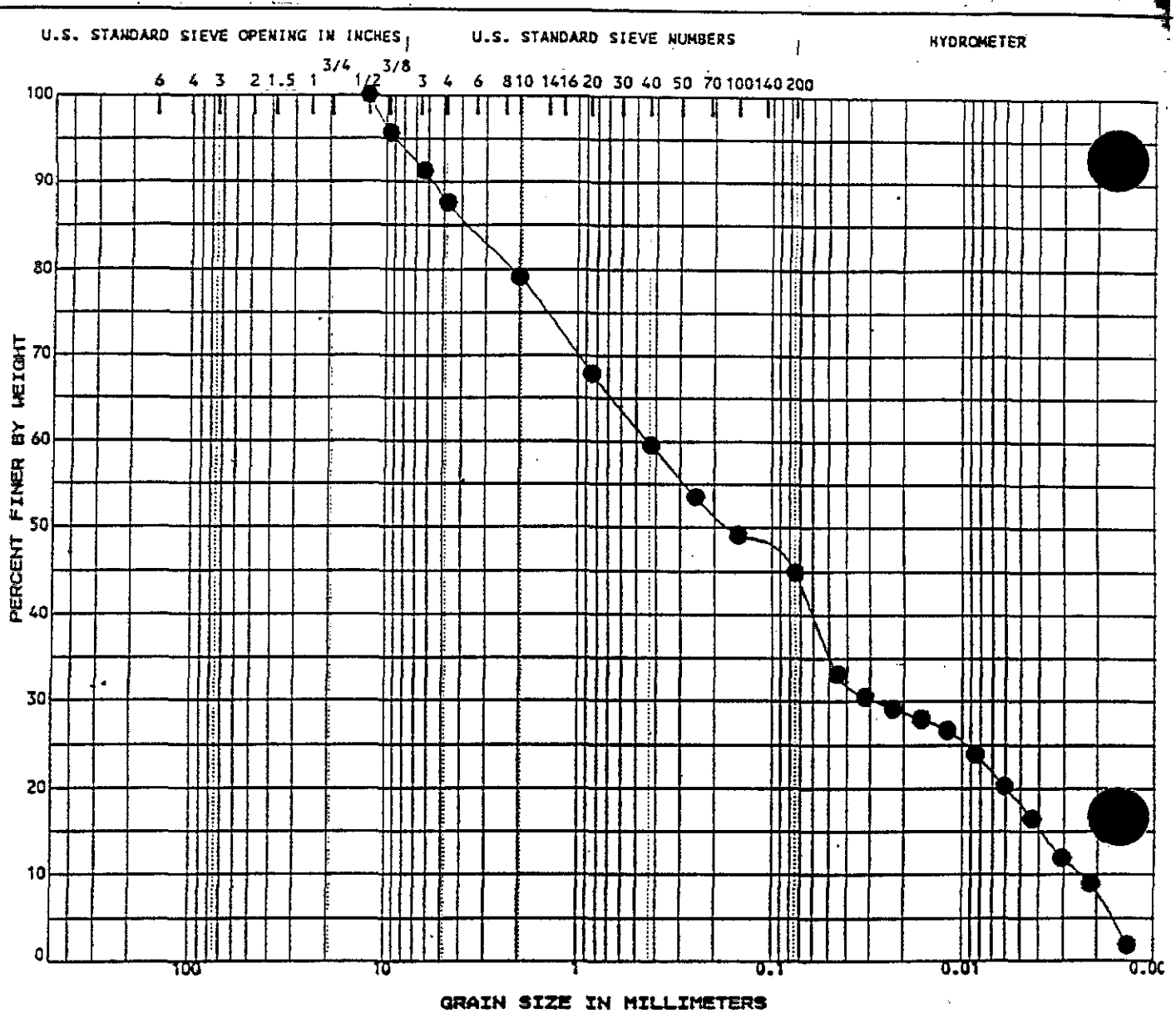


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	W/C%	LL	PL	PI	Cc	Cu
● DS1-11	Fine GRAVEL to Fine SAND; some silt; little clay.	40.8					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-11	19.10	1.30	0.014	0.0038	23.9	33.0	29.4	13.6

AR302969	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



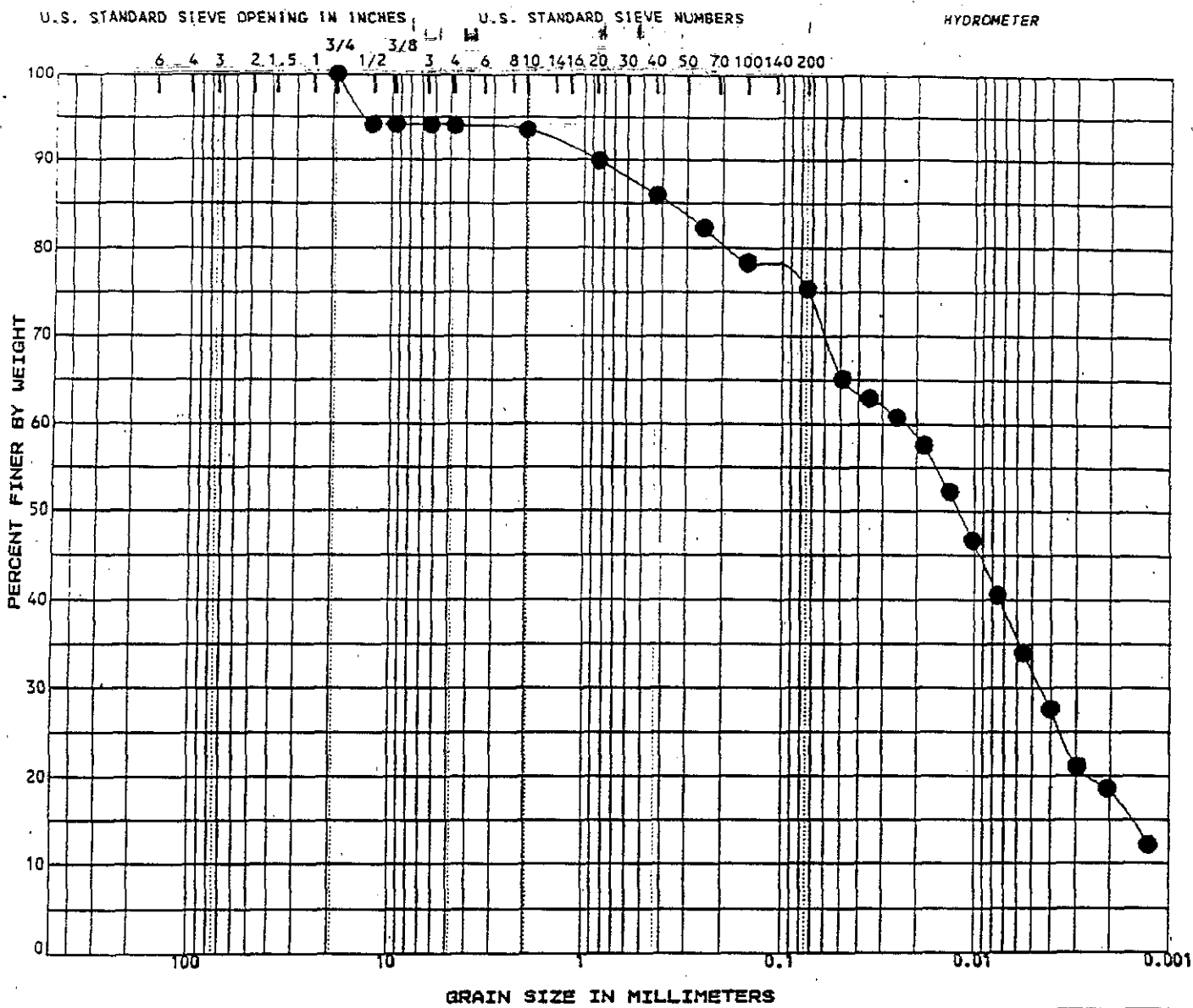
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc
● DS1-12	Fine to Coarse SAND; some silt; little clay and fine gravel.	38.5				

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%C
● DS1-12	12.50	0.44	0.028	0.0025	12.4	42.7	26.9	17

AR302970

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



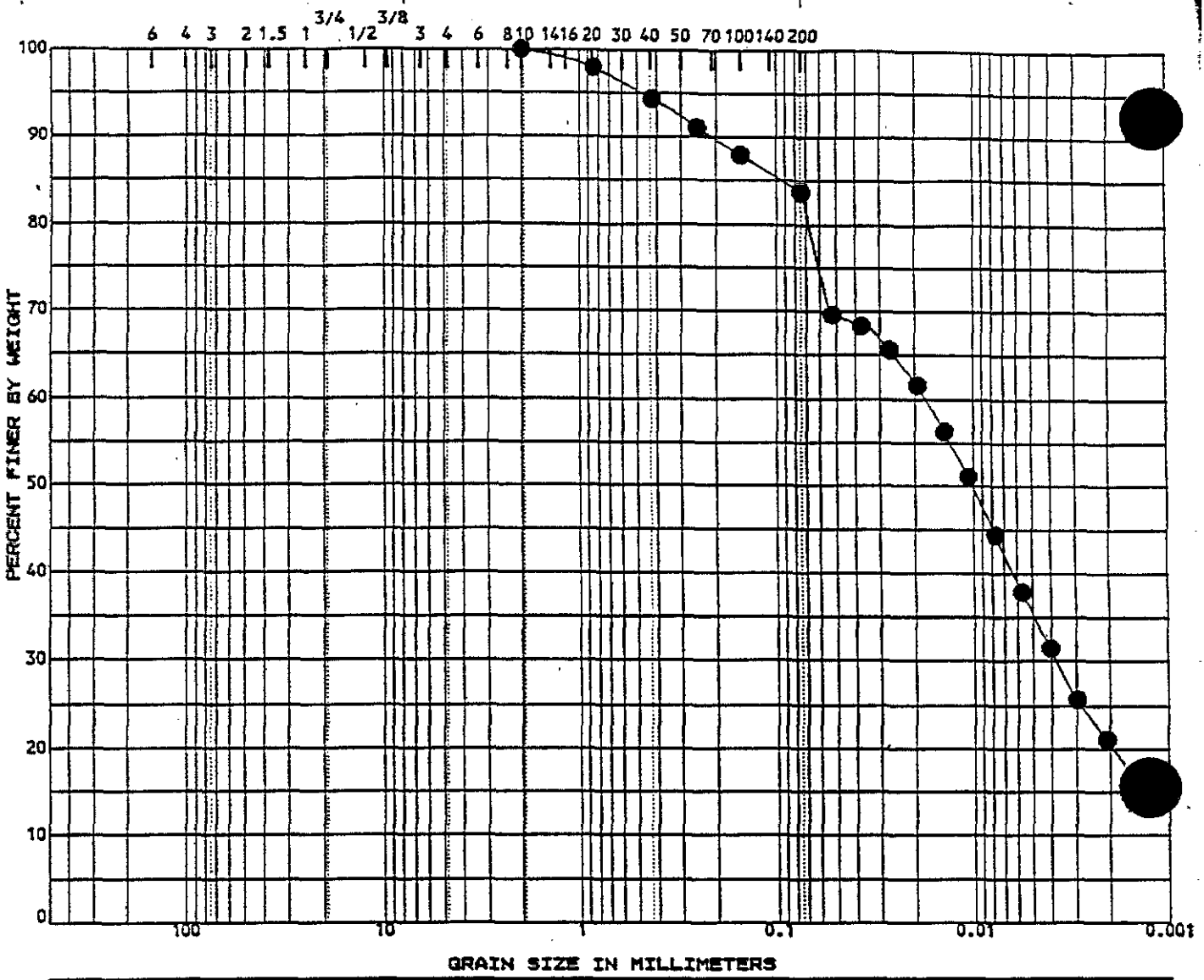
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-13-01-02	SILT; some clay; little fine sand; trace medium and coarse sand and fine gravel. Moderately plastic.	35.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-13-01-02	19.10	0.02	0.005		6.0	18.7	43.6	31.6

AR302971

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



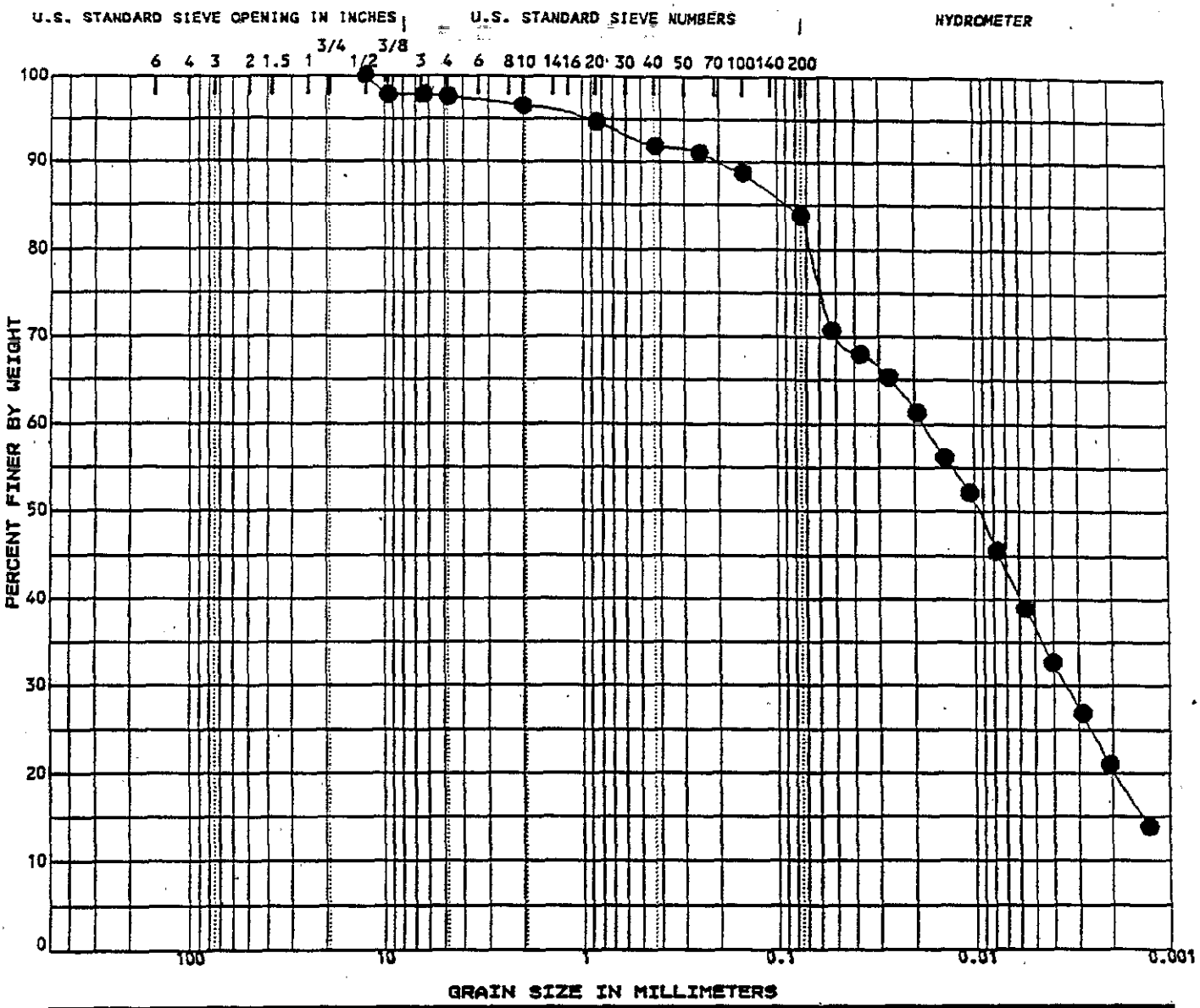
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-14-01-02	Clayey SILT; little fine sand; trace medium sand. Low plasticity.	28.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● DS1-14-01-02	2.00	0.02	0.004		0.0	16.3	48.3	35.3

AR302972

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



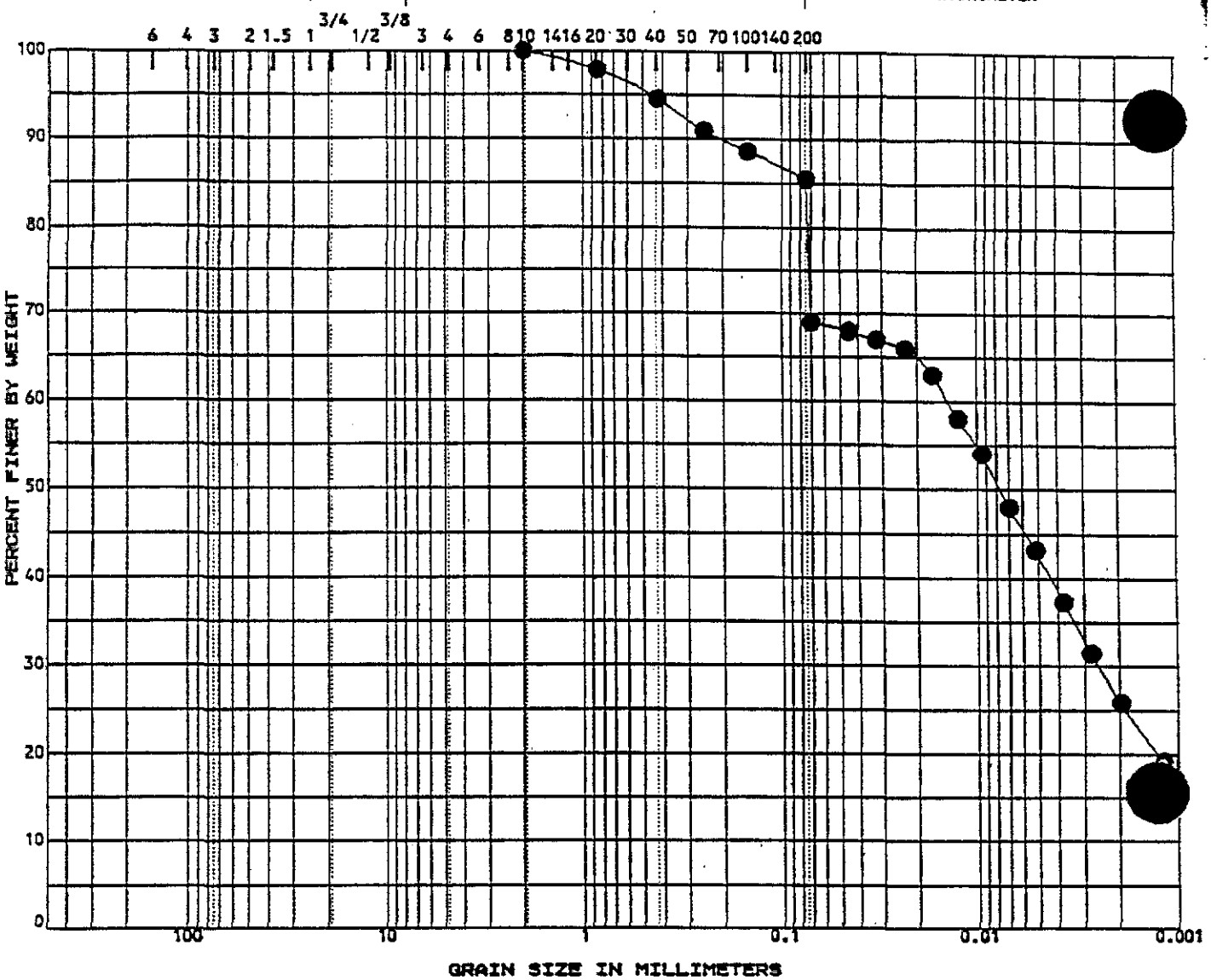
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-15-01-02	Clayey SILT; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	28.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-15-01-02	12.50	0.02	0.004		2.5	13.7	47.0	36.7

AR302973

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	



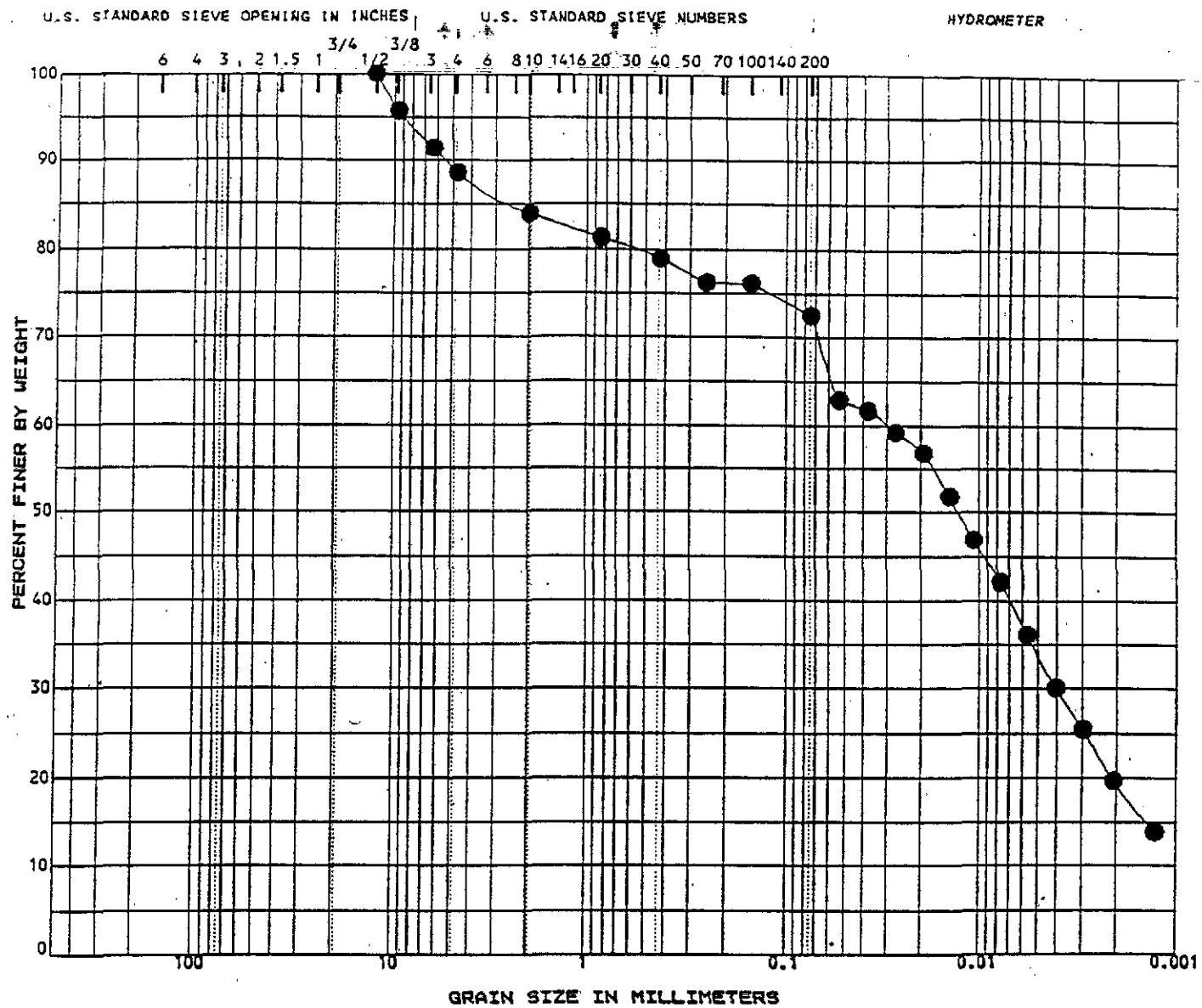
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-15-01-02-D	Clayey SILT; trace fine and medium sand. Low plasticity.	26.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● DS1-15-01-02-D	2.00	0.01	0.003		0.0	14.5	43.0	42.4

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302974



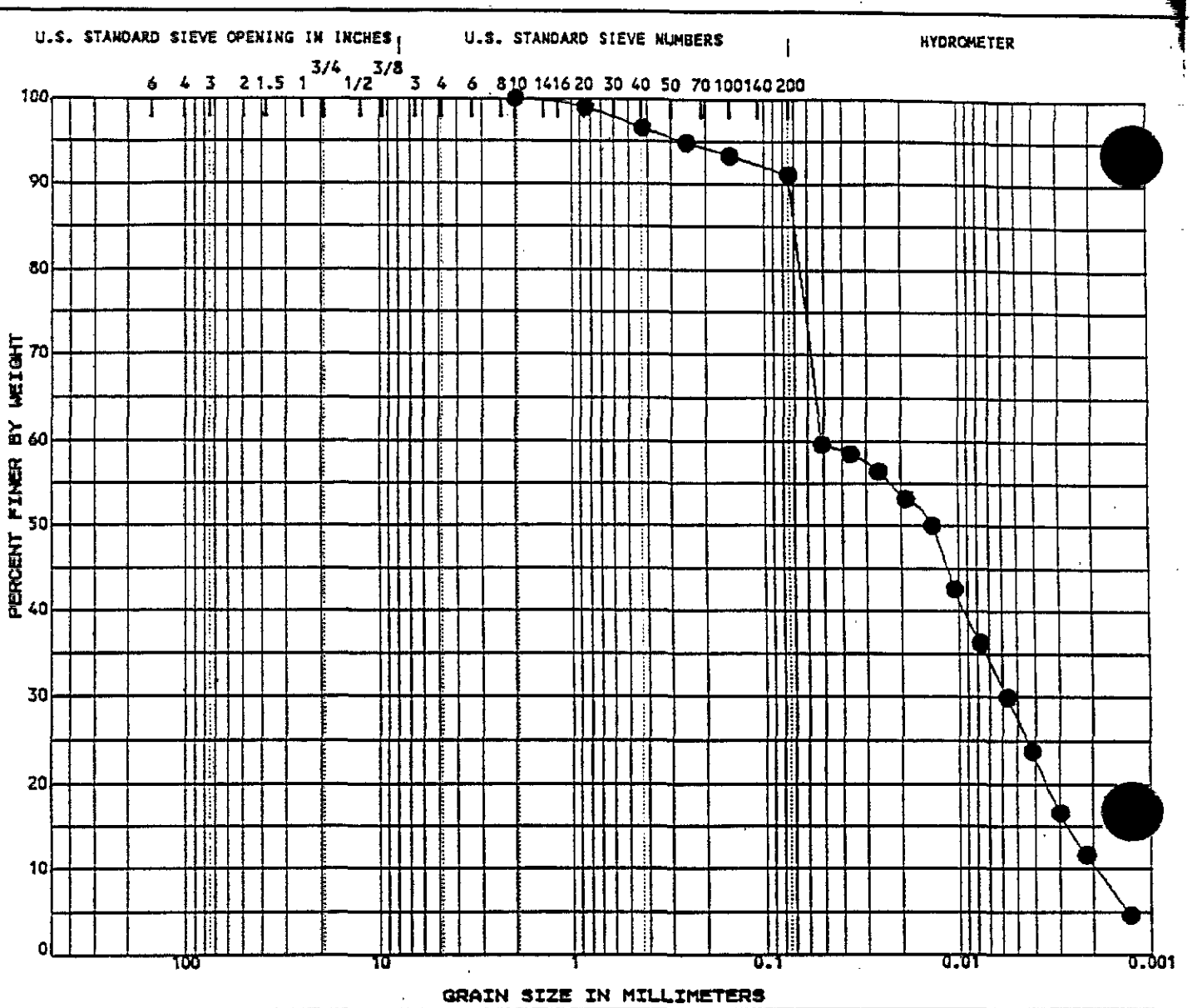
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-15-02-04	SILT; some clay; litle fine gravel; trace fine, medium, and coarse sand.	22.1					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-15-02-04	12.50	0.03	0.004		11.4	16.1	38.7	33.7

AR302975

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



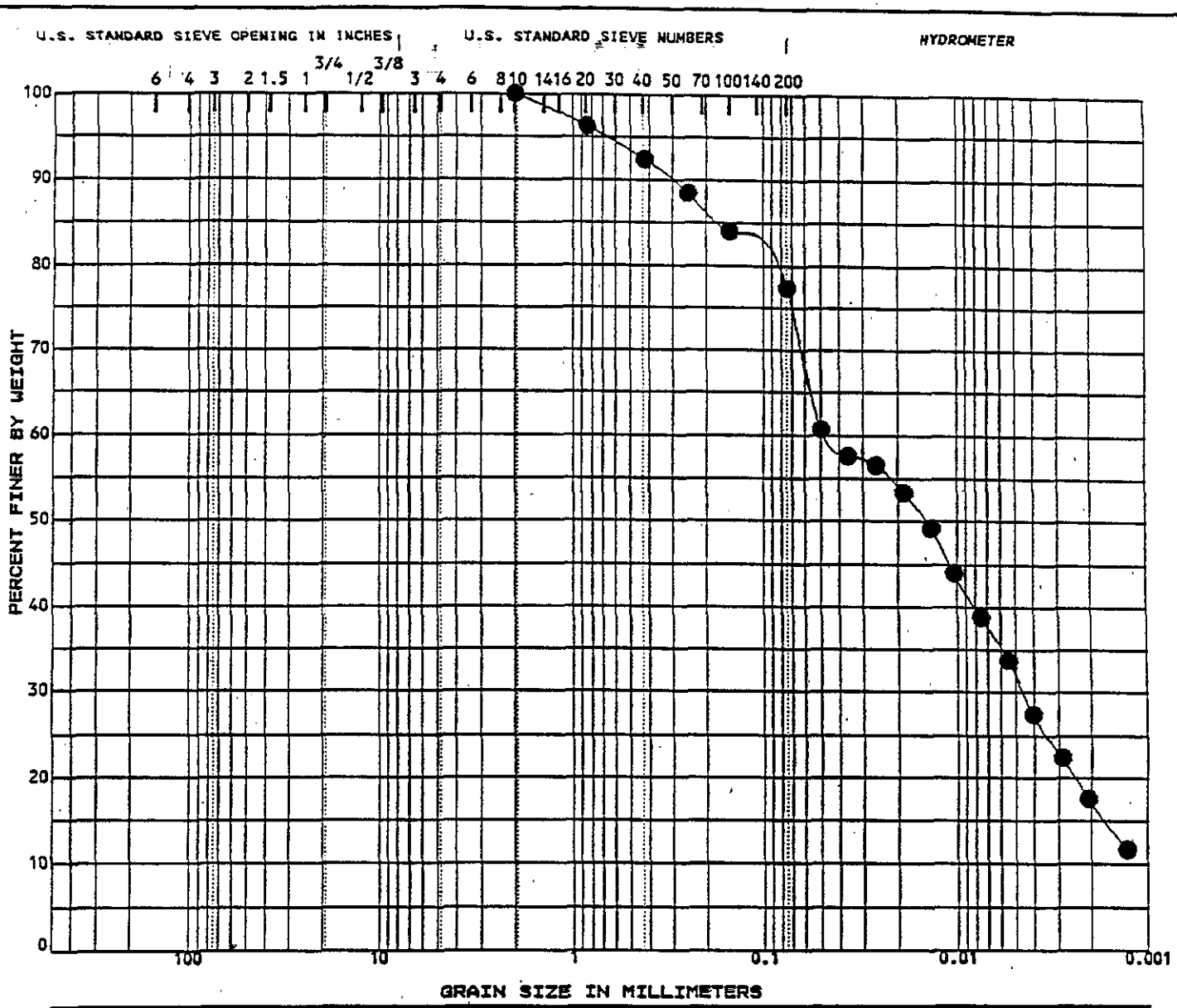
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-17-01-02	SILT; some clay; trace fine and medium sand. Moderately plastic.	37.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● DS1-17-01-02	2.00	0.05	0.006	0.0019	0.0	8.9	63.7	27.3

AR302976

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES

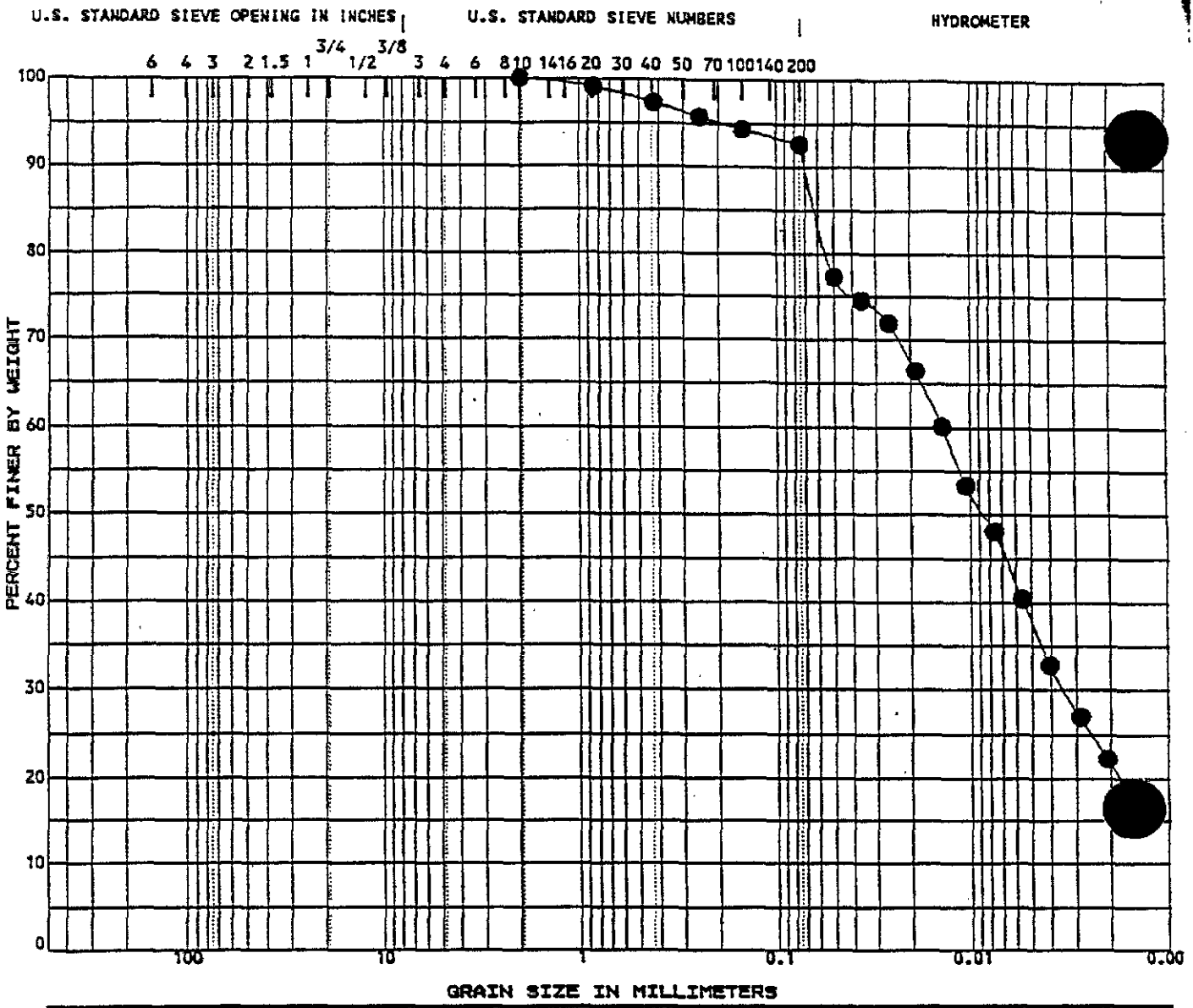


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-17-02-04	SILT; some clay; little fine sand; trace medium sand. Low plasticity.	24.7					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-17-02-04	2.00	0.05	0.005		0.0	22.6	45.6	31.7

AR302977	Project OLIN MORGANTOWN	Location West Virginia
	Area	Notes
	Date April 1996	GRADATION CURVES



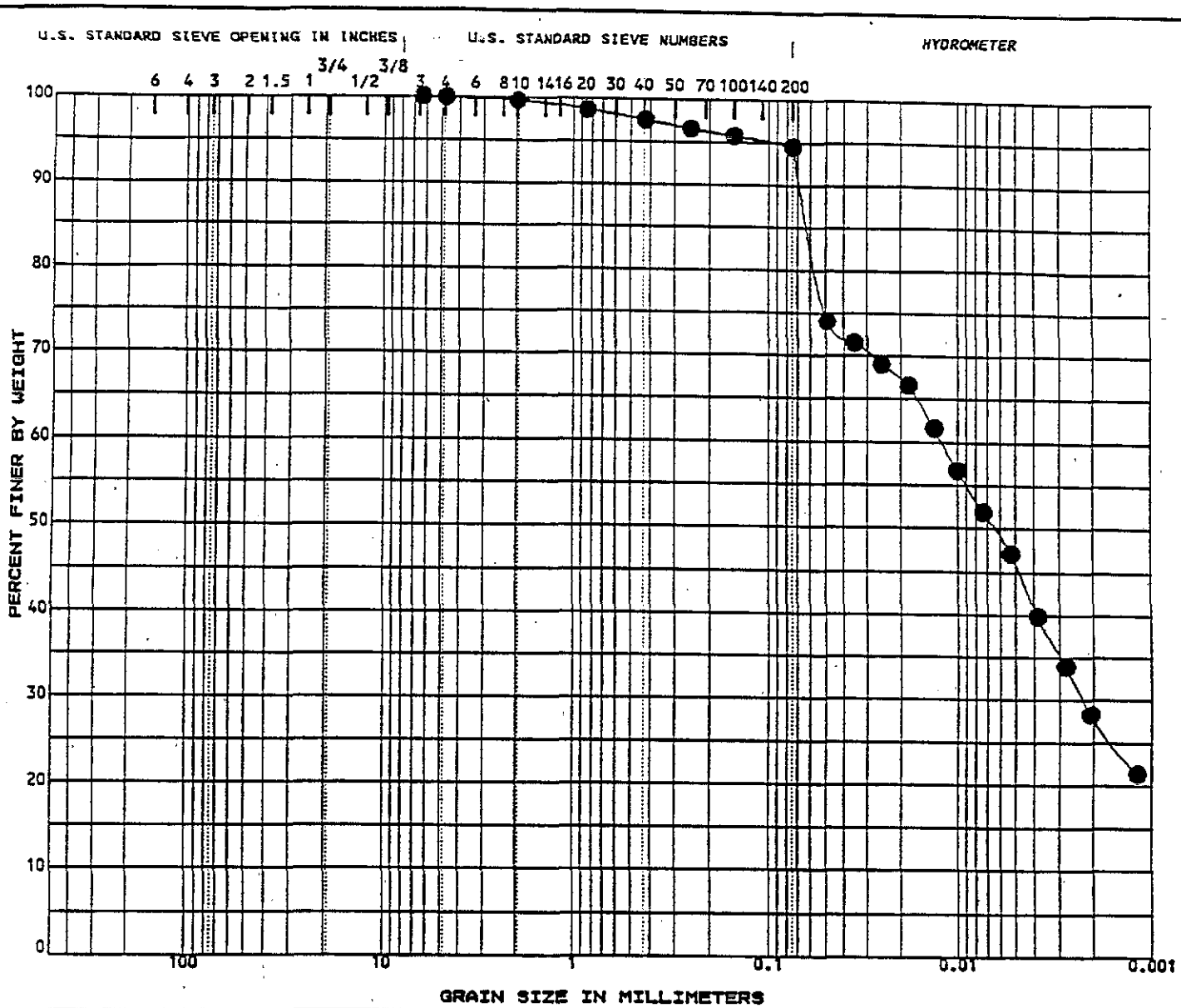
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc
● DS1-18-01-02	Clayey SILT; trace fine and medium sand. Moderately plastic.	28.5				

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%C
● DS1-18-01-02	2.00	0.01	0.004		0.0	7.4	54.9	37

Project	OLIN MORGANTOWN	Location	West Virginia
Area		Notes	
Date	April 1996	GRADATION CURVES	

AR302978



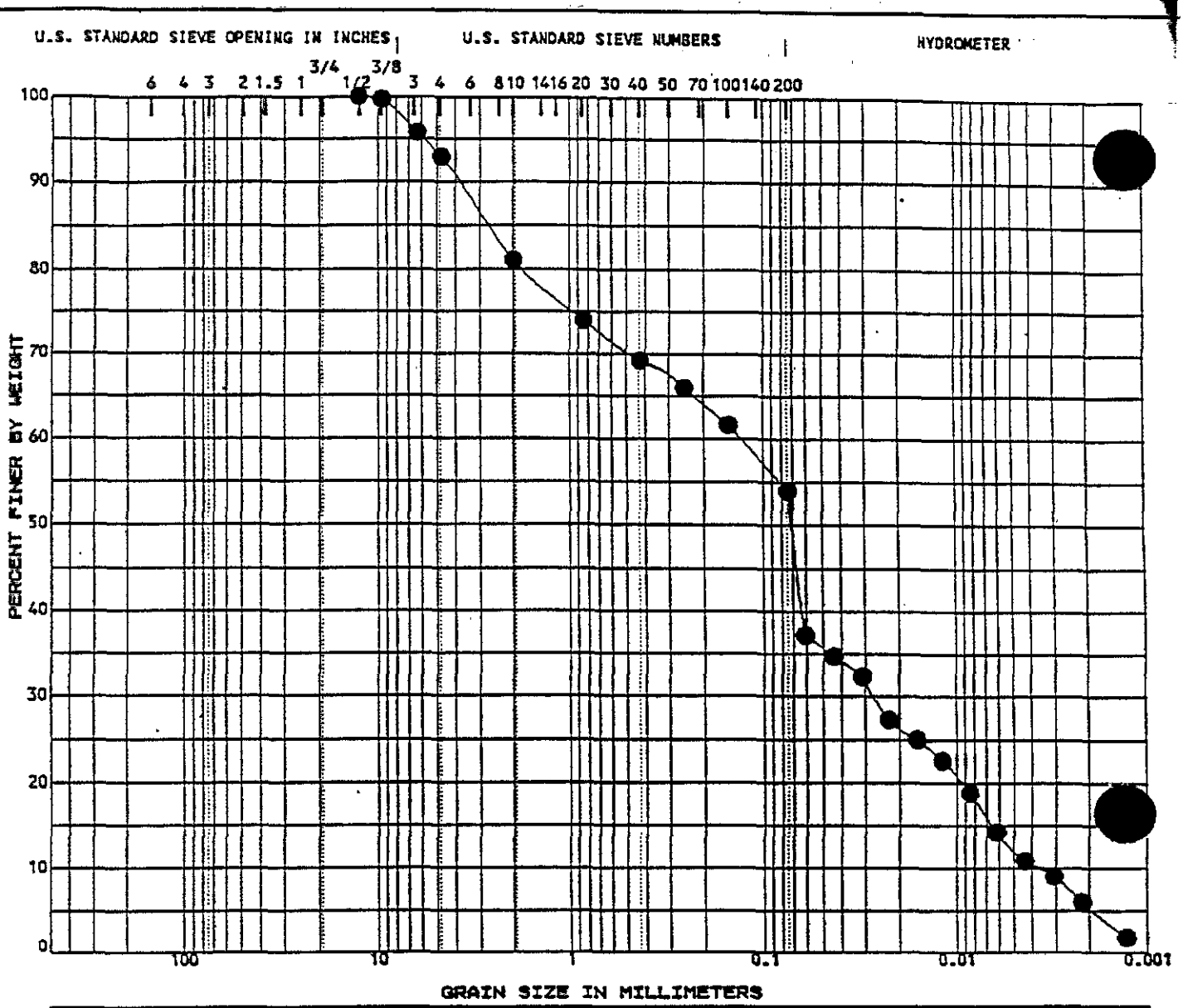
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS1-18-02-04	Clayey SILT; trace fine, medium, and coarse sand and fine gravel. Low plasticity.	25.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS1-18-02-04	6.30	0.01	0.002		0.1	5.4	48.7	45.7

AR302979

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



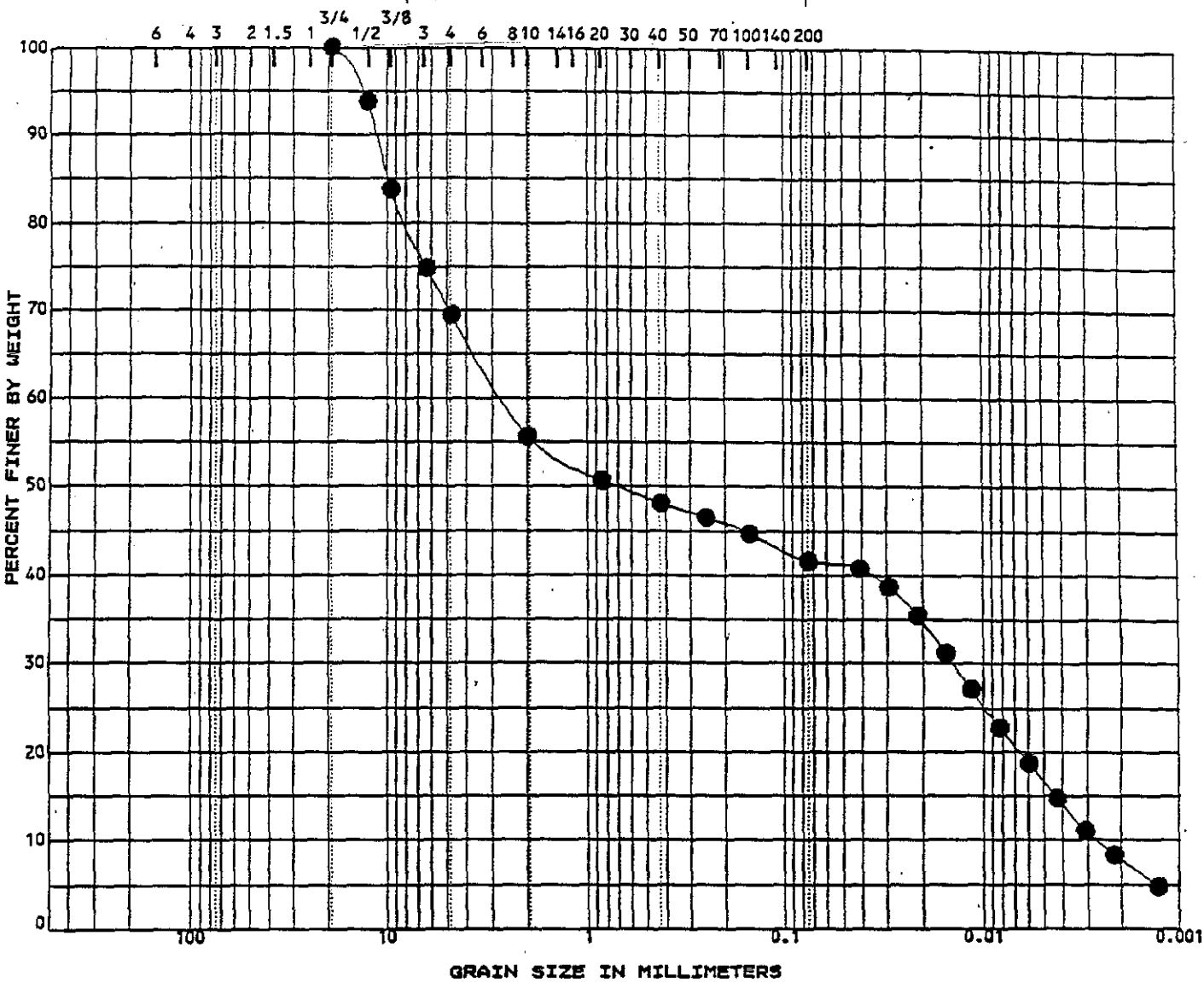
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-03	Fine to Coarse Sandy SILT; little clay; trace fine gravel.	32.8					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Cl
● DS2-03	12.50	0.13	0.027	0.0037	7.1	38.9	41.8	12.1

AR302980

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES



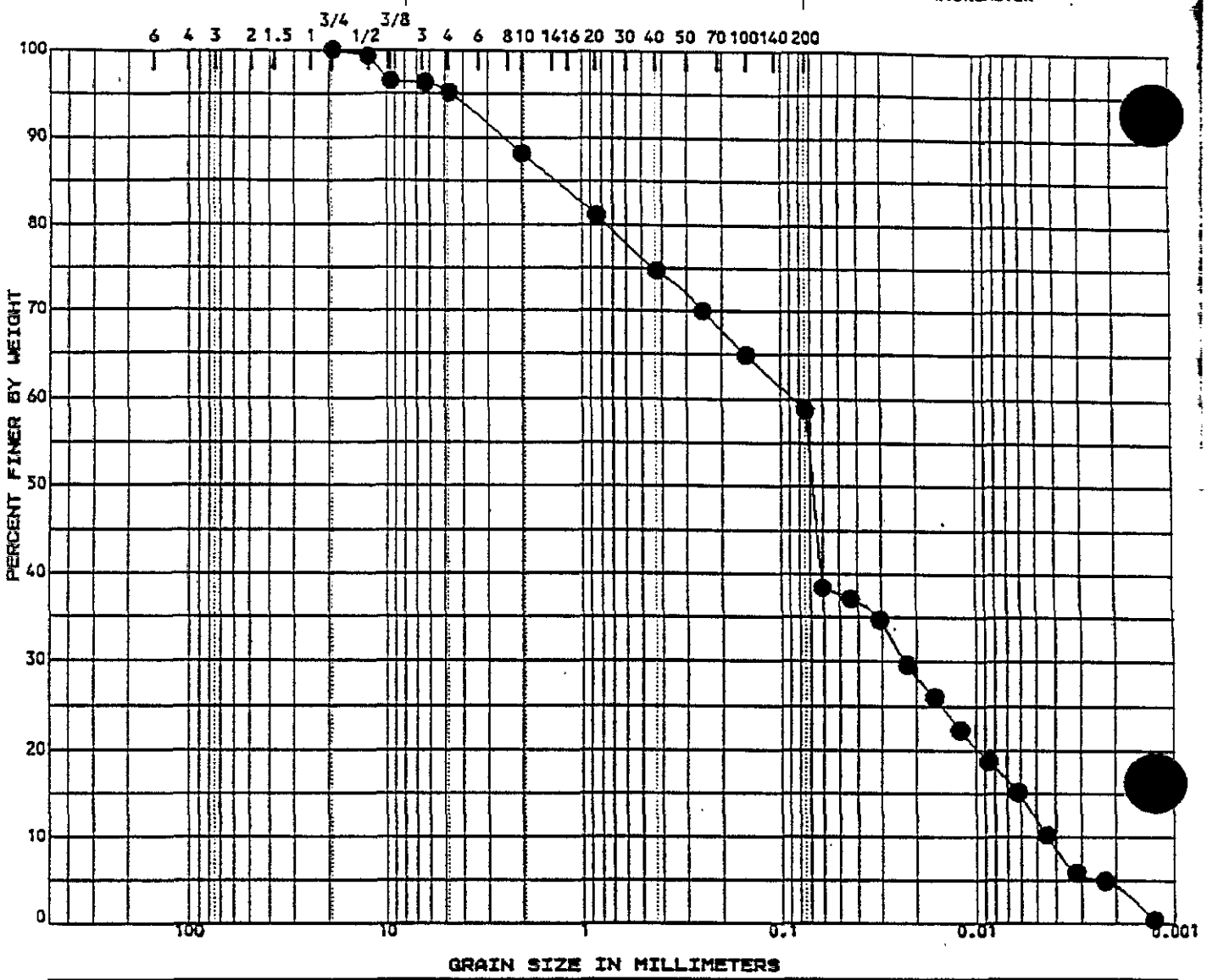
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-05	Fine GRAVEL; some silt; little clay and coarse sand; trace medium and fine sand. Low plasticity.	19.6					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-05	19.10	2.63	0.014	0.0027	30.5	27.9	24.9	16.6

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302981



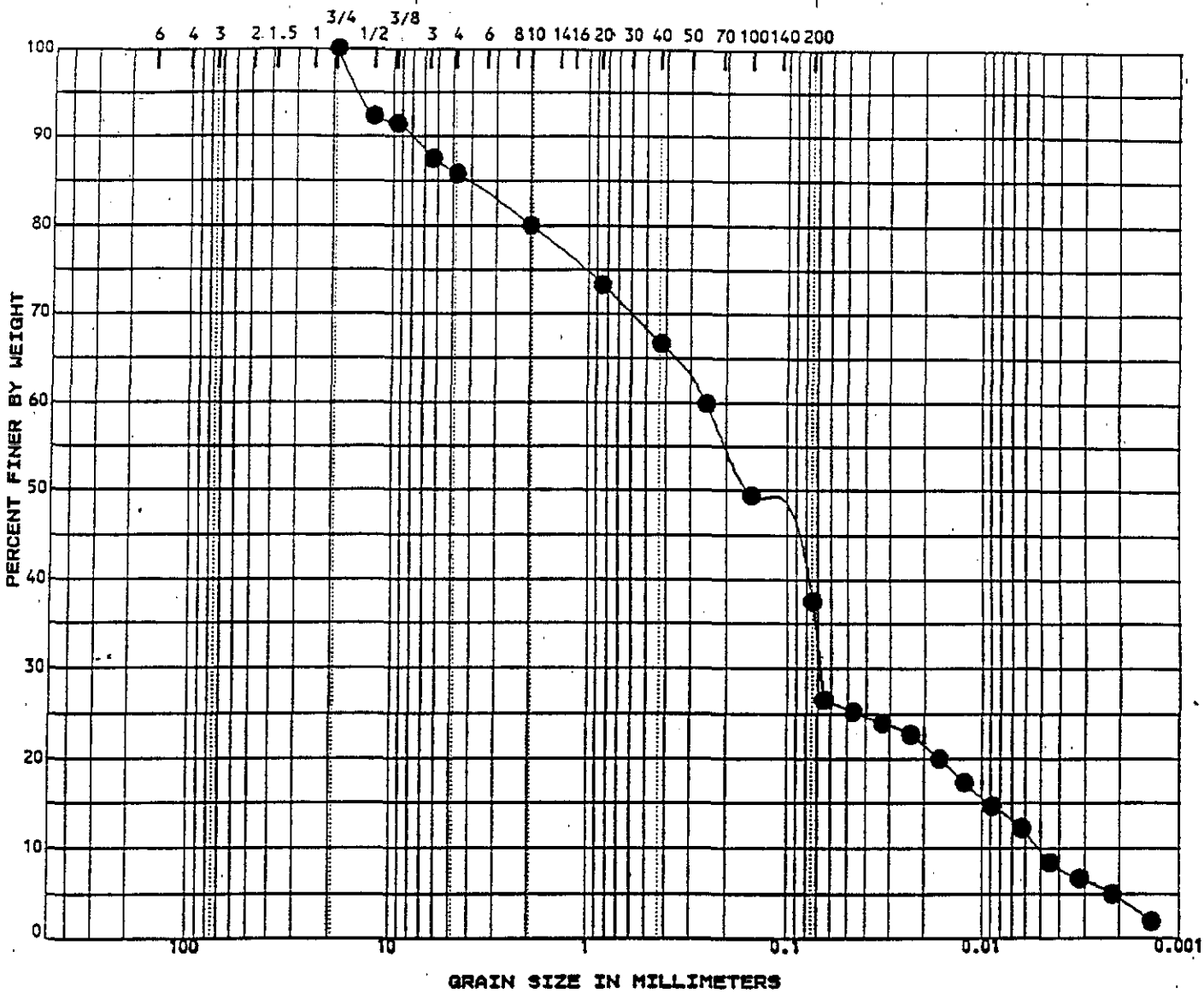
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-06	Fine to Coarse Sandy SILT; little clay; trace fine gravel.	19.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-06	19.10	0.09	0.023	0.0044	4.9	36.3	46.8	11.9

Project OLIN MORGANTOWN	Location West Virginia	
Area	Notes	
Date April 1996	GRADATION CURVES	

AR302982



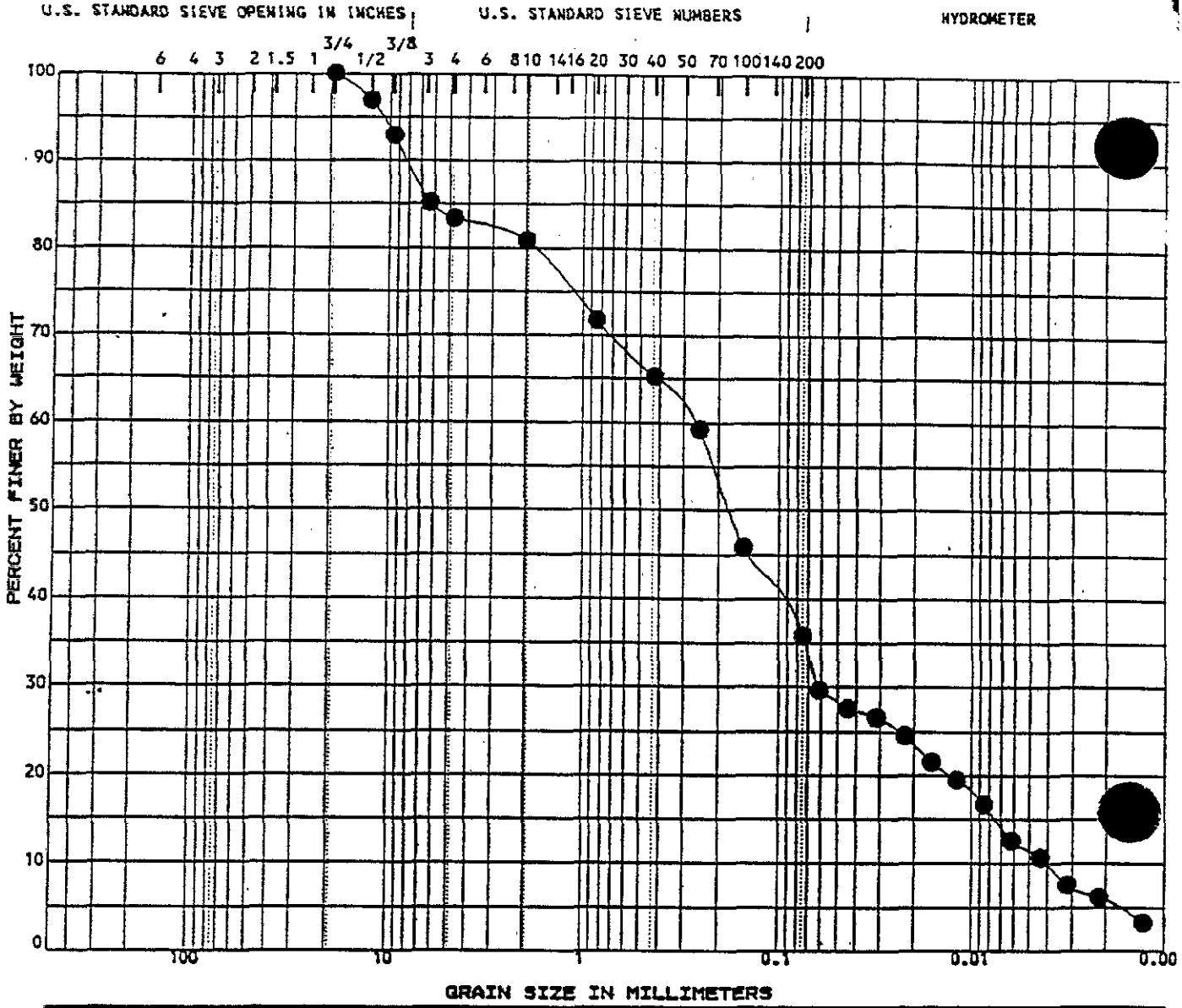
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS2-08	Fine to Coarse SAND; some silt; little fine gravel; trace clay.	26.9					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS2-08	19.10	0.25	0.069	0.0051	14.2	48.2	27.9	9.7

AR302983

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES

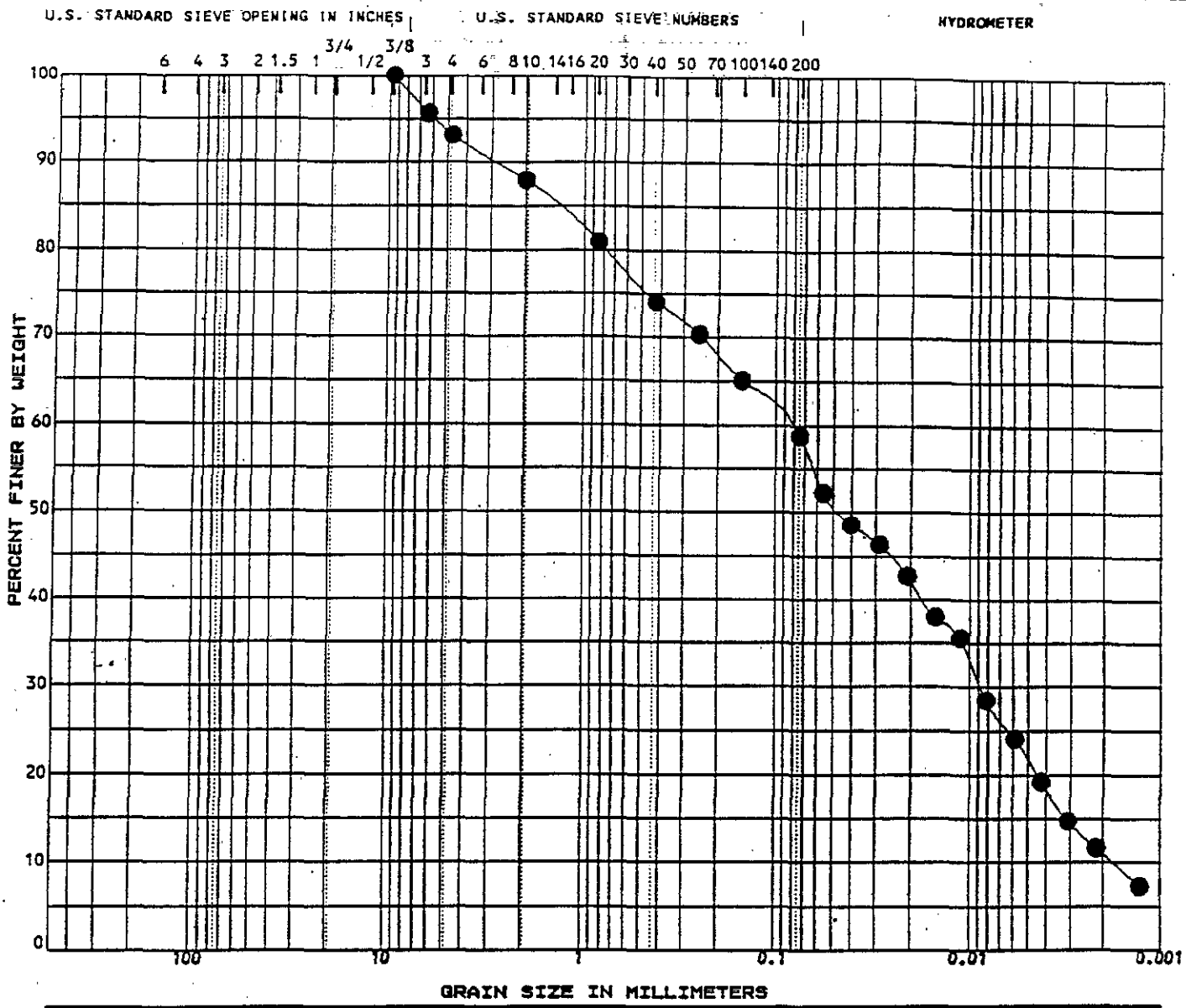


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	C
● DS2-10	Fine to Coarse SAND; some silt; little fine gravel and clay. Moderately plastic.	24.5					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%C
● DS2-10	19.10	0.27	0.063	0.0041	16.6	47.6	24.3	11.

AR302984	Project	OLIN MORGANTOWN	Location West Virginia
	Area		Notes
	Date	April 1996	GRADATION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	WC%	LL	PL	PI	Cc	Cu
● DS3-04	SILT; some clay; little fine and medium sand; trace fine gravel and coarse sand. With organics.	56.4					

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● DS3-04	9.51	0.09	0.009	0.0018	6.9	34.3	37.2	21.5

AR302985

Project OLIN MORGANTOWN	Location West Virginia
Area	Notes
Date April 1996	GRADATION CURVES

ANALYTICAL REPORT

Report To:	Ms. Pat Byrnes ABB Environmental, Inc. Corporate Place 128 107 Audubon Road Wakefield, MA 01880
Project:	Olin MTWN Pre-design Soil Sampling

04/04/1996

NET Job Number: 96.01147

National Environmental Testing, Inc.

Cambridge Division
12 Oak Park
Bedford, MA 01730

Massachusetts Certification Number
M MA023

NET Cambridge Division

ANALYTICAL REPORT

Report To:

Ms. Pat Byrnes
ABB Environmental, Inc.
Corporate Place 128
107 Audubon Road
Wakefield, MA 01880

Reported By:

National Environmental Testing
NET Atlantic, Incorporated
Cambridge Division
12 Oak Park
Bedford, MA 01730

Report Date: 04/04/1996

Collected By: ABB

NET Job Number: 96.01147

Project: Olin MTWN Pre-design Soil Sampling

Shipped Via: Fedex

Client P.O. No: WR#794-HO

Job Description: TOC in Soil

Airbill No:

NET Client No: 10800

This report has been approved and certified for release by the following staff. Please feel free to call the NET Project Manager at 617-275-3535 with any questions or comments.

Antonia Benney
NET Project Manager

Report prepared by
NET Reports Group

Analytical data for the following samples are included in this data report.

SAMPLE ID	NET ID	DATE TAKEN	TIME TAKEN	DATE REC'D	MATRIX
LA-68-03-06	144965			03/30/1996	SOIL
LA-53-08-10	144966			03/30/1996	SOIL
LA-27-00-02	144967			03/30/1996	SOIL
LA-40-00-03	144968			03/30/1996	SOIL
LA-96-00-02	144969			03/30/1996	SOIL
LA-25-00-02	144970			03/30/1996	SOIL
LA-42-00-04	144971			03/30/1996	SOIL
LA-31-04-060	144972			03/30/1996	SOIL
LA-22-00-04	144973			03/30/1996	SOIL
LA-17-00-020	144974			03/30/1996	SOIL
LA-07-00-02	144975			03/30/1996	SOIL
LA-23-02-04	144976			03/30/1996	SOIL
LA-44-08-12	144977			03/30/1996	SOIL
SA-36-03-04	144978			03/30/1996	SOIL
SA-16-00-04	144979			03/30/1996	SOIL
SA-17-00-04	144980			03/30/1996	SOIL
SA-11-00-04	144981			03/30/1996	SOIL
SA-34-00-04	144982			03/30/1996	SOIL
DS1-12	144983			03/30/1996	SOIL
DS3-01	144984			03/30/1996	SOIL
LA-08-04-08	144985			03/30/1996	SOIL
LA-62-00-02	144986			03/30/1996	SOIL
LA-48-02-03	144987			03/30/1996	SOIL
LA-51-02-04	144988			03/30/1996	SOIL

NET Cambridge Division

ANALYTICAL REPORT

Report To:	Reported By:
Ms. Pat Byrnes ABB Environmental, Inc. Corporate Place 128 107 Audubon Road Wakefield, MA 01880	National Environmental Testing NET Atlantic, Incorporated Cambridge Division 12 Oak Park Bedford, MA 01730

Report Date: 04/04/1996	Collected By: ABB	NET Job Number: 96.01147
Project: Olin MTWN Pre-design Soil Sampling	Shipped Via: Fedex	Client P.O. No: WR#794-MO
Job Description: TOC in Soil	Airbill No:	NET Client No: 10800

This report has been approved and certified for release by the following staff. Please feel free to call the NET Project Manager at 617-275-3535 with any questions or comments.

Antonia Ramney
NET Project Manager

Kimberly A. Hubert
Report prepared by
NET Reports Group

Analytical data for the following samples are included in this data report.

SAMPLE ID	NET ID	DATE TAKEN	TIME TAKEN	DATE REC'D	MATRIX
LA-42-02-04	144989			03/30/1996	SOIL
LA-30-00-02	144990			03/30/1996	SOIL
LA-49-00-02	144991			03/30/1996	SOIL
LA-42-04-06	144992			03/30/1996	SOIL
DS2-08	144993			03/30/1996	SOIL
LA-38-03-04	144994			03/30/1996	SOIL
DS1-17-02-04	144995			03/30/1996	SOIL
LA-38-05-06	144996			03/30/1996	SOIL
LA-43-06-08	144997			03/30/1996	SOIL
LA-02-00-04	144998			03/30/1996	SOIL
LA-54-03-04	144999			03/30/1996	SOIL
LA-53-04-08	145000			03/30/1996	SOIL
DS1-14-00-0.5	145001			03/30/1996	SOIL
DS1-15-01-02	145002			03/30/1996	SOIL
DS1-18-02-04	145003			03/30/1996	SOIL
DS1-04	145004			03/30/1996	SOIL
DS1-09	145005			03/30/1996	SOIL
LA-13-02-04	145006			03/30/1996	SOIL
DS2-05	145007			03/30/1996	SOIL
DS2-03	145008			03/30/1996	SOIL
DS2-07	145009			03/30/1996	SOIL
DS2-02	145010			03/30/1996	SOIL
DS1-01	145011			03/30/1996	SOIL
LA-50-00-04	145012			03/30/1996	SOIL

NET Cambridge Division

ANALYTICAL REPORT

Report To:	Reported By:
Ms. Pat Byrnes ABB Environmental, Inc. Corporate Place 128 107 Audubon Road Wakefield, MA 01880	National Environmental Testing NET Atlantic, Incorporated Cambridge Division 12 Oak Park Bedford, MA 01730

Report Date: 04/04/1996 | Collected By: ABB | NET Job Number: 96.01147

Project: Olin MTWN Pre-design Soil Sampling | Shipped Via: Fedex | Client P.O. No: WR#794-MO

Job Description: TOC in Soil | Airbill No: | NET Client No: 10800

This report has been approved and certified for release by the following staff. Please feel free to call the NET Project Manager at 617-275-3535 with any questions or comments.

Antonia Benney
NET Project Manager

Kimberly A. Hubert
Report prepared by
NET Reports Group

Analytical data for the following samples are included in this data report.

SAMPLE ID	NET ID	DATE TAKEN	TIME TAKEN	DATE REC'D	MATRIX
DS1-11	145013			03/30/1996	SOIL
DS1-10	145014			03/30/1996	SOIL
DS3-05	145015			03/30/1996	SOIL
DS1-17-01-02	145016			03/30/1996	SOIL
DS1-15-01-02D	145017			03/30/1996	SOIL
DS1-13-01-02	145018			03/30/1996	SOIL
DS1-15-02-04	145019			03/30/1996	SOIL
DS2-10	145020			03/30/1996	SOIL
DS1-16-00-0.5	145021			03/30/1996	SOIL
DS1-14-01-02	145022			03/30/1996	SOIL
DS3-04	145023			03/30/1996	SOIL
DS3-06	145024			03/30/1996	SOIL
DS1-05	145025			03/30/1996	SOIL
DS1-07	145026			03/30/1996	SOIL
DS1-16-01-02	145027			03/30/1996	SOIL
DS2-07D	145028			03/30/1996	SOIL
DS1-13-00-0.5	145029			03/30/1996	SOIL
DS2-06	145030			03/30/1996	SOIL
DS1-18-01-02	145031			03/30/1996	SOIL
DS3-03	145032			03/30/1996	SOIL
DS2-9	145033			03/30/1996	SOIL
DS3-02	145034			03/30/1996	SOIL
DS1-03	145035			03/30/1996	SOIL
DS1-08	145036			03/30/1996	SOIL

NET Cambridge Division
ANALYTICAL REPORT

Report Date: 04/04/1996

Report To: ABB Environmental, Inc.

NET Job No: 96.01147

Project: Olin NTUM Pre-design Soil Sampling

Date Rec'd: 03/30/1996

Sample ID	NET ID	Result	Units	Run Batch	Analysis Date	Analyst
Total Organic Carbon in Soil	415.1					
LA-68-05-06	144965	1200	mg/Kg	1	04/01/1996	rmg
LA-53-08-10	144966	49000	mg/Kg	1	04/01/1996	rmg
LA-27-00-02	144967	89000	mg/Kg	1	04/01/1996	rmg
LA-40-00-03	144968	21000	mg/Kg	1	04/01/1996	rmg
LA-96-00-02	144969	10000	mg/Kg	1	04/01/1996	rmg
LA-25-00-02	144970	24000	mg/Kg	1	04/02/1996	nsv
LA-42-00-04	144971	40000	mg/Kg	1	04/02/1996	nsv
LA-31-04-06D	144972	2100	mg/Kg	1	04/02/1996	nsv
LA-22-00-04	144973	8400	mg/Kg	1	04/02/1996	nsv
LA-17-00-02D	144974	12000	mg/Kg	1	04/02/1996	nsv
LA-07-00-02	144975	14000	mg/Kg	1	04/02/1996	nsv
LA-23-02-04	144976	12000	mg/Kg	1	04/02/1996	nsv
LA-44-08-12	144977	13000	mg/Kg	1	04/02/1996	nsv
SA-36-03-04	144978	1600	mg/Kg	1	04/02/1996	nsv
SA-16-00-04	144979	33000	mg/Kg	1	04/02/1996	nsv
SA-17-00-04	144980	11000	mg/Kg	1	04/02/1996	nsv
SA-11-00-04	144981	13000	mg/Kg	1	04/02/1996	nsv
SA-34-00-04	144982	50000	mg/Kg	1	04/02/1996	nsv
DS1-12	144983	17000	mg/Kg	1	04/02/1996	nsv
DS3-01	144984	26000	mg/Kg	1	04/02/1996	nsv
LA-08-04-08	144985	12000	mg/Kg	1	04/02/1996	nsv
LA-62-00-02	144986	5300	mg/Kg	1	04/02/1996	nsv
LA-48-02-03	144987	28000	mg/Kg	1	04/02/1996	nsv
LA-51-02-04	144988	35000	mg/Kg	1	04/02/1996	nsv
LA-62-02-04	144989	37000	mg/Kg	1	04/02/1996	nsv
LA-30-00-02	144990	38000	mg/Kg	1	04/02/1996	nsv
LA-49-00-02	144991	45000	mg/Kg	1	04/02/1996	nsv
LA-42-04-08	144992	18000	mg/Kg	1	04/02/1996	nsv
DS2-08	144993	10000	mg/Kg	1	04/02/1996	nsv
LA-38-03-04	144994	4500	mg/Kg	1	04/02/1996	nsv
DS1-17-02-04	144995	4700	mg/Kg	1	04/02/1996	nsv
LA-38-05-06	144996	9200	mg/Kg	1	04/02/1996	nsv
LA-43-06-08	144997	4800	mg/Kg	1	04/02/1996	nsv
LA-02-00-04	144998	42000	mg/Kg	1	04/02/1996	nsv
LA-54-03-04	144999	89000	mg/Kg	1	04/03/1996	nsv
LA-53-04-08	145000	19000	mg/Kg	1	04/03/1996	nsv
DS1-14-00-0.5	145001	16000	mg/Kg	1	04/03/1996	nsv
DS1-15-01-02	145002	8700	mg/Kg	1	04/03/1996	nsv

NET Cambridge Division

ANALYTICAL REPORT

Report Date: 04/04/1996

Report To: ABB Environmental, Inc.

NET Job No: 96.01147

Project: Olin MTWN Pre-design Soil Sampling

Date Rec'd: 03/30/1996

Sample ID	NET ID	Result	Units	Run Batch	Analysis Date	Analyst
Total Organic Carbon in Soil	415.1					
DS1-18-02-04	145003	1500	mg/Kg	1	04/03/1996	nsv
DS1-04	145004	25000	mg/Kg	1	04/03/1996	nsv
DS1-09	145005	28000	mg/Kg	1	04/03/1996	nsv
LA-13-02-04	145006	55000	mg/Kg	1	04/03/1996	nsv
DS2-05	145007	3800	mg/Kg	1	04/03/1996	nsv
DS2-03	145008	9600	mg/Kg	1	04/03/1996	nsv
DS2-07	145009	2900	mg/Kg	1	04/03/1996	nsv
DS2-02	145010	5000	mg/Kg	1	04/03/1996	nsv
DS1-01	145011	13000	mg/Kg	1	04/03/1996	nsv
LA-50-00-04	145012	52000	mg/Kg	1	04/03/1996	nsv
DS1-11	145013	19000	mg/Kg	1	04/03/1996	nsv
DS1-10	145014	31000	mg/Kg	1	04/03/1996	nsv
DS3-05	145015	8800	mg/Kg	1	04/03/1996	nsv
DS1-17-01-02	145016	9600	mg/Kg	1	04/03/1996	nsv
DS1-15-01-02D	145017	6300	mg/Kg	1	04/04/1996	nsv
DS1-13-01-02	145018	5000	mg/Kg	1	04/04/1996	nsv
DS1-15-02-04	145019	2600	mg/Kg	1	04/04/1996	nsv
DS2-10	145020	8900	mg/Kg	1	04/04/1996	nsv
DS1-16-00-0.5	145021	8900	mg/Kg	1	04/04/1996	nsv
DS1-14-01-02	145022	4700	mg/Kg	1	04/04/1996	nsv

Analyst: _____ Supervisor KAA

continued from previous page

Sample ID: Client/Proj. #	Client ID	CAA ID	Percent Solids: Cont. (g)	Cont. + Wet Wt. (g)	Cont. + Dry Wt. (g)	Wet Wt. (g)	Dry Wt. (g)	% Solids	Init. Wet Wt. (g)			B_2SO_4 / $MgCl_2$	Comments
145019		6	0.9460	7.0217	5.9061	6.0757	4.9601	81.55					
145020		5	0.9710	4.1395	3.3278	3.1623	2.3416	74.14					
145021		28	0.9848	4.9960	4.0544	4.0112	3.0696	76.53					
145022		from 134	1.0058	4.2395	3.5506	3.2320	2.5434	78.68					
145023		35	0.9822	5.5109	3.8737	4.5292	2.8915	63.83					
145024		36	0.9850	6.6014	4.7957	5.6164	3.8107	67.85					
145025		52	0.9861	6.8641	5.1122	5.8780	4.1261	70.20					
145026		51	~~0.9850~~	~~4.6983~~									
145027		51	0.9850	4.6983	3.9053	3.7133	2.9203	78.61					
145028		32	0.9844	5.7521	4.9054	4.7647	3.9180	82.23					
145029		38	0.9895	3.8488	3.1203	2.8593	2.1308	74.52					
145030		47	0.9859	5.7042	4.8171	4.7184	3.8312	81.2					
145031		40	0.9865	6.6620	4.8917	5.1875	3.9052	75.37					
145032		48	0.9865	6.8260	3.7326	5.8595	2.7461	47.03					
145033		46	0.9886	5.9880	5.6029	4.9994	4.6213	92.44					
145034		41	0.9885	8.2900	4.2252	7.3015	3.2367	44.33					
145035		45	0.9811	11.7359	8.1199	10.7448	7.4588	69.42					
145036		49	0.9835	5.3607	3.7165	4.3772	2.7330	56.36					
145026		50	0.9822	5.7658	3.0002	4.7836	2.0180	42.17					

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Analyst NSV

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Date 04/03/96
Supervisor KAA.

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Sample ID			Percent Solids											
Client/Proj. #	Client ID	CAA ID	Cont. (g)	Cont. + Wet Wt. (g)	Cont. + Dry Wt. (g)	Wet Wt. (g)	Dry Wt. (g)	% Solids	Init. Wet Wt. (g)			H_2SO_4? / HNO_3?	Comments
01142 145001		16	0.9756	4.6200	3.7981	3.6504	2.823	77.32					
145002		12	0.9790	4.5022	3.7042	3.5252	2.727	77.36					
145003		13	0.9769	3.1080	2.6089	2.1311	1.632	76.58					
145004		17	0.9728	5.3274	3.7629	4.4046	4.4328	63.48					
145005		9	0.9765	6.6283	4.6608	5.6518	3.6843	65.19					
145006		18	0.9712	4.7218	3.1499	3.7501	2.1782	58.08					
145007		14	0.9758	4.7029	4.0483	3.7276	3.073	82.44					
145008		10	0.9762	4.2876	3.4523	3.3114	2.4761	74.78					
145009		19	0.8836	5.2474	4.4314	4.2638	3.5478	81.03					
145010 11		20	0.9743	5.4066	3.8277	4.4323	2.8524	64.37					
145011 (12)		4	0.9753	4.7848	3.7044	3.7795	2.724	72.21					
145012		3	0.9753	5.2808	4.4307	4.2755	3.4554	80.82					
145013		4	0.9768	5.0085	3.7352	4.0287	2.7587	68.47					
145014		1+	0.9744	4.3890	2.7838	3.4146	1.8094	52.99					
145015		2	0.9763	4.9044	3.5139	3.9341	2.5376	64.55					
145016		12+	0.9768	5.1438	4.0420	4.1670	3.0652	73.56					
145017		2	0.9790	3.2162	2.7412	2.2372	1.8022	80.56					
145018		1	0.9761	3.8160	3.0741	2.8393	2.0774	72.87					

Method Reference [illegible]

Analyst NSV

Date 04/[illegible]/96

Supervisor [illegible]

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Sample ID			Percent Solids											
Client/Proj. #	Client ID	CAA ID	Cont. (g)	Cont. + Wet Wt. (g)	Cont. + Dry Wt. (g)	Wet Wt. (g)	Dry Wt. (g)	% Solids	Init. Wet Wt. (g)			H_2SO_4 / $Na_2S_2O_3$	Comments
OMY7-144965		965	0.9268	7.5206	6.1988	6.5338	5.209	0.7972					
144966		966	0.9282	3.6088	2.9423	2.6806	1.9531	0.7480					
144967		967	0.9925	2.3001	2.5167	1.3076	1.5242	0.8432					
144968		968	0.5835	5.1736	4.1927	4.1901	3.2092	0.7658					
144969		969	0.9822	3.1157	3.0935	2.1332	2.1113	0.9897					
144970		970	0.9870	6.2067	6.1667	5.2197	5.1797	0.9928					
144971		971	0.9741	6.4092	5.6582	5.4311	4.6521	0.8565					
144972		972	0.9851	4.1976	3.4645	3.1395	2.4797	0.7897					
144973		973	0.9852	3.9097	3.4582	2.9245	2.4730	0.8456					
144974		974	0.9849	5.1434	4.5811	4.1585	3.5962	0.8647					
144975		975	0.9850	4.1700	3.5214	3.1850	2.9364	0.9219					
144976		976	0.9853	8.5754	7.2543	7.5901	6.2690	0.8255					
144977		977	0.9857	5.1200	4.3034	4.1343	3.3177	0.8025					
144978		978	0.9842	4.3046	3.7086	3.3404	2.7244	0.8156					
144979		979	0.9820	5.5353	4.8471	4.5534	3.9651	0.8706					
144980		980	0.9862	4.0740	3.4578	3.0878	2.4716	0.7995					
144981		981	0.9855	4.6200	4.1893	3.6335	3.2028	0.8808					
144982		982	0.9880	5.4980	4.3815	4.5101	3.3936	0.7524					

Method Reference: 10C-501C
Analyst: NSV

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Date: 04/02/96
Supervisor: KAR

continued from previous page

Sample ID: Client/Proj. #	Client ID	CAA ID	Percent Solids: Cont. (g)	Cont. + Wet Wt. (g)	Cont. + Dry Wt. (g)	Wet Wt. (g)	Dry Wt. (g)	% Solids	Init. Wet Wt. (g)			H_2SO_4 / $MgCl_2$	Comm
144983		29	0.9881	4.2119	3.2335	3.2238	2.2454	0.6965					
144984		25	0.9812	3.8949	1.9015	2.9137	0.9203	0.3182					
144985		30	0.9845	2.9012	2.6334	1.9167	1.6489	0.8603					
144986		21	0.9885	5.2488	4.5183	4.2943	3.6038	0.8392					
144987		26	0.9811	5.3212	4.2622	4.3406	3.2811	0.7559					
144988		22	0.9778	3.5543	2.6812	2.5765	1.7034	0.6611					
144989		23	0.9793	3.3321	2.7391	2.3528	1.7598	0.7479					
144990		27	0.9110	3.4661	2.0500	2.4851	1.869	0.7521					
144991		31	0.9812	4.5647	3.5712	3.5830	2.5900	0.7228					
144992		24	0.9117	5.4961	4.3535	4.5144	3.3718	0.7469					
144993		28	0.9849	5.0860	4.1367	4.1012	3.1525	0.7685					
144994		32	0.9835	3.9361	3.2425	2.9546	2.2590	0.7646					
144995		33	0.9837	7.5271	6.2328	6.5434	5.2491	0.8022					
144996		34	0.9723	6.0811	4.7472	5.0988	3.7649	0.7383					
144997		7	0.9738	5.0732	4.2376	4.0594	3.2638	0.7962					
144998		11	0.9749	4.3953	3.5392	3.4204	2.6243	0.7672					
144999		15	0.9753	7.1129	5.4938	6.1376	4.4685	0.7280					
145000		8	0.9753	4.5241	3.8485	3.5488	2.8412	0.8091					

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APPENDIX D. IEA/ABB STATISTICAL COMPARISON

PFE ORIGINAL (Red)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.90777
R Square	0.824047
Adjusted	0.790714
Standard	1850.759
Observati	31

ANOVA

	df	*SS*	*MS*	*F*	*gnificance F*
Regressio	1	4.81E+08	4.81E+08	140.4999	1.22E-12
Residual	30	1.03E+08	3425309		
Total	31	5.84E+08			

	Coefficient	*andard Err*	*t Stat*	*P-value*	*ower 95%*	*pper 95%*	*ower 95.0*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
X Variable	0.961515	0.07567	12.70669	1.32E-13	0.806976	1.116054	0.806976

RESIDUAL OUTPUT

bservatio	*redicted*	*Residuals*
1	949.9768	-439.977
2	9.63438	37.06562
3	0	0
4	26.15321	75.94679
5	21.14372	48.35628
6	90.95932	-85.0593
7	0	0
8	18.65339	55.24661
9	0	0
10	0	0
11	275.9548	55.44519
12	112.2088	-39.3088
13	626.9078	719.0922
14	0	0
15	0	0
16	144.3234	499.2766
17	0	0
18	0	0
19	0	0
20	0	0
21	26.82627	-5.12627
22	0	0
23	0	0
24	0	0
25	22.98021	93.01979
26	0	0

PFT
ORIGINAL
(Red)

APPENDIX E

ANALYTICAL METHODS

Method 3550A: Ultrasonic Extraction

Method 4035: Soil Screeening for PAH by Immunoassay

Method 6010: Metals by Inductively Coupled Plasma

Method 7060: Arsenic by Atomic Absorption

Modified Method 3550A/8100: Extractable Organics by GC/FID (ABB-ES modification)

Method 8270A: Semivolatile Organic Compounds by GC/MS

ORIGINAL (Red)

1.0 APPROVALS

The signatures of the following individuals indicate that this SOP is complete and meets the requirements specified in corporate document # QAS00200.NET. In addition, it signifies that the content meets the specifications of the referenced "Test Code".

Laboratory Director

Quality Assurance Manager

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2.0 SCOPE AND APPLICATION

2.1 The objective of this document is to outline the extraction methods necessary to prepare BNA soil samples for GC/MS analysis. The extraction method followed is 3550.

2.2 The following test codes are used to define analyses conducted in accordance with all of the conditions set forth by this SOP:

SVE_02 SVE_04

2.3 The document control number for this SOP shall be **SPS01301.NC**

3.0 SUMMARY OF METHOD

3.1 A known amount of sample is extracted using sonication. The extract is concentrated using a steambath and nitrogen evaporation to a known final volume and delivered to the GC/MS department for analysis.

4.0 INTERFERENCES

4.1 Interferences are kept to a minimum by baking the glassware to be used at 900F and prerinsing the glassware with methylene chloride.

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5.0 SAFETY

5.1 Be sure to always wear chemical resistant gloves and eye protection at all times. In addition, each analyst has been issued a personal lab coat and it should be worn at all times while in the laboratory area.

5.2 MSDS sheets are available in the laboratory for immediate reference in case of an emergency.

5.3 Vapor monitors are used quarterly to determine exposure of employees to solvents.

6.0 SAMPLE CONTAINERS, COLLECTION AND PRESERVATION

6.1 Sample Containers - see appropriate analytical SOP.

6.2 Sample Collection - see appropriate analytical SOP.

6.3 Sample Preservation - see appropriate analytical SOP.

6.4 Sample Holding time is 14 days from sampling.

7.0 APPARATUS AND MATERIALS

7.1 250ml beaker

7.2 100ml graduated cylinder

7.3 75mm funnel

7.4 500ml K-D flask

7.5 10ml concentrator tube

7.6 Three ball snyder column

7.7 Aluminum drying pan

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7.8 Whatman 41 filter paper

7.9 Keck clamps

7.10 Silicon Carbide boiling chips

7.11 Metal Spatula

7.12 Top loading balance, accurate to +/- 0.01g

7.13 5 3/4" Pasteur pipets

7.14 Drying Oven

7.15 Nitrogen Evaporator

7.16 Tekmar Sonic Disrupter

7.17 500ul gastight syringe

7.18 2.0 mL amber vial

8.0 REAGENTS AND STANDARD PREPARATION

8.1 Methylene Chloride - Baxter High Purity Solvent

8.2 Powdered Sodium Sulfate

8.3 Acetone - Baxter High Purity Solvent

8.4 BNA Surrogate Solution prepared by GC/MS staff

8.5 BNA QC Check Solution prepared by GC/MS staff

8.6 BNA Matrix Spiking Solution prepared by GC/MS staff

8.7 Surrogate Standard Preparation

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8.7.1 Using a 500 uL gastight syringe, combine 500 uL of MeCl2 and 500 uL of BNA surrogate solution a 2.0 mL amber vial.

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9.0 CALIBRATION

9.1 Top loader balance is calibrated daily to +/- 0.01g.

10.0 QUALITY CONTROL

10.1 All equipment to be used is rinsed with methylene chloride.

10.2 Batch QC

10.2.1 A method blank will be extracted daily with each group of up to 20 samples.

10.2.2 A blank spike, matrix spike, and matrix spike duplicate will be extracted daily with each group of up to 20 samples. The MS/MSD samples are chosen from the samples extracted that day.

11.0 SAMPLE PREPARATION AND INSTRUMENTAL PROCEDURES

11.1 Prerinse all glassware and sonicator tips with methylene chloride.

11.2 Dry weight determination

11.2.1 Weigh an aluminum pan and record the weight in the dry weight notebook.

11.2.2 Weigh approximately 3g of the soil sample into the aluminum pan and record the weight in the dry weight notebook.

11.2.3 Place pan with sample into a drying oven set at 100C for at least 2 hours.

11.2.4 Reweigh pan with sample and record in the dry weight notebook.

11.3 Sample Extraction

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11.3.1 Place a labeled 250ml beaker onto the balance, tare the balance, weigh out approximately 30g of the sample into the beaker and record the weight on the extraction sheet.

11.3.2 Mix in 60g of powdered sodium sulfate with the sample and stir to homogenize. For the blank weigh out 60g of sodium sulfate only.

11.3.3 Add 0.5ml of BNA surrogate to all samples. Add 1.0ml of QC Spike to blank spike. Add 0.5ml of matrix spike solution to matrix spike and matrix spike duplicate samples.

11.3.4 Add 100ml of 50/50 methylene chloride/acetone to the sample and sonicate for 90 seconds with sonicator on pulse mode with output setting at 10 (maximum) and a duty cycle set at 50%.

11.3.5 Pour extract through funnel containing filter paper and 5g sodium sulfate into the K-D setup.

11.3.6 Repeat steps 11.3.4 through 11.3.5 twice more.

11.3.7 Rinse funnel down with 5ml of methylene chloride.

11.4 Sample Concentration

11.4.1 Remove funnel and place snyder column on K-D setup containing 2 carbide boiling chips.

11.4.2 Place K-D setup on steambath until approximately 3ml remain in the concentrator tube. Remove at this point and let cool for 10 minutes.

11.4.3 Disassemble K-D setup and place concentrator tube on N-Evap until final volume is at 1ml.

11.4.4 Transfer extract into a 2ml amber vial and label with parameter, sample number, extraction date, and final volume. Deliver this with completed extraction sheet to GC/MS department for screening and analysis.

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12.0 CALCULATIONS

12.1 Dry Weight Calculations

* %moisture =(dried sample weight - pan weight)/ wet sample weight x 100

* Sample dry weight = wet sample weight x % solid of sample

13.0 ACCEPTANCE OF DATA

13.1 Method blanks must not contain target analytes exceeding MDL for that specific analyte.

13.2 Surrogates and spikes must meet criteria set forth by analytical SOP's in GC/MS dept.

14.0 REPORTING OF RESULTS

N/A

15.0 SUPPLEMENTAL DOCUMENTS

N/A

16.0 REFERENCES

16.1 USEPA SW-846, 3rd Edition, Method 3550.

16.2 USEPA 40 CFR Part 136: Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, October 1984, Method 625.

16.3 USEPA SW-846, 3rd. Edition, Method 8270.

17.0 SUBSTANTIVE REVISIONS

17.1 Section 2.3 amended: Document control number changed to SPS01301.NC to reflect SOP revision. Section 5.3 amended: Monitoring changed from monthly to quarterly. Section 7.17 amdended: 1000 uL gastight syringe changed to 500 uL. Addendum: Section 7.18: 2.0 mL amber vial. Section 8.1 amended: Methylene chloride grade

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changed from Fisher Optima Grade to Baxter High Purity Solvent. Section 8.3 amended: Acetone grade changed from Fisher Optima Grade to Baxter High Purity Solvent. Addendum: Section 8.7 added to include surrogate standard preparation. Addendum: Section 8.7.1 added to detail surrogate standard preparation. Addendum to Section 10.2.2: Explains how MS/MSD samples are chosen. Amendment to 11.3.6: Repeated steps changed from 11.3.3 through 11.3.4 to 11.3.4 through 11.3.5. Amendment to 11.4.2: 1 mL changed to 3 mL. Amendment to Section 11.4.4: 2 mL vial changed to 2 mL amber vial. Addendum to Section 11.4.4: Delivery of extraction sheet to GC/MS department added. Section 11.4.5, detailing delivery of extracts to GC/MS department omitted. Section 12.1 amended: Parentheses added around dried sample weight - pan weight to clarify equation. Addendum to Section 13.2: Specifies SOP's in GC\MS department.

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ORIGINAL (Red)

METHOD 4035

SOIL SCREENING FOR POLYNUCLEAR AROMATIC HYDROCARBONS BY IMMUNOASSAY

1.0 SCOPE AND APPLICATION

1.1 Method 4035 is a procedure for screening soils to determine when polynuclear aromatic hydrocarbons (PAHs) are present at concentrations above 10 or 100 mg/Kg. Method 4035 provides an estimate for the concentration of PAHs by comparison against up to two different standards. Method 4035 uses a polyclonal antibody specific for PAH. The antibodies are manufactured by the Millipore Corporation and marketed in the EnviroGard™ PAH in Soil Test Kit. Kits and antibodies from other manufacturers with the same selectivity may be suitable for this application, however analysts must demonstrate adequate performance using other materials prior to analyzing samples.

1.2 Analytical measurements are based on competitive binding between PAH extracted from samples with a PAH-enzyme conjugate in antibody coated tubes.

1.3 A color reagent is added to each of the tubes which reacts with the bound PAH-enzyme conjugate to generate a blue color. Addition of hydrochloric acid produces a final yellow color that is monitored at 450 nm.

1.4 Because there are the same number of antibody binding sites in each tube, and the same amount of PAH-enzyme conjugate is added to each tube, the amount of color observed in individual tubes is inversely related to the amount of PAH in the sample. The negative control should have the most highly colored tube; the sample or calibrator with the highest PAH concentration should be the least colored tube.

1.5 Analysts using this kit should be experienced in biochemical and immunological techniques including the use of automatic pipettes.

1.6 Proper storage (4°C to 8°C) of the antibodies and enzyme reagents is critical to successful application of immunoassay. Kits must not be frozen or subjected to prolonged exposure to temperatures greater than 37°C. Incubations and measurements must be made at the temperature specified in the kit. (18°C - 27°C).

1.7 Some samples should also be analyzed using Method 8270 in order to confirm the measurement of PAH concentration in environmental samples.

AR303005

2.0 SUMMARY OF METHOD

2.1 A 5 g soil sample is extracted by shaking the soil for 5 minutes with 5 mL of methanol in the polyethylene jar with stainless steel ball bearings supplied with the PAH kit.

2.2 The extract is filtered and retained for analysis. Extracts may be stored at 2°C - 7°C in the dark at this stage. Extracts are diluted 1:100 in the extraction solvent prior to analysis using dilution vials supplied with the kit.

2.3 Transfer aliquots of the negative control, calibrators and diluted sample extracts to the antibody tubes. Transfer the PAH-enzyme conjugate to each tube and incubate.

2.4 Following incubation, the antibody tubes are washed to remove unbound PAH and PAH-enzyme conjugate. The enzyme substrate is added to cause the color reaction.

2.5 After reaction of the enzyme reagent, add the stop solution (1N hydrochloric acid) to fix the amount of color development.

2.6 The concentration of PAH is measured using a photometer referenced against one of the calibrator tubes. The resulting color is inversely related to the PAH concentration in the soil. The absorbance difference between the calibrators and the negative control is evaluated as part of method quality control.

3.0 INTERFERENCES

3.1 The EnviroGard PAH in Soil Test Kit will not distinguish between PAH and chemically similar compounds which might be found as soil contaminants. The data for the lower limit of detection of these compounds are provided in Table 1.

3.2 Use a new tip each time you use the micropipette to avoid cross-contamination.

4.0 APPARATUS AND MATERIALS

4.1 Balance - Capable of accurately weighing 5.0 ± 0.1 g. Acculab pocket pro model 80 or equivalent.

4.2 Stopwatch or timer.

4.3 Micropipette - Positive displacement with disposable tips, Gilson Microman model M-25 or equivalent.

4.4 Wash bottle

4.5 Photometer - Capable of reading optical density at 450 nm

4.5.1 Millipore Differential Photometer, or equivalent for screening

4.5.2 Millipore EnviroQuant Photometer, or equivalent for dual wavelength measurements.

4.6 Immunoassay test kit (EnviroGard™ PAH in Soil Test Kit, or equivalent). Supplies for calibration, method QC and sample analysis are included in each kit:

4.6.1 20-place test tube rack

4.6.2 22 Pipette tips for the Gilson Microman M-25 pipette

4.6.3 20 Antibody coated test tubes

4.6.4 18 Sample extract dilution vials.

4.7 Soil extraction kit. Supplies for the extraction of 14 soil samples are included in each kit:

4.7.1 Wooden spatulas (18)

4.7.2 Plastic weigh boats (18)

4.7.3 30 mL Extraction jars with stainless steel ball bearings (14)

4.7.4 Filtration caps with pre-filter (14)

4.7.5 Millex-HV13® filters (14)

4.7.6 4 mL Sample extract collection vials (14)

4.7.7 20 mL syringe with coupler (1)

4.8 Laboratory wipes or equivalent absorbent material.

5.0 REAGENTS

5.1 All necessary reagents with the exception of methanol are supplied in the EnviroGard test kit. These reagents must be stored according to the specification on the packaging and handled to avoid cross-contamination. They must not be diluted or adulterated using procedures not described in the product literature or this method. Do not use reagents with supplies from different test kits.

5.1.1 Vial of Assay Diluent

5.1.2 Vial of Negative Control

5.1.3 Vial of 10 ppm PAH Calibrator

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5.1.4 Vial of 100 ppm PAH Calibrator

5.1.5 Vial of PAH-Enzyme conjugate

5.1.6 Vial of Chromogenic Substrate

5.1.7 Vial of Stop Solution (1N hydrochloric acid)

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material to this chapter, Organic Analytes, Section 4.1.

6.2 Soil samples may be contaminated, and should therefore be considered hazardous and handled accordingly.

7.0 PROCEDURE

NOTE - This procedure summarizes the instructions provided with the EnviroGard PAH in Soil Test Kit. Use of the instructions provided with the commercial kit is generally preferred to the use of this summary because additional details and clarifications may be provided by the manufacturer.

7.1 Sample weighing and extraction:

7.1.1 Weigh 5.0 ± 0.1 g soil into plastic weighing boat. Quantitatively transfer the sample to an appropriately labeled 30 mL extraction jar. Wipe jar lid to remove loose soil or debris.

7.1.2 Attach a 50 mL Combitip to the repeater pipette and add 5 mL of extraction solvent to each extraction jar.

7.1.3 Cap the jar tightly. Swirl or shake vigorously for at least two minutes. Ensure that the ball bearings thoroughly mix the soil sample.

7.2 Sample preparation:

7.2.1 Remove and discard the extraction jar cap. Tightly screw a filter cap on the jar and attach a Millex filter unit to the filter cap.

7.2.2 Draw the syringe plunger to the 20 cc mark. Twist the syringe assembly onto the open end of the filter unit.

7.2.3 Push firmly down on the plunger to inject air into the extraction jar. Remove the syringe from the extraction jar and immediately invert it on top of a collection vial and let dri to collect the extract.

7.2.4 Plug the filtration unit with a filter plug and dispose of in an approved manner.

7.3 Sample dilution:

7.3.1 Label the extract dilution vials appropriately.

7.3.2 Attach a clean yellow pipette tip to the positive displacement pipette and adjust the dial to "100" to pipet 10 µL.

7.3.3 Remove 10 µL from the extract vial and transfer to the appropriate extract dilution vial. Cap the dilution vial and mix thoroughly.

7.4 Immunoassay

NOTE - Allow all reagents and sample extracts to reach room temperature before conducting the assay. This phase requires critical timing.

7.4.1 Label tubes for Negative Control (NC); 10 ppm Calibrator (C1); 100 ppm Calibrator (C2) and all samples and duplicates.

7.4.2 Place the tubes in the test tube rack so that they are held firmly.

7.4.3 Attach a 12.5 mL Combitip to the Repeat pipette and adjust the dial setting to "2". Add 500 µL of Assay Diluent to each tube.

7.4.4 Attach a clean yellow tip to the positive displacement pipette and adjust the dial setting to "100". Add 10 µL of the Negative Control and each Calibrator solution to the appropriate tube. Change the pipette tip for each solution added.

NOTE - Replace the caps on the Calibrator vials immediately after use to minimize evaporation.

7.4.5 Attach a clean yellow to the positive displacement pipette. Add 10 µL of each diluted sample extract to the appropriate tubes. Change the pipette for each sample added.

7.4.6 Attach a 5 mL Combitip to the Repeat pipette and set the dial to "2". and add 200 µL of PAR-enzyme conjugate to each tube.

7.4.7 Shake the test tube rack for 10 seconds to mix the contents. Incubate for 15 minutes.

7.4.8 At the end of the 15 minute incubation, shake out the contents of the tubes into an appropriate waste container.

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7.4.9 Place the nozzle of the wash bottle just above the top of a tube. Forcefully overfill each tube with water and invert to empty into waste container.

7.4.10 Repeat Section 7.4.9 three more times for a total of four washes.

7.4.11 Tap inverted tubes on absorbent several times to remove as much water as possible.

7.5 Color development

7.5.1 Attach a 12.5 mL Combitip to the Repeat pipette and adjust the dial setting to "2". Add 500 µL of Substrate to each tube.

7.5.2 Incubate the tubes for 5 minutes.

7.5.3 Attach a 12.5 mL Combitip to the Repeat pipette and adjust the dial setting to "2". Add 500 µL of Stop Solution to each tube.

7.6 Measurement of data

NOTE - Although the Millipore product literature describes an option for visual interpretation of data, Method 4035 requires the use of a differential photometer for RCRA applications.

7.6.1 Solutions must be measured within 30 minutes of the addition of Stop Solution.

7.6.2 Place a water blank containing 1.5 mL of water into the left reference well. Place the negative control tube into the right sample well. Record the value.

7.6.3 Place, in sequence, the 10 ppm and 100 ppm Calibrator tubes into the right sample well. Record the values.

NOTE - The Millipore EnviroQuant photometer measures the optical density (OD) at 450 nm minus the OD at 600 nm. This technique provides better quantitation of the OD but is not required for Method 4035.

7.7 Data interpretation

7.7.1 A smaller reading for a sample extract than a calibrator tube indicates that the sample extract is more concentrated than the Calibrator solution.

7.7.2 A larger reading for a sample extract than a calibrator tube indicates that the sample extract is less concentrated than the Calibrator solution.

7.7.3 If more information is required for samples which contain greater than 100 ppm, sample extracts should be diluted further and re-assayed. For example, a further 1:5 dilution changes the measurement range to 50 - 500 ppm.

8.0 QUALITY CONTROL

8.1 If the Negative Control tube does not develop color, the assay is invalid and must be repeated.

8.2 The OD values for the Negative Control and Calibrator tubes must be: Negative Control > 10 ppm Calibrator > 100 ppm Calibrator.

8.3 Do not use test kits past their expiration date.

8.4 Do not use tubes or reagents designated for use with other test kits.

8.5 Use the test kits within their specified storage temperature and operating temperature limits.

8.6 Method 4035 is intended for field or laboratory use. The appropriate level of quality assurance should accompany the application of this method to document data quality.

9.0 METHOD PERFORMANCE

9.1 Method sensitivity was determined by assaying 8 different soils which did not contain PAH greater than 1 ppm. Each of these soils was extracted in triplicate and each extract was assayed in three different assays. The mean and the standard deviation of the resulting %Bo's were calculated and the sensitivity was estimated at two standard deviations below the mean. The sensitivity for Method 4035 was determined to be 67% Bo at a 95% confidence interval. Based on the average assay response, this corresponds to 0.25 ppm total PAH. These data are shown in Table 2.

9.2 The effect of water content of the soil samples was determined by assaying three different untreated soil samples which had subsequently had water added to a final concentration of 30% (w/w). Aliquots of these samples were then fortified with PAH. Both the fortified and unfortified samples were extracted and each of these extracts were assayed three times. It was determined that water in soil up to 30% had no significant effect on the method. These data are shown in Table 3.

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9.3 The effect of the pH of the soil extract was determined by adjusting the soil pH of three soil samples. Soil samples were adjusted to pH 2 - 4 using 6N HCl and pH 10 - 12 using 6N NaOH. Aliquots of the pH adjusted soil samples were fortified with PAH and the unfortified and fortified samples were extracted. These extracts were assayed three times. It was determined that soil samples with pH ranging from 3 to 11 had no detectable effect on the performance of the method. These data are shown in Table 4.

9.4 False negative and false positive rates were estimated by fortifying eight soil samples at 20% and 200% of the action level (1 ppm). Each sample was extracted and the extracts were assayed three times. Based on this critaria, there were 4% false negatives and 8% false positives detected. These data are shown in Table 5.

9.5 For the purpose of this experiment, quantitative results were obtained using a pyrene standard curve. The method bias was estimated by fortifying three different soil samples at two levels, 0.2 and 0.8 ppm. The spike solution was a mixture of 3 PAH's equivalent in expected assay response to 85 and 340 ppb pyrene. Each fortified sample was extracted three times and each extract was assayed three times. Recovery values were calculated based on the expected assay response to the mixture of the three spiked compounds. Recovery for individual determinations ranged from 48% to 105%. Average recovery for each individual extract ranged from 68% to 83%. Overall average recovery for all samples was 76% suggesting a negative bias for the method. These data are summarized in Table 6.

9.6 A field study was conducted at a contaminated site using a commercially available test kit (EnviroGard™ PAH in Soil Test Kit, Millipore Corp.). The immunoassay was used to identify soil which had been contaminated with PAHs from creosote.

9.6.1 Four sets of field duplicates were performed by both the immunoassay and the standard method. The coefficient of variation for the standard method averaged 62%. The coefficient of variation for immunoassay operator 1 ranged from 2% to 93% and averaged 38% and for immunoassay operator 2 ranged from 0% to 47% and averaged 20%. These data demonstrate that the method is comparable in reproducibility to the standard method. These data are shown in Table 7.

9.6.2 A total of 42 samples were analyzed by both the immunoassay and the standard method. Interpretation of the results at a 100 ppm action level yielded 2.4% (1/42) false negatives and 4.8% (2/42) false positives. Interpretation of the results at a 1,000 ppm action level yielded 2.4% (1/42) false negatives and 2.4% (1/42) false positives. These data are shown in Table 8.

TABLE 1 (PAGE 1)
CROSS REACTIVITY OF DIFFERENT COMPOUNDS

Compound	Concentration (ppm) Required for Positive Interpretation at 1 ppm
Acenaphthene	3.7
Acenaphthylene	2.4
Anthracene	7.6
Benzo(a)anthracene	4.9
Benzo(b)fluoranthene	2.7
Benzo(k)fluoranthene	6.2
Benzo(ghi)perylene	5.3
Benzo(a)pyrene	0.8
Chrysene	4.3
Dibenz(ah)anthracene	356
Fluorene	3.4
Fluoranthene	0.3
Indeno(123cd)pyrene	6.5
Naphthalene	40
Phenanthrene	0.9
Pyrene	0.2
Biphenyl	250

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TABLE 1 (PAGE 2)
CROSS REACTIVITY OF DIFFERENT COMPOUNDS

Creosote	3.5
Diesel Fuel	75
Home Heating Oil	80
Gasoline	1000
BTEX	>300
pentachlorophenol	>1000
#2 fuel oil	150
#6 fuel oil	150
Bunker C oil	125
crude oil	800
new motor oil	>1000
hydraulic oil	>1000
K-1 kerosene	500
mineral oil	>1000
Aroclor 1242	>200
Aroclor 1248	>200
Aroclor 1254	>200
Aroclor 1260	>200

TABLE 2
METHOD SENSITIVITY

Sensitivity of the method to detect PAH in soil samples was determined by establishing the "noise" level expected from matrix effects encountered in negative soil samples and determining the corresponding PAH concentration by comparison to the analyte-specific response curve.

Part 1 - Average Response with Negative Soils

Soil#	Soil Type	Average %Bo (n = 9)	Standard Deviation
S1	LOAM	71.7	2.4
S2	CLAY*	33.5	4.4
S3	SAND	85.9	10.1
S4	LOAM	81.1	2.7
S5	SAND	88.6	2.7
S6	CLAY	87.3	4.4
S7	LOAM/SAND	95.1	1.7
S8	SAND/LOAM	93.0	1.1
AVERAGE		79.5	6.4

Part 2 - Average Response with PAH Calibrators

PAH Calibrator Level	Average Absorbance	Average %Bo
0 ppm	1.098	N/A
0.156	0.835	76.4
0.625	0.508	46.5
2.5	0.280	25.5
10.0	0.250	22.8

Part 3 - Method Sensitivity

Based on Part 1 and Part 2 Above:

Average %Bo - 2 SD = 67%Bo which is equivalent to 0.25 ppm total PAH

Average %Bo - 3 SD = 60%Bo which is equivalent to 0.35 ppm total PAH

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TABLE 3

EFFECT OF WATER CONTENT IN SOIL SAMPLES

Each soil sample was assayed with and without added water (30% w/w) and with and without PAH fortification. It was determined that water content up to 30% had no deleterious effect on the immunoassay.

Soil	% Water	Fortified?	Rep. 1	Rep. 2	Rep. 3	Mean	Std. Dev.	± 2 SD Range
S1	15	No	60.5	57.0	55.1	57.5	2.7	52.1 - 63.0
S1	30	No	78.0	88.8	80.5	82.4	5.6	71.2 - 93.7
S1	15	Yes	25.4	29.7	23.2	26.1	3.3	19.5 - 32.8
S1	30	Yes	39.5	53.5	29.0	40.7	12.3	16.1 - 65.3
S2	2	No	77.5	84.0	89.3	83.6	5.9	71.8 - 95.4
S2	30	No	83.1	89.1	91.1	87.8	4.2	79.4 - 96.1
S2	2	Yes	27.1	26.6	23.8	25.9	1.8	22.3 - 29.4
S2	30	Yes	44.9	41.1	33.7	39.9	5.7	28.5 - 51.4
S3	7	No	89.0	107.1	109.7	101.9	11.3	79.4 - [illegible]
S3	30	No	108.6	107.4	103.7	106.5	2.5	101.5 - [illegible]
S3	7	Yes	26.3	27.6	23.4	25.8	2.1	21.5 - 30.1
S3	30	Yes	41.1	43.9	34.7	39.9	4.7	30.5 - 49.3

TABLE 4
EFFECT OF pH OF SOIL SAMPLES

Each soil sample was as assayed unadjusted and with pH adjusted to 2-4 and 10-12 and both unfortified and fortified with PAH. It was determined that sample pH in the range of 3 to 11 had no deleterious effect on the assay.

Soil	pH Adj.	Fortified?	Rep. 1[1]	Rep. 2	Rep. 3	Mean	Std. Dev.	± 2 SD Range
S1	None	No	80.2	71.4	69.0	73.5	5.9	61.7 - 85.3
S1	Acidic	No	70.6	62.8	79.0	70.8	8.1	54.6 - 87.0
S1	Basic	No	69.3	60.4	67.3	65.7	4.7	56.3 - 75.1
S1	None	Yes	46.8	41.9	47.6	45.5	3.1	39.3 - 51.7
S1	Acidic	Yes	49.0	44.2	47.8	47.0	2.5	42.0 - 52.0
S1	Basic	Yes	39.1	41.8	40.8	40.6	1.3	38.0 - 43.2
S2	None	No	71.3	84.7	93.3	83.1	11.1	60.9 - 105
S2	Acidic	No	96.5	90.4	89.6	92.2	3.8	84.6 - 99.8
S2	Basic	No	76.1	81.9	78.4	78.8	2.9	73.0 - 84.6
S2	None	Yes	38.9	35.5	40.1	38.2	2.4	33.4 - 43.0
S2	Acidic[2]	Yes	60.2	64.6	63.9	62.9	2.3	58.3 - 67.5
S2	Basic	Yes	36.1	40.3	37.7	38.0	2.1	33.8 - 42.2
S3	None	No	93.1	86.5	95.7	91.8	4.7	82.4 - 101
S3	Acidic	No	82.2	91.3	96.0	89.8	7.0	75.8 - 104
S3	Basic	No	91.8	96.4	89.8	92.7	3.4	85.9 - 99.5
S3	None	Yes	41.0	41.9	37.1	40.0	2.3	35.0 - 45.0
S3	Acidic	Yes	46.4	47.6	51.4	48.3	2.6	43.3 - 53.7
S3	Basic	Yes	37.2	39.3	51.5	42.6	7.7	27.2 - 58.0

1) All values shown are %Bo (= $(OD_{sample}/OD_{negative\ control})\times100$)
2) Significant gas generated upon acidification, results questionable

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TABLE 5 (PAGE 1)
FALSE NEGATIVE AND FALSE POSITIVE RATES

Eight soil samples were fortified with PCB at 20% (0.2 ppm) and 200% (2.0 ppm) of the action level (1.0 ppm). Each sample was extracted and the extracts assayed three times. Based on this criteria, there were 2% false negatives and 4% false positives.

ASSAY #1

Soil#	Fortification (ppm)	Theoretical Result	Absorbance (OD450)	Interpretation	Agrees With Theoretical
Control	1.0	N/A	0.240	N/A	N/A
S1	0.2	Negative	0.338	Negative	Yes
S1	2.0	Positive	0.165	Positive	Yes
S2	0.2	Negative	0.211	Positive	No
S2	2.0	Positive	0.204	Positive	Yes
S3	0.2	Negative	0.591	Negative	Yes
S3	2.0	Positive	0.267	Negative	No
S4	0.2	Negative	0.453	Negative	Yes
S4	2.0	Positive	0.209	Positive	Yes
S5	0.2	Negative	0.421	Negative	Yes
S5	2.0	Positive	0.236	Positive	Yes
S6	0.2	Negative	0.460	Negative	Yes
S6	2.0	Positive	0.177	Positive	Yes
S7	0.2	Negative	0.450	Negative	Yes
S7	2.0	Positive	0.186	Positive	Yes
S8	0.2	Negative	0.563	Negative	Yes
S8	2.0	Positive	0.236	Positive	Yes

ASSAY #2

Soil#	Fortification (ppm)	Theoretical Result	Absorbance (OD450)	Interpretation	Agrees With Theoretical
Control	1.0	N/A	0.309	N/A	N/A
S1	0.2	Negative	0.402	Negative	Yes
S1	2.0	Positive	0.213	Positive	Yes
S2	0.2	Negative	0.275	Positive	No
S2	2.0	Positive	0.254	Positive	Yes
S3	0.2	Negative	0.650	Negative	Yes
S3	2.0	Positive	0.305	Positive	Yes
S4	0.2	Negative	0.512	Negative	Yes
S4	2.0	Positive	0.243	Positive	Yes
S5	0.2	Negative	0.484	Negative	Yes
S5	2.0	Positive	0.227	Positive	Yes
S6	0.2	Negative	0.468	Negative	Yes
S6	2.0	Positive	0.229	Positive	Yes
S7	0.2	Negative	0.460	Negative	Yes
S7	2.0	Positive	0.211	Positive	Yes
S8	0.2	Negative	0.681	Negative	Yes
S8	2.0	Positive	0.251	Positive	Yes

TABLE 5 (PAGE 2)
FALSE NEGATIVE AND FALSE POSITIVE RATE

ASSAY #3

Soil#	Fortification (ppm)	Theoretical Result	Absorbance (OD450)	Interpretation	Agrees With Theoretical
Control	1.0	N/A	0.255	N/A	N/A
S1	0.2	Negative	0.452	Negative	Yes
S1	2.0	Positive	0.135	Positive	Yes
S2	0.2	Negative	0.260	Negative	Yes
S2	2.0	Positive	0.199	Positive	Yes
S3	0.2	Negative	0.577	Negative	Yes
S3	2.0	Positive	0.192	Positive	Yes
S4	0.2	Negative	0.437	Negative	Yes
S4	2.0	Positive	0.137	Positive	Yes
S5	0.2	Negative	0.408	Negative	Yes
S5	2.0	Positive	0.183	Positive	Yes
S6	0.2	Negative	0.449	Negative	Yes
S6	2.0	Positive	0.235	Positive	Yes
S7	0.2	Negative	0.438	Negative	Yes
S7	2.0	Positive	0.198	Positive	Yes
S8	0.2	Negative	0.583	Negative	Yes
S8	2.0	Positive	0.238	Positive	Yes

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TABLE 6
METHOD BIAS

Three aliquots each of three soil samples were fortified with PAH at 86 and 340 ppm. The soils were extracted and assayed and the quantitative PAH concentration was estimated by interpolation.

Soil#	Fortification(ppb)*	Extraction#	Recovered(ppb)*	% Recovery
S1	86	1	78	90
S1	86	2	61	71
S1	86	3	90	105
S1	340	1	250	74
S1	340	2	275	81
S1	340	3	268	79
Average	>>			83
S2	86	1	60	70
S2	86	2	63	73
S2	86	3	65	75
S2	340	1	277	82
S2	340	2	241	71
S2	340	3	296	87
Average	>>			76
S3	86	1	42	48
S3	86	2	55	64
S3	86	3	43	50
S3	340	1	286	84
S3	340	2	263	77
S3	340	3	288	85
Average	>>			68

Overall Average %Recovery = 76

* For the purpose of this comparison, quantitative values were calculated for the immunoassay. Concentrations given are expected or actual responses relative to pyrene.

TABLE 7
FIELD DUPLICATES
(ALL VALUES PPM TOTAL PAH)

Four of the field samples were run as field duplicates in both Method 8270 and the immunoassay.

	Sample ID			
	HAB-1 02	HAB-4 01	HAB-12 02	HAB-28 03
Method 8270				
Field Duplicate #1	297	12.6	550	296
Field Duplicate #2	198	66.3	162	148
Average	248	39.4	356	222
Standard Deviation	70	38.0	274	105
% Coefficient of Variation	28	96	77	47
Immunoassay*				
Field Duplicate #1	129	20	610	298
Field Duplicate #2	133	95	294	271
Average	131	58	452	284
Standard Deviation	3	53	223	19
% Coefficient of Variation	2	92	49	7

* For the purpose of this comparison, quantitative values were calculated for the immunoassay.

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TABLE 8 (PAGE 1)
IMMUNOASSAY COMPARED TO METHOD 8270
(ALL VALUES PPM TOTAL PAH)

Interpretation at 100 ppm

Sample ID	Method 8270	Immunoassay	Agreed?
DRB-1 01	470	POSITIVE	YES
DRB-1 02	1,700	POSITIVE	YES
DRB-1 03	410	POSITIVE	YES
DRB-1 04	1,800	POSITIVE	YES
DRB-1 05	30	NEGATIVE	YES
DRB-1 06	8.7	NEGATIVE	YES
HAB-D3 03	270	POSITIVE	YES
HAB-1 02	297	POSITIVE	YES
HAB-1 02D	198	POSITIVE	YES
HAB-2 07	270	POSITIVE	YES
HAB-3 04	180	POSITIVE	YES
HAB-3 06	2400	POSITIVE	YES
HAB-3 08	840	POSITIVE	YES
HAB-4 01	12.6	NEGATIVE	YES
HAB-4 01D	66.3	NEGATIVE	YES
HAB-5 00	140	POSITIVE	YES
HAB-5 02	740	POSITIVE	YES
HAB-6 04	630	POSITIVE	YES
HAB-7 05	53	NEGATIVE	YES
HAB-7 09	5.0	NEGATIVE	YES
HAB-8 02	190	POSITIVE	YES
HAB-8 06	20	NEGATIVE	YES
HAB-10 04	170	POSITIVE	YES
HAB-10 08	12	NEGATIVE	YES
HAB-11 03	230	POSITIVE	YES
HAB-11 09	340	POSITIVE	YES
HAB-12 02	550	POSITIVE	YES
HAB-12 02D	162	POSITIVE	YES
HAB-14 06	110	NEGATIVE	FALSE NEGATIVE
HAB-14 08	1100	POSITIVE	YES
HAB-15 09	3800	POSITIVE	YES
HAB-17 02	870	POSITIVE	YES
HAB-18 03	340	POSITIVE	YES
HAB-18 09	70	NEGATIVE	YES
HAB-21 00	300	POSITIVE	YES
HAB-22 05	430	POSITIVE	YES
HAB-22 07	75	POSITIVE	FALSE POSITIVE
HAB-22 09	25	NEGATIVE	YES
HAB-24 09	18	NEGATIVE	YES
HAB-25 00	5.2	NEGATIVE	YES
HAB-28 03	296	POSITIVE	YES
HAB-28 03D	148	POSITIVE	YES

TABLE 8 (PAGE 2)
IMMUNOASSAY COMPARED TO METHOD 8270
(ALL VALUES PPM TOTAL PAH)

Interpretation at 1,000 ppm

Sample ID	Method 8270	Immunoassay	Agreed?
DRB-1 01	470	NEGATIVE	YES
DRB-1 02	1,700	POSITIVE	YES
DRB-1 03	410	NEGATIVE	YES
DRB-1 04	1,800	POSITIVE	YES
DRB-1 05	30	NEGATIVE	YES
DRB-1 06	8.7	NEGATIVE	YES
HAB-D3 03	270	NEGATIVE	YES
HAB-1 02	297	NEGATIVE	YES
HAB-1 02D	198	NEGATIVE	YES
HAB-2 07	270	NEGATIVE	YES
HAB-3 04	180	NEGATIVE	YES
HAB-3 05	2400	POSITIVE	YES
HAB-3 08	840	POSITIVE	FALSE POSITIVE
HAB-4 01	12.6	NEGATIVE	YES
HAB-4 01D	66.3	NEGATIVE	YES
HAB-5 00	140	NEGATIVE	YES
HAB-5 02	740	NEGATIVE	YES
HAB-6 04	630	NEGATIVE	YES
HAB-7 05	53	NEGATIVE	YES
HAB-7 09	5.0	NEGATIVE	YES
HAB-8 02	190	NEGATIVE	YES
HAB-8 06	20	NEGATIVE	YES
HAB-10 04	170	NEGATIVE	YES
HAB-10 08	12	NEGATIVE	YES
HAB-11 03	230	NEGATIVE	YES
HAB-11 09	340	NEGATIVE	YES
HAB-12 02	550	NEGATIVE	YES
HAB-12 02D	162	NEGATIVE	YES
HAB-14 06	110	NEGATIVE	YES
HAB-14 08	1100	POSITIVE	YES
HAB-15 09	3800	NEGATIVE	FALSE NEGATIVE
HAB-17 02	870	NEGATIVE	YES
HAB-18 03	340	NEGATIVE	YES
HAB-18 09	70	NEGATIVE	YES
HAB-21 00	300	NEGATIVE	YES
HAB-22 05	430	POSITIVE	FALSE POSITIVE
HAB-22 07	75	NEGATIVE	YES
HAB-22 09	25	NEGATIVE	YES
HAB-24 09	18	NEGATIVE	YES
HAB-25 00	5.2	NEGATIVE	YES
HAB-28 03	296	NEGATIVE	YES
HAB-28 03D	148	NEGATIVE	YES

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TABLE 8 (PAGE 3)
IMMUNOASSAY COMPARED TO METHOD 8270

Field Performance Summary

I) For 100 ppm action level interpretation:

Specificity = {1-(Reported Positives/True Negatives)}
= {1-(1/13)} = 92%

Sensitivity = {1-(Reported Negatives/True Positives)}
= {1-(1/29)} = 97%

II) For 1,000 ppm action level interpretation:

Specificity = {1-(Reported Positives/True Negatives)}
= {1-(2/37)} = 95%

Sensitivity = {1-(Reported Negatives/True Positives)}
= {1-(1/5)} = 80%

METHOD 6010

INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROSCOPY

1.0 SCOPE AND APPLICATION

1.1 Inductively coupled plasma atomic emission spectroscopy (ICP) determines elements including metals in solution. The method is applicable to a large number of metals and wastes. All matrices, including ground water, aqueous samples, EP extracts, industrial wastes, soils, sludges, sediments, and other solid wastes, require digestion prior to analysis.

1.2 Elements for which Method 6010 is applicable are listed in Table 1. Detection limits, sensitivity, and optimum ranges of the metals will vary with the matrices and model of spectrometer. The data shown in Table 1 provide concentration ranges for clean aqueous samples. Use of this method is restricted to spectroscopists who are knowledgeable in the correction of spectral, chemical, and physical interferences.

1.3 The method of standard addition (MSA) (Paragraph 8.5.3) shall be used for the analysis of all EP extracts and sample digests unless either serial dilution or matrix spike addition demonstrates that it is not required.

2.0 SUMMARY OF METHOD

2.1 Prior to analysis, samples must be solubilized or digested using appropriate Sample Preparation Methods (e.g., Methods 3005-3050).

2.2 Method 6010 describes the simultaneous, or sequential, multielemental determination of elements by ICP. The method measures element-emitted light by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the lines are monitored by photomultiplier tubes. Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interference and reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Section 3.0 should also be recognized and appropriate corrections made; tests for their presence are described in Section 8.5.

TABLE 1. RECOMMENDED WAVELENGTHS AND ESTIMATED INSTRUMENTAL DETECTION LIMITS

Element	Wavelength[a] (nm)	Estimated Detection Limit[b] (ug/L)
Aluminum	308.215	45
Antimony	206.833	32
Arsenic	193.696	53
Barium	455.403	2
Beryllium	313.042	0.3
Boron	249.773	5
Cadmium	226.502	4
Calcium	317.933	10
Chromium	267.716	7
Cobalt	228.616	7
Copper	324.754	6
Iron	259.940	7
Lead	220.353	42
Magnesium	279.079	30
Manganese	257.610	2
Molybdenum	202.030	8
Nickel	231.604	15
Potassium	766.491	See note c
Selenium	196.026	75
Silicon	288.158	58
Silver	328.068	7
Sodium	588.995	29
Thallium	190.864	40
Vanadium	292.402	8
Zinc	213.856	2

[a]The wavelengths listed are recommended because of their sensitivity and overall acceptance. Other wavelengths may be substituted if they can provide the needed sensitivity and are treated with the same corrective techniques for spectral interference (see Paragraph 3.1). In time, other elements may be added as more information becomes available and as required.

[b]The estimated instrumental detection limits shown are taken from Reference 1 in Section 10.0 below. They are given as a guide for an instrumental limit. The actual method detection limits are sample dependent and may vary as the sample matrix varies.

[c]Highly dependent on operating conditions and plasma position.

3.0 INTERFERENCES

3.1 Spectral interferences are caused by: (1) overlap of a spectral line from another element; (2) unresolved overlap of molecular band spectra; (3) background contribution from continuous or recombination phenomena; and (4) stray light from the line emission of high-concentration elements. Spectral overlap can be compensated for by computer-correcting the raw data after monitoring and measuring the interfering element. Unresolved overlap requires selection of an alternate wavelength. Background contribution and stray light can usually be compensated for by a background correction adjacent to the analyte line.

Users of simultaneous multielement instruments must verify the absence of spectral interference from an element in a sample for which there is no instrument detection channel. Potential spectral interferences for the recommended wavelengths are given in Table 2. The data in Table 2 are intended as rudimentary guides for indicating potential interferences; for this purpose, linear relations between concentration and intensity for the analytes and the interferents can be assumed.

3.1.1 The interference is expressed as analyte concentration equivalents (i.e., false analyte concentrations) arising from 100 mg/L of the interference element. For example, assume that As is to be determined (at 193.696 nm) in a sample containing approximately 10 mg/L of Al. According to Table 2, 100 mg/L of Al would yield a false signal for As equivalent to approximately 1.3 mg/L. Therefore, the presence of 10 mg/L of Al would result in a false signal for As equivalent to approximately 0.13 mg/L. The user is cautioned that other instruments may exhibit somewhat different levels of interference than those shown in Table 2. The interference effects must be evaluated for each individual instrument since the intensities will vary with operating conditions, power, viewing height, argon flow rate, etc.

3.1.2 The dashes in Table 2 indicate that no measurable interferences were observed even at higher interferent concentrations. Generally, interferences were discernible if they produced peaks, or background shifts, corresponding to 2 to 5% of the peaks generated by the analyte concentrations.

3.1.3 At present, information on the listed silver and potassium wavelengths is not available, but it has been reported that second-order energy from the magnesium 383.231-nm wavelength interferes with the listed potassium line at 766.491 nm.

3.2 Physical interferences are effects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by diluting the sample, by using a peristaltic pump or by using the standard additions method. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, which affects aerosol flow rate and causes instrumental drift. The problem can be controlled by wetting the argon prior to nebulization, using a

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TABLE 2. ANALYTE CONCENTRATION EQUIVALENTS ARISING FROM INTERFERENCE AT THE 100-mg/L LEVEL

Analyte	Wavelength (nm)	Interferent[a,b]									
		Al	Ca	Cr	Cu	Fe	Mg	Mn	Ni	Tl	V
Aluminum	308.215	—	—	—	—	—	—	0.21	—	—	1.4
Antimony	206.833	0.47	—	2.9	—	0.08	—	—	—	0.25	0.45
Arsenic	193.696	1.3	—	0.44	—	—	—	—	—	—	1.1
Barium	455.403	—	—	—	—	—	—	—	—	—	—
Beryllium	313.042	—	—	—	—	—	—	—	—	0.04	0.05
Boron	249.773	0.04	—	—	—	0.32	—	—	—	—	—
Cadmium	226.502	—	—	—	—	0.03	—	—	0.02	—	—
Calcium	317.933	—	—	0.08	—	0.01	0.01	0.04	—	0.03	0.03
Chromium	267.716	—	—	—	—	0.003	—	0.04	—	—	0.04
Cobalt	228.616	—	—	0.03	—	0.005	—	—	0.03	0.15	—
Copper	324.754	—	—	—	—	0.003	—	—	—	0.05	0.02
Iron	259.940	—	—	—	—	—	—	0.12	—	—	—
Lead	220.353	0.17	—	—	—	—	—	—	—	—	—
Magnesium	279.079	—	0.02	0.11	—	0.13	—	0.25	—	0.07	0.12
Manganese	257.610	0.005	—	0.01	—	0.002	0.002	—	—	—	—
Molybdenum	202.030	0.05	—	—	—	0.03	—	—	—	—	—
Nickel	231.604	—	—	—	—	—	—	—	—	—	—
Selenium	196.026	0.23	—	—	—	0.09	—	—	—	—	—
Silicon	288.158	—	—	0.07	—	—	—	—	—	—	0.01
Sodium	588.995	—	—	—	—	—	—	—	—	0.08	—
Thallium	190.864	0.30	—	—	—	—	—	—	—	—	—
Vanadium	292.402	—	—	0.05	—	0.005	—	—	—	0.02	—
Zinc	213.856	—	—	—	0.14	—	—	—	0.29	—	—

[a]Dashes indicate that no interference was observed even when interferents were introduced at the following levels:

Al - 1000 mg/L,
Ca - 1000 mg/L,
Cr - 200 mg/L,
Cu - 200 mg/L
Fe - 1000 mg/L
Mg - 1000 mg/L,
Mn - 200 mg/L,
Tl - 200 mg/L,
V - 200 mg/L

[b]The figures recorded as analyte concentrations are not the actual observed concentrations; to obtain those figures, add the listed concentration to the interferent figure.

tip washer, or diluting the sample. Also, it has been reported that better control of the argon flow rate improves instrument performance; this is accomplished with the use of mass flow controllers.

3.3 Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique. If observed, they can be minimized by careful selection of operating conditions (incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. Chemical interferences are highly dependent on matrix type and the specific analyte element.

4.0 APPARATUS AND MATERIALS

4.1 Inductively coupled argon plasma emission spectrometer:

4.1.1 Computer-controlled emission spectrometer with background correction.

4.1.2 Radio frequency generator.

4.1.3 Argon gas supply: Welding grade or better.

4.2 Operating conditions: The analyst should follow the instructions provided by the instrument's manufacturer. For operation with organic solvents, use of the auxiliary argon inlet is recommended, as are solvent-resistant tubing, increased plasma (coolant) argon flow, decreased nebulizer flow, and increased RF power to obtain stable operation and precise measurements. Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be established for each individual analyte line on that particular instrument. All measurements must be within instrument linear range where coordination factors are valid. The analyst must (1) verify that the instrument configuration and operating conditions satisfy the analytical requirements and (2) maintain quality control data confirming instrument performance and analytical results.

5.0 REAGENTS

5.1 Acids used in the preparation of standards and for sample processing must be reagent grade or better. Redistilled acids may be used.

5.1.1 Concentrated hydrochloric acid (HCl).

5.1.2 Hydrochloric acid (1:1): Add 500 mL concentrated HCl to 400 mL Type II water and dilute to 1 liter.

5.1.3 Concentrated nitric acid (HNO_3).

5.1.4 Nitric acid (1:1): Add 500 mL concentrated HNO_3 to 400 mL Type II water and dilute to 1 liter.

5.2 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.3 Standard stock solutions may be purchased or prepared from ultra-high purity grade chemicals or metals (99.99 to 99.999% pure). All salts must be dried for 1 hr at 105°C, unless otherwise specified.

(CAUTION: Many metal salts are extremely toxic if inhaled or swallowed. Wash hands thoroughly after handling.)

Typical stock solution preparation procedures follow. Concentrations are calculated based upon the weight of pure metal added, or with the use of the mole fraction and the weight of the metal salt added.

Metal

$$\text{Concentration (ppm)} = \frac{\text{weight (mg)}}{\text{volume (L)}}$$

Metal salts

$$\text{Concentration (ppm)} = \frac{\text{weight (mg)} \times \text{mole fraction}}{\text{volume (L)}}$$

5.3.1 Aluminum solution, stock, 1 mL = 100 ug Al: Dissolve 0.10 g of aluminum metal, weighed accurately to at least four significant figures, in an acid mixture of 4 mL of (1:1) HCl and 1 mL of concentrated HNO_3 in a beaker. Warm gently to effect solution. When solution is complete, transfer quantitatively to a liter flask, add an additional 10 mL of (1:1) HCl and dilute to 1,000 mL with Type II water.

5.3.2 Antimony solution, stock, 1 mL = 100 ug Sb: Dissolve 0.27 g $K(SbO)C_4H_4O_6$ (mole fraction Sb = 0.3749), weighed accurately to at least four significant figures, in Type II water, add 10 mL (1:1) HCl, and dilute to 1,000 mL with Type II water.

5.3.3 Arsenic solution, stock, 1 mL = 100 ug As: Dissolve 0.13 g of As_2O_3 (mole fraction As = 0.7574), weighed accurately to at least four significant figures, in 100 mL of Type II water containing 0.4 g NaOH. Acidify the solution with 2 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.4 Barium solution, stock, 1 mL = 100 ug Ba: Dissolve 0.15 g $BaCl_2$ (mole fraction Ba = 0.6595), dried at 250°C for 2 hr, weighed accurately to at least four significant figures, in 10 mL Type II water with 1 mL (1:1) HCl. Add 10.0 mL (1:1) HCl and dilute to 1,000 mL with Type II water.

5.3.5 Beryllium solution, stock, 1 mL = 100 ug Be: Do not dry. Dissolve 1.97 g $BeSO_4 \cdot 4H_2O$ (mole fraction Be = 0.0509), weighed accurately to at least four significant figures, in Type II water, add 10.0 ml concentrated HNO_3, and dilute to 1,000 mL with Type II water. Mole fraction = 0.0509.

5.3.6 **Boron solution**, stock 1 mL = 100 ug B: Do not dry. Dissolve 0.57 g anhydrous H_3BO_3 (mole fraction B = 0.1748), weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL. Use a reagent meeting ACS specifications, keep the bottle tightly stoppered, and store in a desiccator to prevent the entrance of atmospheric moisture.

5.3.7 **Cadmium solution**, stock, 1 mL = 100 ug Cd: Dissolve 0.11 g CdO (mole fraction Cd = 0.8754), weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Heat to increase rate of dissolution. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.8 **Calcium solution**, stock, 1 mL = 100 ug Ca: Suspend 0.25 g $CaCO_3$ (mole Ca fraction = 0.4005), dried at 180°C for 1 hr before weighing, weighed accurately to at least four significant figures, in Type II water and dissolve cautiously with a minimum amount of (1:1) HNO_3. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.9 **Chromium solution**, stock, 1 mL = 100 ug Cr: Dissolve 0.19 g CrO_3 (mole fraction Cr = 0.5200), weighed accurately to at least four significant figures, in Type II water. When solution is complete, acidify with 10 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.10 **Cobalt solution**, stock, 1 mL = 100 ug Co: Dissolve 0.1000 g of cobalt metal, weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Add 10.0 mL (1:1) HCl and dilute to 1,000 mL with Type II water.

5.3.11 **Copper solution**, stock, 1 mL = 100 ug Cu: Dissolve 0.13 g CuO (mole fraction Cu = 0.7989), weighed accurately to at least four significant figures), in a minimum amount of (1:1) HNO_3. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.12 **Iron solution**, stock, 1 mL = 100 ug Fe: Dissolve 0.14 g Fe_2O_3 (mole fraction Fe = 0.6994), weighed accurately to at least four significant figures, in a warm mixture of 20 mL (1:1) HCl and 2 mL of concentrated HNO_3. Cool, add an additional 5.0 mL of concentrated HNO_3, and dilute to 1,000 mL with Type II water.

5.3.13 **Lead solution**, stock, 1 mL = 100 ug Pb: Dissolve 0.16 g $Pb(NO_3)_2$ (mole fraction Pb = 0.6256), weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Add 10 mL (1:1) HNO_3 and dilute to 1,000 mL with Type II water.

5.3.14 **Magnesium solution**, stock, 1 mL = 100 ug Mg: Dissolve 0.17 g MgO (mole fraction Mg = 0.6030), weighed accurately to at least four significant figures, in a minimum amount of (1:1) HNO_3. Add 10.0 mL (1:1) concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.15 **Manganese solution**, stock, 1 mL = 100 ug Mn: Dissolve 0.1000 g of manganese metal, weighed accurately to at least four significant figures, in acid mixture (10 mL concentrated HCl and 1 mL concentrated HNO_3) and dilute to 1,000 mL with Type II water.

5.3.16 **Molybdenum solution**, stock, 1 mL = 100 ug Mo: Dissolve 0.20 g $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ (mole fraction Mo = 0.5772), weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL with Type II water.

5.3.17 **Nickel solution**, stock, 1 mL = 100 ug Ni: Dissolve 0.1000 g of nickel metal, weighed accurately to at least four significant figures, in 10.0 mL hot concentrated HNO_3, cool, and dilute to 1,000 mL with Type II water.

5.3.18 **Potassium solution**, stock, 1 mL = 100 ug K: Dissolve 0.19 g KCl (mole fraction K = 0.5244) dried at 110°C, weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL.

5.3.19 **Selenium solution**, stock, 1 mL = 100 ug Se: Do not dry. Dissolve 0.17 g H_2SeO_3 (mole fraction Se = 0.6123), weighed accurately to at least four significant figures, in Type II water and dilute to 1,000 mL.

5.3.20 **Silica solution**, stock, 1 mL = 100 ug SiO_2: Do not dry. Dissolve 0.47 g $Na_2SiO_3\cdot 9H_2O$ (mole fraction Si = 0.09884), weighed accurately to at least four significant figures, in Type II water. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.21 **Silver solution**, stock, 1 mL = 100 ug Ag: Dissolve 0.16 g $AgNO_3$ (mole fraction Ag = 0.6350), weighed accurately to at least four significant figures, in Type II water and 10 mL concentrated HNO_3. Dilute to 1,000 mL with Type II water.

5.3.22 **Sodium solution**, stock, 1 mL = 100 ug Na: Dissolve 0.25 g NaCl (mole fraction Na = 0.3934), weighed accurately to at least four significant figures, in Type II water. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.23 **Thallium solution**, stock, 1 mL = 100 ug Tl: Dissolve 0.13 g $TlNO_3$ (mole fraction Tl = 0.7672), weighed accurately to at least four significant figures, in Type II water. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.24 **Vanadium solution**, stock, 1 mL = 100 ug V: Dissolve 0.23 g NH_4VO_3 (mole fraction V = 0.4356), weighed accurately to at least four significant figures, in a minimum amount of concentrated HNO_3. Heat to increase rate of dissolution. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.3.25 **Zinc solution**, stock, 1 mL = 100 ug Zn: Dissolve 0.12 g ZnO (mole fraction Zn = 0.8034), weighed accurately to at least four significant figures, in a minimum amount of dilute HNO_3. Add 10.0 mL concentrated HNO_3 and dilute to 1,000 mL with Type II water.

5.4 Mixed calibration standard solutions: Prepare mixed calibration standard solutions by combining appropriate volumes of the stock solutions in volumetric flasks (see Table 3). Add 2 mL (1:1) HNO_3 and 10 mL of (1:1) HCl and dilute to 100 mL with Type II water (see NOTE, below). Prior to preparing the mixed standards, each stock solution should be analyzed separately to determine possible spectral interference or the presence of impurities. Care should be taken when preparing the mixed standards to ensure that the elements are compatible and stable together. Transfer the mixed standard solutions to FEP fluorocarbon or previously unused polyethylene or polypropylene bottles for storage. Fresh mixed standards should be prepared, as needed, with the realization that concentration can change on aging. Calibration standards must be initially verified using a quality control sample (see Paragraph 5.8) and monitored weekly for stability. Some typical calibration standard combinations are listed in Table 3. All mixtures should then be scanned using a sequential spectrometer to verify the absence of interelement spectral interference in the recommended mixed standard solutions.

NOTE: If the addition of silver to the recommended acid combination results in an initial precipitation, add 15 mL of Type II water and warm the flask until the solution clears. Cool and dilute to 100 mL with Type II water. For this acid combination, the silver concentration should be limited to 2 mg/L. Silver under these conditions is stable in a tap-water matrix for 30 days. Higher concentrations of silver require additional HCl.

TABLE 3. MIXED STANDARD SOLUTIONS

Solution	Elements
I	Be, Cd, Mn, Pb, Se and Zn
II	Ba, Co, Cu, Fe, and V
III	As, Mo, and Si
IV	Al, Ca, Cr, K, Na, and Ni
V	Ag (see Note to Paragraph 5.4), B, Mg, Sb, and Tl

5.5 Two types of blanks are required for the analysis. The calibration blank is used in establishing the analytical curve, and the reagent blank is used to correct for possible contamination resulting from varying amounts of the acids used in the sample processing.

5.5.1 The calibration blank is prepared by diluting 2 mL of (1:1) HNO_3 and 10 mL of (1:1) HCl to 100 mL with Type II water. Prepare a sufficient quantity to flush the system between standards and samples.

5.5.2 The reagent blank must contain all the reagents and in the same volumes as used in the processing of the samples. The reagent blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis.

5.6 The instrument check standard is prepared by the analyst by combining compatible elements at concentrations equivalent to the midpoint of their respective calibration curves (see Paragraph 8.6.2.1 for use).

5.7 The interference check solution is prepared to contain known concentrations of interfering elements that will provide an adequate test of the correction factors. Spike the sample with the elements of interest at approximate concentrations of 10 times the instrumental detection limits. In the absence of measurable analyte, overcorrection could go undetected because a negative value could be reported as zero. If the particular instrument will display overcorrection as a negative number, this spiking procedure will not be necessary.

5.8 The quality control sample should be prepared in the same acid matrix as the calibration standards at 10 times the instrumental detection limits and in accordance with the instructions provided by the supplier.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material in Chapter Three, Inorganic Analytes, Sections 3.1 through 3.3.

7.0 PROCEDURE

7.1 Preliminary treatment of all matrices is always necessary because of the complexity and variability of sample matrices. Solubilization and digestion procedures are presented in Sample Preparation Methods (Methods 3005-3050). The method of standard addition (MSA) (Paragraph 8.5.3) shall be used for the analysis of all EP extracts and sample digests unless either serial dilution or matrix spike addition demonstrates that it is not required. An internal standard may be substituted for the MSA.

7.2 Set up the instrument with proper operating parameters established in Paragraph 4.2. The instrument must be allowed to become thermally stable before beginning (usually requiring at least 30 min of operation prior to calibration).

7.3 Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures, using the typical mixed calibration standard solutions described in Paragraph 5.4. Flush the system with the calibration blank (5.5.1) between each standard (see NOTE, below). (Use the average intensity of multiple exposures for both standardization and sample analysis to reduce random error.)

NOTE: For boron concentrations greater than 500 ug/L, extended flush times of 1 or 2 min may be required.

7.4 Before beginning the sample run, reanalyze the highest mixed calibration standard as if it were a sample. Concentration values obtained should not deviate from the actual values by more than 5% (or the established control limits, whichever is lower). If they do, follow the recommendations of the instrument manufacturer to correct for this condition.

7.5 Flush the system with the calibration blank solution for at least 1 min (Paragraph 5.5.1) before the analysis of each sample (see Note to Paragraph 7.3). Analyze the instrument check standard (5.6) and the calibration blank (5.5.1) after each 10 samples.

7.6 Calculations: If dilutions were performed, the appropriate factors must be applied to sample values. All results should be reported in ug/L with up to three significant figures.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Dilute and reanalyze samples that are more concentrated than the linear calibration limit or use an alternate, less sensitive line for which quality control data is already established.

8.3 Employ a minimum of one laboratory blank per sample batch to determine if contamination or any memory effects are occurring.

8.4 Analyze one duplicate sample for every 20 samples. A duplicate sample is a sample brought through the whole sample preparation and analytical process.

8.5 It is recommended that whenever a new or unusual sample matrix is encountered, a series of tests be performed prior to reporting concentration data for analyte elements. These tests, as outlined in 8.5.1 through 8.5.3, will ensure the analyst that neither positive nor negative interferences are operating on any of the analyte elements to distort the accuracy of the reported values.

8.5.1 Serial dilution: If the analyte concentration is sufficiently high (minimally, a factor of 10 above the instrumental detection limit after dilution), an analysis of a 1:4 dilution should agree within ±10% of the original determination. If not, a chemical or physical interference effect should be suspected.

8.5.2 Matrix spike addition: An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within 75% to 125% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike is not recovered within the specified limits, a matrix effect should be suspected. The use of a standard-addition analysis procedure can usually compensate for this effect.

CAUTION: The standard-addition technique does not detect coincident spectral overlap. If suspected, use of computerized compensation, an alternate wavelength, or comparison with an alternate method is recommended.

8.5.3 Standard addition: The standard-addition technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences which cause a baseline shift. The simplest version of this technique is the single-addition method, in which two identical aliquots of the sample solution, each of Volume V_x, are taken. To the first (labeled A) is added a small volume V_s of a standard analyte solution of concentration c_s. To the second (labeled B) is added the same volume V_s of the solvent. The analytical signals of A and B are measured and corrected for nonanalyte signals. The unknown sample concentration c_x is calculated:

$$c_x = \frac{S_B V_s c_s}{(S_A - S_B)\ V_x}$$

where S_A and S_B are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_s and c_s should be chosen so that S_A is roughly twice S_B on the average. It is best if V_s is made much less than V_x, and thus c_s is much greater than c_x, to avoid excess dilution of the sample matrix. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure. For the results of this technique to be valid, the following limitations must be taken into consideration:

1. The analytical curve must be linear.

2. The chemical form of the analyte added must respond the same way as the analyte in the sample.

3. The interference effect must be constant over the working range of concern.

4. The signal must be corrected for any additive interference.

The absorbance of each solution is determined and then plotted on the vertical axis of a graph, with the concentrations of the known standards plotted on the horizontal axis. When the resulting line is extrapolated back to zero absorbance, the point of interception of the abscissa is the concentration of the unknown. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction from the ordinate. An example of a plot so obtained is shown in Figure 1.

8.6 Check the instrument standardization by analyzing appropriate quality control check standards as follows.

8.6.1 Check instrument calibration using a calibration blank and two appropriate standards.

8.6.2 Verify calibration every 10 samples and at the end of the analytical run, using a calibration blank (5.5.1) and a single point check standard (5.6).

8.6.2.1 The results of the check standard are to agree within 10% of the expected value; if not, terminate the analysis, correct the problem, and recalibrate the instrument.

8.6.2.2 The results of the calibration blank are to agree within three standard deviations of the mean blank value. If not, repeat the analysis two more times and average the results. If the average is not within three standard deviations of the background mean, terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples.

8.6.3 Verify the interelement and background correction factors at the beginning and end of an analytical run or twice during every 8-hour work shift, whichever is more frequent. Do this by analyzing the interference check sample (Paragraph 5.7). Results should be within ±20% of the true value obtained in 8.6.2.1.

8.6.4 Duplicate spiked samples are to be analyzed at a frequency of 20%.

8.6.4.1 The relative percent difference between duplicate determinations is to be calculated as follows:

$$RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100$$

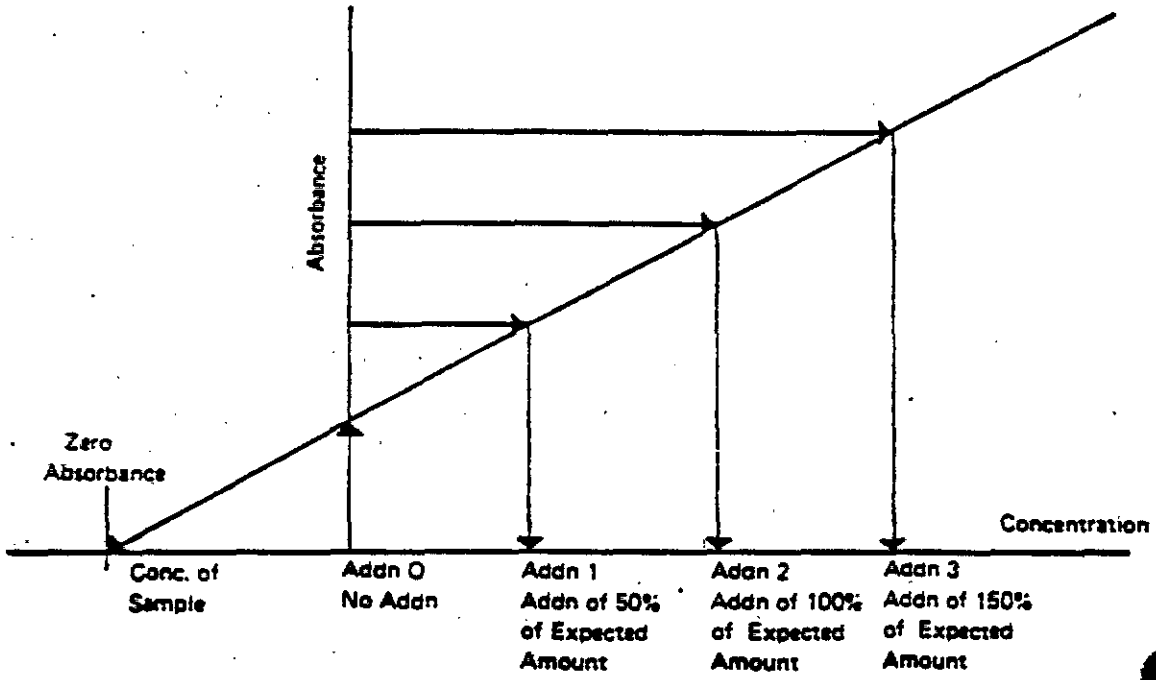

Figure 1. Standard Addition Plot.

where:

RPD = relative percent difference.
D_1 = first sample value.
D_2 = second sample value (duplicate).

(A control limit of ±20% for RPD shall be used for sample values greater than 10 times the instrument detection limit.)

8.6.4.2 The duplicate matrix spike sample recovery is to be within ±20% of the actual value.

8.6.5 The method of standard addition (Paragraph 8.5.3) shall be used for the analysis of all EP extracts.

9.0 METHOD PERFORMANCE

9.1 In an EPA round-robin Phase 1 study, seven laboratories applied the ICP technique to acid-distilled water matrices that had been spiked with various metal concentrates. Table 4 lists the true values, the mean reported values, and the mean percent relative standard deviations.

9.2 In a single laboratory evaluation, seven wastes were analyzed for 22 elements by this method. The mean percent relative standard deviation from triplicate analyses for all elements and wastes was 9±2%. The mean percent recovery of spiked elements for all wastes was 93±6%. Spike levels ranged from 100 ug/L to 100 mg/L. The wastes included sludges and industrial wastewaters.

10.0 REFERENCES

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2. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-05, December 1982, Method 200.7.

3. Patel, B.K., Raab, G.A., et al., Report on a Single Laboratory Evaluation of Inductively Coupled Optical Emission Method 6010, EPA Contract No. 68-03-3050, December 1984.

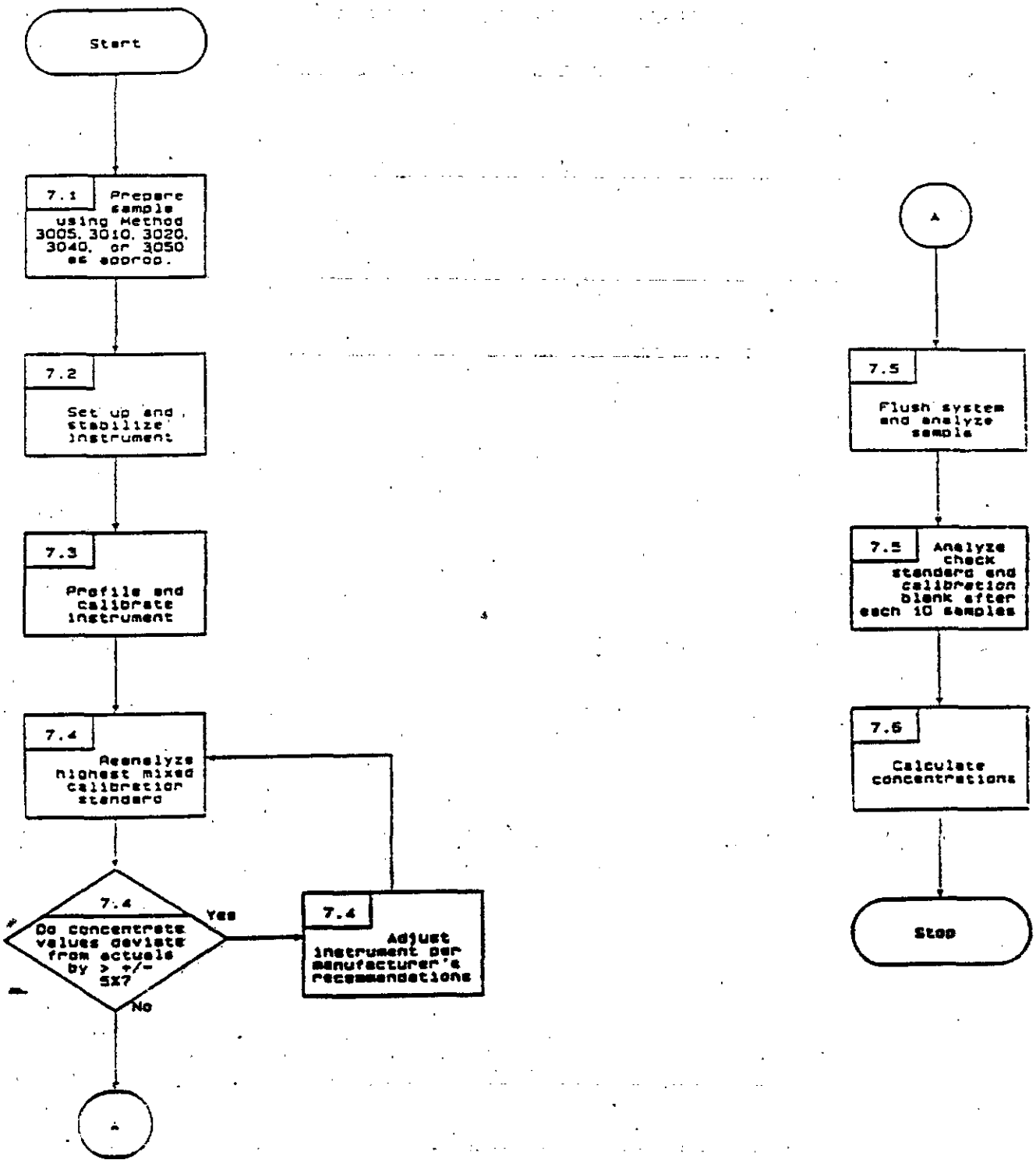
TABLE 4. ICP PRECISION AND ACCURACY DATA[a]

Element	Sample No. 1			Sample No. 2			Sample No. 3		
	True Value (ug/L)	Mean Reported Value (ug/L)	Mean SD[b] (%)	True Value (ug/L)	Mean Reported Value (ug/L)	Mean SD[b] (%)	True Value (ug/L)	Mean Reported Value (ug/L)	Mean SD[b] (%)
Be	750	733	6.2	20	20	9.8	180	176	5.2
Mn	350	345	2.7	15	15	6.7	100	99	3.3
V	750	749	1.8	70	69	2.9	170	169	1.1
As	200	208	7.5	22	19	23	60	63	17
Cr	150	149	3.8	10	10	18	50	50	3.3
Cu	250	235	5.1	11	11	40	70	67	7.9
Fe	600	594	3.0	20	19	15	180	178	6.0
Al	700	696	5.6	60	62	33	160	161	13
Cd	50	48	12	2.5	2.9	16	14	13	16
Co	700	512	10	20	20	4.1	120	108	21
Ni	250	245	5.8	30	28	11	60	55	14
Pb	250	236	16	24	30	32	80	80	14
Zn	200	201	5.6	16	19	45	80	82	9.4
Se[c]	40	32	21.9	6	8.5	42	10	8.5	8.3

[a]Not all elements were analyzed by all laboratories.

[b]SD = standard deviation.

[c]Results for Se are from two laboratories.


Start
7.1 Prepare sample using Method 3005, 3010, 3020, 3040, or 3050 as approp.
7.2 Set up and stabilize instrument
7.3 Profile and calibrate instrument
7.4 Reanalyze highest mixed calibration standard
7.4 Do concentrate values deviate from actuals by > +/- 5%?
Yes
No
7.4 Adjust instrument per manufacturer's recommendations
A
A
7.5 Flush system and analyze sample
7.5 Analyze check standard and calibration blank after each 10 samples
7.6 Calculate concentrations
Stop

AR303041

METHOD 7060

ARSENIC (ATOMIC ABSORPTION, FURNACE TECHNIQUE)

1.0 SCOPE AND APPLICATION

1.1 Method 7060 is an atomic absorption procedure approved for determining the concentration of arsenic in wastes, mobility procedure extracts, soils, and ground water. All samples must be subjected to an appropriate dissolution step prior to analysis.

2.0 SUMMARY OF METHOD

2.1 Prior to analysis by Method 7060, samples must be prepared in order to convert organic forms of arsenic to inorganic forms, to minimize organic interferences, and to convert the sample to a suitable solution for analysis. The sample preparation procedure varies depending on the sample matrix. Aqueous samples are subjected to the acid digestion procedure described in this method. Sludge samples are prepared using the procedure described in Method 3050.

2.2 Following the appropriate dissolution of the sample, a representative aliquot of the digestate is spiked with a nickel nitrate solution and is placed manually or by means of an automatic sampler into a graphite tube furnace. The sample aliquot is then slowly evaporated to dryness, charred (ashed), and atomized. The absorption of hollow cathode or EDL radiation during atomization will be proportional to the arsenic concentration.

2.3 The typical detection limit for this method is 1 ug/L.

3.0 INTERFERENCES

3.1 Elemental arsenic and many of its compounds are volatile; therefore, samples may be subject to losses of arsenic during sample preparation. Spike samples and relevant standard reference materials should be processed to determine if the chosen dissolution method is appropriate.

3.2 Likewise, caution must be employed during the selection of temperature and times for the dry and char (ash) cycles. A nickel nitrate solution must be added to all digestates prior to analysis to minimize volatilization losses during drying and ashing.

3.3 In addition to the normal interferences experienced during graphite furnace analysis, arsenic analysis can suffer from severe nonspecific absorption and light scattering caused by matrix components during atomization. Arsenic analysis is particularly susceptible to these problems because of its low analytical wavelength (193.7 nm). Simultaneous background

correction must be employed to avoid erroneously high results. Aluminum is a severe positive interferent in the analysis of arsenic, especially using D_2 arc background correction. Zeeman background correction is very useful in this situation.

3.4 If the analyte is not completely volatilized and removed from the furnace during atomization, memory effects will occur. If this situation is detected by means of blank burns, the tube should be cleaned by operating the furnace at full power at regular intervals in the analytical scheme.

4.0 APPARATUS AND MATERIALS

4.1 Griffin beaker: 250 mL.

4.2 Volumetric flasks: 10-mL.

4.3 Atomic absorption spectrophotometer: Single or dual channel, single- or double-beam instrument having a grating monochromator, photomultiplier detector, adjustable slits, a wavelength range of 190 to 800 nm, and provisions for simultaneous background correction and interfacing with a strip-chart recorder.

4.4 Arsenic hollow cathode lamp, or electrodeless discharge lamp (EDL): EDLs provide better sensitivity for arsenic analysis.

4.5 Graphite furnace: Any graphite furnace device with the appropriate temperature and timing controls.

4.6 Strip-chart recorder: A recorder is strongly recommended for furnace work so that there will be a permanent record and so that any problems with the analysis such as drift, incomplete atomization, losses during charring, changes in sensitivity, etc., can easily be recognized.

4.7 Pipets: Microliter with disposable tips. Sizes can range from 5 to 1,000 uL, as required.

5.0 REAGENTS

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid: Acid should be analyzed to determine levels of impurities. If a method blank using the acid is <MDL, the acid can be used.

5.3. Hydrogen peroxide (30%): Oxidant should be analyzed to determine levels of impurities. If a method blank using the H_2O_2 is <MDL, the acid can be used.

5.4 Arsenic standard stock solution (1,000 mg/L): Either procure a certified aqueous standard from a supplier and verify by comparison with a second standard, or dissolve 1.320 g of arsenic trioxide (As_2O_3, analytical reagent grade) or equivalent in 100 mL of Type II water containing 4 g NaOH. Acidify the solution with 20 mL concentrated HNO_3 and dilute to 1 liter (1 mL = 1 mg As).

5.5 Nickel nitrate solution (5%): Dissolve 24.780 g of ACS reagent grade $Ni(NO_3)_2 \cdot 6H_2O$ or equivalent in Type II water and dilute to 100 mL.

5.6 Nickel nitrate solution (1%): Dilute 20 mL of the 5% nickel nitrate to 100 mL with Type II water.

5.7 Arsenic working standards: Prepare dilutions of the stock solution to be used as calibration standards at the time of the analysis. Withdraw appropriate aliquots of the stock solution, add 1 mL of concentrated HNO_3, 2 mL of 30% H_2O_2, and 2 mL of the 5% nickel nitrate solution. Dilute to 100 mL with Type II water.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and Type II water. Plastic and glass containers are both suitable.

6.3 Special containers (e.g., containers used for volatile organic analysis) may have to be used if very volatile arsenic compounds are to be analyzed.

6.4 Aqueous samples must be acidified to a pH of <2 with nitric acid.

6.5 Nonaqueous samples shall be refrigerated, when possible, and analyzed as soon as possible.

7.0 PROCEDURE

7.1 Sample preparation: Aqueous samples should be prepared in the manner described in Paragraphs 7.1.1-7.1.3. Sludge-type samples should be prepared according to Method 3050. The applicability of a sample-preparation technique to a new matrix type must be demonstrated by analyzing spiked samples and/or relevant standard reference materials.

7.1.1 Transfer 100 mL of well-mixed sample to a 250-mL Griffin beaker; add 2 mL of 30% H_2O_2 and sufficient concentrated HNO_3 to result in an acid concentration of 1% (v/v). Heat for 1 hr at 95°C or until the volume is slightly less than 50 mL.

7.1.2 Cool and bring back to 50 mL with Type II water.

7.1.3 Pipet 5 mL of this digested solution into a 10-mL volumetric flask, add 1 mL of the 1% nickel nitrate solution, and dilute to 10 mL with Type II water. The sample is now ready for injection into the furnace.

7.2 The 193.7-nm wavelength line and a background correction system are required. Follow the manufacturer's suggestions for all other spectrophotometer parameters.

7.3 Furnace parameters suggested by the manufacturer should be employed as guidelines. Because temperature-sensing mechanisms and temperature controllers can vary between instruments or with time, the validity of the furnace parameters must be periodically confirmed by systematically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to overly high temperature settings or losses in sensitivity due to less than optimum settings can be minimized. Similar verification of furnace parameters may be required for complex sample matrices.

7.4 Inject a measured microliter aliquot of sample into the furnace and atomize. If the concentration found is greater than the highest standard, the sample should be diluted in the same acid matrix and reanalyzed. The use of multiple injections can improve accuracy and help detect furnace pipetting errors.

7.5 Analyze all EP extracts, all samples analyzed as part of a delisting petition, and all samples that suffer from matrix interferences by the method of standard additions.

7.6 Run a check standard after every 10 injections of samples. Standards are run in part to monitor the life and performance of the graphite tube. Lack of reproducibility or significant change in the signal for the standard indicates that the tube should be replaced.

7.7 Calculate metal concentrations by (1) the method of standard additions, or (2) from a calibration curve, or (3) directly from the instrument's concentration readout. All dilution or concentration factors must be taken into account. Concentrations reported for multiphased samples must be appropriately qualified (e.g., 5 ug/g aqueous phase).

7.8 Duplicates, spiked samples, and check standards should be routinely analyzed.

8.0 QUALITY CONTROL

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Calibration curves must be composed of a minimum of a blank and three standards. A calibration curve should be made for every hour of continuous sample analysis.

8.3 Dilute samples if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve.

8.4 Employ a minimum of one blank per sample batch to determine if contamination or any memory effects are occurring.

8.5 Verify calibration with an independently prepared check standard every 15 samples.

8.6 Run one spike duplicate sample for every 20 samples. A duplicate sample is a sample brought through the whole sample preparation and analytical process.

8.7 The method of standard additions (see Method 7000, Section 8.7) shall be used for the analysis of all EP extracts, on all analyses submitted as part of a delisting petition, and whenever a new sample matrix is being analyzed.

9.0 METHOD PERFORMANCE

9.1 Precision and accuracy data are available in Method 206.2 of Methods for Chemical Analysis of Water and Wastes.

9.2 The optimal concentration range for this method is 5-100 ug/L.

9.3 The data shown in Table 1 were obtained from records of state and contractor laboratories. The data are intended to show the precision of the combined sample preparation and analysis method.

10.0 REFERENCES

1. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-055, December 1982, Method 206.2.

2. Gaskill, A., Compilation and Evaluation of RCRA Method Performance Data, Work Assignment No. 2, EPA Contract No. 68-01-7075, September 1986.

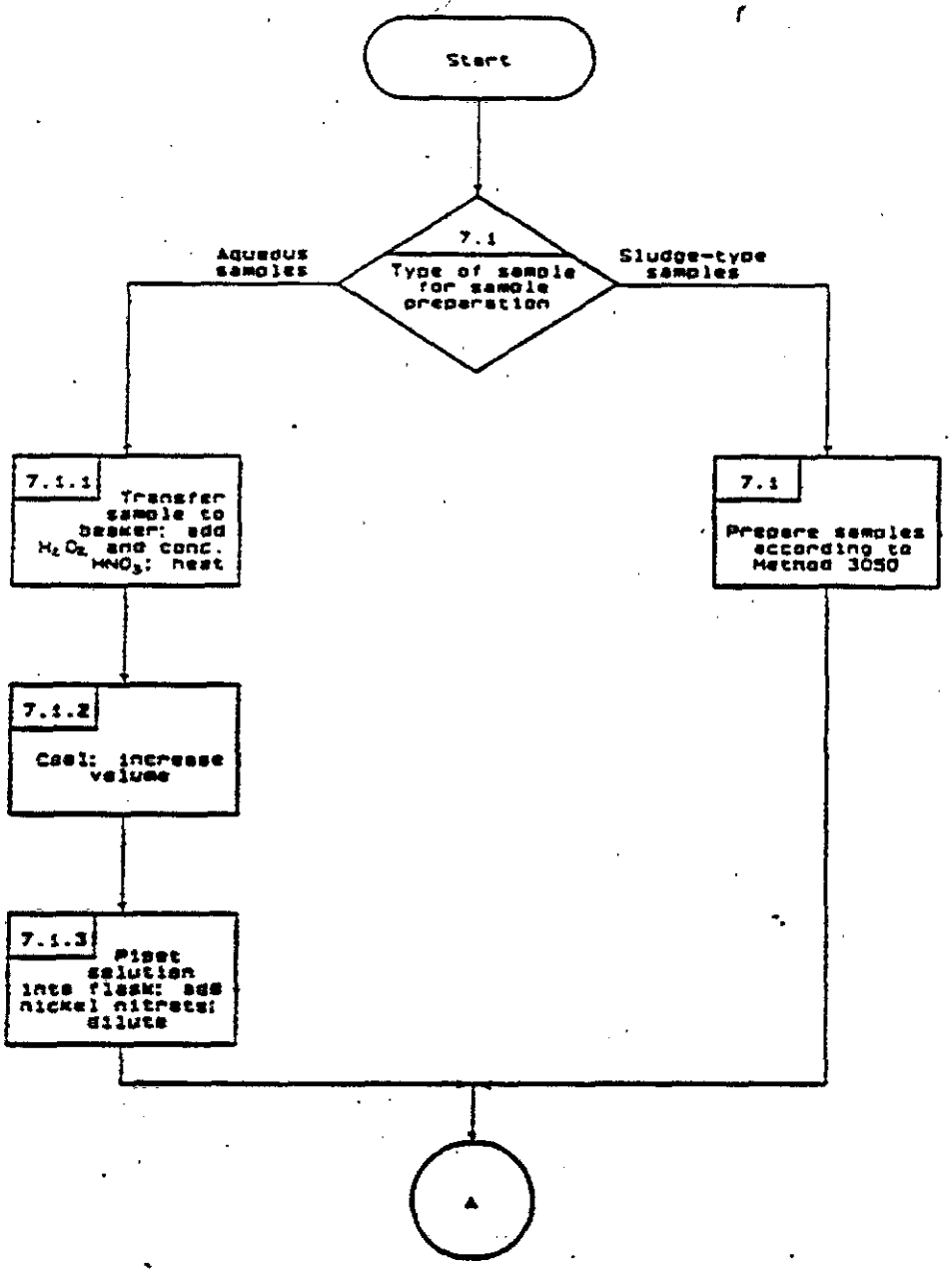
TABLE 1. METHOD PERFORMANCE DATA

Sample Matrix	Preparation Method	Laboratory Replicates
Contaminated soil	3050	2.0, 1.8 ug/g
Oily soil	3050	3.3, 3.8 ug/g
NBS SRM 1646 Estuarine sediment	3050	8.1, 8.33 ug/g[a]
Emission control dust	3050	430, 350 ug/g

[a]Bias of -30 and -28% from expected, respectively.

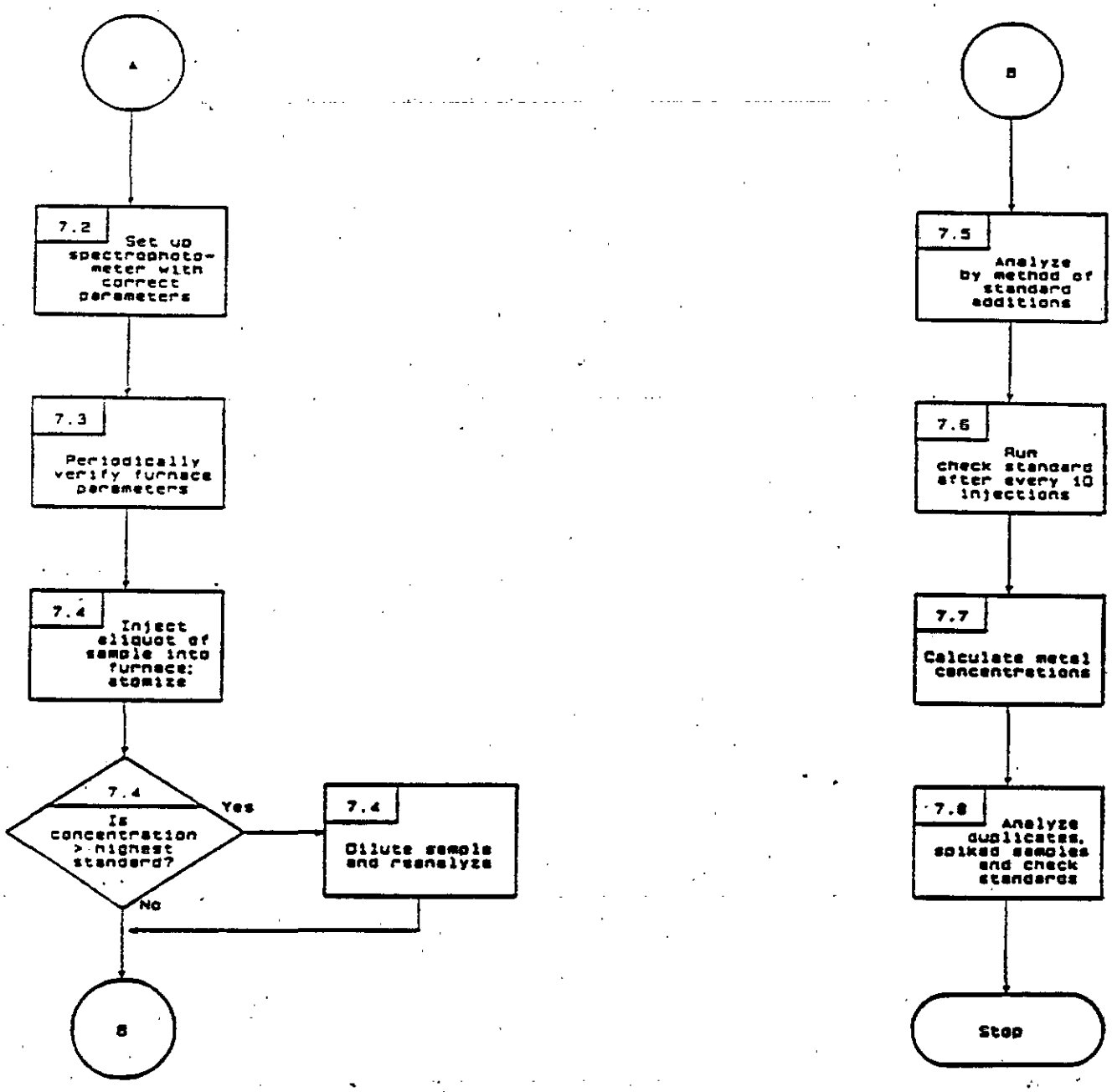
METHOD 7060

ARSENIC (ATOMIC ABSORPTION, FURNACE TECHNIQUE)



Revision 0
Date September 1986

AR303048


A
7.2
Set up spectrophotometer with correct parameters
7.3
Periodically verify furnace parameters
7.4
Inject aliquot of sample into furnace; atomize
7.4
Is concentration > highest standard?
Yes
No
7.4
Dilute sample and reanalyze
B
B
7.5
Analyze by method of standard additions
7.6
Run check standard after every 10 injections
7.7
Calculate metal concentrations
7.8
Analyze duplicates, spiked samples and check standards
Stop

Modified Method 3550A/8100 for Extractable Organics in Soil GC/FID Analysis

Standard Operation Procedure 10/94

Scope of Application

ABB-ES' use of method 3550A/8100 is based on the methods prescribed by EPA for extractable organics hydrocarbons in soils. However, it has been modified such that only certain compounds will be quantitated. The two target lists of compounds for the modified method 8100 used routinely are:

Mono- and Poly- Aromatic Hydrocarbons:

- toluene
- ethylbenzene
- m/p-xylene
- o-xylene
- trimethylbenzene
- naphthalene
- 2-methylnaphthalene
- 1-methylnaphthalene
- acenapthylene
- acenaphthene
- fluorene
- phenanthrene
- anthracene
- fluoranthrene
- pyrene
- benzanthracene
- chrysene
- benzo-b- and benzo-k-fluoranthene
- benzo-a-pyrene
- indenopyrene
- dibenzanthracene
- benzoperylene
- bis(2-ethylhexyl)phthalate

Fuel Oils:

- n-alkanes (C-7 through C-27)
- farnesane
- pristane
- phytane

Characterization of petroleum using fingerprinting and quantitation of total petroleum hydrocarbons can also be quantitated by this method.

Since some of the compounds of interest in this method are suspected carcinogens and the reagents necessary for the extraction can pose potential threats to health, standard good laboratory practice (GLP) will be required. This includes no eating, drinking, smoking in laboratories. Proper attire such as lab coat and gloves are necessary. All sample extractions and standard preparations will take place in either sealed containers or a laboratory hood.

Analytical Procedure

The instrument to be used is a Hewlett-Packard (HP) model 5880 gas chromatograph fitted with a DB-5 (J. and W. Scientific) capillary column and equipped with a flame ionization detector. Samples are introduced to the GC by autoinjection using an HP 7673A automatic sampler. Separation of compounds is achieved by a temperature program beginning at 40°C then increasing by 8°C per minute to 290°C and holding for 30 minutes.

Method 3550A is modified such that samples are prepared by extracting organic compounds from the soil using 30 g soil and 150 ml methylene chloride:acetone (50:50), shaken for 15 minutes in a container with an amount of sodium sulfate equal to the soil. A representative volume of extract (1 ml) is then removed from the sedimented soil and placed into an autosampler vial. The solution is then spiked with an appropriate amount of an internal standard. After crimped tops are put on the vials, they are loaded onto an autosampler for injection into the GC (1 ul).

Calibration Standard Preparation

Mono- and Polyaromatic Hydrocarbons

A calibration standard solution, containing the target compounds, is prepared every two weeks. The calibration standards are made to a final concentration of 50 ug/ml. The standard compounds are obtained from a referenced source and prepared in methylene chloride in a mini-inert vial. This procedure is repeated every two weeks. All calibration standards are stored at 0°C.

Internal Standard Preparation

The internal standard that is used for 8100 analysis is orthoterphenyl (OTP) for mono- and polyaromatic hydrocarbons and paraterphenyl (PTP) for fuel oils. The internal standard is prepared to a concentration of 50 ug/ml in a mini-inert vial. The standard is stored at 0°C.

Check Standard Preparation

A check standard is prepared from standards that have been obtained from a different referenced source than what was used for calibration standards. The check standard contains all compounds in calibration standard and is made in the same manner. The concentration of check standard is 50 ug/ul.

Calibration Procedures for Mono- and Polyaromatic Hydrocarbons

The instrument is calibrated and results obtained using the internal standard method. Relative response factors for each compound are calculated from the multicomponent standard mix which is also used for compound identification by retention time matching.

Daily when samples will be analyzed, a mid-level standard (50 ppm) is analyzed. The value must be within ± 15% of the standard value. If the standard is outside the range a check standard is analyzed. If this fails to fall within the range, the instrument is recalibrated. A continuing calibration standard is run every 10 samples or per batch.

Calibration Procedures for Fuel Oil Hydrocarbons and Total Petroleum Hydrocarbons

The instrument is calibrated and results obtained using the internal standard method. A response factor is calculated from the internal standard and used for the target list compounds and for quantitating total petroleum hydrocarbons. Total Hydrocarbons may also be quantitated using a response factor generated from the analysis of standard amounts of diesel fuel. Compound identification is by retention time match with known standards.

Pre-Analysis

Set up the GC with the following conditions:

Column:	0.25 m x 30 m DB-5 Fused Silica		Signal: Attn:	2
Oven:	Temp 1	40°C	Area Reject:	0
	Time 1	0.1 min	Threshold:	1
	Rate	8°C/min	Peak Width:	0.04
	Time 2	30 min		

Run Table: 0.00 Valve 5 on
0.50 valve 5 off
0.1 Int. 0 off
3.0 Int. on

If the capillary column needs to be changed or maintenance performed, the oven should be brought to room temperature. The injection port nut, once removed, allows replacement of septa, 0-rings and cleaning of the injection port liner. The column should be checked to be sure both ends are cut evenly and are fitted with fresh ferrules such that both the injection an detector ends are secured

properly. All nuts should be tightened and the carrier gas flow should be checked for leaks. The column, if time allows, can be held at its maximum temperature (290°C) for 30 minutes. The carrier gas flow of 20 psi should be used.

Routine Analysis

For routine analysis, samples are loaded into the autosampler. A final volume of 1 ml is always used and 1 ul is injected into the GC. All samples must have Internal Standard solution added to it just prior to loading on the autosampler. All samples are quantified using the Internal Standard Method.

Internal Standard Calculations

For Mono- and polyaromatic hydrocarbons:

$$\text{Conc (ug/g wet wght)} = \frac{\text{Area of Component}}{\text{Area of Internal Standards (IS)}} \times \frac{\text{ug of IS}}{\text{1 ml (IS)}} \times \frac{1}{\text{Sample Amt (g)}} \times \frac{\text{Extraction Volume (ml)}}{\text{RRF}} \text{ DF}$$

$$\text{RRF} = \frac{\text{Area of Component}}{\text{Area of IS}} \times \frac{\text{Amt IS}}{\text{Amt. Component}}$$

DF = dilution factor

Sample concentrations are then corrected for dry weight as shown on page 6

A solution of standard PAH should be analyzed and used to calibrate the instrument (see Calibration). After this has occurred and the analyst has checked the runs for quality, samples can be analyzed. Consult the manufacturers operations notebook for program run commands for the autosampler.

After samples have been chromatographed by GC/FID, the analyst must once again visually check for quality of chromatography, consistency in internal standard area and proper instrument

identification of compound peaks. Once this is assured, the amount of each compound of interest (ug/ml) is transposed to a data sheet and calculations performed.

Calculations

To determine the moisture content of each sample, tare the weight of an aluminum boat. Then add approximately 10 g of sample and reweigh. Let the sample dry overnight in an oven at 100°C. The dry mass is then determined by recording the new (dry) mass of sample and boat and subtracting the mass of the boat. The following calculation must be performed in order to determine concentration factors and final concentrations.

1. Mass of water in sample (g) = mass wet sample - mass dry sample

2. $$\% \text{ moisture in sample} = \frac{\text{mass of water}}{\text{mass wet sample}} \times 100$$

Quality Control

Quality control procedures for the modified 8100 method include calibration standards, calibration check standards, blanks, and internal standard, as well as laboratory control samples and reagent blanks. A reagent blank shall be run each time a new reagent lot is used. A method blank shall be analyzed daily after calibration or calibration check runs, when samples are to be analyzed, and after the analysis of any high concentration sample.

Data Reporting

Analytical results (raw data) are collected using an IBM compatible computer system to measure peak height/area and interpret results in concentrations (ppm). Documentation of analyses will appear in a laboratory log. Final results, after QC review, are reported.

References

(1) U.S. EPA. 1979. Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79-020 (Revised, March 1983). EPA/EMSL, Cincinnati, Ohio.

(2) U.S. EPA. 1986. Test Methods for Evaluating Solid Waste-Physical/Chemical Methods. SW-846 Third Edition. Office of Solid Waste, U.S. EPA, Washington, D.C.

SAMPLE FORMAT

PROJECT NAME _____
RUN # ____
SAMPLE # ____ DATE OF RUN _____

EXPERIMENT NAME _____
SAMPLE NAME _____
SIGNAL FILE _____

SAMPLE PREP DATE _____
SOLVENT _____
SOLVENT VOL _____

PREP PERSON _____
SAMPLE AMT _____
DRY WT _____

METHOD _____
ISTD _____
CONC/DIL _____

ANALYST _____
QA ANALYST _____

CALCULATIONS _____
QA CALCULATIONS _____

TOTAL AREA _____
ISTD _____
BACKGROUND _____
NET AREA _____
TOTAL (ug/ml) _____

CAL FACTOR _____
ISTD AMOUNT _____

TOTAL (ug/g) _____

RT	COMPOUND	AMOUNT (ug/ml)	AMOUNT (ug/g)
	C7		
	TOLUENE		
	C8		
	M/P-XYLENE		
	C9		
	TRIMETHYLBENZENE		
	C10		
	C11		
	C12		
	C13		
	C14		
	FARNESANE		
	C15		
	C16		
	C17		
	PRISTANE		
	C18		
	PHYTANE		
	C19		
	C20		
	C21		
	C22		
	C23		
	C24		
	C25		
	C26		
	C27		

SUM OF COMPOUNDS _____

Work # ___-___-___

FUELGC.fm

Pages 303059 through 303078 are on file at
EPA Region III and are available upon request.

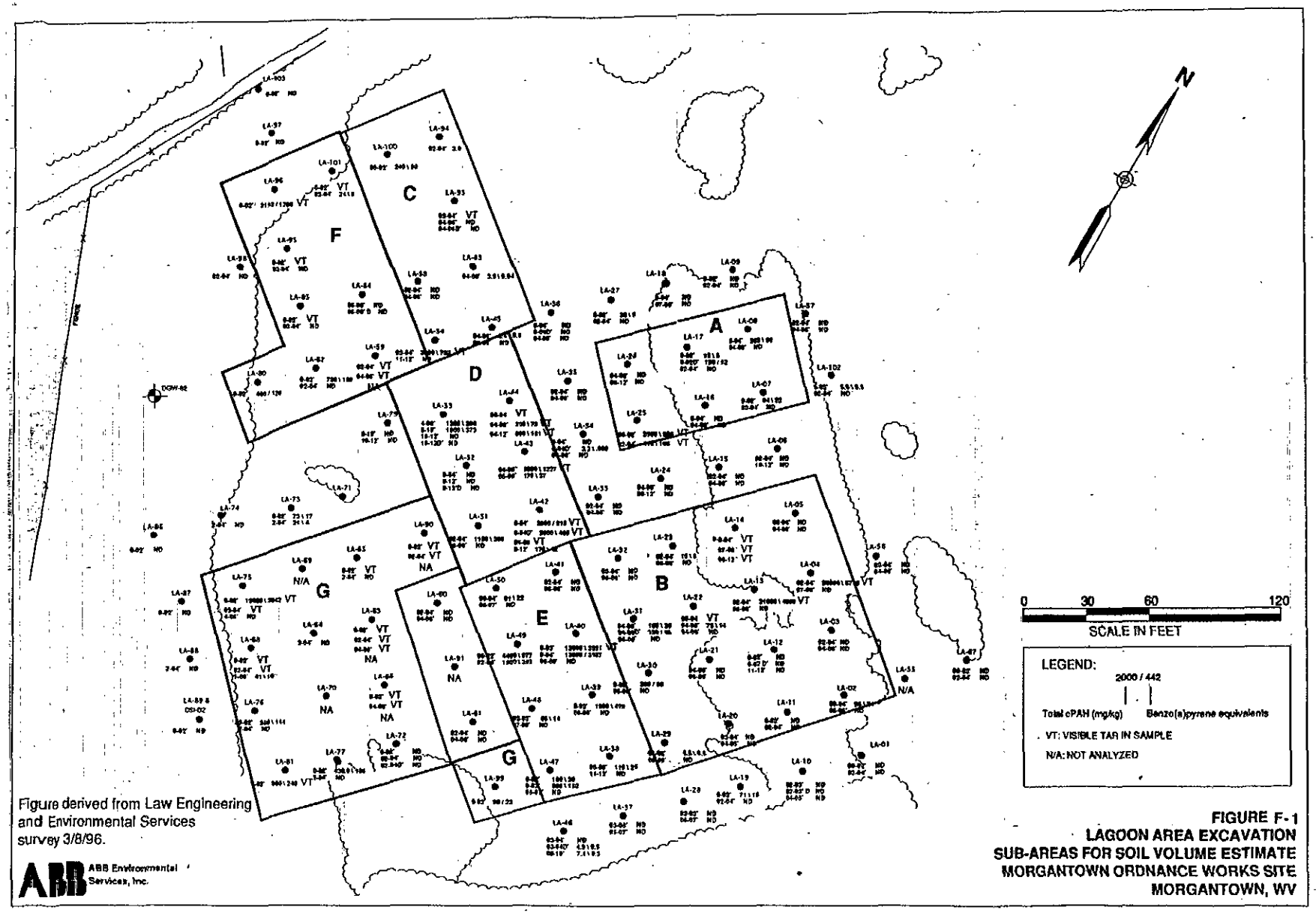


Figure derived from Law Engineering and Environmental Services survey 3/8/96.

ABB Environmental Services, Inc.

FIGURE F-1
LAGOON AREA EXCAVATION
SUB-AREAS FOR SOIL VOLUME ESTIMATE
MORGANTOWN ORDNANCE WORKS SITE
MORGANTOWN, WV

AR303079

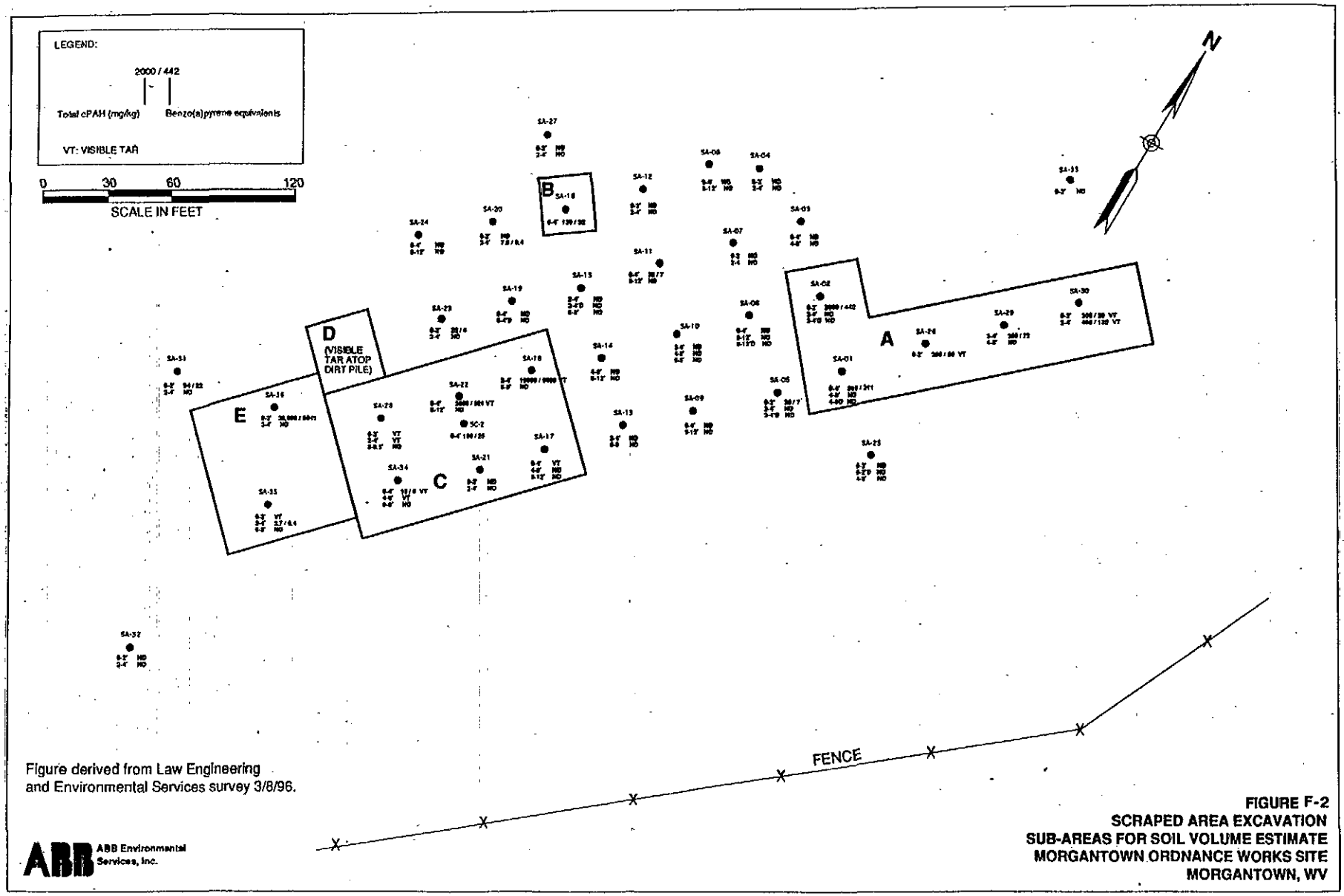


Figure derived from Law Engineering and Environmental Services survey 3/8/96.

ABB Environmental Services, Inc.

FIGURE F-2
SCRAPED AREA EXCAVATION
SUB-AREAS FOR SOIL VOLUME ESTIMATE
MORGANTOWN ORDNANCE WORKS SITE
MORGANTOWN, WV

AR303080

Olin CHEMICALS

P.O. BOX 248, 1186 LOWER RIVER ROAD NW, CHARLESTON, TN 37310
Phone: (615) 336-4000

May 10, 1996

Ms. Melissa Whittington
Remediation Project Manager
U. S. EPA
Regio III Mail Code 3HW41
841 Chestnut Building
Philadelphia, PA 19107

Re: Morgantown Ordnance Works Site OU-1
"Certification of Destruction"

Dear Ms. Whittington,

Please find enclosed copies of the above referenced certificates for the treatment of the Investigatory Derived Waste from the OU-1 Investigation. I have enclosed a copy for the waste generated by USEPA and the material from the Predesign Sampling completed in 1996.

Should there be any questions, please call me at 423-336-4511.

Sincerely,

OLIN CORPORATION

Steve Morrow

Steve Morrow
Principal, Environmental Specialist

SGM1165

cc:
Jay Johnson-ABB
Morgantown Site Team
Mike Stratton-WVDEP
OU-1 PRP Group

TRADE WASTE INCINERATION
A DIVISION OF CHEMICAL WASTE MANAGEMENT
Federal EPA ID: ILD098642424
State EPA ID: 1631210009
7 MOBILE AVENUE
SAUGET, IL 62201-1069
(618) 271-2804

RECEIVED
MAY 0 6 1996
S. G. MORROW

MORGANTOWN ORDINANCE WORKS
ATTN: MANIFEST SECTION
WVD000850404
1100 DUPONT RD
MORGANTOWN WV 26505

CERTIFICATE OF DESTRUCTION

Chemical Waste Management, Inc. has received waste material from MORGANTOWN ORDINANCE WORKS on 03/15/96 as described on [State Manifest or Uniform] Hazardous Waste Manifest number(s) IL07000998.

Profile Number: BL2927
CWM Tracking ID: 7-7751
Treatment Date: 04/14/96
CWM Unit #: 1*0 thru 13*0

I certify, on behalf of the above listed treatment facility, that to the best of my knowledge, the above-described waste was managed in compliance with all applicable laws, regulations, permits and licenses on the date listed above.

SUSAN A. DIPAOLA

Certificate # 31684
04/25/96

AR303082

TRADE WASTE INCINERATION
A DIVISION OF CHEMICAL WASTE MANAGEMENT
Federal EPA ID: ILD098642424
State EPA ID: 1631210009
7 MOBILE AVENUE
SAUGET, IL 62201-1069
(618) 271-2804

MORGANTOWN ORDINANCE WORKS
ATTN: MANIFEST SECTION
WVD000850404
1100 DUPONT RD
MORGANTOWN WV 26505

CERTIFICATE OF DESTRUCTION

Chemical Waste Management, Inc. has received waste material from MORGANTOWN ORDINANCE WORKS on 03/15/96 as described on [State Manifest or Uniform] Hazardous Waste Manifest number(s) IL07000996.

Profile Number: BL2930
CWM Tracking ID: 7-7753
Treatment Date: 04/14/96
CWM Unit #: 1-0 thru 3-0

I certify, on behalf of the above listed treatment facility, that to the best of my knowledge, the above-described waste was managed in compliance with all applicable laws, regulations, permits and licenses on the date listed above.

SUSAN A. DIPAOLA

Certificate # 31685
04/25/96

Olin CHEMICALS

P.O. BOX 248, 1186 LOWER RIVER ROAD NW, CHARLESTON, TN 37310
Phone: (615) 336-4000

April 12, 1996

Ms. Melissa Whittington
Remediation Project Manager
U. S. EPA
Region III Mail Code 3HW41
841 Chestnut Building
Philadelphia, PA 19107

Re: Morgantown Ordnance Works Site OU-1
Manifest for Investigatory Derived Waste

Dear Ms. Whittington,

Enclosed are copies of the manifest used for transportation of the investigatory derived waste (IDW) from the above referenced site. I have included copies for both the material generated by USEPA and the most resent material generated during the predesign sampling. Also, I have included the invoice from the facility for your information.

Should there be any questions, please call me at 423-336-4511.

Sincerely,

OLIN CORPORATION

Steve Morrow
Principal, Environmental Specialist

SGM1149

cc:

Jay Johnson-ABB
Morgantown Site Team
Mike Stratton-WVDEP
OU-1 PRP Group

STATE OF ILLINOIS

P O BOX 19276 SPRINGFIELD ILLINOIS 62794-9276 217 782-6761
State Form LPC 52 3/81 IL532-0610

FOR SHIPMENT OF HAZARDOUS AND SPECIAL WASTE

PLEASE TYPE (Form designed for use on elite (12 pitch) typewriter) EPA Form 8700-22 (Rev. 6-89) Form Approved. OMB No. 2050-0039, Expires 3-30-96

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No.: WVD000850404
Manifest Document No.: 100001
2. Page 1 of 2
Information in the shaded areas is not required by Federal law but is required by Illinois law.

3. Generator's Name and Mailing Address — Location If Different
MORGANTOWN ORDINANCE WORKS
1100 DUPONT RD
MORGANTOWN WV 26505
4. 24 HOUR EMERGENCY AND SPILL ASSISTANCE NUMBERS: 423 336-4511

A. Illinois Manifest Document Number: IL 7000996 FEE PAID IF APPLICABLE
B. Illinois Generator's ID: 9 5 4 0 6 1 5 4 8 6

5. Transporter 1 Company Name: HORWITH TRUCKING
6. PAD 148 774878 ~~PAD064035819~~
C. Illinois Transporter's ID:
D. 215 261-1411 Transporter's Phone

7. Transporter 2 Company Name: ADVANCED ENVIRONMENTAL TECHNICAL SERVICES, LLC
8. US EPA ID Number: N J D 0 8 0 6 3 1 3 6 9
E. Illinois Transporter's ID: 3 8 9 0
F. (716 879-0606 Transporter's Phone

9. Designated Facility Name and Site Address
CHEMICAL WASTE MANAGEMENT, INC.
#7 MOBILE AVE
SAUGET IL 62201
10. US EPA ID Number: ILD098642424
G. Illinois Facility's ID: 1 6 3 1 2 1 0 0 0 9
H. Facility's Phone: (618) 271-2804

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. HAZARDOUS WASTE, SOLID, N.O.S., 9, NA3077, III, (MERCURY, BENZENE), RQ (D009)	0 0 3	DM	0 0 2 5 5	G	EPA HW Number: X X D 0 0 7; Authorization Number: 0 9 0 0 0 1
b.					EPA HW Number: X X; Authorization Number:
c.					EPA HW Number: X X; Authorization Number:
d.					EPA HW Number: X X; Authorization Number:

J. Additional Description for Materials Listed Above
a. BL2930 D008, D009, D010, K141, K143 NEW MANIFEST
Changed per Steve Morrow 3-18-96 SJ

K. Handling Codes for Wastes Listed Above in Item #14

15. Special Handling Instructions and Additional Information
CHEMTREC Emergency Response Number (800) 424-9300 SR# 283630

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

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

Printed/Typed Name: STEVE MORROW — Signature: Steve Morrow — Date (Month Day Year): 03 06 96

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: Bill Cassium — Signature: Bill Cassium — Date (Month Day Year): 03 06 96

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name: DAVID L. D'ANGELO — Signature: David L. D'Angelo — Date (Month Day Year): 03 07 96

19. Discrepancy Indication Space
#6 wrong EPA Number Bill Cassium

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.
Printed/Typed Name: Diane Bolbach — Signature: Diane Bolbach — Date (Month Day Year): 03 15 96

This Agency is authorized to require, pursuant to Illinois Revised Statute, 1989, Chapter 111 1/2, Section 1004 and 1021, that this information be submitted to the Agency. Failure to provide this information may result in a civil penalty against the owner or operator not to exceed $25,000 per day of violation. Falsification of this information may result in a fine up to $50,000 per day of violation and imprisonment up to 5 years. This form has been approved by the Forms Management Center.

AR303085 7-775B

COPY 1 - TO BE MAILED TO GENERATOR

[redacted] EMERGENCY CONTACT TELEPHONE NUMBER [redacted]

UNIFORM HAZARDOUS WASTE MANIFEST
(Continuation Sheet)

21. Generator's US EPA ID No. WVD000850404 — Manifest Document No. 00001

22. Page 2 of 2

Information in the shaded areas is not required by Federal law.

23. Generator's Name
MORGANTOWN ORDINANCE WORKS
1100 DUPONT ROAD
MORGANTOWN, WV 26505

L. State Manifest Document Number 1000796

M. State Generator's ID 9540615286

24. Transporter 3 Company Name: HAZMAT ENVIRONMENTAL GROUP, INC.

25. US EPA ID Number: NYD980769947

N. State Transporter's ID 1797

O. Transporter's Phone 716-827-7200

26. Transporter ____ Company Name

27. US EPA ID Number

P. State Transporter's ID

Q. Transporter's Phone

28. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	29. Containers No	29. Containers Type	30. Total Quantity	31. Unit Wt/Vol	R. Waste No.
a					
b					
c					
d					
e					
f					
g					
h					
i					

S. Additional Descriptions for Materials Listed Above

T. Handling Codes for Wastes Listed Above
7-7751

32. Special Handling Instructions and Additional Information

GENERATOR

TRANSPORTER

33. Transporter 3 Acknowledgement of Receipt of Materials

Printed/Typed Name: DONALD BATT

Signature: Donald Batt

Date: Month 03 Day 21 Year 9

34. Transporter ____ Acknowledgement of Receipt of Materials

Printed/Typed Name

Signature

Date: Month [redacted] Year

FACILITY

35. Discrepancy Indication Space

AR303086

ORIGINAL-RETURN TO GENERATOR

CHEMICAL WASTE MANAGEMENT, INC
7 Mobile Avenue
Sauget, IL 62201
618/271-2804

INVOICE

THIS IS AN INVOICE FOR CURRENT CHARGES.
PLEASE PAY AMOUNT INDICATED BELOW.

TERMS
DUE UPON REC'T OR
PER CONTRACT

ALL PAST DUE AMOUNTS WILL BEAR INTEREST AT TWO PERCENT PER MONTH OR THE MAXIMUM RATE ALLOWED BY LAW, WHICHEVER IS LESS.

SERVICE PROVIDED BY:
TRADE WASTE INCIN.

OLIN CORPORATION
..
1186 LOWER RIVER RD NW
PO BOX 248
CHARLESTON TN 37310-5230

CUSTOMER ACCOUNT NUMBER		
584 564 4021819		
INVOICE NO.	INVOICE DATE	PAGE
58428961	03/29/96	1

0 1996

960329

REFERENCE NO.	PROFILE	DESC / UNIT	QUANTITY	RATE	AMOUNT
IL07000996-01	TWI-BL2930	PPE/PLASTIC SAMPLING SLEEVES		SVC DATE:	03/15/96
	DISPOSAL	85 GAL DRM	3.00	309.0000	927.00
	TRANSPORTATION	DRUMS	3.00	100.0000	300.00
	PO# OR CONTRACT#	MORGANTOWN ORDINANC			
	HAZ WASTE FEE	GALLONS	255.00	.0300	7.65
				SUBTOTAL	1,234.65 *
7-7753					
PO#FP-HW-MT-96001					
IL07000998-02	TWI-BL2927	EPA DERIVED WASTE/WORKS OU-1 L		SVC DATE:	03/15/96
	DISPOSAL	POUNDS	6,110.00	.8000	4,888.00
	DISPOSAL	OVERPACK	6.00	75.0000	450.00
	TRANSPORTATION	DRUMS	13.00	100.0000	1,300.00
	PO# OR CONTRACT#	MORGANTOWN ORDINANC			
	HAZ WASTE FEE	GALLONS	1,105.00	.0300	33.15
				SUBTOTAL	6,671.15 *
7-7751					
IL07000998-01	TWI-BL2928	EPA DERIVED WASTE/WORKS OU-1 L		SVC DATE:	03/15/96
	DISPOSAL	55 GAL DRM	3.00	250.0000	750.00
	DISPOSAL	85 GAL DRM	1.00	386.0000	386.00
	DISPOSAL	OVERPACK	3.00	75.0000	225.00
	TRANSPORTATION	DRUMS	4.00	100.0000	400.00
	PO# OR CONTRACT#	MORGANTOWN ORDINANC			
	HAZ WASTE FEE	GALLONS	340.00	.0300	10.20
				SUBTOTAL	1,771.20 *
7-7752					

RECEIVED
APR 09 1996
S. G. MURROW

REMIT TO ADDRESS
CHEMICAL WASTE MANAGEMENT, INC
P.O.BOX 651290
CHARLOTTE, N.C. 28265-1290

PLEASE PAY THIS AMOUNT
9,677.00**

WE APPRECIATE YOUR BUSINESS!

ORIGINAL INVOICE

AR303087

STATE OF ILLINOIS

P.O. BOX 19276 SPRINGFIELD, ILLINOIS 62794-9276 217/782-6761

State Form LPC 62 9/91 IL532-0610

(4)

FOR SHIPMENT OF HAZARDOUS AND SPECIAL WASTE

PLEASE TYPE (Form designed for use on elite (12 pitch) typewriter.)

EPA Form 8700-22 (Rev. 6-89)

Form Approved OMB No. 2050-0039, Expires 9/...

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No.: WVD000850404

Manifest Document No.: 00002

2. Page 1 of 2

Information in the shaded areas is not required by Federal law, but is required by Illinois law.

3. Generator's Name and Mailing Address / Location If Different:
MORGANTOWN ORDINANCE WORKS
1100 DUPONT RD
MORGANTOWN WV 26505

A. Illinois Manifest Document Number: IL 7000998 FEE IF A[redacted]

B. Illinois Generator's ID: 9 5 4 0 6 1 5 4 8

4. 24 HOUR EMERGENCY AND SPILL ASSISTANCE NUMBERS: 423 336-4511

5. Transporter 1 Company Name: HORWITH TRUCKING

6. US EPA ID Number: PAD 986 914 878 ~~PAD986035819~~

C. Illinois Transporter's ID:

D. 215 261-1411 Transporter's Phone

7. Transporter 2 Company Name: ADVANCED ENVIRONMENTAL TECHNICAL SERVICES, LLC

8. US EPA ID Number: N J D 0 8 0 6 3 1 3 6 9

E. Illinois Transporter's ID: 3 8 9

F. (716) 879-0600 Transporter's Phone

9. Designated Facility Name and Site Address:
CHEMICAL WASTE MANAGEMENT, INC.
#7 MOBILE AVE
SAUGET IL 62201

10. US EPA ID Number: I L D 0 9 8 6 4 2 4 2 4

G. Illinois Facility's ID: 1 6 3 1 2 1 0 0 0

H. Facility's Phone: (618) 271-2804

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. WASTE FLAMMABLE LIQUIDS, N.O.S., 3, UN1993, III, (TOLUENE), RQ (D001)	0.0.4	DM	3 4 0	G	EPA HW Number: X X D 0 0 1; Authorization Number: 0 9 0 0 0
b. HAZARDOUS WASTE, SOLID, N.O.S., 9, NA3077, III, (MERCURY, BENZENE), RQ (D009)	0 1 3	DM	1 1 0 5	G	EPA HW Number: X X D 0 0 1; Authorization Number: 0 9 0 0 0
c.					EPA HW Number: X X; Authorization Number:
d.					EPA HW Number: X X; Authorization Number:

J. Additional Description for Materials Listed Above
a. BL2928
b. BL2930 D008, D009, D010, K141, K143
27 per Steve Morrow 3-18-96 SP

K. Handling Codes for Wastes Listed A[redacted] in Item #14

15. Special Handling Instructions and Additional Information
CHEMTREC Emergency Response Number (800) 424-9300 SR# 283630

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

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

Printed/Typed Name: Melissa Whittington — Signature: Melissa Whittington — Date (Month Day Year): 0 3 0 6 9

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name: Bill Cassrum — Signature: Bill Cassrum — Date (Month Day Year): 0 3 0 6 9

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name: DAVID L. D'ANGELO — Signature: David L. D'Angelo — Date (Month Day Year): 0 3 0 7 9

FACILITY

19. Discrepancy Indication Space
Wrong EPA Number - Bill Cassrum

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.

Printed/Typed Name: Diane Belbach — Signature: Diane Belbach — Date (Month Day Year): 0 3 1 5 9

This Agency is authorized to require, pursuant to Illinois Revised Statute, 1989, Chapter 111 1/2, Section 1004 and 1021, that this information be submitted to the Agency. Failure to provide this information may result in a civil penalty against the owner or operator not to exceed $25,000 per day of violation. Falsification of this information may result in a fine up to $50,000 per day of violation and imprisonment up to 5 years. This form has been approved by the Forms Management Center.

AR303088 7-7752 A ~~7-7753~~ B 7-7751

COPY 1 - TSD MAIL TO GENERATOR

EMERGENCY CONTACT TELEPHONE NUMBER

UNIFORM HAZARDOUS WASTE MANIFEST
(Continuation Sheet)

21. Generator's US EPA ID No. WVD000850404 — Manifest Document No. 00002

22. Page 2 of 2

Information in the shaded areas is not required by Federal law.

23. Generator's Name
MORGANTOWN ORDINANCE WORKS
1100 DUPONT ROAD
MORGANTOWN, WV 26505

L. State Manifest Document Number 7000998

M. State Generator's ID 9540615486

24. Transporter 3 Company Name: HAZMAT ENVIRONMENTAL GROUP, INC.

25. US EPA ID Number: NYD980769947

N. State Transporter's ID 1797

O. Transporter's Phone 716-827-7200

26. Transporter ____ Company Name

27. US EPA ID Number

P. State Transporter's ID

Q. Transporter's Phone

28. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Numbers)	29. Containers No	Type	30. Total Quantity	31. Unit Wt/Vol	R. Waste No.
a.					
b.					
c.					
d.					
e.					
f.					
g.					
h.					
i.					

S. Additional Descriptions for Materials Listed Above

T. Handling Codes for Wastes Listed Above
7-7752
7-7753

32. Special Handling Instructions and Additional Information

GENERATOR

TRANSPORTER

33. Transporter 3 Acknowledgement of Receipt of Materials

Printed/Typed Name: DONALD BATT — Signature: Donald Batt — Date: Month 03 Day 12 Year 90

34. Transporter ____ Acknowledgement of Receipt of Materials

Printed/Typed Name — Signature — Date: Month Day Year

FACILITY

35. Discrepancy Indication Space

AR303089

ORIGINAL-RETURN TO GENERATOR

Olin-Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	LA-46-03-04		LA-46-03-04 DUP.					LA-46-03-04 MS		LA-46-03-04 MSD		
Sampled date:	02/02/96		02/02/96									
Date Analysis:	02/05/96		02/05/96					02/05/96		02/05/96		
Matrix	SOIL											
								Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	2.60	0.40	5.00	0.60	0.60	12.50	13.10	12.10	92.4	12.70	96.9	4.84
Chrysene	1.90	0.30	2.70	0.40	0.35	12.50	12.85	12.60	99.6	13.30	103.5	3.83
Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.80	94.4	11.90	95.2	0.84
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.60	92.8	11.80	94.4	1.71
Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.80	94.4	12.10	96.8	2.51
Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	13.70	109.6	10.90	87.2	-22.76
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.70	93.6	12.00	96.0	2.53
Chlorotoluene(Recovery%)		95.9		96.2				95.6		85		

AR303090

Olin—Macgamieum Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	SA-19-00-04	SA-19-00-04 DUP.						SA-19-00-04 MS		SA-19-00-04 MSD		
Sampled date:	02/04/96	02/04/96										
Date Analysis:	02/04/96	02/04/96						02/04/96		02/04/96		
Matrix	SOIL											
								Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Blanket	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.50	92.0	11.80	94.4	2.58
Chrysene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	13.20	105.6	13.60	108.8	2.99
Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.40	91.2	11.80	94.4	3.45
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.60	92.8	11.90	95.2	2.55
Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	11.60	92.8	11.80	94.4	1.71
Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	12.40	99.2	12.80	102.4	3.17
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.50	12.50	12.30	98.4	12.60	100.8	2.41
Chlorotoluene(Recovery%)		107		97.6				98.1		98.1		

AR303091

Olin-Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	SA-22-00-04 RE	SA-22-00-04 RE DUP.						SA-22-00-04 RE MS		SA-22-00-04 RE MSD		
Sampled date:	02/05/96	02/05/96										
Date Analysis:	03/15/96	03/15/96						03/15/96		03/15/96		
Matrix	SOIL											
Compound	mg/kg in sample	ug/ml in extract 1:4	mg/kg in sample duplicate	ug/ml in extract duplicate 1:4	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	Replicate 1 ug/ml 1:4 FOUND	% Recovery	Replicate 2 ug/ml 1:4 FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	716.80	25.61	971.90	34.41	30.01	6.25	36.26	35.20	97.1	49.34	136.1	33.45
Chrysene	613.70	21.92	834.80	29.56	25.74	6.25	31.99	30.40	95.0	43.15	134.9	34.67
Benzo(b)fluoranthene	470.40	16.81	728.10	25.78	21.30	6.25	27.55	27.00	98.0	36.57	132.8	30.11
Benzo(k)fluoranthene	427.80	15.28	592.00	20.96	18.12	6.25	24.37	20.00	82.1	26.01	106.7	28.12
Benzo(a)pyrene	550.40	19.66	765.20	27.09	23.38	6.25	29.63	27.10	91.5	37.28	125.8	31.62
Indeno(1,2,3-cd)pyrene	339.90	12.15	434.50	15.38	13.77	6.25	20.02	18.40	91.9	21.07	105.3	13.53
Dibenzo(a,h)anthracene	41.50	1.48	45.50	1.61	1.55	6.25	7.80	7.00	89.8	7.55	96.9	7.58
Chlorotoluene(Recovery%)		141.1		151.5				150		181.8		

AR303092

Olin–Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	SA-22-00-04	SA-22-00-04 DUP.						SA-22-00-04 MS		SA-22-00-04 MSD		
Sampled date:	02/06/96	02/06/96										
Date Analysis:	02/07/96	02/28/96						02/28/96		02/28/96		
Matrix:	SOIL											
Compound	mg/kg in sample	ug/ml in extract 1:2	mg/kg in sample duplicate	ug/ml in extract duplicate 1:2	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	Replicate 1 ug/ml 1:2 FOUND	% Recovery	Replicate 2 ug/ml 1:2 FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	764.70	54.64	1068.70	77.09	65.87	6.25	72.12	74.95	103.9	100.53	151.9	37.49
Chrysene	675.40	48.26	1108.20	79.95	63.41	6.25	69.66	77.40	111.1	114.49	164.4	38.66
Benzo(b)fluoranthene	643.60	46.00	964.90	67.62	56.81	6.25	63.06	68.78	109.0	101.05	160.3	38.03
Benzo(k)fluoranthene	402.00	28.72	527.20	37.33	33.03	6.25	39.28	39.18	99.8	47.39	120.7	18.94
Benzo(a)pyrene	633.80	45.29	867.40	61.42	53.36	6.25	59.61	61.91	103.9	86.46	145.1	33.09
Indeno(1,2,3-cd)pyrene	367.70	26.42	602.70	42.66	36.66	6.25	41.80	37.00	88.5	45.33	108.4	20.24
Dibenzo(a,h)anthracene	38.10	2.72	52.30	3.71	3.22	6.25	9.47	14.06	148.4	15.61	164.9	10.52
Chlorotoluene (Recovery%)		144		196.1				147		172		

AR303093

Olin-Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	DS1-17-02-04				DS1-17-02-04 MS		DS1-17-02-04 MSD		
Sampled date:	02/14/96								
Date Analysis:	02/16/96				02/26/96		02/26/96		
Matrix	SOIL								
					Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	ug/ml Spiked	ug/ml Expect	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	12.5	12.50	11.16	89.3	12.29	98.3	9.64
Chrysene	0.00	0.00	12.5	12.50	13.12	105.0	14.24	113.9	8.19
Benzo(b)fluoranthene	0.00	0.00	12.5	12.50	11.62	93.0	12.67	101.4	8.65
Benzo(k)fluoranthene	0.00	0.00	12.5	12.50	11.16	89.3	12.18	97.4	8.74
Benzo(a)pyrene	0.00	0.00	12.5	12.50	11.76	94.1	12.83	102.6	8.70
Indeno(1,2,3-cd)pyrene	0.00	0.00	12.5	12.50	14.21	113.7	15.40	123.2	8.04
Dibenzo(a,h)anthracene	0.00	0.00	12.5	12.50	13.59	108.7	14.75	118.0	8.19
Chlorotoluene(Recovery%)		95.7			89.7		60.8		

AR303094

Ohio–Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	LA–76–02–04				LA–76–02–04 MS		LA–76–02–04 MSC		
Sampled date:	02/18/96								
Date Analysis:	02/18/96				02/22/96		02/27/96		
Matrix	SOIL								
					Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	ug/ml Spiked	ug/ml Expect	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	12.5	12.50	14.76	118.1	12.74	101.9	−14.69
Chrysene	0.00	0.00	12.5	12.50	13.71	109.7	14.49	115.9	5.63
Benzo(b)fluoranthene	0.00	0.00	12.5	12.50	14.68	117.4	12.74	101.9	−14.15
Benzo(k)fluoranthene	0.00	0.00	12.5	12.50	14.52	116.2	12.45	99.6	−15.35
Benzo(a)pyrene	0.00	0.00	12.5	12.50	14.87	119.0	12.75	102.0	−15.35
Indeno(1,2,3–cd)pyrene	0.00	0.00	12.5	12.50	15.78	126.2	13.60	108.8	−14.84
Dibenzo(a,h)anthracene	0.00	0.00	12.5	12.50	16.16	129.3	13.90	111.2	−15.04
Chlorotoluene(Recovery%)		101.8			108.5		95.3		

AR303095

Olin–Morgantown Phase II PAH Screening Results
Matrix Spike Recovery.

Sample ID:	SA–06–00–04	SA–06–00–04 DUP.						SA–06–00–04 MS		SA–06–00–04 MS		
Sampled date:	02/06/96	02/06/96										
Date Analysis:	02/06/96	02/23/96						02/23/96		02/23/96		
Matrix	SOIL											
								Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	11.97	95.8	12.19	97.5	1.82
Chrysene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.99	103.9	12.68	101.4	-2.42
Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	11.83	94.6	12.13	97.0	2.50
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.01	96.1	12.34	98.7	2.71
Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	11.92	95.4	12.22	97.8	2.49
Indeno(1,2,3–cd)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.42	99.4	12.81	102.5	3.09
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.96	103.8	13.43	107.4	3.41
Chlorotoluene(Recovery%)		93.6		93.5				93.4		93.4		

AR303096

Olin—Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	LA-36-05-06	LA-36-05-06 DUP.						LA-36-05-06 MS		LA-36-05-06 MSD		
Sampled date:	02/02/96	02/02/96										
Date Analyzed:	02/04/96	02/23/96						02/23/96		02/20/96		
Matrix	SOIL											
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	Replicate 1 ug/ml FOUND	% Recovery	Replicate 2 ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	27.00	4.10	37.10	5.45	4.78	12.5	17.28	16.58	96.0	15.66	91.6	-4.50
Chrysene	21.50	3.30	30.80	4.60	3.90	12.5	16.40	13.19	80.4	15.76	96.1	17.75
Benzo(b)fluoranthene	13.00	2.00	20.00	2.84	2.47	12.5	14.97	16.90	112.9	16.19	108.1	-4.29
Benzo(k)fluoranthene	15.00	2.30	24.90	3.66	2.98	12.5	15.48	16.67	107.7	16.20	104.7	-2.86
Benzo(a)pyrene	19.30	2.90	29.20	4.31	3.61	12.5	16.11	18.10	112.4	17.34	107.7	-4.29
Indeno(1,2,3-cd)pyrene	12.90	2.00	18.50	2.72	2.36	12.5	14.86	17.61	118.9	15.90	113.7	-5.24
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	15.59	124.7	15.22	121.8	-2.40
Chlorotoluene(Recovery%)		87.7		102				103.9		101		

AR303097

Olin-Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	LA-60-04-06		LA-60-04-06 DUP.					LA-60-04-06 MS		LA-60-04-06 MSD		
Sampled date:	02/06/96		02/06/96									
Date Analysis:	02/06/96		02/22/96					02/22/96		02/22/96		
Matrix	SOIL											
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	Replicate 1 ug/ml FOUND	% Recovery	Replicate 2 ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.04	96.3	12.50	100.0	3.75
Chrysene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.72	101.8	14.17	113.4	10.78
Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.37	99.0	12.66	101.3	2.32
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.19	97.5	12.91	103.3	5.74
Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.53	100.2	12.87	103.0	2.68
Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.83	118.6	13.59	108.7	-8.73
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.43	115.4	14.14	113.1	-2.03
Chlorotoluene(Recovery%)		96.6		97				94.6		99.6		

AR303098

Olin—Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	SA-25-00-02	SA-25-00-02	SA-25-00-02 MS	SA-25-00-02 MSD
Sampled date:	02/14/96	02/14/96		
Date Analyzed:	02/21/96	02/22/96	02/22/96	02/22/96
Matrix	SOIL			

Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	Replicate 1 ug/ml FOUND	% Recovery	Replicate 2 ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.14	97.1	12.72	101.8	4.67
Chrysene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.17	113.4	14.60	116.8	2.99
Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.64	101.1	12.63	101.0	−0.08
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.60	100.8	12.89	103.1	2.28
Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.57	100.6	12.88	103.0	2.44
Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	13.49	107.9	13.88	111.0	2.85
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.28	114.2	14.54	116.3	1.80
Chlorotoluene(Recovery%)		99.7		98.9				97.1		96.2		

AR303099

Olin–Morgantown Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	SA-27-00-02	SA-27-00-02 DUP.						SA-27-00-02 MS		SA-27-00-02 MSD		
Sampled date:	02/12/96	02/12/96										
Date Analysis:	02/15/96	02/27/96						02/27/96		02/27/96		
Matrix	SOIL											
								Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.46	99.7	12.31	98.5	-1.21
Chrysene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.12	113.0	13.96	111.7	-1.14
Benzo(b)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.57	100.6	12.51	100.1	-0.48
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.60	100.8	12.38	99.0	-1.76
Benzo(a)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	12.88	102.9	12.67	101.4	-1.48
Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.02	112.2	13.38	107.0	-4.67
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.50	116.0	13.65	109.2	-6.04
Chlorotoluene(Recovery%)		104.7		97.9				101		100.9		

AR303100

Olin–Morganton Phase II PAH Screening Results
Matrix Spike Recovery

Sample ID:	D61-11		D61-11 DUP.					D61-11 MS		D61-11 MSD		
Sampled date:	02/10/96		02/10/96									
Date Analysis:	02/13/96		02/13/96					02/27/96		02/27/96		
Matrix:	SOIL											
								Replicate 1		Replicate 2		
Compound	mg/kg in sample	ug/ml in extract	mg/kg in sample duplicate	ug/ml in extract duplicate	Average ug/ml in extract	ug/ml Spiked	ug/ml Expect	ug/ml FOUND	% Recovery	ug/ml FOUND	% Recovery	REL % DIFF
Benzo(a)anthracene	3.99	0.59	7.44	1.06	0.83	12.5	13.33	14.64	109.9	13.60	102.1	-7.37
Chrysene	3.84	0.57	7.17	1.02	0.80	12.5	13.30	14.46	108.8	15.01	112.9	3.73
Benzo(b)fluoranthene	2.60	0.37	4.67	0.66	0.52	12.5	13.02	13.58	104.3	13.20	101.4	-2.84
Benzo(k)fluoranthene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	13.58	108.6	13.00	104.0	-4.36
Benzo(a)pyrene	3.14	0.47	6.08	0.86	0.67	12.5	13.17	14.06	107.0	13.48	102.4	-4.35
Indeno(1,2,3-cd)pyrene	0.00	0.00	3.31	0.47	0.24	12.5	12.74	15.78	123.8	15.36	120.6	-2.57
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00	0.00	12.5	12.50	14.59	116.7	14.93	119.4	2.30
Chlorotoluene(Recovery%)		101.8		96.5				94.5		95.8		

AR303101

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES
3355 McLemore Drive
Pensacola, Florida 32514
(904) 857-0606

June 24, 1996

Mr. R. Daniel Looper, P.E.
LAW Engineering & Environmental Services, Inc.
112 TownPark Dr.
Kennesaw, GA 30144

SUBJECT: Laboratory Audit Report

Dear Mr. Looper,

Enclosed is a summary of my findings for the validation of the IEA screening data (SW8270). The validation was performed in support of the Morgantown Ordnance Works Operable Unit One Work Plan. The validation was performed for compliance to: 1) Administrative Order for Remedial Design and Remedial Action, Operable Unit One, Morgantown Ordnance Works, USEPA, Region III, dated June 20, 1990; 2) Work Plan Phase II Interim Tasks for Morgantown Ordnance Works Site OU1, Morgantown West Virginia, dated November 1995; 3) Methodological compliance to the stated methods in the Work Plan; 4) Data Quality Objectives for Remedial Response Activities 1987 and 5) USEPA National Functional Guidelines for Data Review, February 1, 1988.

Feel free to contact me at (904)969-6128 if you have questions or need additional information.

Sincerely,

Keith R. Greene

I. Compliance to Administrative Order for Remedial Design and Remedial Action, USEPA, Region III, Dated June 20, 1990.

A. IEA laboratory has complied to the Administrative Order. No deviations were found.

II. Compliance to Work Plan

A. IEA laboratory has complied to the workplan. The workplan did not address the modifications required to comply to the administrative order (ie. analyzing samples by SW8270 for confirmation). The laboratory adhered to the methodological objectives.

1. The definition of Level III Data Quality Objectives is as stated "All analyses performed in an off-site analytical laboratory. Level III analyses may or may not use CLP procedures, but do not usually utilize the validation or documentation procedures required of CLP Level IV analysis. The laboratory may or may not be a CLP laboratory".

A. The IEA laboratory has provided the level of documentation needed to satisfy this requirement.

III. Methodological compliance

A. Methodological compliance to method SW8270

1. The IEA laboratory has performed the methodological requirements as stated in SW-846, method SW8270. No deviations were found.

The laboratories data was inspected for the above stated objectives.