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Results of the long-term study show that there is essentially little change in the dissolution of metal ions into the water column. It is recommended that shrouding systems continue to be used on bridge cleaning operations pending completion of more in-depth environmental investigations.

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

LONG TERM ENVIRONMENTAL EVALUATION OF PAINT RESIDUE AND BLAST CLEANING ABRASIVES FROM THE MIDDLE RIVER BRIDGE REPAINTING PROJECT

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Chief, Office of Transportation Laboratory

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17. KEY WORDS	18. DISTRIBUTION STATEMENT
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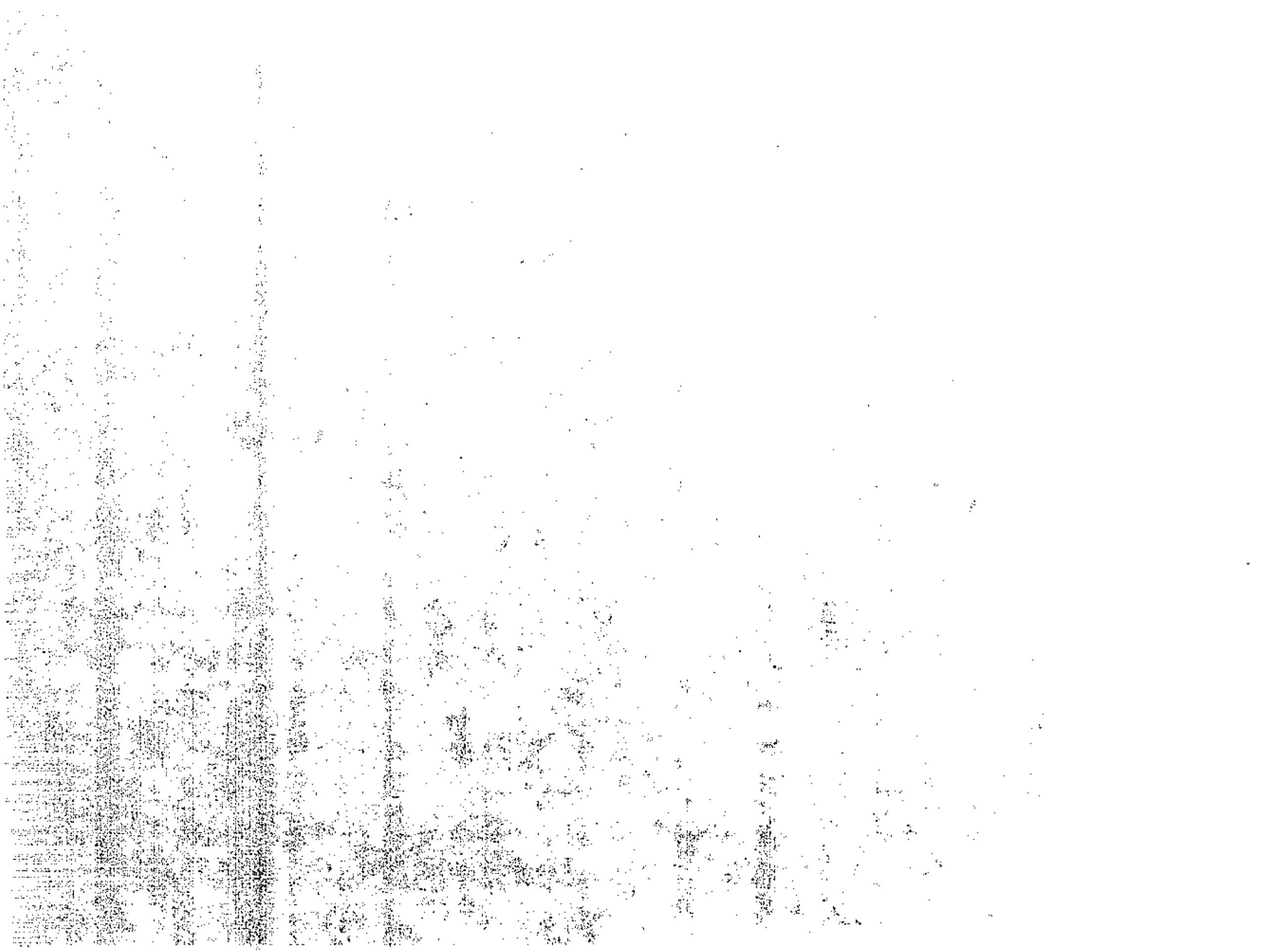

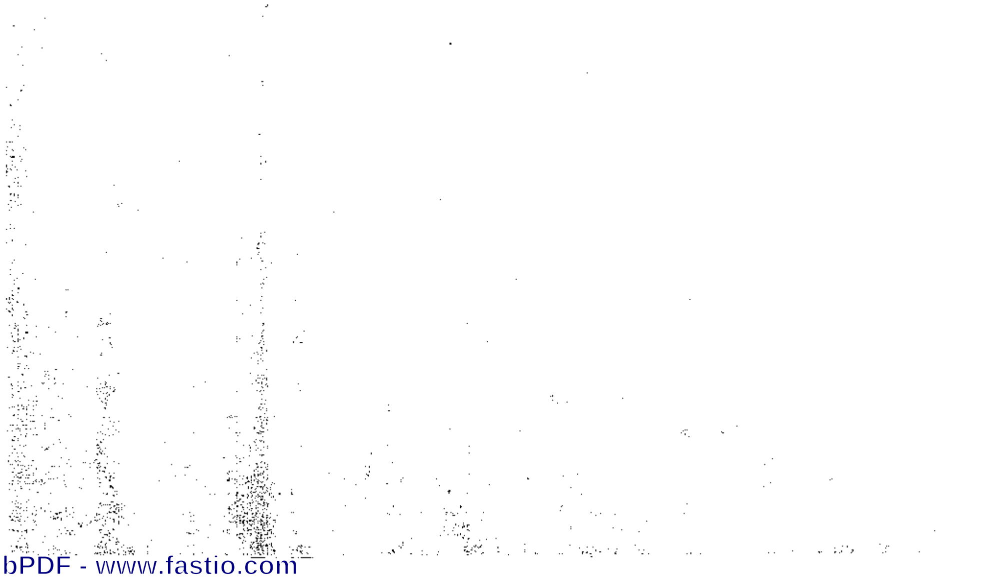

CONVERSION FACTORS

English to Metric System (SI) of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)or(")	25.40 .02540	millimetres (mmm) metres (m)
	feet (ft)or(')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2)	6.432×10^{-4}	square metres (m^2)
	square feet (ft^2) acres	.09290 .4047	square metres (m^2) hectares (ha)
Volume	gallons (gal)	3.785	litres (l)
	cubic feet (ft^3)	.02832	cubic metres (m^3)
	cubic yards (yd^3)	.7646	cubic metres (m^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour (mph) feet per second (fps)	.4470 .3048	metres per second (m/s) metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity (G)	9.807	metres per second squared (m/s^2)
Weight Density	pounds per cubic (lb/ft^3)	16.02	kilograms per cubic metre (kg/m^3)
Force	pounds (lbs) kips (1000 lbs)	4.448 4448	newtons (N) newtons (N)
Thermal Energy	British thermal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds (ft-lb) foot-kips (ft-k)	1.356 1356	joules (J) joules (J)
Bending Moment or Torque	inch-pounds (ft-lbs) foot-pounds (ft-lbs)	.1130 1.356	newton-metres (Nm) newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Stress Intensity	kips per square inch square root inch (ksi $\sqrt{in}$)	1.0988	mega pascals $\sqrt{metre}$ (MPa $\sqrt{m}$)
	pounds per square inch square root inch (psi $\sqrt{in}$)	1.0988	kilo pascals $\sqrt{metre}$ (KPa $\sqrt{m}$)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (F)	$\frac{tF - 32}{1.8} = tC$	degrees celsius (°C)

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INTRODUCTION

Middle River Bridge is located in the San Joaquin Delta on Route 4 about 10 miles west of Stockton, California, Figure 1. This 547-foot steel bridge spans a delta river which supports many types of aquatic life normally found in delta waters.

Middle River water is suitable for irrigation but would have to be treated for domestic use. The flow of the river in this area is influenced by tidal fluctuations and drafts from two nearby pumping stations, Figure 1.

In 1976, Middle River Bridge was blast cleaned and repainted. At that time, the Central Valley Regional Water Quality Control Board and the Department of Fish and Game were concerned with possible environmental impacts from these operations. In response to this concern, the California Department of Transportation (Caltrans) initiated a study to determine any short-term impacts on river water quality due to this project. Caltrans' Office of Transportation Laboratory (TransLab) conducted this work in cooperation with District 10. The results of the study were published in a Caltrans report titled "The Effects on the Aquatic Environment Due to the Cleaning and Repainting of the Middle River Bridge", CA-TL-7108-77-29, September 1977.

Middle River Bridge was previously repainted in 1953 with three coats of paint. The 3-mil undercoat was a ready-mixed, semiquick drying priming paint containing 97% red lead. The finish coat consisted of a 1-mil phenolic varnish base paint containing 74% aluminum.

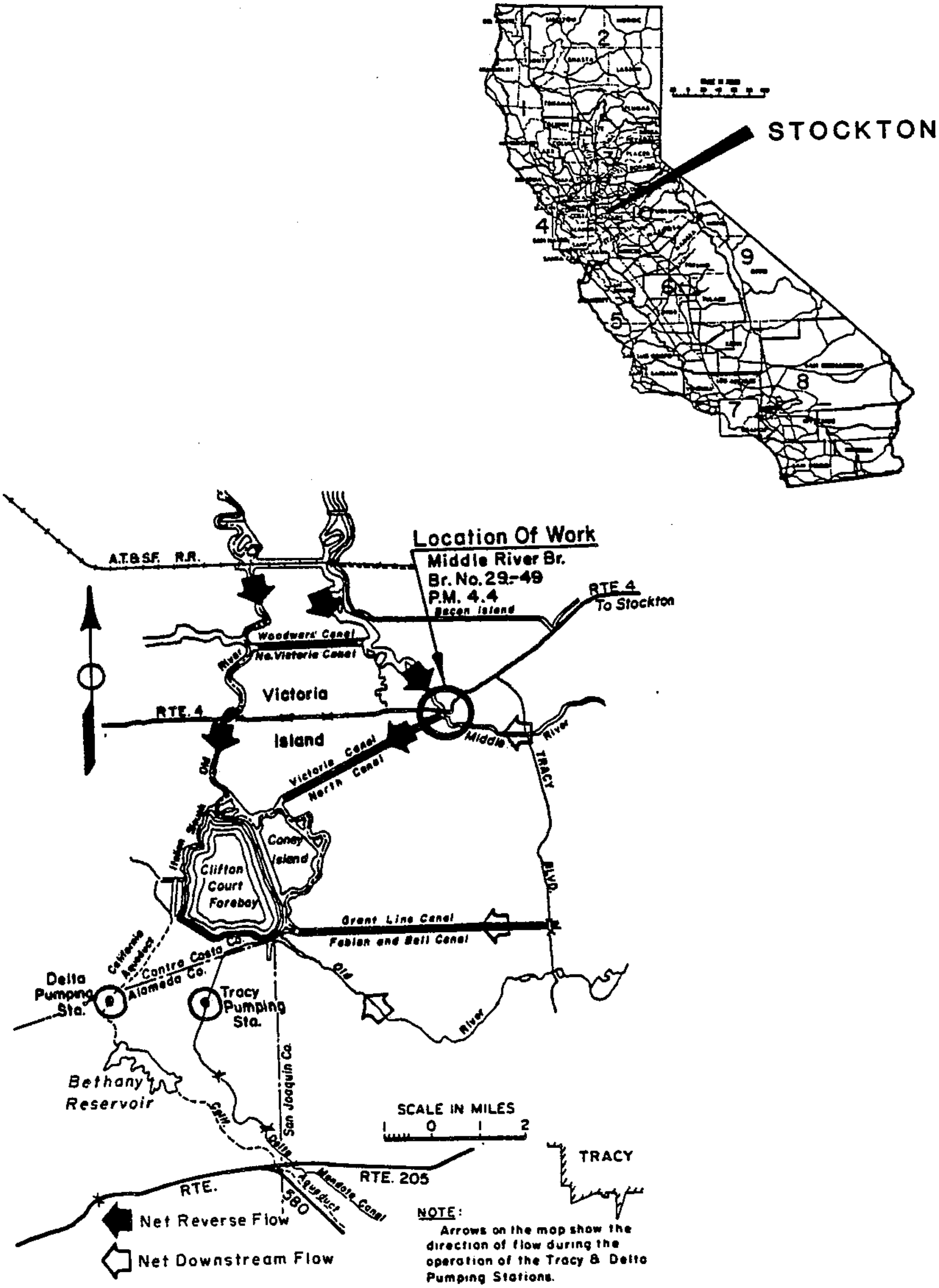


FIGURE 1, PROJECT LOCATION

During the bridge cleaning operation in 1976, approximately 4,100 lbs of lead and 180 lbs of aluminum were removed from the steel bridge with approximately 314 tons of slag type blast cleaning abrasives(1).

The 1976-77 study concluded that approximately 50-75% of the waste material (paint residue and blasting abrasives) was contained by the shrouding system used to prevent these materials from entering the Middle River. The containment system consisted of porous drapes attached by cables at the top of the bridge, extending below the bridge deck to a small barge floating in the river, Figures 2, 3 and 4. Originally, nonporous drapes were used, however, they were replaced with porous drapes when billowing caused by the turbulence of the blasting operation and the wind allowed waste material to be dumped into the river.

Due to the large volume of water (148,500 cfs) available to dilute the waste material which was not captured by the shrouding system, no harmful effects to aquatic life were identified in the 1976-77 study. The study recommended that a long-term evaluation of the dissolution of metals in the waste material from the bridge repainting project and from samples of the river bottom be investigated.

The long-term evaluation was accomplished as part of a Federal Highway Administration research project (E75TL03), "Mitigation of Highway Related Chemical Water Quality Pollutants". The results of this study are contained in this report. Two and three-year analyses of the dissolution of metals from the waste material collected during the 1976-77 study are presented along with dissolved metal concentrations found in Middle River water samples taken two, three

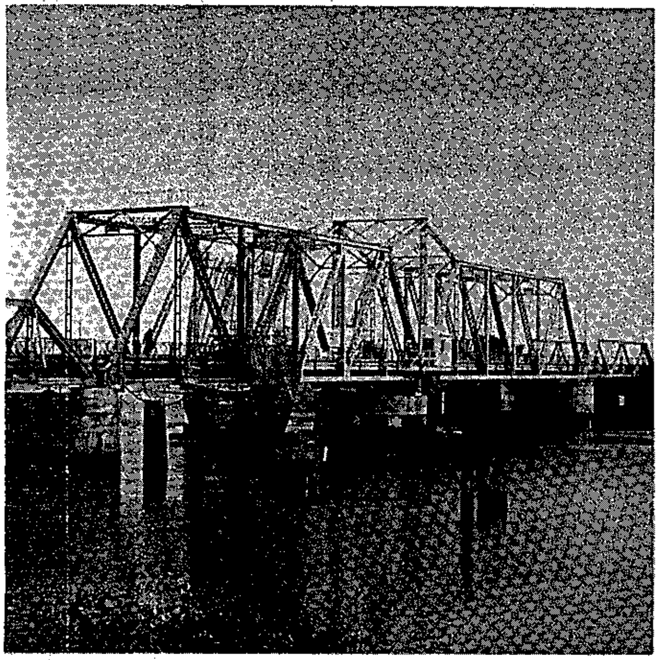


Figure 2

Middle River Bridge during repainting operations.

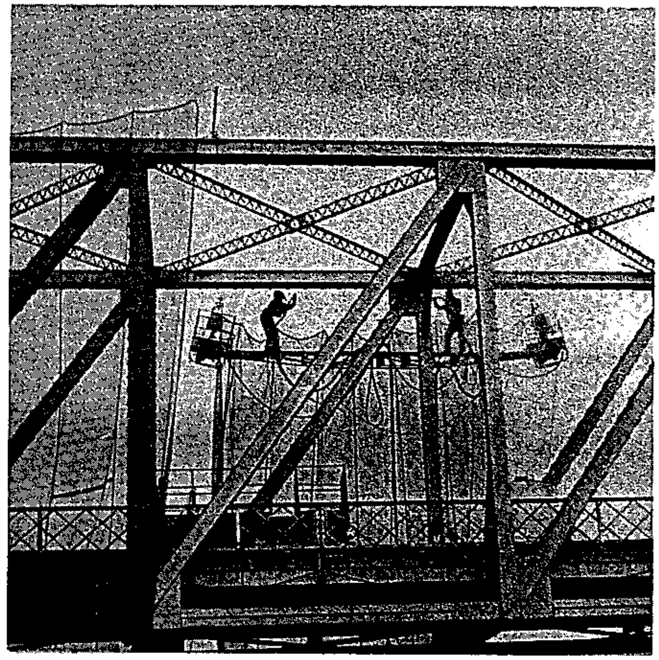


Figure 3

One end of the drapes attached to cables near the top of the superstructure.

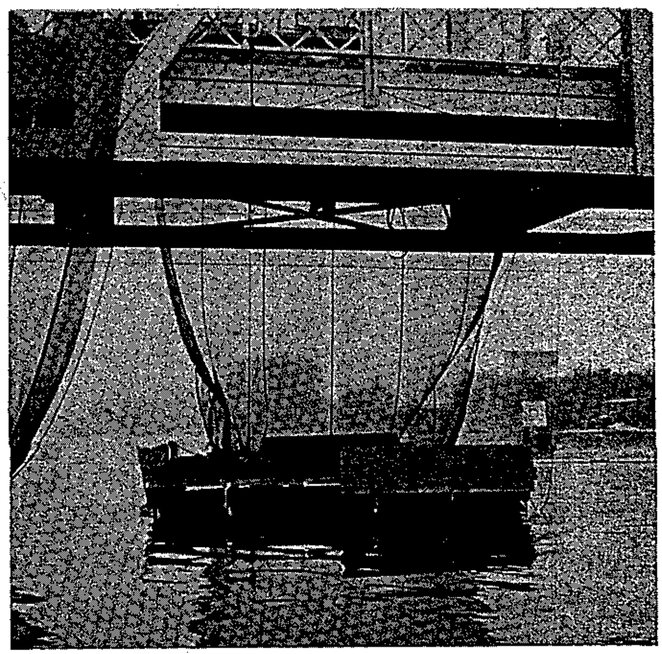


Figure 4

The lower ends of the drapes were placed on a small barge floating in the river.

and four years after completion of the bridge repainting project. The distribution of blast cleaning abrasives which escaped shrouding and entered the river during the cleaning operation is also reported.

CONCLUSIONS

The following conclusions are based on a limited number of test results:

° Samples of paint residue and blast cleaning abrasives were placed in flasks containing distilled water and Middle River water at the time the bridge was cleaned and repainted. Water samples taken from these flasks two and three years later had dissolved lead, iron, chromium and aluminum concentrations of 0.1 mg/l or less. Based on these results, there were no discernible increases in the dissolved concentrations of these metals within this time period.

° Analysis of Middle River water samples taken two, three and fours years after the repainting project showed neither significant differences among the dissolved concentrations of lead, iron, chromium or aluminum at the upstream or downstream sampling locations in the vicinity of the bridge, nor significant increases in these dissolved metal concentrations since the bridge repainting project was completed.

° For all bottom samples, the percentage by weight of blast cleaning abrasives during the four year sampling period after the repainting project was less than 5%, but the amount found in each sample varied across the width of the river. More blasting abrasives were found close to the banks and near bridge piers where there were low flows. Generally, the abrasives remained within approximately 100 feet of the bridge with varying amounts decreasing downstream to about 500 feet from the bridge.

RECOMMENDATIONS

° Since the scope of this study did not address effects on the aquatic ecosystem, more thorough studies should be initiated to identify long-term aquatic effects associated with bridge cleaning and repainting projects. Additional work should include bioassays and tissue uptake studies to determine the chronic effects of bridge repainting materials on the various trophic levels of the river environment.

° Until the results of long-term aquatic ecosystem studies are known, a shrouding or containment system should be used to collect the paint residue and cleaning material from bridge cleaning and repainting projects. Shrouding, cleaning and painting specifications for the Middle River Bridge repainting project are in the Appendix.

° Additional work should be initiated to develop test procedures for determining environmentally acceptable cleaning, blasting and painting materials for use on bridge repainting projects. These procedures would minimize possible environmental impacts by excluding the use of deleterious materials.

IMPLEMENTATION

Copies of this report will be distributed to the Federal Highway Administration, California Department of Transportation's 11 Districts and appropriate Headquarters offices. The Federal Highway Administration will distribute the report within their organization and to other interested highway agencies.

Information in this report will be used in the Transportation Laboratory's proposed research study titled "Effects of Bridge Repainting Operations on the Environment". Information from all of these studies will be used to develop specifications for future bridge cleaning and repainting operations to protect the environment.

SAMPLING AND TESTING PROCEDURES

Dissolution Tests of Paint Residue and Blast Cleaning Abrasives

In order to study possible long-term effects of the waste material that may go into solution in the Middle River, samples of paint residue and blast cleaning abrasives were taken from the bridge deck and the barge during the blasting operation. Samples were obtained by placing 8x20 foot sheets of plastic directly below the work area for approximately 30 minutes during the blasting operation. Representative samples were prepared from the material collected from the bridge deck and the barge.

Eighty-gram samples from the bridge deck were placed in flasks containing 400 milliliters (1:5 dilution) of deionized water (pH 6.5). Samples from the barge were prepared in the same manner except the water used was taken from the Middle River (pH 8.2). The four flasks were agitated daily and 15-milliliter aliquots were taken and filtered through a Whatman No. 40 paper filter and the filtrate analyzed. Dissolved lead, iron, chromium and aluminum concentrations in the filtrates were determined after 25 months and 39 months. Metal analyses were conducted at TransLab using a Perkin-Elmer Model 403, Atomic Absorption Spectrophotometer (AA) according to test methods in Standard Methods(2).

Middle River Water Analyses

Middle River water samples were taken at 27, 40 and 48 months after the repainting operation. These samples were taken at about 500 feet upstream and downstream from the Middle River Bridge in the middle of the river from a boat using a plastic Kemmerer sampler. Additional river water samples were taken under the bridge at 40 and 48 months. At each sampling location, individual samples were taken one foot above the bottom of the river, at mid-depth, and at one foot below the surface of the river.

A composite sample was made for each sampling location by combining an equal volume of water from the three sampling depths. Dissolved concentrations of lead, iron, chromium and aluminum in these composite water samples were determined at the TransLab using the same methods described for the flask analyses. Field pH and electrical conductivity readings were measured with a Martek Mark V Water Quality Analyzer.

River Bottom Sampling

Bottom samples were taken with a drag bucket within 100 feet of the bridge at various locations 27 and 40 months after completion of the bridge repainting project.

A more complete set of bottom samples used to determine the distribution of blast cleaning abrasives remaining on the bottom of the Middle River in the vicinity of the bridge was obtained four years after the project was completed. Samples were taken, at this time, along five transects parallel to the streamline. Samples were taken along each transect under the bridge and at 20 feet, 100 feet and 500 feet (only at the middle of the river) upstream from the bridge. Samples were also obtained along the same transects downstream from the bridge at 100 foot intervals out to 500 feet.

A drag bucket was used to retrieve the river bottom samples. The bucket was thrown from a motor boat at a point approximately 50 feet on one side of the transect line. As the boat travelled parallel to the bridge (perpendicular to the transect line), the bucket was dragged along the bottom of the river past the sampling location to a position about 50 feet on the other side of the transect line. If a bottom sample was not obtained in one pass, a second sampling attempt was made.

The bottom samples were oven dried, split and weighed. The percentage of blast cleaning abrasives by weight for each representative sample was determined as follows: The blast abrasive particles were counted using a microscope and the weight of these particles was calculated by multiplying the number of particles by the unit weight of a representative sample of unused blasting abrasives. The weight of the particles was then divided by the total weight of the representative bottom sample and multiplied by 100 to determine the percentage of blasting abrasives in each bottom sample.

Green Diamond (290 tons) and Kleen Blast (24 tons) slag type blasting abrasives were used to clean the Middle River Bridge in 1976. The green particles of the Green Diamond abrasives were more easily seen with a microscope than the black Kleen Blast abrasive particles. Both types of abrasives were counted at TransLab with an American Optical Stereoscopic Microscope.

RESULTS AND DISCUSSION

Dissolved metal concentrations determined from analyses of flasks containing samples of paint residue and blasting abrasives and either Middle River or deionized water are shown in Table 1. The results of the long-term evaluations, representing two and three years, are included with the short-term test results of one hour to 90 days reported by Nakao, et al, after the Middle River Bridge repainting project was completed(1). The metal analyses of the flask samples indicate that, under laboratory conditions, only a small amount of lead, iron, chromium or aluminum dissolved within a three-year period after the repainting project.

One-way analysis of variance and linear regression statistical tests were run for the mean concentrations of each parameter from both the barge and the bridge deck flask sample results shown in Table 1. Results of these tests indicated that even though there was a significant difference at the 95% confidence level between the means of the dissolved metal concentrations (lead, iron, chromium and aluminum) for each set of data, there was no correlation of the data with respect to time.

Based on the limited amount of data, possible sampling errors, and realizing that the detection limits were approached for some of the parameters during the AA analyses of the flask samples, these results show that there have been no appreciable increases in the dissolved concentrations of lead, iron, chromium or aluminum within a period of three years after the bridge was repainted.

TABLE 1, ANALYSES OF WATER CONTAINING WASTE MATERIAL FROM BLAST CLEANING OPERATION
(Paint Residue and Blasting Abrasives)

Dissolved Concentrations(1), mg/l

	COMPONENT	1 Hr	1 Day	4 Days	12 Days	90 Days	2 Yrs(2)	3 Yrs(3)
Flasks Containing Barge Samples(4)	Lead	0.2	0.4	0.3	0.2	0.2	0.04	0.1
	Iron	0.02	0.05	0.16	-	0.00	0.04	0.08
	Chromium	<0.01	<0.01	<0.01	<0.01	0.02	0.04	0.05
	Aluminum	0.0	0.0	0.0	-	0.0	0.04	0.0
Flasks Containing Bridge Deck Samples(5)	Lead	0.4	0.8	0.3	0.3	0.20	0.05	0.1
	Iron	0.05	0.00	0.11	-	0.00	0.06	0.06
	Chromium	<0.01	<0.01	<0.01	<0.01	<0.005	0.001	0.02
	Aluminum	0.2	0.2	0.5	-	0.0	0.04	0.0

(1) Results are a mean of two tests

(2) 2 years ≈ 25 months

(3) 3 years ≈ 39 months

(4) Waste material from barge placed in flasks in 1976 containing Middle River water (pH 8.2)

(5) Waste material from bridge deck placed in flasks in 1976 containing deionized water (pH 6.5)

Table 2 shows the dissolved metal concentrations for lead, iron, chromium and aluminum detected in AA tests of depth integrated water samples taken from the Middle River approximately two, three and four years after completion of the repainting project.

One-way analyses of variance tests of these data showed that there were no significant differences in the dissolved concentrations of lead, iron, chromium or aluminum between the upstream and the downstream sampling locations. Also, except for iron, there were no significant changes in the mean dissolved concentrations of the other metals studied for the two, three and four-year Middle River water samples. The mean dissolved iron concentration decreased slightly over time.

Since further dissolution of the metals investigated in the water samples has not taken place within four years after the repainting project, it is unlikely that there will be any significant increases in the dissolved concentrations of these metals in the future unless the pH of the river water decreases significantly.

Judging from the low dissolved concentrations of metals in both the flask and the Middle River water samples, it follows that there probably were no long-term aquatic impacts associated with the repainting project. None of these concentrations approached the toxic levels that would affect the aquatic ecosystem of the Middle River. However, further work such as chronic bioassay testing and tissue uptake studies are needed to properly address these topics.

TABLE 2, MIDDLE RIVER WATER ANALYSES

	Sampling Date	10/30/76	2/1/79		3/21/80			10/30/80		
	Time Since Completion of Repainting Project	0	27 months		40 months			48 months		
	Sampling Locations (2)	-	500 ft Down-Stream	500 ft Upstream	500 ft Down-Stream	500 ft Upstream	Under Bridge (3)	500 ft Down-Stream	500 ft Upstream	Under Bridge (4)
Field Measurements	pH	8.2	7.6	7.6	7.6	7.9	7.8	7.1	7.1	7.1
Field Measurements	Ec, mmhos/cm at 25°C	-	575	568	162	168	162	210	212	209
DISSOLVED CONCENTRATIONS, mg/l (1)	Lead	0.2 (5)	0.001	0.001	0.0	0.0	0.0	0.01	0.01	0.01
DISSOLVED CONCENTRATIONS, mg/l (1)	Iron	-	0.74	1.50	0.41	1.60	0.40	0.55	0.89	0.57
DISSOLVED CONCENTRATIONS, mg/l (1)	Chromium	-	0.002	0.004	<0.002	<0.002	<0.002	0.001	0.001	0.001
DISSOLVED CONCENTRATIONS, mg/l (1)	Aluminum	-	0.28	0.43	0.3	0.7	0.2	0.28	0.50	0.35

(1) Concentrations for depth integrated water samples

(2) Samples taken at middle of river

(3) Middle of most easterly bridge span

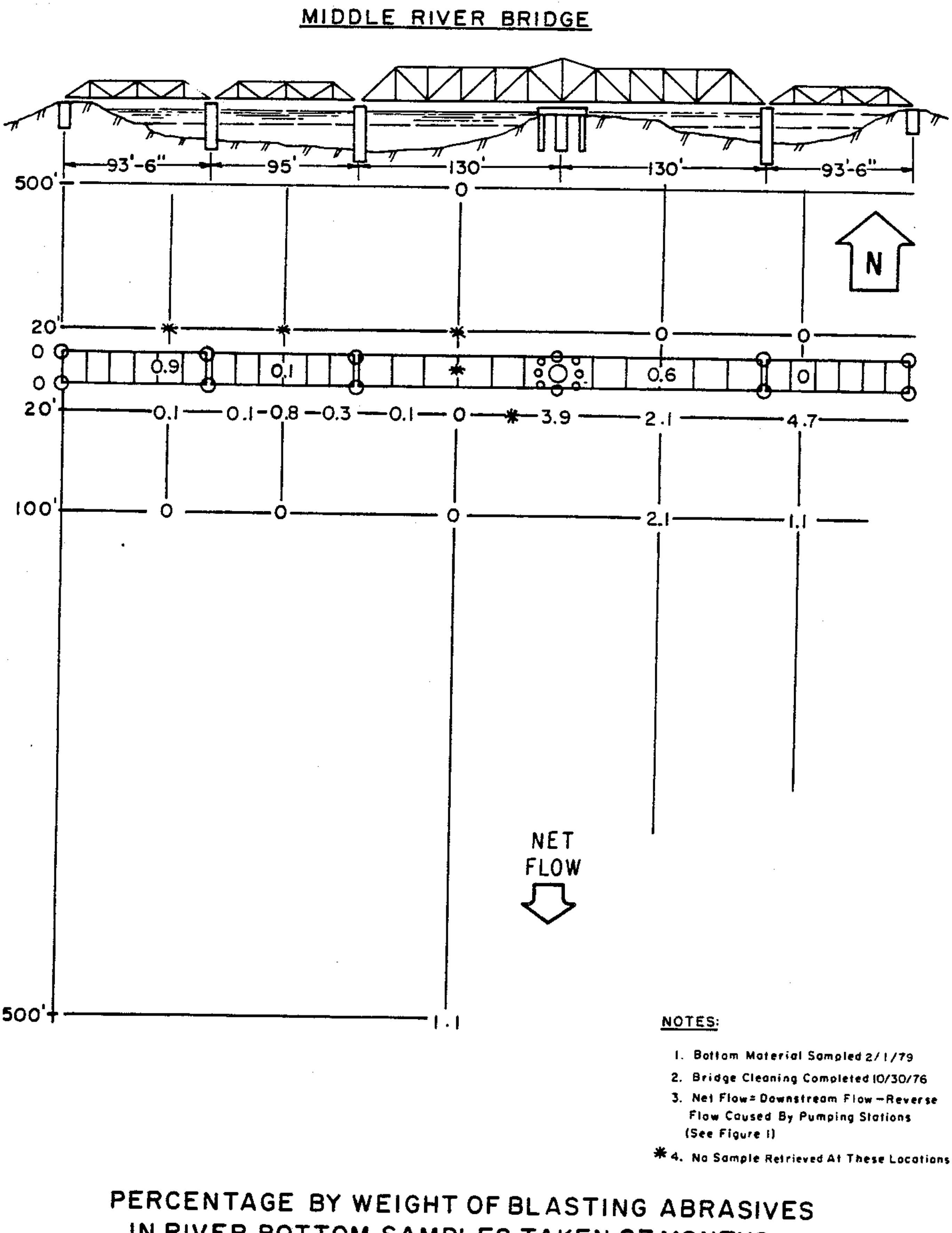
(4) Middle of center bridge span

(5) Mean of three samples, two near the bridge and one approximately 1000 ft. upstream of the bridge.

The results of the river bottom samples are shown in Figures 5, 6 and 7. Figure 5 shows the percentages of blasting abrasives found on the bottom of the Middle River near the bridge 27 months after completion of the repainting project. Although just a few bottom samples were taken at this time, Figure 5 indicates that a higher percentage of particles was located in areas of low flow in the river, near the banks and close to bridge piers. The percentages found near the banks might be somewhat high because waste material was left under the bridge on the bank after the repainting project was completed. It is likely that some of this material entered the water at these locations due to the changes in river stage.

Figure 6 shows a similar distribution of blasting abrasives remaining in the vicinity of the bridge 40 months after the repainting project. The results of the bottom samples are approximate values since the drag bucket sampling technique used is not considered an accurate sampling method. The same equipment, operators and technique, however, were used to obtain all the bottom samples for this study.

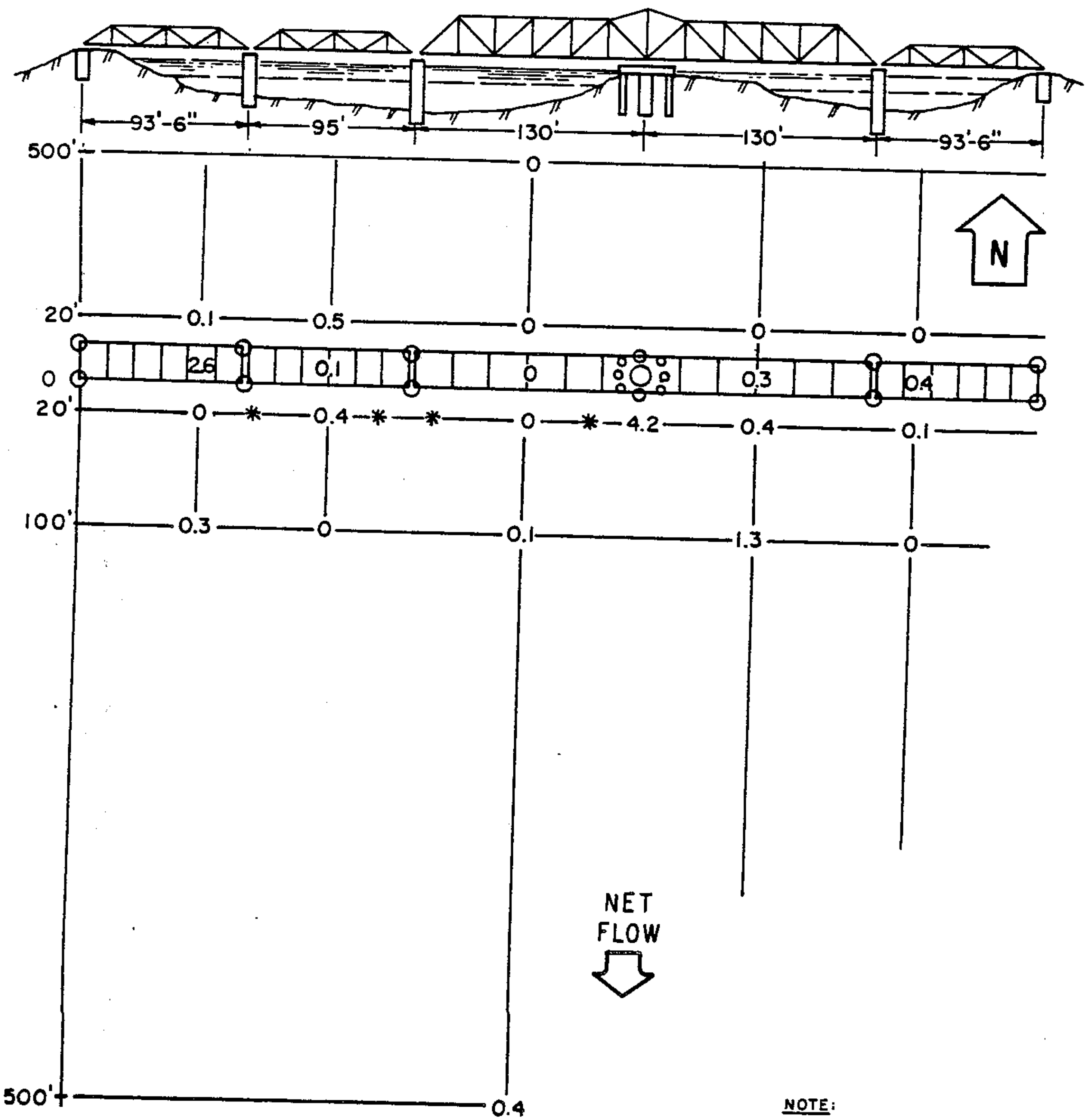
Four years after the Middle River Bridge repainting project, a more extensive set of bottom samples was obtained to determine the distribution of blasting abrasives out to 500 feet from the bridge. Figure 7 shows these results. The percentage by weight of blasting abrasives in the bottom samples for each parallel transect in Figure 7 have been plotted graphically with respect to distance from the bridge in Figure 8. These data show that most of the particles have remained within about 100 feet of the bridge with lesser amounts extending generally out to at least 500 feet downstream.



PERCENTAGE BY WEIGHT OF BLASTING ABRASIVES IN RIVER BOTTOM SAMPLES TAKEN 27 MONTHS AFTER THE BRIDGE REPAINTING PROJECT

FIGURE 5

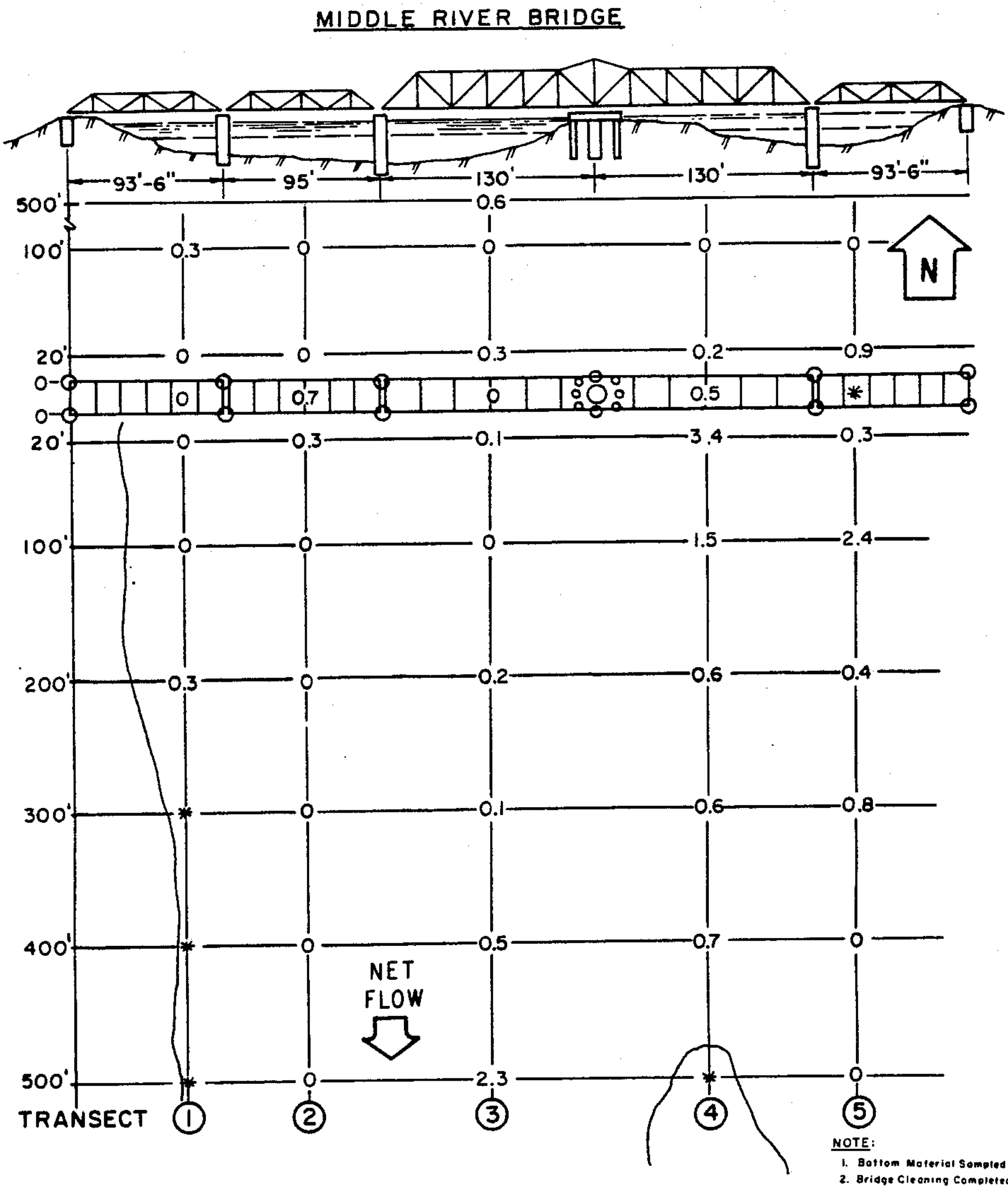
MIDDLE RIVER BRIDGE



NOTE:
1. Bottom Material Sampled 3/21/80
2. Bridge Cleaning Completed 10/30/76
3. Net Flow=Downstream Flow – Reverse Flow Caused By Pumping Stations (See Figure 1)
*4. No Samples Retrieved At These Locations

PERCENTAGE BY WEIGHT OF BLASTING ABRASIVES IN RIVER BOTTOM SAMPLES TAKEN 40 MONTHS AFTER THE BRIDGE REPAINTING PROJECT

FIGURE 6



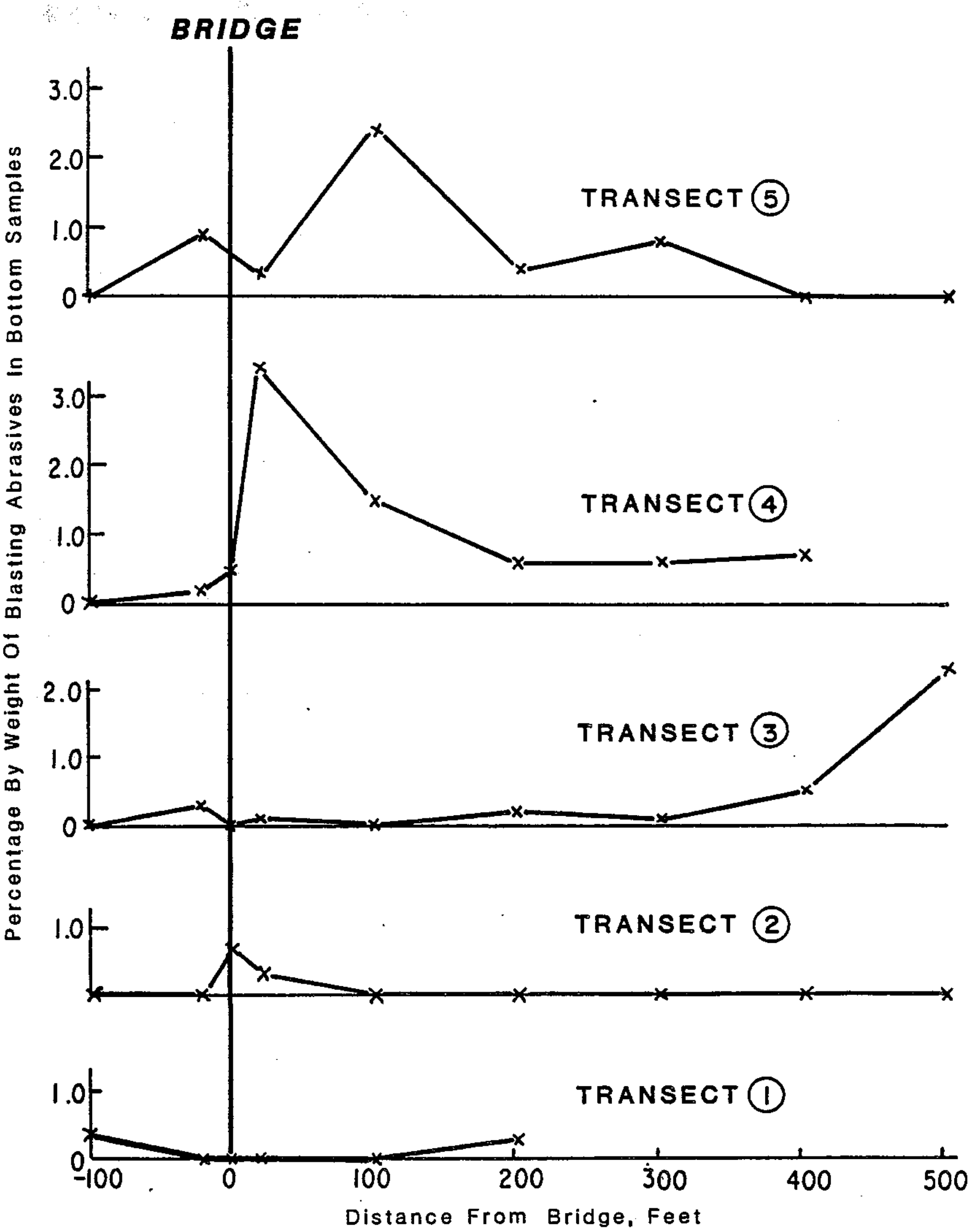
NOTE:

1. Bottom Material Sampled 10/30/80
2. Bridge Cleaning Completed 10/30/76
3. Net Flow = Downstream Flow - Reverse Flow Caused By Pumping Stations (See Figure 1)

*4. No Samples Retrieved At These Locations

PERCENTAGE BY WEIGHT OF BLASTING ABRASIVES IN RIVER BOTTOM SAMPLES TAKEN FOUR MONTHS AFTER THE BRIDGE REPAINTING PROJECT

FIGURE 7



PERCENTAGE BY WEIGHT OF BLASTING ABRASIVES IN BOTTOM SAMPLES TAKEN FOUR YEARS AFTER THE BRIDGE REPAINTING PROJECT VERSUS DISTANCE FROM THE BRIDGE

FIGURE 8

FUTURE RESEARCH

Caltrans is proposing a research project beginning in fiscal year 1982-83 titled, "The Effects of Bridge Repainting Operations on the Environment" (E81TL11). The scope of this study involves determining the environmental impacts for existing lead and vinyl paint systems, evaluating paint systems proposed for future projects and the suitability of disposal of existing paint/abrasive system residue, evaluating the environmental impacts of existing cleaning materials and abrasives, developing a testing procedure to evaluate future materials, and methods of analyses and reporting techniques which address potential environmental impacts of a repainting operation which can serve as input for the environmental document. Information from the Middle River Bridge research studies will be useful to this proposed project.

The National Cooperative Highway Research Program has sponsored research project 10-23, "Removal of Lead-Based Bridge Paints". Environmental analyses of bridge paints from this study will also be helpful to the Caltrans research.

The results from these environmental research studies will provide useful information to develop specifications for blast cleaning and painting steel bridges and to designate appropriate mitigation to alleviate potential environmental hazards.

REFERENCES

1. Nakao, D. I., et al, "The Effects on the Aquatic Environment Due to the Cleaning and Repainting of the Middle River Bridge," California Department of Transportation, CA-TL-7108-77-29, September 1977.

2. American Public Health Association, et al, "Standard Methods for the Examination of Water and Wastewater," 14th edition, 1975.

APPENDIX

10-1.04 RELATIONS WITH CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD.--The location of the Middle River Bridge is within an area controlled by the Regional Water Quality Control Board. The Contractor shall fully inform himself of all rules, regulations and conditions that may govern his operations in said area and shall conduct his work accordingly.

Attention is directed to Sections 7-1.11, "Preservation of Property," and 7-1.12, "Responsibility for Damage," of the Standard Specifications.

The Contractor's attention is directed to the following conditions which are among those established by the Regional Water Quality Control Board for this project:

- Cloth or plastic drapes shall be erected on the bridge such that waste material that drifts off the bridge during cleaning and painting operations shall be retained by the drapes, with the exception of the locations where drapes cannot be supported. The bottoms of the drapes shall be anchored in such a manner that waste material retained by the drapes shall be deposited on the bridge deck, or so that waste material retained by the drapes is removed without falling into the water.

Waste material shall consist of paint overspray, paint spillage, blasting abrasives, removed paint, rust, grease, bird droppings, dirt and other materials removed by the cleaning operation.

Whenever adverse weather conditions or other temporary conditions prevent the erection of drapes or prevent properly containing the waste material, all blasting operations shall be suspended until such time that the drapes can again serve these functions. Use of drapes that are torn or made of a material that permits the transmission of dust will not be allowed.

All waste material that is collected shall become the property of the Contractor and shall be disposed of as provided in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

No waste material is to be deposited in the Middle River. The waste material shall be disposed of in such a manner that ground waters and surface waters shall not be contaminated.

Drapes shall be removed and disposed of when no longer needed.

Any change in the above listed conditions proposed by the Contractor shall be submitted to the Regional Water Quality Control Board for approval by way of the Engineer, and shall not be implemented until approved in writing by both the Regional Water Quality Control Board and the Engineer.

10-1.07 CLEANING AND PAINTING STRUCTURAL STEEL.--All exposed metal surfaces except pier casings, galvanized railing elements, and the inside surfaces and equipment in the control house shall be cleaned and painted in accordance with the provisions in Sections 59, "Painting," and 91, "Paint," of the Standard Specifications and these special provisions.

Attention is directed to the regulations for abrasive blasting operations adopted by the State Air Resources Board, Subchapter 6 in Chapter 1, of Part III of Title 17, California Administrative Code.

The paints to be applied to steel surfaces, the minimum number of applications and the total dry film thicknesses shall conform to the provisions in Section 59-2.11, "Paint," of the Standard Specifications.

All exterior surfaces of the control house shall be hand cleaned and painted with 2 applications of finish coat paint. Full compensation for cleaning and painting the exterior of the control house shall be considered as included in the contract lump sum price paid for clean and paint structural steel (existing bridge) and no additional compensation will be allowed therefor.

Attention is directed to the section "Reset Railing" in these special provisions.

All bearings, gears and other movable parts, signs and signals shall be protected from damage resulting from the Contractor's operations; and all areas of the bridge not specified to be cleaned and painted shall be covered or wrapped as necessary to prevent the entry of foreign materials such as sand or paint.

Tie plates holding lattice railings to the diagonal chords of the trusses shall be removed before cleaning structural steel in the immediate vicinity. Tie plates shall be removed by chiseling off the rivet heads and punching out the rivets. After removal, trim the tie plates as directed by the Engineer. Abrasive blast clean and give one application of undercoat paint to the contact surfaces between tie plates and chord and railing. Reinstall the modified tie plates, replacing all removed rivets with commerical quality ASTM A 307 bolts with flat washers under bolt heads. Dispose of all removed rivets and portions of tie plates not reused. Removing, trimming and replacing railing tie plates; furnishing and installing bolts; and disposing of surplus material shall be done as directed by the Engineer and will be paid for as extra work as provided in Section 4-1.03D of the Standard Specifications.

Full compensation for cleaning and painting railing tie plates and fasteners shall be considered as included in the contract lump sum price paid for clean and paint structural steel (existing bridge) and no additional compensations will be allowed therefor.

The paint systems to be removed consist of red lead undercoats and aluminum finish coats of varying thicknesses.

The paints to be applied to steel surfaces, the minimum number of applications and the dry film thicknesses shall conform to the following:

1. Pre-treatment primer shall be applied in one application. The primer shall conform to the provisions in Section 91-2.07, "Pre-treatment, Vinyl Wash Primer," of the Standard Specifications.

2. Undercoat paint conforming to the provisions in Section 91-2.10, "Vinyl Primer, Red Iron Oxide Type," of the Standard Specifications shall be applied as the first and third paint applications.

3. Undercoat paint conforming to the provisions in Section 91-2.11, "Vinyl Primer, Red Iron Oxide-Titanium Dioxide Type," of the Standard Specifications shall be applied as the second and fourth paint applications. Total thickness of undercoats shall be at least 4 mils.

4. Finish coat paint conforming to the provisions in Section 91-2.12, "Vinyl Paint, Aluminum Finish Coat," of the Standard Specifications shall be applied in not less than 2 applications. The total thickness of the finish coat shall be at least 2 mils.

The Contractor's attention is directed to the possibility that all mill scale may not have been removed during previous cleaning and painting of structural steel at this bridge. The presence of such mill scale will not relieve the Contractor from any of the requirements in Section 59-2.03, "Blast Cleaning," of the Standard Specifications.

If during inspection of the site, as provided for in Section 2-1.03, "Examination of Plans, Specifications, Contract and Site of Work," of the Standard Specifications, the Contractor wishes to investigate surface conditions of existing structural steel by either the use of hand tools or other equipment, permission shall first be obtained from the District Permit Engineer of the California Department of Transportation.