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RESEARCH AND PRELIMINARY ENGINEERING REPORT ON THE PLACEMENT OF A RANNEY COLLECTOR IN THE STILLAGUAMISH RIVER FOR CITY OF MARYSVILLE, WASHINGTON

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Prepared by

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PROJECT NO. STILLAGUAMISH WELL

CITY OF MARYSVILLE

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2. The transmission main will be buried a minimum of six feet below the low water level of the river allowing the operation of equipment across it.

3. Mining operations should be kept at a distance to insure that gouges will not be taken out of the structure by equipment.

INTRODUCTION

On a gravel bar located on the west side of the Stillaguamish River, Snohomish County, Washington, adjacent to Arlington Sand and Gravel, the construction of an infiltration well is proposed to be constructed by the City of Marysville. The well is to be constructed by sinking the base of a 16-foot diameter, round concrete caisson to a depth approximately 40 feet below the surface of the gravel bar. The upper portion of the caisson will extend approximately 20 feet above the surface. The gravel bar in which the well is to be situated is also used by Arlington Sand and Gravel Company as their source of gravel.

The intent of this report is to examine the location of the well and transmission facilities and to determine the possible effects the well would have on the downstream gravel deposits and the shoreline areas of the river. After determining whether or not any adverse effect will result from the placement of the facilities, it is then necessary to determine the extent of the effects and examine the possible solutions and alternatives. The final step then consists of making recommendations as to the best course of action to pursue to assure compatibility between the gravel operations and the municipal water supply.

Summary and Recommendations

The City of Marysville proposes to install a Ranney Collector infiltration well system on a gravel bar of the Stillaguamish River, 1.2 miles northwest of Arlington, Washington. This system is needed to supply the additional 4.73 million gallons of water per day required to meet the City of Marysville's predicted 1990 demand. This system is recommended by Marysville's 1974 Comprehensive Water Plan over other alternatives because it can satisfy the 1990 water demands more economically and with water which requires only preventive chlorination treatment.

The gravel deposits in the area of the proposed well are mined by Arlington Sand and Gravel. Two concerns were expressed regarding the proposed well: would the well casing rising above the stream bed create changes in the gravel-depositing characteristics of the river for this gravel bar? And if so, what effect would this have on the gravel operation?

Research was initiated in order to study the problem and determine possible solutions to minimize the effects. We examined textbooks and published reports to determine what effects might occur, and it was determined that scour would occur. Then we consulted institutes and organizations with expertise in this area to obtain their opinions on this problem.

Based on the research results, the report makes three recommendations as to the most beneficial method of minimizing the scour effects and protecting the future mining activity in the immediate area of the well. These recommendations are as follows:

1. A disk type scour arrestor be installed around the well caisson so as to minimize any possible downstream scour effects and provide protection for the well and piping.

SECTION 1

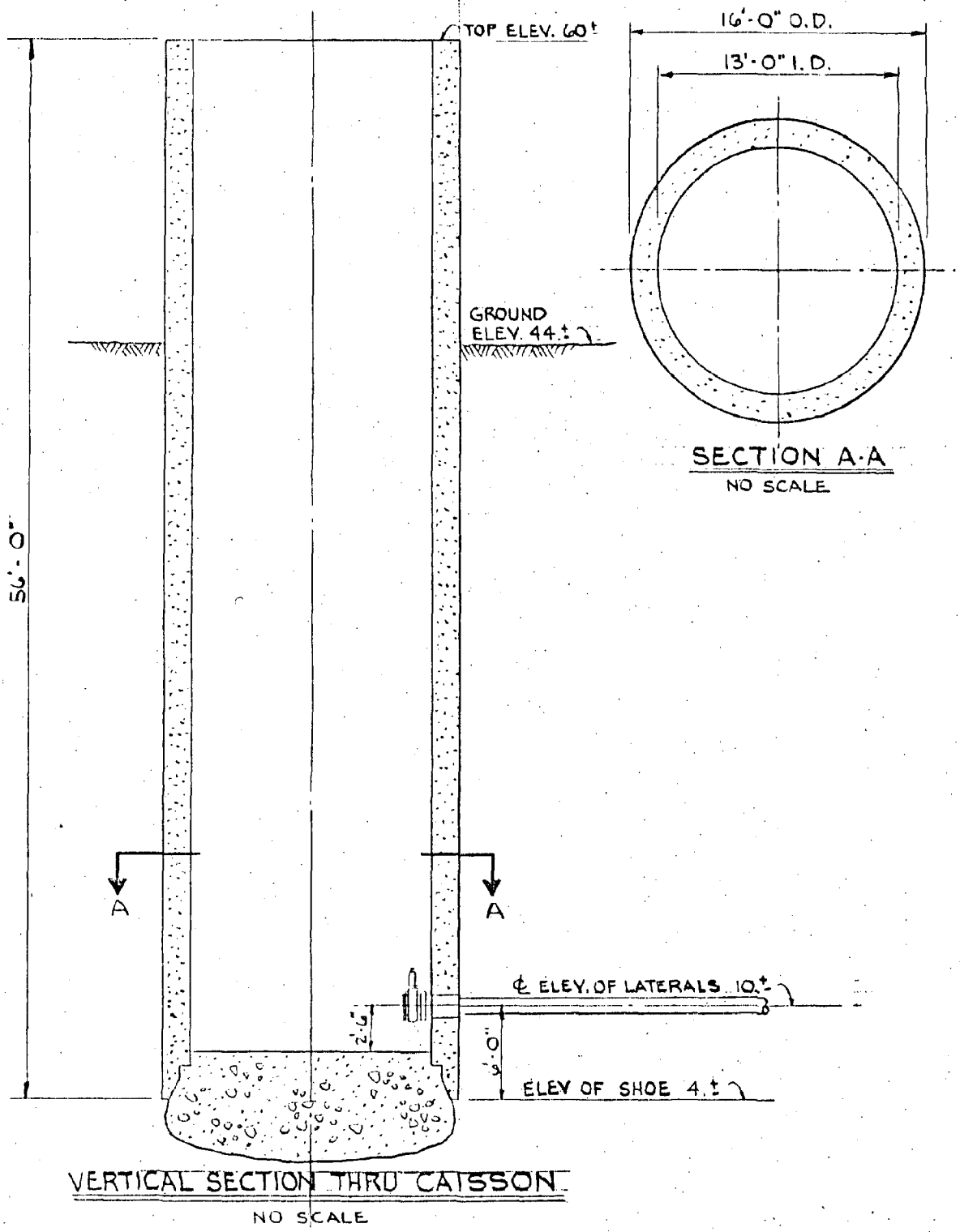
PROJECT DESCRIPTION

According to the City of Marysville's 1974 Comprehensive Water Plan, a new source of water capable of supplying 4.73 million gallons per day needs to be developed by the year 1990. The comprehensive Plan recommends the use of an infiltration system in the Stillaguamish River at a location determined by a 1969 hydro-geological study. The location is on a bar in the River which consists of a highly permeable sand-and-gravel aquifer. The site is well suited for a collection system and presently is the most economical method of meeting the 1990 water demands of the City of Marysville.

The proposed well will be a Ranney Collector which is termed an infiltration system. The basic system consists of a round concrete caisson with lateral infiltration arms located at the base. The caisson will be extended approximately 20 feet above the surface level of the stream and will support a superstructure which will house the pump motors and controls.

A. Caisson

The caisson as shown in Figure No. 1 will be a round, reinforced concrete structure with an outside diameter of 16 feet. The walls will be constructed to a width of 1.5 feet by utilizing concrete and number 5 reinforcing bar. The caisson is formed in segments at ground level. After a section solidifies, it is lowered into the ground by a combination of its own weight, and the removal of soil directly beneath the caisson. The base section is formed with portholes so that the lateral arms can be extended outward from the caisson. A concrete tremie seal is poured in the bottom of the caisson to prevent further movement. After the seal is installed, the above ground portion of the caisson is constructed to the desired height.



CROSS SECTION OF CAISSON

FIGURE NO. 1

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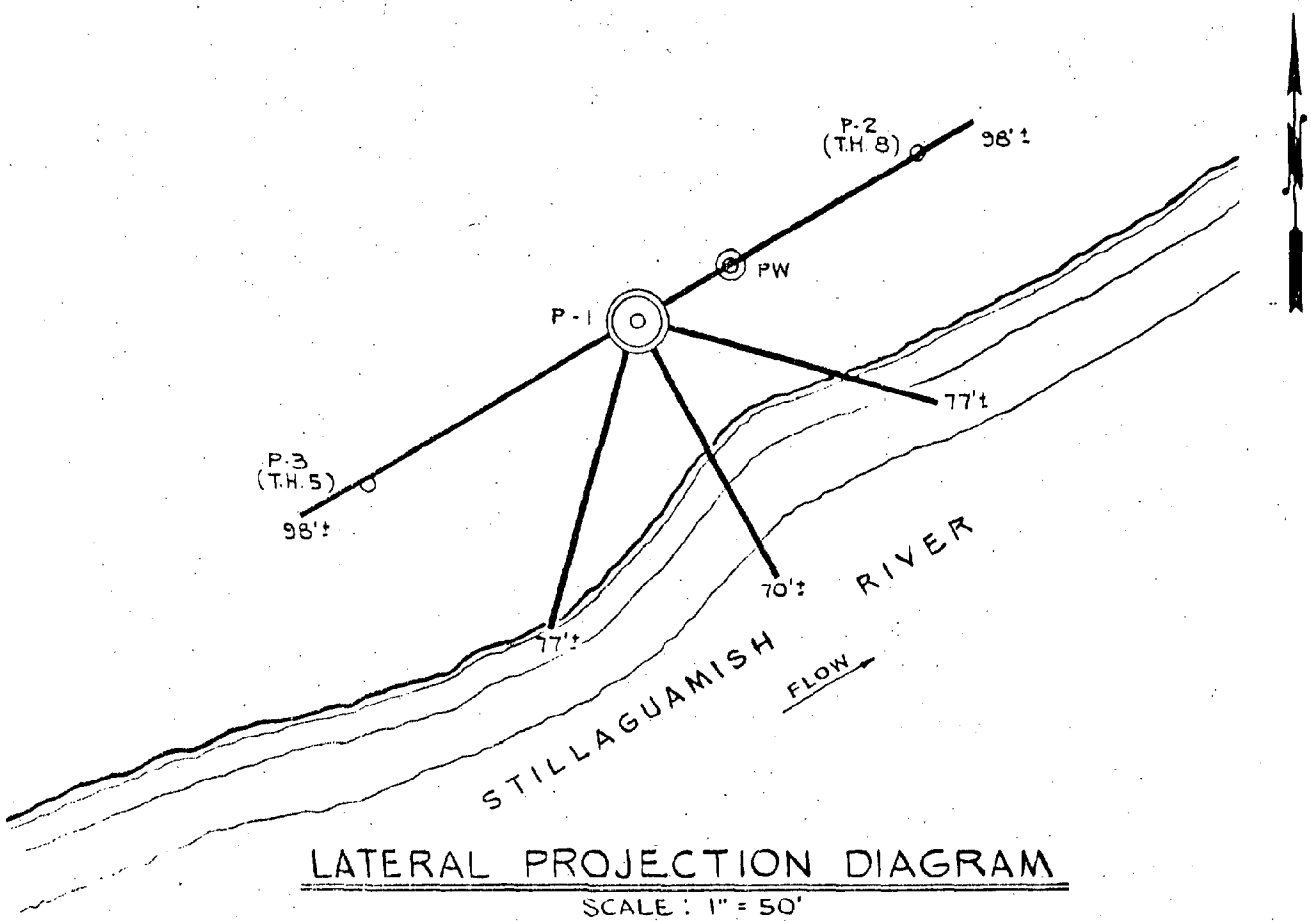
B. Laterals

Through the portholes formed at the base of the caisson, laterals are extended for the purpose of collecting water. The lateral configuration and construction details are shown in Figure No. 2. Each lateral consists of a slotted screen pipe with a digging head mounted on the end. A 4-1/2 inch diameter movable sand line is placed inside a 10-3/4 inch diamter screen pipe during the development stage. The laterals are installed by a combination of jacking and washing.

C. Pumps, Piping and Superstructure

The pumps and motors are located in a superstructure on top of the well approximately 15 feet above the surface of the gravel bar. The superstructure can be designed to be round, square, or rectangular. Figure No. 3 shows the designs selected for wells at Carmichael, and Santa Rosa, California. Since the structure is to be located at a site where it can be easily viewed, adequate architectural treatment is a necessity.

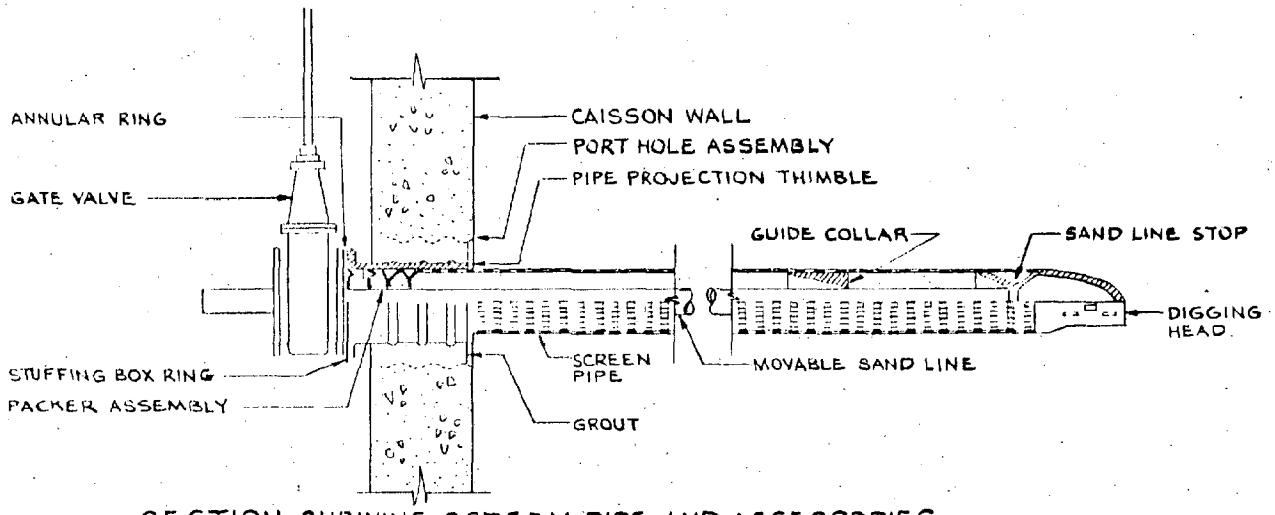
The transmission main from the structure, as well as the electrical service, will be buried as they traverse the gravel bar. However, it is necessary to attach both lines to the exterior of the caisson between the surface of the gravel bar and the superstructure. This is necessary to avoid any potential contamination that could be caused by a connection through the wall of the caisson below the level of the maximum flood.



LATERAL PROJECTION DIAGRAM

SCALE: 1" = 50'

TOTAL LENGTH OF LATERALS TO BE NOT LESS THAN 400 FEET ACTUAL LENGTH. LOCATION, DIRECTION, NUMBER AND ELEVATION OF LATERALS TO BE DETERMINED BY FIELD CONDITIONS.



SECTION SHOWING SCREEN PIPE AND ACCESSORIES

SCALE: NONE

PROPOSED LATERAL ASSEMBLY

FIGURE NO. 2

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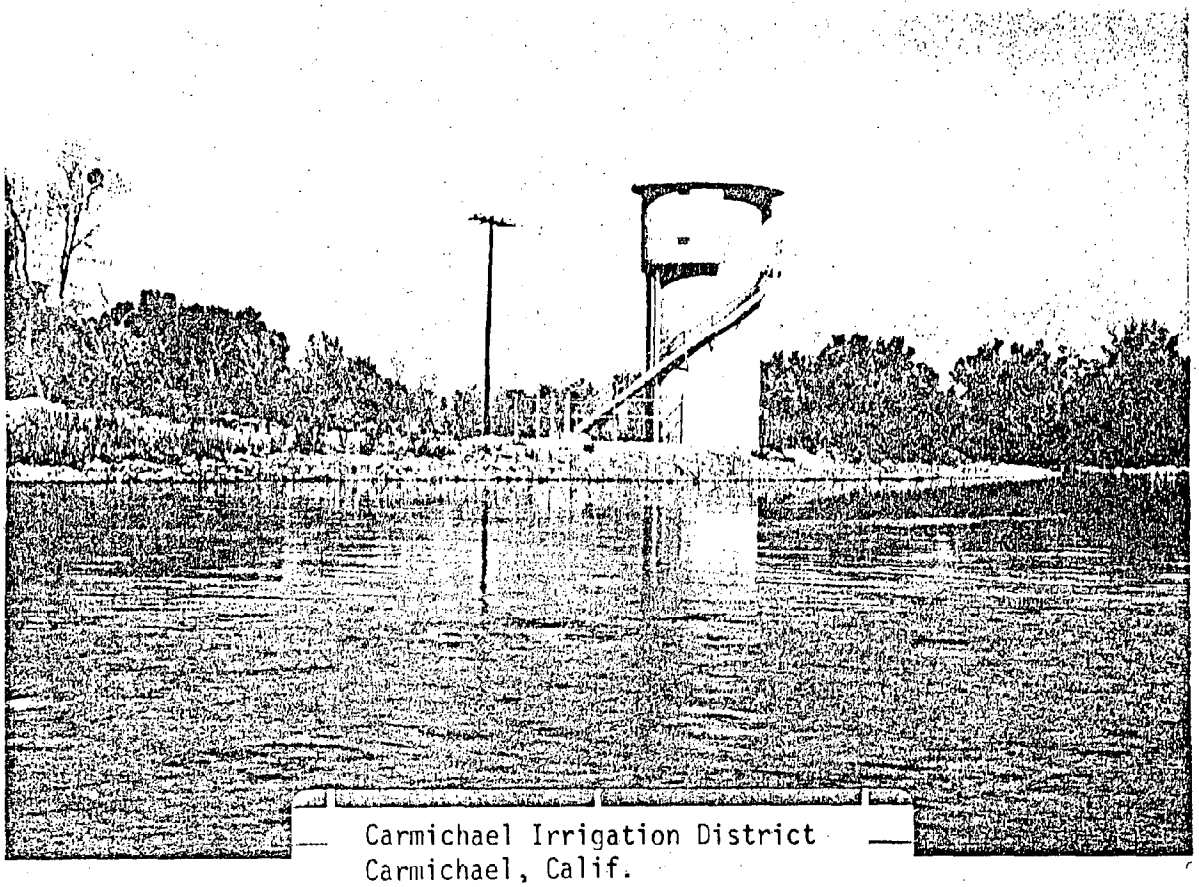
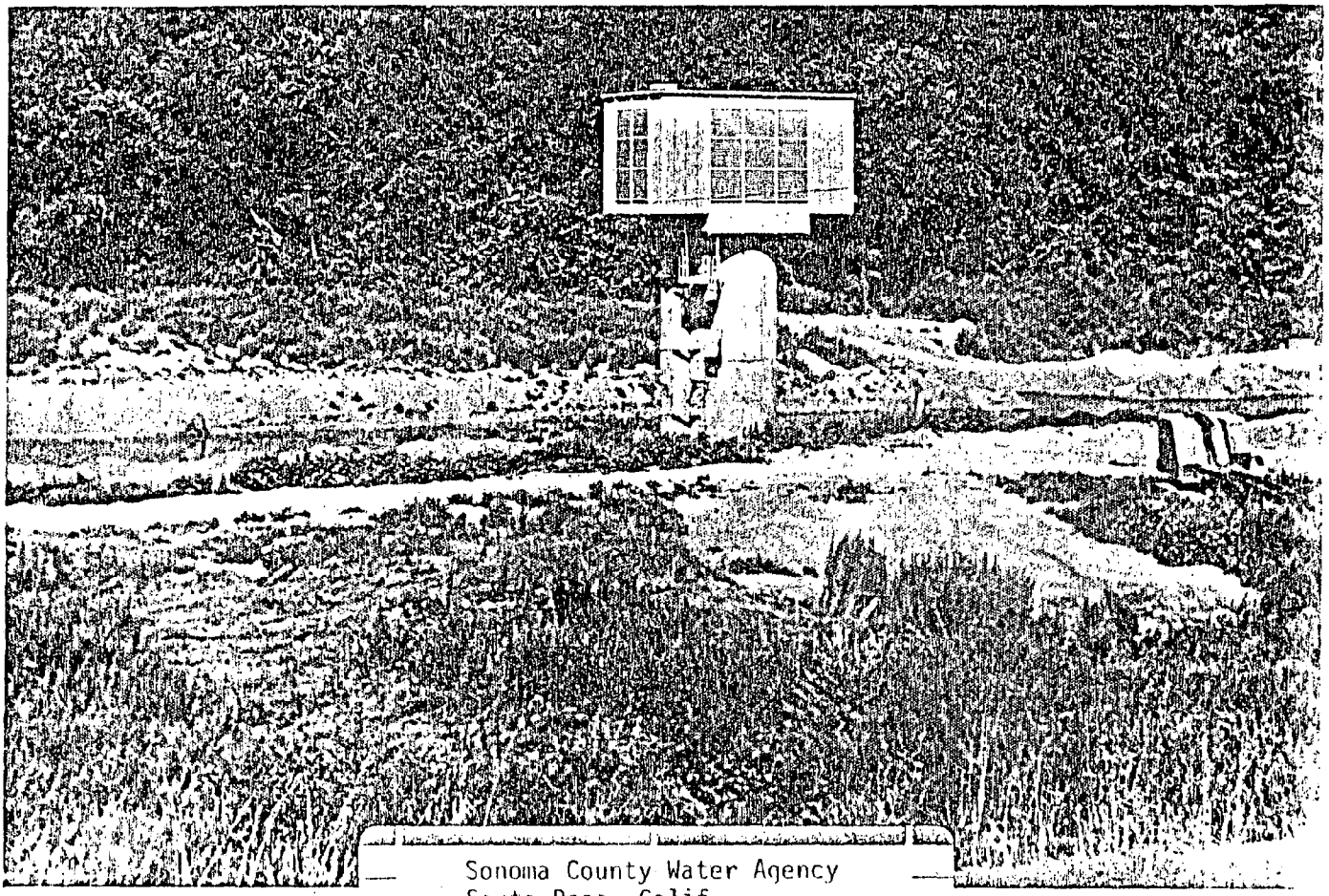


Carmichael Irrigation District
Carmichael, Calif.



Sonoma County Water Agency
Santa Rosa, Calif.

EXISTING RANNEY COLLECTORS

FIGURE NO. 3

D. Location

The proposed collector is located approximately 1 mile northwest of Arlington, Washington, on the Stillaguamish River. Eight sites were investigated along the river and this particular one was chosen because the water is virtually free of iron and there is no noticeable taste or odor. All the other sites would have required the construction of a treatment plant.

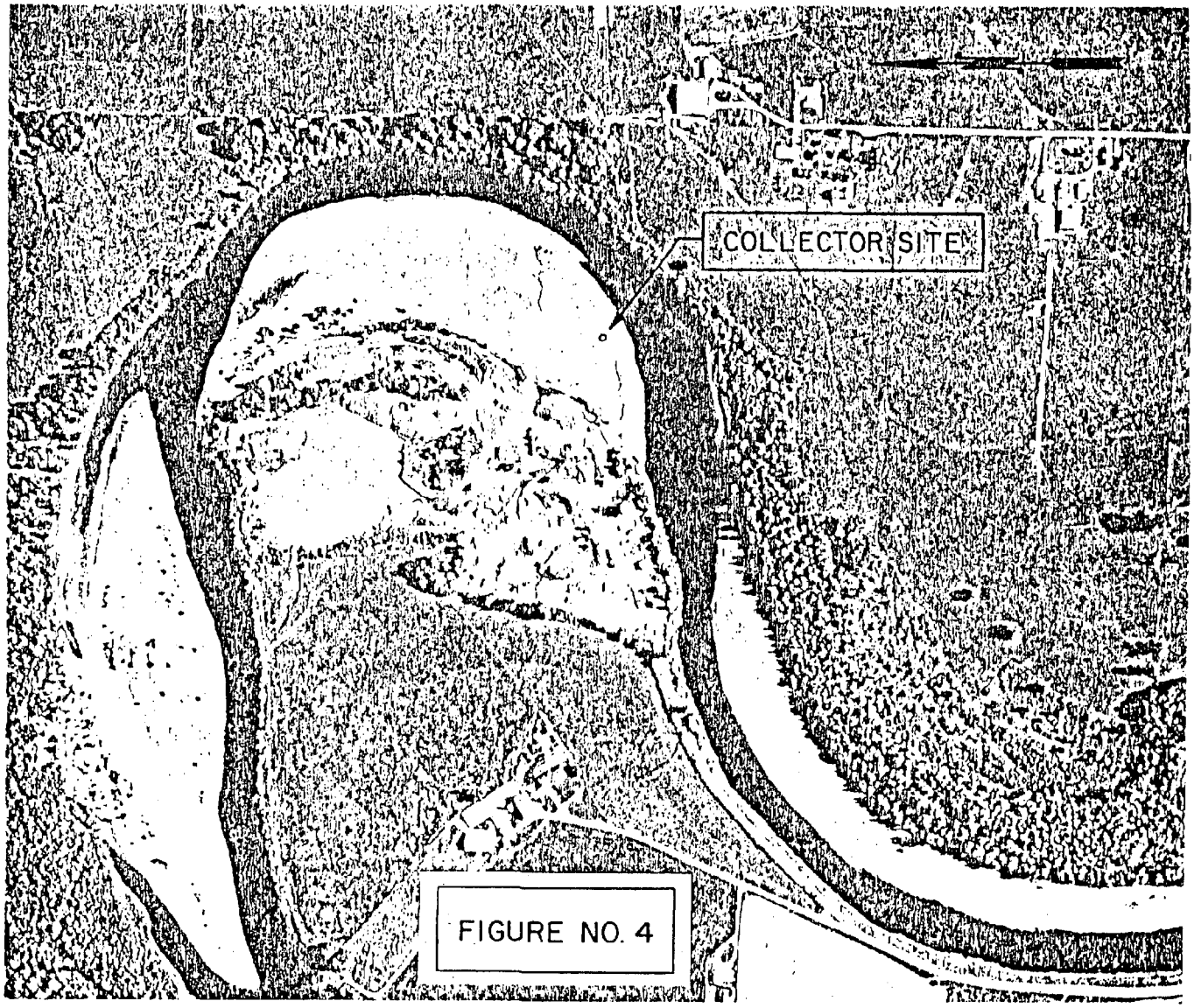


FIGURE NO. 4

The site is on a gravel bar at a bend in the Stillaguamish River as can be seen in Figure No. 4. Arlington Sand and Gravel is located adjacent to

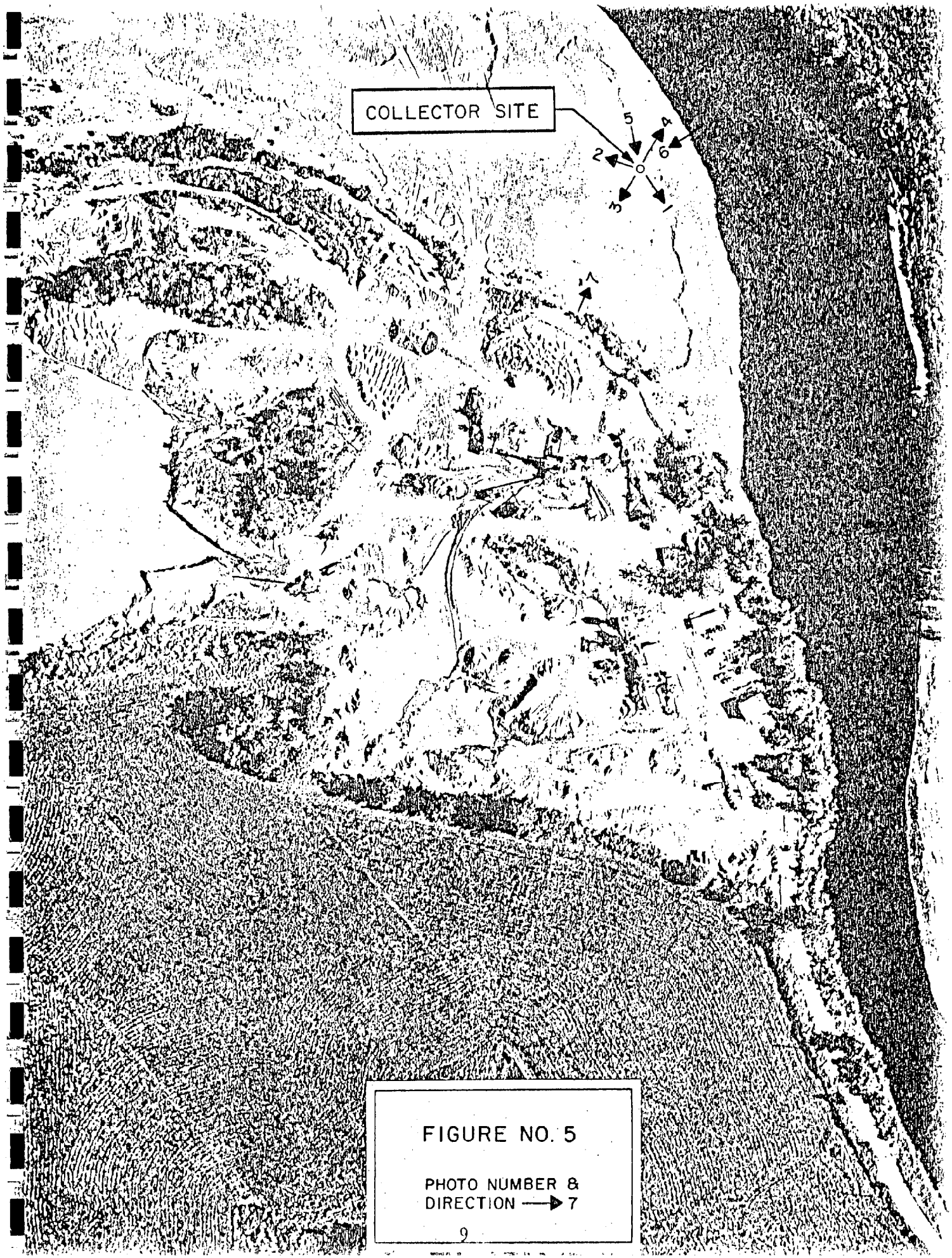


FIGURE NO. 5

PHOTO NUMBER & DIRECTION ⟶ 7

the site and mines the river gravel from the bar. Figure No. 5 shows a closeup aerial view of the operations of Arlington Sand and Gravel in relation to the bar and collector site.

The collector is to be located in the upstream portion of the bar and towards the River's low water edge. Figures No. 6, 7 and 8 show views taken on the ground of the area surrounding the site.

E. Transmission Main

The transmission main from the collector to the distribution area will consist of a 14-inch ductile iron pipe. The pipe will be under a static head of 80 psi at the collector site. The transmission main will begin at the collector where it will traverse the gravel bar to the upper bank of the river. It will then follow the bank of the river adjacent to the natural vegetation across the property of Arlington Sand and Gravel to the Thompson Road (59th Avenue N.E.). See Figures 9 and 10. The main will then proceed southerly along 59th Avenue N.E. to Highway 530, turn west and tie into the present line serving the Island Crossing area or as an alternate turn south before Island Crossing and tie into the City's present system in the vicinity of the Arlington Airport.

Approximately 180 feet of transmission main will be located on the gravel bar. It is proposed that this section of main will be buried a minimum of 6 feet and a maximum of 8 feet. The trench will be backfilled with native granular material. The backfill will be in conformance with the Department of Fisheries request per their letter of August 30, 1976. The six to eight feet of backfill over the pipe will assure the safety of the water main plus allow the gravel bar to be mined above the pipe to an elevation of approximately low water level.

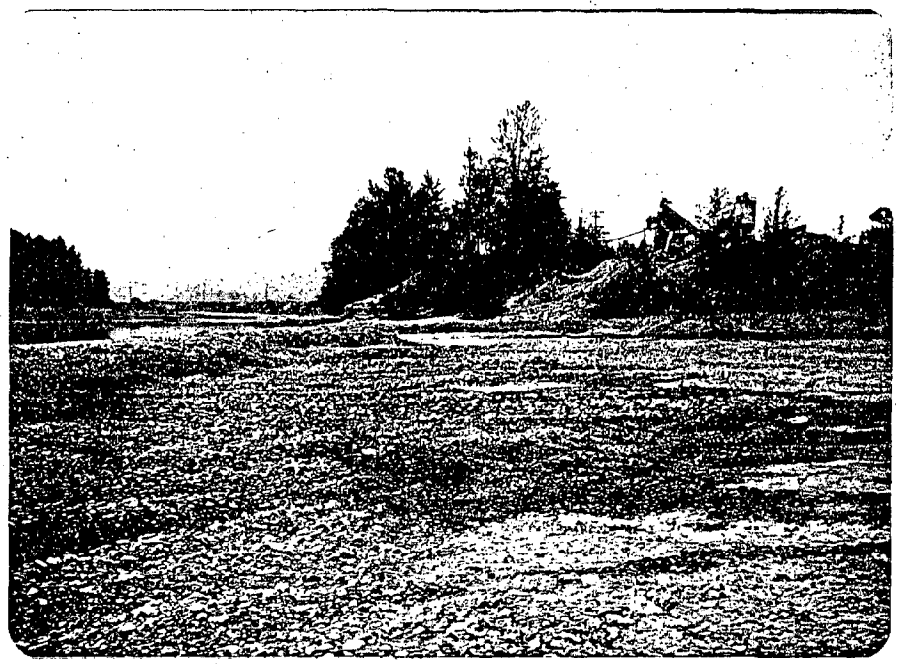


PHOTO NO. 1
UPSTREAM VIEW FROM COLLECTOR SITE

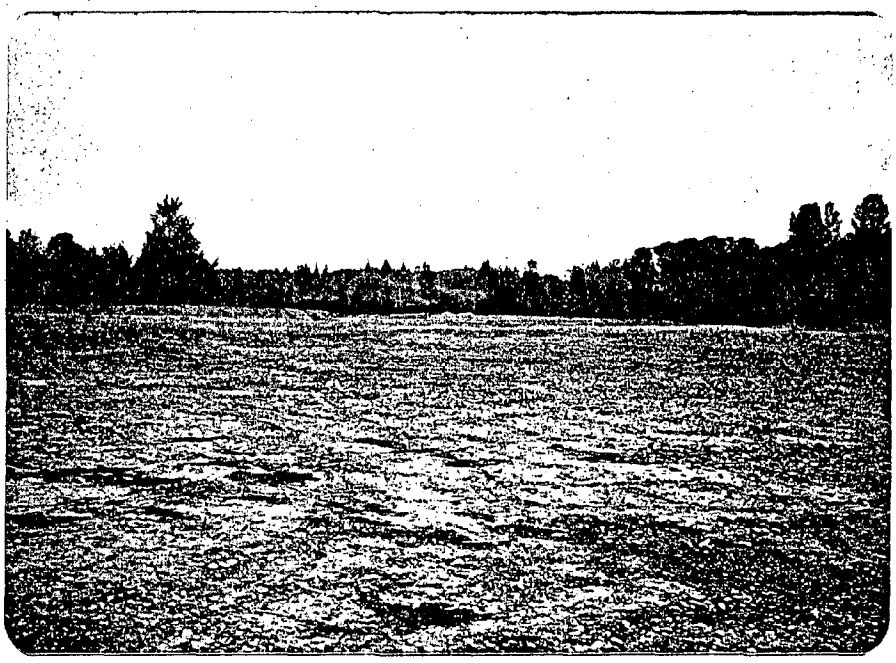


PHOTO NO. 2
DOWNSTREAM VIEW FROM COLLECTOR SITE

LOCATION OF COLLECTOR

FIGURE NO. 6

PHOTOS TAKEN OCTOBER 14, 1976

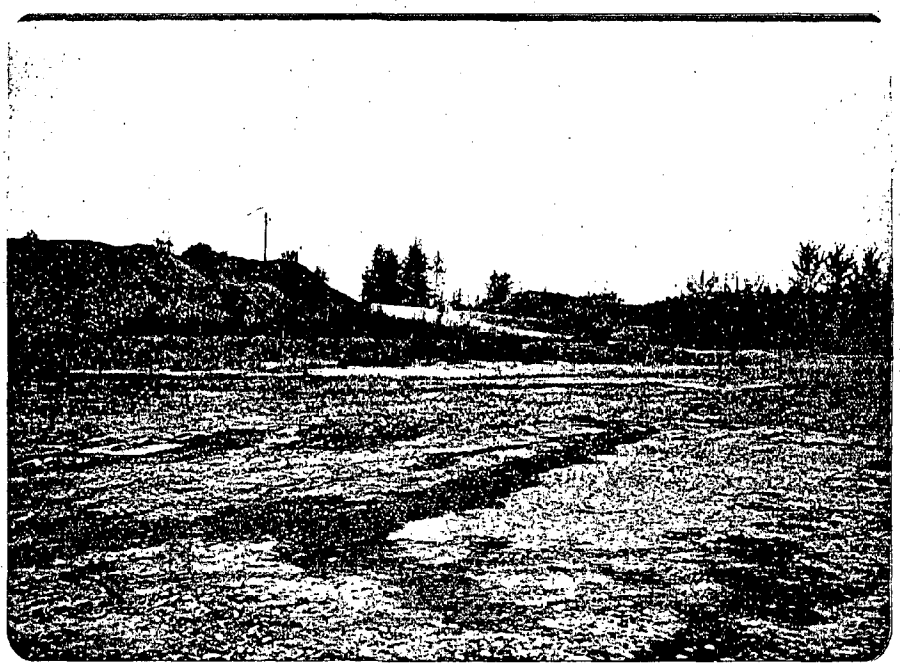


PHOTO NO. 3

BANK VIEW FROM COLLECTOR SITE

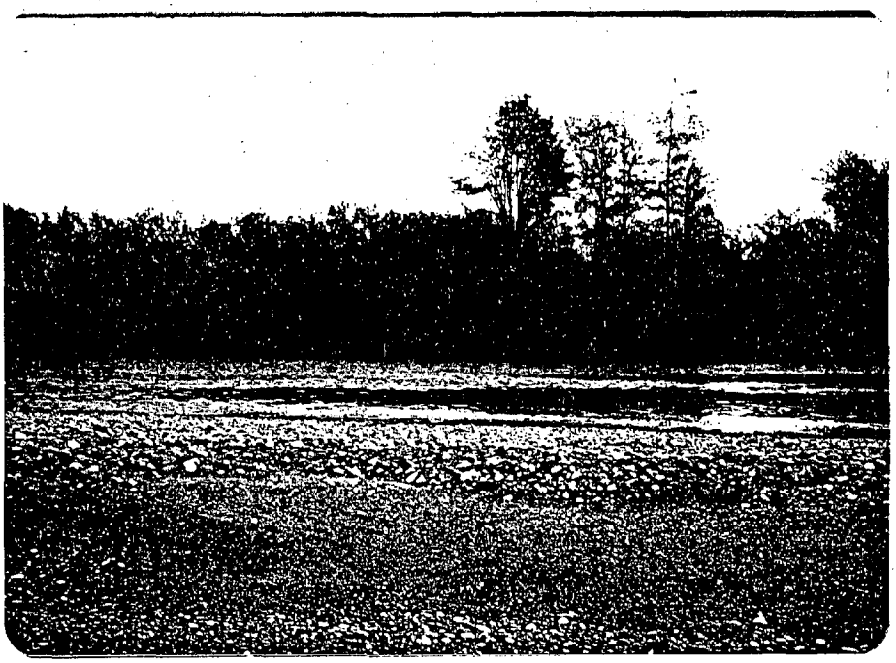


PHOTO NO. 4

RIVER VIEW FROM COLLECTOR SITE

LOCATION OF COLLECTOR

FIGURE NO. 7

PHOTOS TAKEN OCTOBER 14, 1976

PHOTO NO. 5

COLLECTOR SITE
LOOKING SOUTHWEST

PHOTO NO. 6

COLLECTOR SITE
FROM EDGE OF RIVER

PHOTO NO. 7

COLLECTOR SITE
FROM RIVER BANK

LOCATION OF COLLECTOR

FIGURE NO. 8

PHOTOS TAKEN OCTOBER 14, 1976

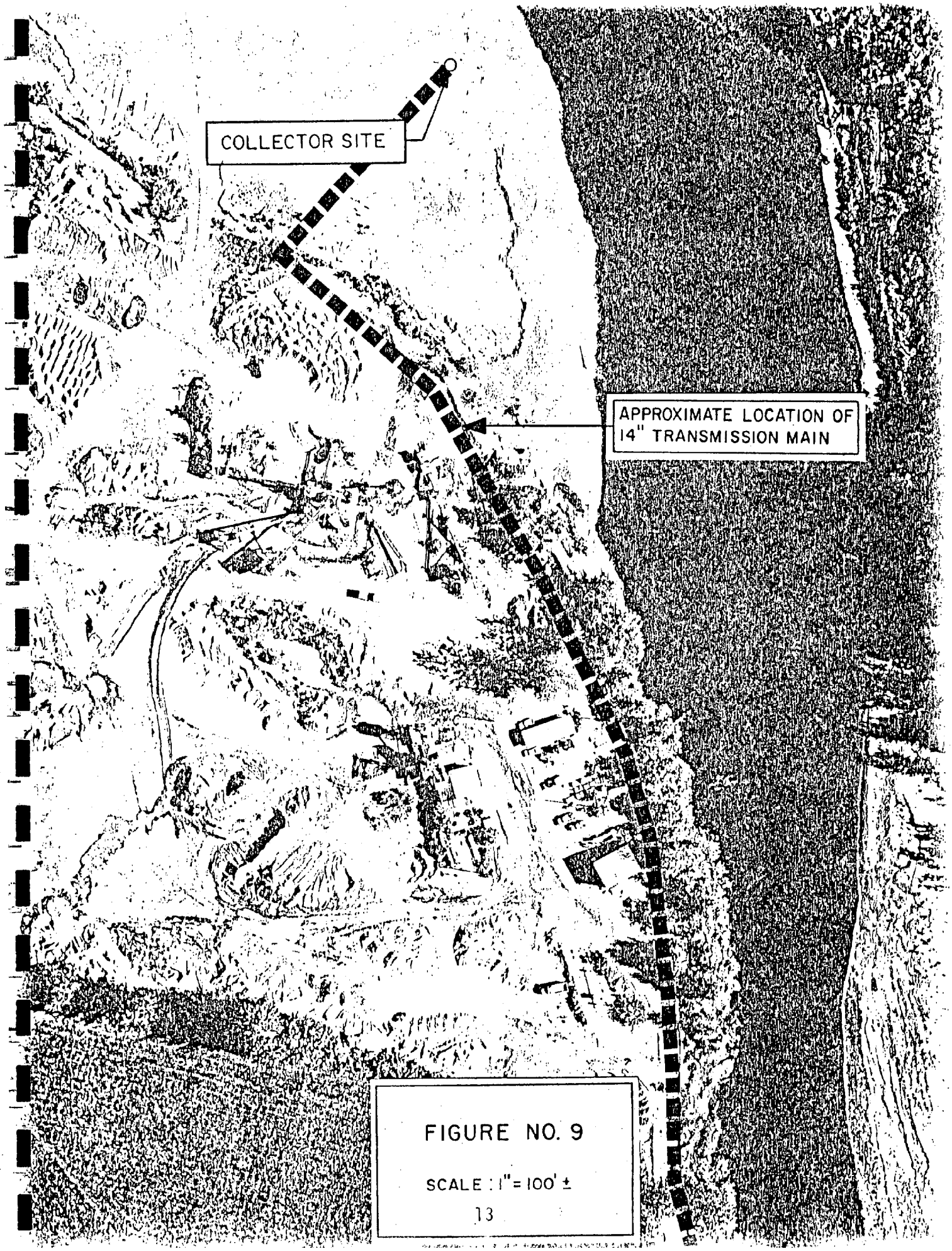


FIGURE NO. 9

SCALE : 1" = 100' ±

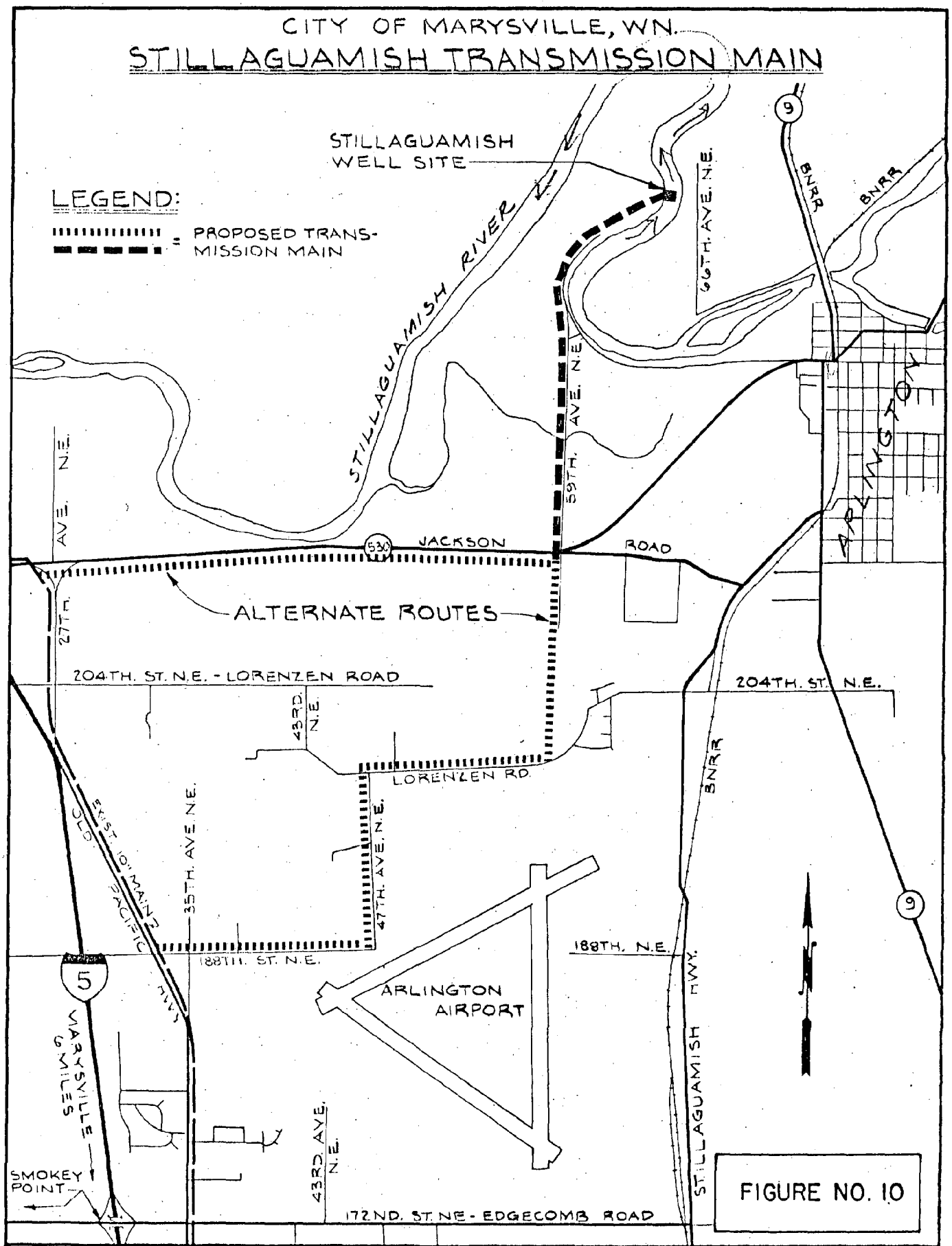


FIGURE NO. 10

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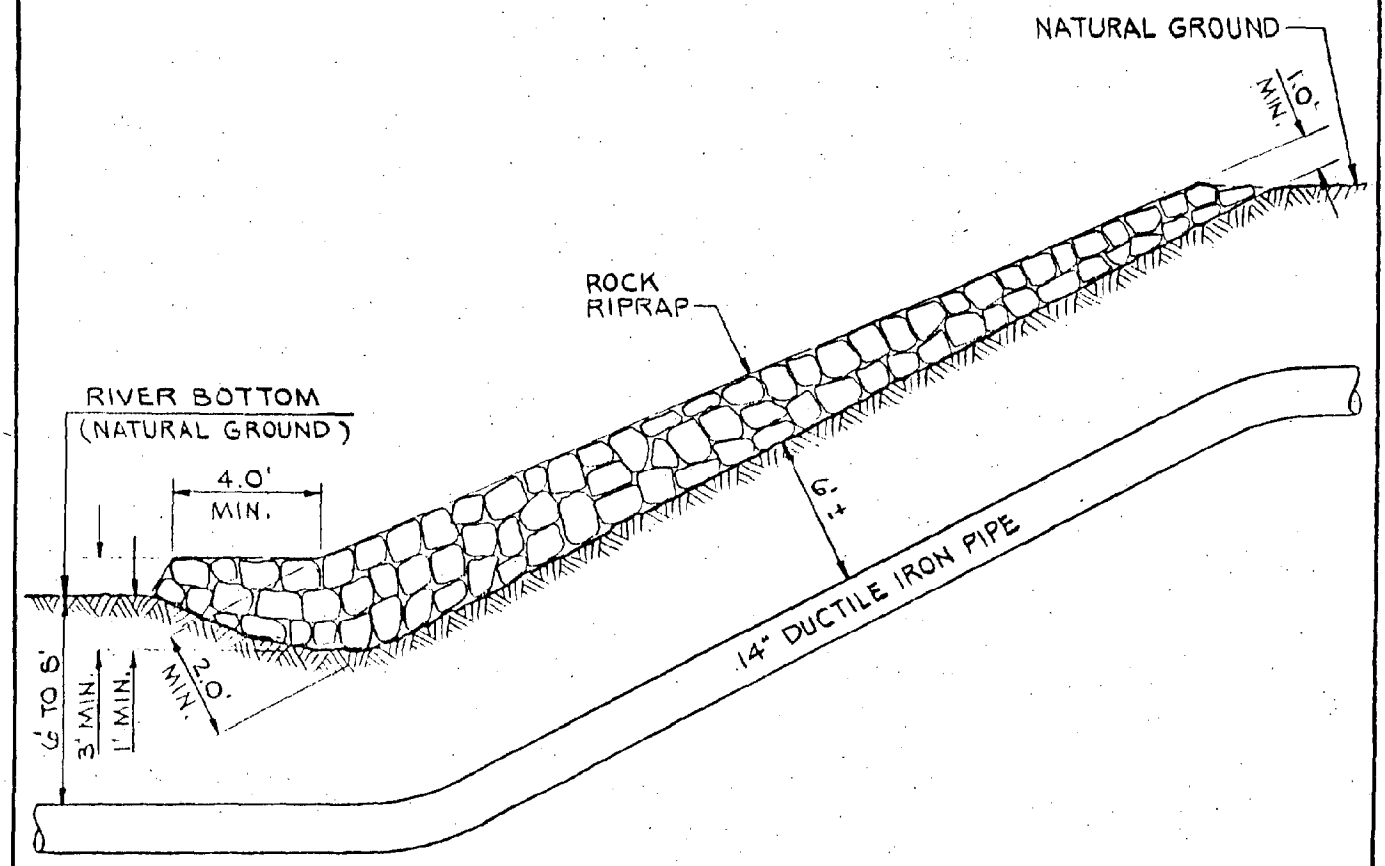
Where the pipe traverses up the river bank we propose that the depth of bury be six feet and that the trench be again backfilled with native granular material. Further, we propose that a rip rap blanket be placed over the disturbed area to provide additional protection. Figure 11 shows the type of rip rap protection proposed.

The transmission main will be placed along the river bank so as not to disturb the natural vegetation: In some areas where the vegetation is lacking or it is apparent that bank erosion could be a threat to the main, the bank will be rip rapped similar to Figure No. 11.

In order to provide protection to the river bank in case of a break in the main, a check valve will be installed at the intersection of 59th Avenue N.E. and the Dike Road.



TYPICAL SECTION
SLOPE PROTECTION

FIGURE NO. 11

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SECTION 2

POSSIBLE CONFLICTS WITH SURROUNDING AREA

The effects of the well on the natural characteristics of the Stillaguamish River are of major concern to the City of Marysville as well as the adjacent property owners. The major effect that could result from the placement of a structure at the site is the rearrangement of the gravel deposits due to river scour. The term scour applies to the net removal of sediment from a channel, stream bed or bank by water action. Scour can be of two basic types, either localized or generalized. Localized scour occurs when sediment is removed only from a relatively small area around the obstruction with no effect further downstream; generalized scour on the other hand consists of sediment removal over a wide area and in some cases can affect the stream bed for a considerable distance downstream. The effects of scour are not always of great concern. However, at this particular site, if there was a considerable amount of scour it could have an adverse affect on Arlington Sand and Gravel's operations as well as the structure itself.

SECTION 3

SCOUR RESEARCH

Research was initiated to determine the extent of scour that would be caused by the proposed collector. Scour is critical because of the effects it could have on the Channel and the gravel deposits mined by Arlington Sand and Gravel. The purpose of the research was first to determine if scour would occur and if so, to what extent. A second part of the research was to determine possible solutions to any adverse condition that could expect to occur.

A. Method of Research

The effects of scour can vary in magnitude and depend upon the characteristics of the stream flow and the composition of the stream bed. Since the effects vary within each stream system and the characteristics of each river are different more than one source had to be consulted. Several sources were examined and their results compiled in order to reach a realistic conclusion for our particular site on the Stillaguamish River.

The research on scour centered around two basic sources of information. First, textbooks and published reports were consulted in order to determine the theory and basic principles behind scour. Through the use of the information obtained from the textbooks and reports, it was possible to determine whether or not scour would occur and if further research was required. The information gathered from this source indicated that scour would occur to some magnitude. Since it was determined that scour would occur, we consulted institutes and organizations known for their work or experience in this area. Those consulted included Purdue University, the Universities of Iowa and Illinois, the U. S. Department of Interior - Geologic Division, the Corps of Engineers Waterways Experiment Station and consulting Engineers and Cities who have had experience with Ranney Collectors under similar conditions.

B. Research Results

All sources that were contacted agreed that scour would occur to some extent and if the magnitude was large enough, it would interfere with gravel deposits downstream. However, it was apparent there were steps that could be taken to minimize it. Although experimentation is normally required to determine the exact extent of scour and the best method for minimizing its effect, approximations are possible to determine the scour severity and the necessity for further investigation.

Basically, all those consulted agreed on the extent of scour expected around the well. The summary of the findings by those consulted is as follows:

John F. Kennedy - The University of Iowa: Mr. Kennedy is certain that local scour will be produced, but his preliminary judgment is that the scour effects would be mainly localized. The downstream effects would be observed for only a few caisson diameters from the structure.

M. Sid Allsop, P.E. - Sonoma County, (California) Water Agency: The Agency has two wells similar to the proposed collector on the Stillaguamish River. One collector on the Russian River has a similar type river bed. They have had erosion of about two to three feet in depth upstream for a distance of approximately 10 feet. Downstream there has been a buildup of material of about two to three feet in depth which tapers to nothing in about 50 feet.

Edwin R. Stowell - Dewante and Stowell, Consulting Engineers: Mr. Stowell was Consulting Engineer on two Ranney collectors located in the flood plain of the American River. One of the collectors was constructed with submersible pumps installed in a sealed structure whose top was flush with the river bed. The other was of normal caisson type construction and located in a deposit

of sand and gravel. Localized shifting of the sands and gravels were observed. At the caisson site the river channel has shifted away from the collector, but it is his opinion that this is probably due more to the river configuration rather than the collector location. It is also his opinion that the basic river has not been materially altered due to the collectors.

G.H. Toebes - Purdue University: Mr. Toebes was unable to furnish us specific research on our particular scour question, however, he was able to provide an opinion based on his past experience. Mr. Toebes stated that the effect would be localized with the maximum depth of scour not likely to exceed two diameters in distance from the caisson. Noticeable scour would not likely extend further than 40 caisson diameters downstream. He believes that theoretically the deposits would be improved downstream by the presence of less fines. He suggested that the planting and maintaining of brush in a teardrop shape could minimize any detrimental effect. Also, if the effect were too great, the well could be made flush with the river bed and on-shore pumps could be used.

Roy M. Trotter, Principal - Trotter-Yoder and Associates: Mr. Trotter was associated with the construction of two Ranney Collectors on the Smith River at Crescent City, California. Both were located upstream from sand and gravel operations. It is his opinion that the well will have very little effect on the sand and gravel deposits in a channel of the size of the Stillaguamish River.

E.B. Pickett - Corps of Engineers Waterway Experiment Station: Mr. Pickett provided a list of reference material which leads back to the information referenced by John Kennedy of the University of Iowa,

BOOKS AND REPORTS

Guide to Bridge Hydraulics by C.R. Neil was published for the Roads and Transportation Association of Canada, by the University of Toronto Press.

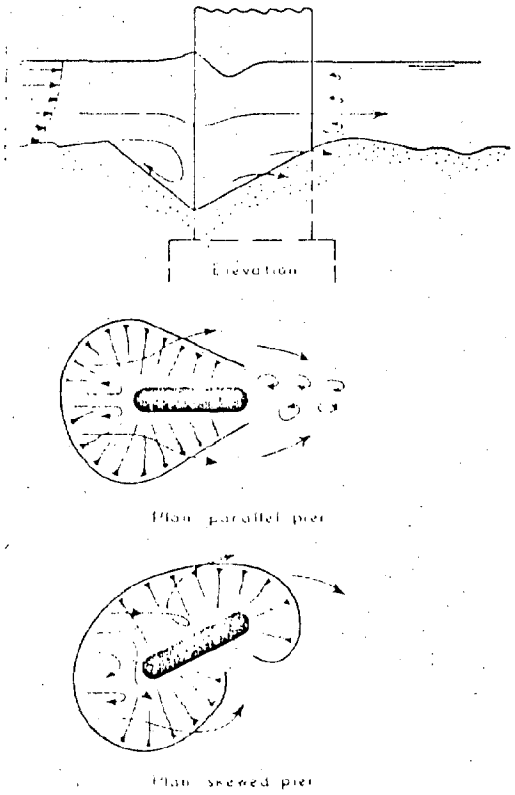
Portions of the publication dealing with scour suggested that at the City of Marysville's site, localized scour would more than likely be all that would occur. Figure No. 12 shows a chart used to predict the shape of scour for different shapes of obstructions.

Scour and Fill in Alluvial Channels by D.M. Culbertson, L.E. Young and J.C. Brice, published by the United States Department of the Interior Geological Survey. The publication agreed with the other sources that scour would occur, but would probably be only localized.

Scour Around Bridge Piers and Abutments by Emmett M. Laursen and Arthur Toch, prepared by the Iowa Institute of Hydraulic Research. This report suggested several methods to minimize the effects of scour around obstruction in river beds. The one which is most suitable to the City of Marysville's needs and requirements makes use of a scour arrestor as shown in Figure No. 13. According to their criteria, the disk-shaped arrestor without a space between it and the caisson would be of the most value. Also, they suggest the use of rip rap around the obstruction which would function in much the same capacity as the arrestor. However, they point out that the rip rap stands the possibility of being carried away during heavy flooding.

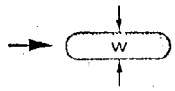
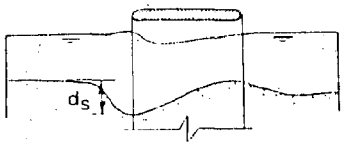
C. Summary of Methods of Minimizing the Downstream Scour Affects

1. Do nothing to correct the amount of scour because of its relatively low magnitude. This is a possible alternative because the scour predicted is only localized and of a low magnitude.



Usual form of local scour holes at piers, as demonstrated by model experiments.

Local scour allowances for piers aligned parallel to flow

Pier shape in plan	Pier shape in profile	Suggested allowance for local scour*
		d_s - 1.5 W
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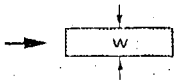
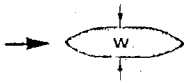
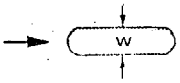
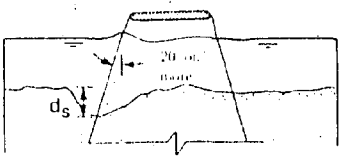
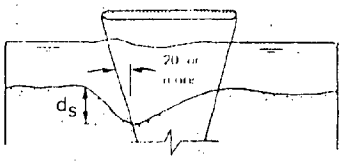
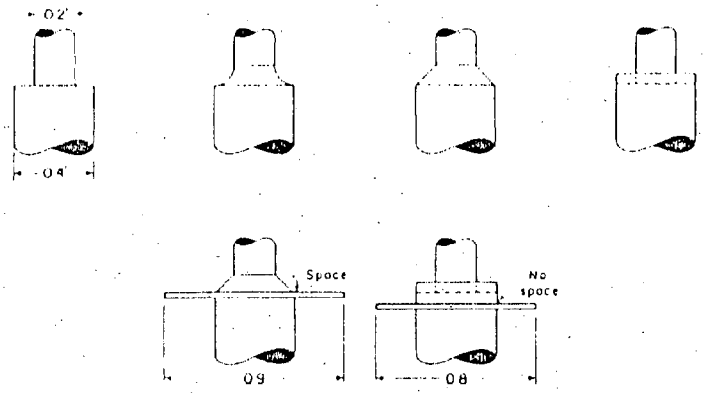
	Ditto	d_s - 2.0 W
	Ditto	d_s - 1.2 W
		d_s - 1.0 W
Ditto		d_s - 2.0 W

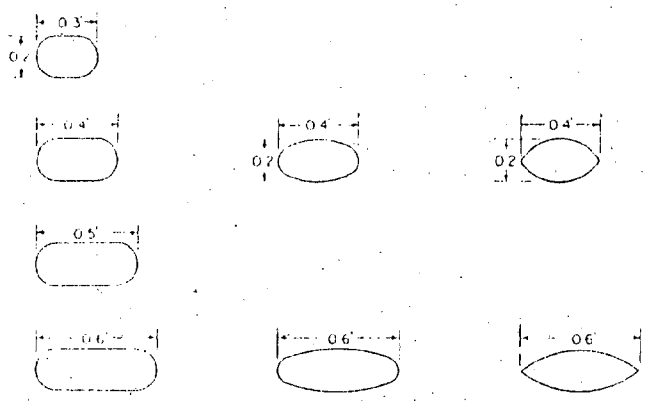
* Note that if the depth of flow exceeds 5W, the allowances should be increased by 50 per cent.

SCOUR SHAPES FROM "GUIDE TO BRIDGE HYDRAULICS"

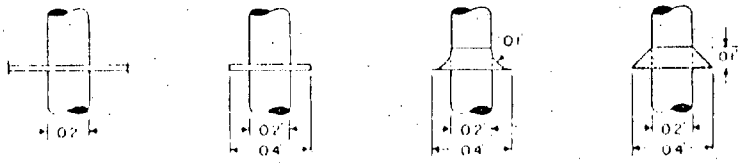
FIGURE NO. 12



Scour arrestors—caisson type.



Basic geometrical pier shapes.



Scour arrestors—ring type.

SCOUR ARRESTORS

FIGURE NO. 13

2. Relocate the well to a site where the gravel deposits are not as important. This alternative is not too feasible due to the fact that the water at this particular location is higher in quality than any of the other locations explored and would require no pre-treatment other then chlorination.

3. Install a form of erosion control such as a scour arrestor to rip rap around the caisson. The use of this type of control would minimize the effects better than the other forms of arrestor. Rip rap would possibly bring around the same results as a ring arrestor, except that during heavy flooding, it is quite possible that the rip rap may be carried away and require replacement.

4. Construct the caisson so that is top is flush with the river bed and utilize on-shore or submersible pumps. If an extremely large amount of critical scour was predicted or appearance was critical, this would be a favorable alternative. However, due to the low amount of scour anticipated and the use of sound architectural treatment, there seems to be no logical reasons to go to this added expense. Further, if the caisson is not sealed properly, potential contamination could occur.

SECTION 4

RECOMMENDATIONS

Scour on Gravel Bar. It is apparent from our research that a certain amount of localized scour will take place at the Arlington Sand and Gravel Site. It is predicted that these scour effects will be minimal and cause little change in the gravel depositing characteristics of the Stillaguamish River. It appears that if the downstream gravel bar is changed at all, it probably would be for a distance of not greater than 150 feet. The change downstream would be in the form of fill rather than scour, thus adding to the gravel deposits.

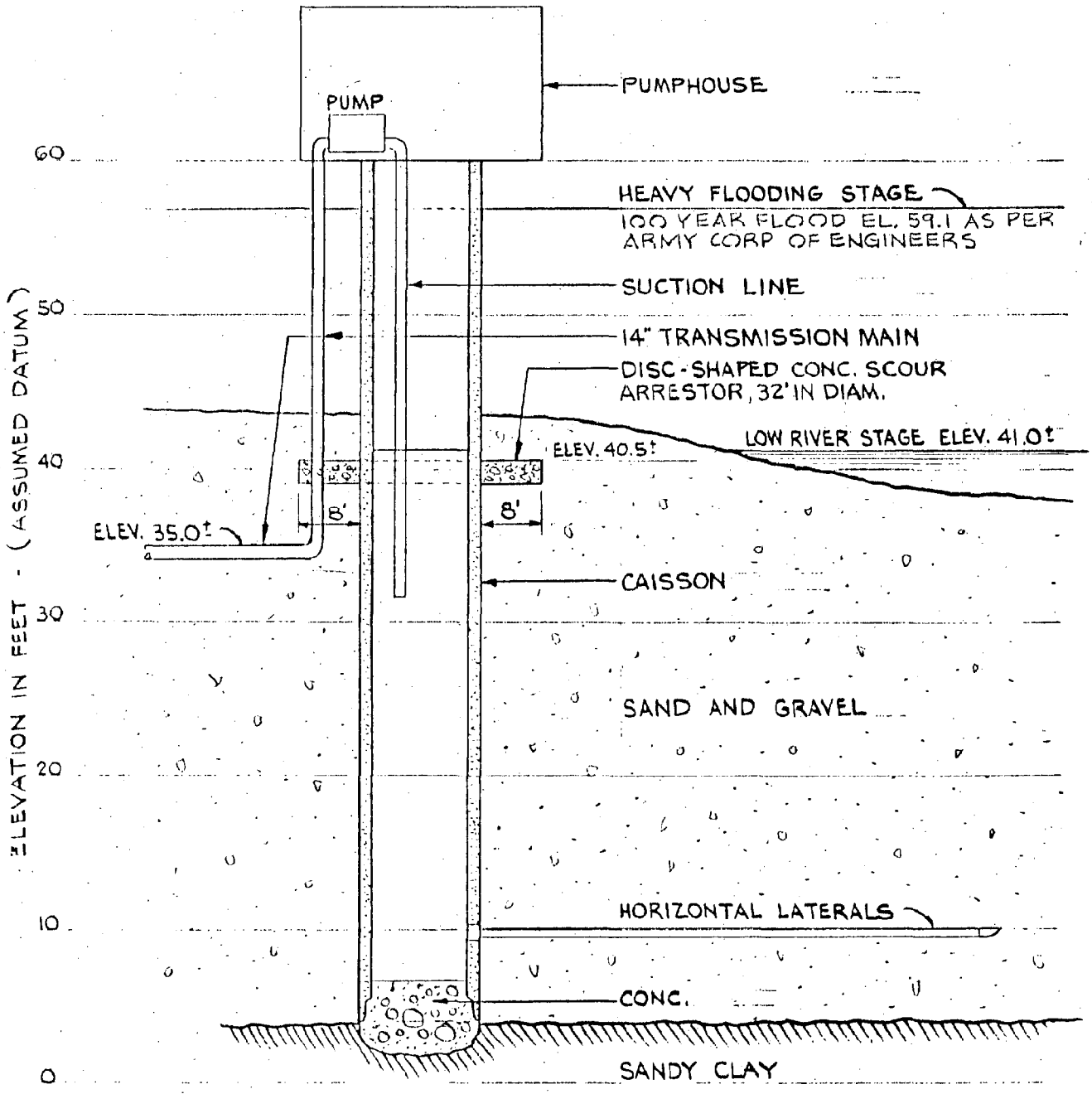
After considering all the material consulted on this project, it appears that the structure should have some type of protection against localized scour. The best alternative for this particular site and structure would be the installation of a disk type scour arrestor which is structurally attached to the caisson. Figure No. 14 shows a cross-section of the proposed collector with the selected arrestor. Besides minimizing any possible downstream scour, it would also deter the undermining of the discharge piping leading from the well to the shore. Also, during periods of heavy flooding, it would lessen the possibility of deep scouring which could damage the structure itself. In our opinion, the structure would cause little change in the gravel bar downstream if the scour arrestor were not installed, however, providing the arrestor will minimize what effects there will be and also protect the well and piping.

Mining Operations. The gravel bar where the collector is to be placed and where a portion of the transmission main will be installed is presently actively mined by Arlington Sand and Gravel. It is our opinion, that the

mining operation as now undertaken will not have an effect on the water quality of the well. The sand and gravel deposits are only removed to an elevation of the surface of the river. Therefore, the lowest elevation of removal would be the summer low water level which will provide approximately 30 feet of material above the collector's horizontal laterals.

Further, the transmission main will be buried a minimum of six feet below this low water level. This depth will provide sufficient protection to the pipe so equipment can move and operate over the site. The depth also provides at least three feet of protection in case the mining should go below the low water level.

The construction of the collector and the installation of the transmission main will not prohibit Arlington Sand and Gravel from mining the materials on and adjacent to the collector site. The materials can be excavated up to the concrete scour arrestor if necessary. However, we do recommend that the City request that the materials only be mined to a distance that will not cause damage to the structure by the equipment, i.e., mining should not be so close that gouges are taken out of the walls of the arrestor or collector.



PROPOSED RANNEY COLLECTOR INSTALLATION WITH SCOUR ARRESTOR

SCALES: HORIZ. 1" = 20'
VERT. 1" = 10'

FIGURE NO. 14

DRAWN BY: J.E.W.	SCALE: AS SHOWN	HAMMOND, COLLIER & WADE-LIVINGSTONE ASSOCIATES, INC.
CHECKED BY: L.R.W	DATE: 12-30-76	CONSULTING ENGINEERS
APPROVED BY:	F.B. NO	1010 STONE WAY N SEATTLE WASHINGTON 98103 (206) 632-2064

REFERENCES CONSULTED

Books and Reports

Open Channel Hydraulics by Ven Te Chow, Ph.D., the McGraw-Hill Book Company, New York, 1959.

Guide to Bridge Hydraulics by C.R. Neil, University of Toronto Press, Toronto, 1974.

Scour Around Bridge Piers and Abutments by Emmett M. Laursen and Arthur Toch, Iowa Institute of Hydraulic Research, Iowa City, May, 1956.

Scour at Bridge Crossings by Emmett M. Laursen, Iowa Institute of Hydraulic Research, Iowa City, August 1958.

Scour and Fill in Alluvial Channels by D.M. Culbertson, L.E. Young and J.C. Brice, United States Department of the Interior Geological Survey, 1967.

City of Marysville Comprehensive Water Plan by Hammond, Collier and Wade - Livingstone Associates, Inc., January 1974.

Letters

Bennett, Truman W. - Executive Vice President of the Ranney Company, Naterville, Ohio; dated September 30, 1976.

Chow, Vente, Ph.D - Professor of Hydraulic Engineering, University of Illinois, Urbana Illinois; dated September 3, 1976.

Kennedy, John F. - Director of the Institute of Hydraulic Research, The University of Iowa, Iowa City, Iowa; dated October 4, 1976.

Miller, Gordon W. - Chief Engineer, Sonoma County Water Agency, Santa Rosa, California; dated October 11, 1976.

Pickett, E.B. - Director of Hydraulic Engineering Information Analysis Center, Vicksburg, Mississippi, dated October 1, 1976.

Stowell, Edwin R. - Dewante and Stowell Consulting Engineers, Sacramento, California; dated October 15, 1976.

Toebes, G.H. - Professor and Director of Hydromechanics Laboratory, Purdue University School of Civil Engineering, West Lafayette, Indiana; dated October 21, 1976.

Trotter, Roy M. - Principal, Trotter-Yoder and Associates, Lafayette, California; dated October 20, 1976

APPENDIX

The University of Iowa
Iowa City, Iowa 52242
U.S.A.

Institute of Hydraulic Research

4 October 1976

Mr. Robert G. Smith
Hammond, Collier & Wade--
Livingstone Associates, Inc.
Consulting Engineers
4010 Stone Way North
Seattle, Washington 98103

Dear Mr. Smith:

Please excuse me for being so long in replying to your letter of 1 September 1976. The delay has been occasioned by the press of other commitments that were awaiting me upon my return from a trip which took me out of the country for an extended period.

There is no doubt but what the caisson will produce local scour. An estimate of the magnitude of the scour can be obtained from the graphical predictor prepared by Laursen and presented in the enclosed bulletins. Determination of the lateral extent of the scour hole and its effect on the river channel downstream would require a more detailed study. My preliminary judgment, made on the basis of the information you sent me, is that the scour effects would be relatively localized; i.e., the lateral and downstream extents of the scour hole would be of the order of a few caisson diameters.

Finally, if you are in need of further information on local scour I would refer you to the recently published ASCE monograph entitled Sedimentation Engineering. One whole section of the monograph is given over to a discussion of local scour.

Sincerely yours,

John F. Kennedy
Director

JFK mj

Enclosures

Dictated by Dr. Kennedy but transcribed and signed in his absence.

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OCT 13 1976
HAMMOND, COLLIER & WADE
LIVINGSTONE ASSOCIATES, INC.

SONOMA COUNTY WATER AGENCY
(Formerly Sonoma County Flood Control & Water Conservation District)
SONOMA COUNTY ADMINISTRATION BLDG. SANTA ROSA, CALIFORNIA 95401
PHONE (707) 527-2211
GORDON W. MILLER
Chief Engineer

October 11, 1976

FILE: 60-5-1

Mr. Larry R. Wade, P. E.
Hammond, Collier, Wade & Associates
Consulting Engineers
4010 Stone Way North
Seattle, Washington 98103

Dear Mr. Wade:

In conversation with Fred Mikels recently the tentative installation of a collector for the City of Marysville was discussed. He subsequently sent a letter together with a drawing showing the plan and section of the proposed installation which I find in review to be reasonably similar to the installation of two collectors that we have had in operation on the Russian River since 1958. Fred asked for our comments on the effect our collectors have had on the streambed. The riverbed at our location is at approximately the same elevation above sea level as indicated on your drawing No. 1500/115; our 100-year flood level, however, goes to approximately elevation 75. The aquifer around our collectors is an alluvial deposit of uncemented sand and gravel material down to a bottom of caisson level of approximately zero elevation.

In our eighteen years of operation we have not had any significant change in the character of gravel bars in the vicinity of the collectors. What little change has occurred has been limited to approximately 10 feet upstream of the collector and 50 feet downstream. There has been no noticeable change in the streambed either side of the collector. The change upstream has been limited to an erosion of perhaps two or three feet of material for the 10-foot distance and the change downstream has been building up of two or three feet of material which has been the same width as the diameter of the caisson at the caisson and tapering down to nothing at approximately 50 feet downstream of the caisson.

If we can be of any further assistance by reason of our experience with similar collectors on what looks to be a similar stream condition, please do not hesitate to contact us.

Very truly yours,
GORDON W. MILLER, Chief Engineer

By: M. Sid Allsop

M. Sid Allsop, P.E.
Civil Engineer IV

MSA/cn

THE RANNEY COMPANY
DIVISION OF Layne-NEW YORK COMPANY, INC.

R. E. Reimund
President
Truman W. Bennett
Exec. Vice President

P. O. BOX 145 · WESTERVILLE, OHIO 43081 · TELEPHONE (614) 882-3104

September 30, 1976

Mr. Larry R. Wade, P. E.
Hammond, Collier & Wade and Associates
Consulting Engineers
4010 Stone Way North
Seattle, Washington 98103

REFERENCE: RANNEY COLLECTOR - CITY OF MARYSVILLE, WASHINGTON
SEDIMENTATION IMPACT

Dear Mr. Wade:

Mr. Frederick C. Mikels of the Ranney Method Western Corporation of Kennewick, Washington has supplied us with background data on the proposed Ranney Collector installation for Marysville, Washington. He has requested our opinion with regard to the impact that the Collector will have if installed at the proposed site, upon the patterns of gravel deposition immediately down stream.

Our company, and its predecessors, have been involved in the design and construction of Ranney Collectors since 1933 and have, on several occasions, constructed Collectors in similar hydrogeological situations. In no instance has the installation of the Collector well had any measurable impact on sedimentation patterns other than very minimal scour in the immediate vicinity (within 25 feet) of the caisson itself. We have made these installations along the Ohio and Mississippi Rivers as well as many smaller streams.

If we can provide you with any further information, please do not hesitate to call upon us.

Very truly yours,

THE RANNEY COMPANY

for James M. French Jr.
Truman W. Bennett
Executive Vice President

TWB:bf

cc: Mr. F. C. Mikels

DEWANTE AND STOWELL
CONSULTING ENGINEERS
1767 TRIBUTE ROAD, SACRAMENTO, CALIFORNIA 95815, 916-929-0271

October 15, 1976

Mr. Larry R. Wade, P.E.
Hammond, Collier & Wade Associates
Consulting Engineers
4010 Stone Way North
Seattle, Washington 98103

Gentlemen:

We have been requested by Mr. Frederick Mikels of Ranney Method Western Corporation to offer you our comments regarding the affects of the Carmichael Irrigation District Ranney Collectors on the gravels in the American River.

Our firm was the Consulting Engineers for the Carmichael Irrigation District at the time the Ranney Collectors were constructed in 1958-59 in the flood plain of the American River. The American River normal flow channel in the location of the collectors is for the most part located in clays. The sands and gravels in which the collectors are located are limited deposits within the clay channel. The River flow is regulated by upstream reservoirs with normal releases of 1500 to 3000 cubic feet per second being common. However, releases have varied from 800 c.f.s. to 115,000 c.f.s., plus or minus, since the collectors were constructed.

One of the collectors at the Landis Avenue Site (See attached location map), is located near the normal flow line of the River and is flush with the ground level, submersible pumps being used. The collector at the Oak Avenue site was located near the river channel and is of normal construction with the caisson extending above the River high water level.

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As would be expected, there have been some localized shifting of the sands and gravels in the vicinity of the collectors, particularly at the Oak Avenue site which is on the inside of a bend.

The normal river channel at the Oak Avenue Site has shifted away from the collector caisson over the years, probably more due to the river configuration rather than the collector location. In any event, the gravel deposits in which this and the other collectors are located remain intact.

In our opinion, the basic river channel and gravel deposits in the river have not been materially altered due to the collectors.

Very truly yours,

DEWANTE & STOWELL

Edwin R. Stowell

Edwin R. Stowell

ERS:djk

Ven Te Chow, Ph.D., Hon.Sc.D., Hon.D.Eng.

President, International Water Resources Association
Vice President, International Commission on Surface Water
Editor, Advances in Hydroscience, Academic Press, Inc., New York
Editor, Journal of Hydrology, North-Holland Pub. Co., Amsterdam
Consulting Editor, Water Resources & Environmental Eng., McGraw-Hill, New York
Advisory Editor, Developments in Water Science, Elsevier Sci. Pub. Co., Amsterdam
Editor-in-Chief, Water International, IWRA

Professor of Hydraulic Engineering
Hydrosystems Laboratory
University of Illinois
Urbana, Illinois 61801 U.S.A.
Tel. (217) 333-0107, 333-0687; 328-1166

September 3, 1976

Mr. Robert G. Smith
Hammond, Collier & Wade-Livingstone Assoc. Inc.
400 Stone Way North
Seattle, Washington 98103

Dear Mr. Smith:

Thank you very much for your letter of September 1, 1976 to our Hydraulic Engineering, Civil Engineering Department, concerning the Scour effect in installing an infiltration well.

Unfortunately we are not engaging in any such activities, either in research or teaching. I would suggest that you write Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, Miss. They may have the information you need.

With my best wishes.

Sincerely yours,

V. T. Chow

VTC:nb

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LIVINGSTONE ASSOCIATES, INC.
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PURDUE UNIVERSITY
SCHOOL OF CIVIL ENGINEERING
WEST LAFAYETTE, INDIANA 47907

October 21, 1976

Mr. Larry R. Wade, Partner
Hammond, Collier, and Wade
4010 Stone Way North
Seattle, WA 98103

Dear Mr. Wade:

This is in response to your letter of September 15, 1976, and the set of questions sent earlier by Mr. Robert G. Smith.

In my inquiries I have not come across specific research on the specific question you asked. I will therefore provide an opinion based on my past research involvement in vortex wakes, river flow, Ranney well flow and related areas.

1. Unfortunately the key piece of information, namely the distance between the proposed well and the gravel deposit location of concern, is not given. Consequently the general effect cannot be stated. If the distance is large enough there will be no effect.

2. The scouring effect is localized.

3. The maximum depth of scour will be at the well shaft itself. There it is not likely to exceed 2 diameters.

4. Noticeable scour is not likely to extend further downstream than 40 diameters.

5. To minimize scour one may plant and maintain brush and give the planting a teardrop shape, i.e. streamline it.

6. See #4.

7. If the distance to the gravel deposits is very short, those deposits would (theoretically) be improved (less fines). If the explotation increased, scour at the well could increase and (again theoretically) its stability could be effected.

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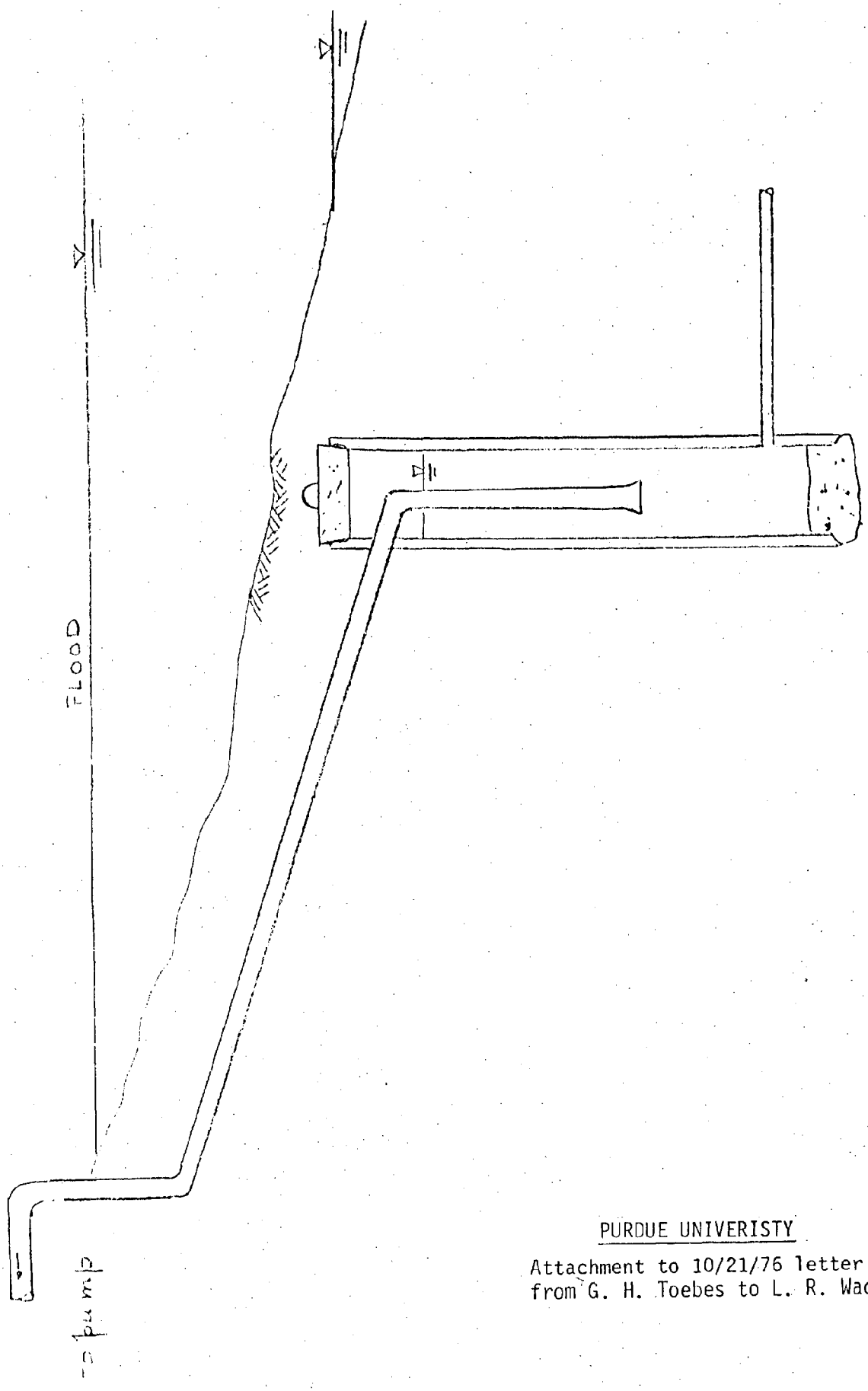
8. If legal questions are to be prevented would it be possible to consider a solution as appended?

Sincerely yours,

G. H. Toebes
Professor and Director
Hydromechanics Laboratory

GHT/sm

Att: 1



PURDUE UNIVERISTY

Attachment to 10/21/76 letter
from G. H. Toebes to L. R. Wade.

TROTTER - YODER & ASSOCIATES
ENGINEERING CONSULTANTS

principal office
3730 Mt. Diablo Blvd.
Lafayette, Calif. 94549
(415) 284-2980

sacramento office
455 Capitol Mall, Suite 270
Sacramento, Calif. 95814
(916) 446-7691

October 20, 1976

Mr. Larry R. Wade, P.E.
Hammond, Collier & Wade and Associates
Consulting Engineers
4010 Stone Way North
Seattle, Washington 98103

Dear Mr. Wade:

Mr. Frederick C. Mikels of Ranney Method Western Corporation has furnished us a plan, section and location plan, and other data on the proposed Ranney Collector for the City of Marysville, Washington. Fred asked me if I would pass on to you my experiences with Ranney Collector installation on the Smith River providing the water supply for the City of Crescent City, California. The collector system was constructed in 1958.

After reviewing the preliminary plans for the proposed collector for the City of Marysville, it would appear that the installation is very similar to the horizontal collector system for the City of Crescent City. Both installations have a sand and gravel operation located downstream from the Ranney Collector system. The real difference is in the physical features of the river channel; those existing at the Crescent City site would be more apt to create problems. I will discuss these differences and point out the conditions that developed problems:

1. The north and south banks forming the river channel in which the collector was constructed are approximately parallel and restrict the flow during storm runoff to a condition which produces velocities that will move gravels up to approximately 12 inches in diameter. The Crescent City Collector was constructed approximately 75 feet north from the south river bank and about 20 feet south of the low river stage waterline.

   The proposed collector at the Marysville site is to be located on the inside of the curve in the Stillagaumish River where the lower

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velocities will occur depositing the finer sands and gravels. At this location, you can expect less nuisance and damage from floating debris, brush, trees, and logs.

2. Approximately 250 yards downstream from the Crescent City Collector, the dry weather river (Smith River) makes a bend to the north and then to the west (see attached plan). At this point, the rapid increase in the channel width during flood stages creates a drop in the flow velocity which results in the deposit of the large gravels from the materials being carried by the flowing water. This bar, or barrier of heavy (large) gravel, is very important to the successful operation of the Crescent City Collector by preventing scour and maintaining a uniform grade of the river bed in the area where the horizontal collection system is located. The high velocities during the winter flows remove the mud and organic materials that may be deposited on the river bottom throughout the periods of the year when the river flows are low.

The only restriction placed on the gravel operation downstream from the collector is the protection of the large gravel deposits at the point of velocity change and increased width of flow channel (large size gravel bar) providing and maintaining a fixed upstream river bottom gradient. Downstream from the point of velocity change (large gravel bar), the fine gravel and sands are deposited every year as a new supply to be excavated and used for construction.

It is our feeling that the Ranney Collector structure has very little effect on the sand and gravel transport capacity and depositing characteristics of the river.

It is our opinion that the efficiency and proper operation of the proposed Ranney Horizontal Collector system for the City of Marysville will not be affected by the Arlington Sand and Gravel Company's operation as long as the company does not remove material from the area over the horizontal collector system and will always

maintain a natural stream gradient from the material being excavated to the material over the collector system.

Again, we want to comment that, in our opinion, the Ranney Collector structure has very little effect on the depositing of material in a channel of this magnitude.

The 1964-65 flood on the Smith River created scour problems at the collector structure. The City lost the water connection from the collector structure to the supply line to the City. This was repaired within ten days with the support of a hard-hat diving crew. In 1967, scour protection was designed and constructed around the collector structure and since that time, as far as we know, no problems have occurred.

It is our hope that our experiences with the Ranney Collector system at the City of Crescent City will assist you in working out your design problems for the City of Marysville. With the right conditions and location, we feel that the Ranney Horizontal Collector system is one of the best supply systems.

Should you have any questions on the information submitted, please call me at (415) 284-2980.

Very truly yours,

TROTTER-YODER & ASSOCIATES

Roy M. Trotter

Roy M. Trotter, Principal

RMT:scj
enclosures
cc/en: Mr. Frederick C. Mikels, President
Ranney Method Western Corporation

Mr. Michael Young, City Manager
Crescent City

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESHP

1 October 1976

Mr. Robert G. Smith
Hammond, Collier & Wade
Livingstone Associates, Inc.
4010 Stone Way North
Seattle, Washington 98103

Dear Mr. Smith:

Considerable research has been conducted on scour around local obstructions such as described in your letter of 7 September 1976. Unfortunately, no universal solutions have been derived because of the very complex flow pattern. The local sediment transport rate, and thus the depth of scour for equilibrium, cannot easily be determined. Copies of several abstracts from our reference file are inclosed and may indicate some material which you may find helpful.

Because of this difficulty of evaluating the flow pattern and the resulting shear forces, most of the data upon which estimates of the extent of scour are made have been obtained by experiments. For example, an investigation by means of hydraulic models was carried out by Laursen and Toch (see references 9 and 13). They related the depth of scour around piers to the flow parameters and pier geometry. The depth of scour was measured for a rather wide range of velocities and sediment sizes. Professor Laursen is now teaching at the University of Arizona should you wish to contact him.

As to bed stabilization at the well site, reference number 1 should prove helpful. The author, Dr. G. L. Lewis, is now a professor at the University of Nebraska at Omaha. You may wish to consult him for more detailed assistance.

In addition to a shoreline management permit, the Corps of Engineers also requires a permit to place obstructions in waterways below the ordinary high-water line. You should consult the Seattle District of the Corps on this matter. Their address is P. O. Box C-3775, Seattle, 98124.

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LIVINGSTONE ASSOCIATES, INC.

WESHP
Mr. Robert G. Smith

1 October 1976

Although we could not give you specific answers to your questions, we hope that this information will lead you to a satisfactory solution.

Sincerely yours,

E. B. Pickett

E. B. PICKETT
Director
Hydraulic Engineering Information
Analysis Center

1 Incl
As stated

CF:
Seattle District

WASHINGTON
Department of
FISHERIES

DANIEL J. EVANS
GOVERNOR

ROOM 115, GENERAL ADMINISTRATION BUILDING • PHONE 753-6600
OLYMPIA, WASHINGTON 98504

DONALD W. MOOS
DIRECTOR

August 30, 1976

Snohomish County Planning Department
County Administration Building
Everett, Washington 98201

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SEP 1976
CO. PLANNING DEPT.

Attention Leslie Stephen, Senior Planner

Gentlemen:

Shoreline Management Substantial Development
Permit for City of Marysville, SM 13 (6-76)

We see no problems with appropriating water or constructing the Ranney Collector for the subject project. The pipeline in the flood plain should create no problems if backfilled with native granular material as stated. There may be a problem where (and if) the pipeline climbs the bank from the flood plain if erosion is not prevent by check dams.

If the collector or pipeline lies within the ordinary high water line, a Hydraulic Project Approval will be required from the Departments of Fisheries and Game.

Thank you for the opportunity to review this project.

Sincerely,

Fay Conroy

Fay Conroy
Hydraulic Engineer

cc: Richard E. Noble, SEPA Coordinator, WDF

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"Riprap Protection of Bridge Footings," Dissertation by Gary L. Lewis, CO State Univ, March 1972 294 pgs (Microfilmed copy)

Analytical and experimental evaluations of the hydraulic characteristics and stability of rock-riprap for bridge embankments are presented. A numerical technique for estimating the velocities and depths of free-surface constricted flow in a river channel is developed, and the technique is evaluated by comparisons of predicted and measured velocity and depth data collected from small-scale bridge constrictions constructed in two laboratory flumes. A technique for determining stable rock-riprap sizes for flood protection of the channel bed and constricting embankments is also developed and tested with data from small-scale riprap-protected embankments that were

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Scour Around Pile Bridge Piers by R. D. King and L.E. Cox. Submitted in partial fulfillment of the requirements for the Degree of Master of Science at MIT. 1947. 624.15 K586

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Local Scour Around Piers in Rivers by Ing. O.J. Maggiolo. (In Spanish). Seminario Internacional De Hidraulica Y Mecanica De Fluidos, 20 Al 25 De Agosto, 1962, Santiago, Chile. Laboratorio De Hidraulica, Universidad de Chile, 1963.

The results of a research about depth of scour occurring at the front of bridge piers placed in an alluvial channel are reported. The local bed scour is a function of the particular regime of flow. In all experiences the regime was axial, and the bed was maintained in the zone between rides and the transition to plane. The shear stress at the bottom of the experimental flume was always slightly superior to the critical value for incipient

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Pamphlet Box on loan

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KEY WORDS: bridge abutments; bridges; hydraulics; piers; scour; sediment

ABSTRACT: Based on the proposition that the limit of clear-water scour is a boundary shear equal to the critical tractive force, analytical relationships are obtained for the scour in a long contraction, at an abutment, and around a pier. The pier and abutment solutions make use of the assumption that the flow beyond the scour hole can be ignored and that the depth of scour at the pier or abutment is a multiple r of the scour in the equivalent long contraction. An expression for the active phase of scour is obtained using a simplified transport equation. Comparison of predictions with measurements from several laboratories is reasonably satisfactory.

REFERENCE: "Analysis of Relief Bridge Scour," by Emmett M. Laursen, Journal of the Hydraulics Division, ASCE, Vol. 89, No. HY3, Proc. Paper 3516, May, 1963, pp. 93-118.

Discussion by S. V. Chitale, Journal of the Hyd. Div., ASCE Proceedings, Jan. 1964, p.287. Closure by Emmett M. Laursen, Journal of Hyd. Div., ASCE Proceedings, July 1964, p.231.

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"Report of an Investigation of Scour at Bridges Caused by Floods," by L. K. Moulton, C. Belcher, and B. E. Butler, Civil. Engr. and Public Works Review, Vol.53, No. 624, June 1958.

Article based on scour observations at bridges after New England flood of 1955. Author develops theory and equation for average scour at bridges based on flood discharges. Gives curve data for equations. Compares computed with observed scour.

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Erosion autour de piles de ponts en riviers (Erosion Around Bridge Piers in a River) by L. J. Tison. Annales des Travaux Publics de Belgique, v.41, no.6, p.513-571, Dec. 1940. Includes bibliography. (In French).

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The Hydraulic Design of Bridges for River Crossings - A Case History by A. G. Anderson. University of Minnesota, SAFHL, Technical Paper No. 23, Series A, Jan. 1966.

Discusses model study performed to define hydraulic conditions that led to collapse of one of the I-29 bridges on April 1, 1962, and to test proposed protective works. Collapse was initiated by undermining by erosion of one of the piers of the upstream bridge; a consequence of the erosion pattern was subsidence of a portion of the left bank, which was left without support when the bed downstream of the bridges eroded to a considerable depth. (RGC)

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"Report of an Investigation of Scour at Bridges Caused by Floods," by L. K. Moulton, C. Belcher, and B. E. Butler, Civil. Engr. and Public Works Review, Vol.53, No. 624, June 1958.

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Scour Around Bridge Piers and Abutments by Emmett M. Laursen and Arthur Toch. Bulletin No. 4, Iowa Highway Research Board. Prepared by the Iowa Institute of Hydraulic Research, State University of Iowa, May 1956, in cooperation with the Iowa State Highway Commission and the Bureau of Public Roads.

2.0013, SCOUR AT BRIDGE CROSSINGS IN ALASKA
L.S. LEVEEN, U.S. Dept. of Interior, Geological Survey, Anchorage, Alaska

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Alaska.

Only meager information is available on scour of alluvial channels at constrictions and no generally accepted method of predicting depth of scour is presently available. The objective of this project is to develop general relationships between observed depth of scour and measurements of the associated hydraulic and sediment transport variables at selected bridge crossing in Alaska.

The project is designed to obtain detailed information on the cross sectional and longitudinal profile of the streambed utilizing echo sounders from a boat; and to provide measurements of hydraulic and transport variables such as the vertical velocity and sediment distributions, stage discharge and depth-discharge relationships and particle size of suspended sediment and bed material. The results of this investigation will complement laboratory experiments and aid in understanding the mechanics of scour around bridge piers and abutments.

"Mechanics of Local Scour - Discussion and Bibliography" by S. S. Karaki and R. M. Hynie, prepared for U. S. Dept of Commerce, Bureau of Public Roads, at Civil. Engr. Sec. Colorado State University, November 1963. (Copy in RCL)

Presents discussion of theory of local scour with historical background and development of theory and equations. Includes a 301 item annotated bibliography. (RGC)

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"Studies on the Nature of Local Scour," by Peder Jorgensen, Dept of Water Resources Engineering, Lund Institute of Technology, 1975

This study is mainly concentrated to the mechanism of the local scour process associated with pipelines and cylindrical bridge piers. The pipelines are supposed to be lying on or to be partly embedded in a uniform sediment bed. The oncoming flow is supposed to be at right angles to the axis of the pipeline. The cylindrical bridge piers investigated are of three shapes, circular, square and square turned 45° to have an edge facing the oncoming flow. Finally an example is given of how to use the findings of this study to design a rip-rap scour arresting mat.

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Scour at Bridge Crossings by Emmett M. Laursen. Journal of the Hydraulics Division, ASCE Proceedings, Feb. 1960, pp.39-54.
Discussion by Joseph N. Bradley, Journal of the Hyd. Div ASCE Proceedings, August 1960, pp.69.
Discussions in Journal of the Hyd. Div., ASCE Proceedings Nov. 1960 by the following: D.V. Joglekar, p.129; W. J. Bauer, p.132; L. J. Tison, p.134; by S. V. Chitale, p. 137; by A. Rylands Thomas, p.142; by Mushtaq Ahmad, p. 144; by Pier Luigi Romita, p.151.
Discussion in Journal of the Hydraulics Division, ASCE Proceedings, July 1961, pp.227-229. Closure by E. M. Laursen.

TA1 A5J HY V.87

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6591 LOCAL SCOUR AROUND BRIDGE PIERS

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KEY WORDS: abrasion; bridges (piers); hydraulics; pile structures; scouring; vortices

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ABSTRACT: Local scour caused by the horseshoe vortex system which forms at the base of the piers is considered. Piers which induce a pressure field strong enough to cause the formulation of the horseshoe vortex system are termed "blunt nosed"; all others being classed as sharp-nosed piers. The condition of the sediment transported into and out of the scour hole forms the basis for the further classification of the scour process into clear-water scour and scour with continuous sediment motion. The pier Reynolds number is shown to be an important variable describing the strength of the horseshoe vortex system. Further, the equilibrium scour depth depends on the initial sediment transport condition for a steady uniform flow with fully developed bed material transport. Design criteria are proposed for blunt-nosed piers under the conditions of clear-water scour and scour with continuous sediment motion. Several deviations from the above ideal design conditions are discussed; methods for design in these cases are suggested.

REFERENCE: Shen, Hsieh W., Schneider, Verne R., and Karaki, Susumu, "Local Scour Around Bridge Piers," Journal of the Hydraulics Division, ASCE, Vol. 95, No. HY6, Proc. Paper 6591, November, 1969, pp. 1919-1940.

TA1 A5J HY V.95 July-Nov.

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Laboratory Observations of Scour at Bridge Abutments by H. K. Liu and M. M. Skinner. Prepared for Hydraulic Division of the U.S. Bureau of Public Roads. Jan. 1959. Publication 728. 1960. Research Reports, Papers, Bulletins, and Theses, 1948 through 1961, Civil Engineering Section, Dec. 1961, Item 108, p.A13.

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Effect of Bridge Pier Shape on Local Scour by Hsieh W. Shen and Verne R. Schneider. ASCE National Meeting on Transportation Engineering, Boston, Mass, 13-17 July 1970, Preprint 1238.

This paper presents results of a laboratory investigation on the effect of bridge pier shape on local scour depth. Local scour depth near a sharp-nosed pier is much shallower than that near a blunt-nosed pier if the sharp-nosed pier is properly aligned with the flow. (RGC)

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"Measurements of Bridge Scour and Bed Changes in a Flooding Sand-Bed River" by C. R. Neill, Proceeding, Institute of Civil Engineers, London, Feb. 1965.

Measurements of river-bed scour in the vicinity of several bridges and changes in bed profile along river course made during exceptional flood. Summary of the regime and tractive force theories and of associated methods of estimating scour depths. Also gives methods of estimating scour depth. (RGC)

TA1 C4 V.33

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"Scour at Bridge Piers" by L. Stabilini, Civil Engineering, p.46, May 1963.
Discusses mechanism of scour, methods of prevention. Gives several illustrations of bridge failures. Includes photographs of failures and flow conditions. Copy in HAB Technical File 090. (RGC)

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