DOLE

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT No. 1

2320 California St., Everett, Washington 98201 258-8211
Mailing Address: P. O. Box 1107, Everett, Washington 98206

December 3, 1990
PUD-19384

Ms. Lois Cashell, Secretary
Federal Energy Regulatory Commission
825 North Capitol Street NE
Washington, D. C. 20426

Dear Ms. Cashell:

RE: Henry M. Jackson (Sultan River) Project
FERC No. 2157 Article 55
1990 Winter-Run Steelhead Spawning Ground Survey

Please find enclosed the original and 14 copies of the report "1990 Steelhead Spawning Ground Surveys". Public Utility District No. 1 of Snohomish County (District) is submitting this report as fulfillment of one of several obligations under Article 55 of the amended Project License (17 FERC ¶61,056) and the Settlement Agreement (22 FERC ¶61,140) between the Licensees and the Joint Agencies (Washington Departments of Fisheries and Wildlife, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Tulalip Tribes).

This report is the third in a three part series of studies assessing the success of the powerhouse berm to facilitate upstream migration of spawning winter-run steelhead. The study was mentioned in the letter transmitting to you this year the Adult Fish Passage Study Final Report (PUD-19221).

Study results showed 68% of redds counted occurred above the powerhouse, the largest percentage of any pre- and post-project years surveyed. This occurred during a season where powerhouse flows were higher than normal and exceeded 50% of the total river flow.

The consultant concluded "results of the post-project surveys indicate that over the range of flow patterns observed, project operations do not appear to inhibit the passage of steelhead past the powerhouse".

Combined with the results of earlier fish passage studies, the District concludes that the powerhouse berm successfully attracts anadromous fish into the upper reaches of the Sultan River.

The Joint Agencies were asked in writing to comment on the report in mid-September. To date, no written comments have been received. However, several agencies were notified by phone of our intent to submit this report to FERC and their oral response was concurrence with the District's position that the berm appears to be performing the passage function for which it was designed. Although we have not received any written agency comments to date, we will forward any received in the future for consideration in this matter.

This study concludes the formal studies on powerhouse fish passage which the District was required to conduct under Article 55 and the Settlement Agreement. However, District personnel will continue to monitor visually fish activity in the passage area particularly during the various spawning seasons. Any signs of abnormal behavior will be recorded and reported to the Joint Agencies. Furthermore, the District remains open to discuss with the Joint Agencies any future issues regarding powerhouse fish passage.

Very truly yours,

Original Signed By
R.E. JOHNSON

Richard E. Johnson, Director
Construction & Operations

Enclosures
BFM:vr
cc: Joint Agencies
Bell & Ingram (Attorneys for Tulalip Tribes)
A. Martin, FERC (Portland)
bcc: B. Jones, City of Everett
C. Olivers, City of Everett
R. Goodell (w/o attachment) - OP
B. Meaker - BB
D. Dole - BB
Bob Sullivan - Parametrix

HENRY M. JACKSON HYDROELECTRIC PROJECT
(Federal Energy Regulatory Commission Project No. 2157)

Licensees

Public Utility District No. 1 of Snohomish County
and City of Everett, Washington

1990 WINTER-RUN STEELHEAD SPAWNING GROUND SURVEYS

Final Report

Prepared by:

PARAMETRIX, INC.
Bob Sullivan
13020 Northup Way, Suite 8
Bellevue, Washington 98005

Prepared for:

PUBLIC UTILITY DISTRICT NO. 1 OF SNOHOMISH COUNTY
Bruce Meaker, Project Leader
P.O. Box 1107
Everett, Washington 98206

November 1990

EXECUTIVE SUMMARY

The Henry M. Jackson Hydroelectric Project on the Sultan River in northwestern Washington State was completed in 1984. It is owned and operated by the Public Utility District No. 1 of Snohomish County. At the upstream end of the powerhouse is a low-head dam (berm) which was constructed to create attraction flows for fish migrating upstream past the powerhouse. The berm is intended to alleviate potential fish passage problems associated with project operation. The area above the powerhouse is used primarily by chinook salmon and steelhead trout making them the species of concern. This report provides information on the 1990 steelhead spawning ground surveys which were conducted to evaluate spawning distribution relative to the powerhouse.

This was the last of a 3-year series (1987, 1989, and 1990) of spawner surveys requested by the fisheries resource agencies, to evaluate the possible effects of project operation on steelhead spawning distributions. The agencies believed that high powerhouse discharges combined with low river flows ("worst-case" scenario) might inhibit the passage of fish above the project. During earlier pre-project surveys (conducted in 1979 and 1980), the percentage of redds observed above the powerhouse were 29 and 30 percent, respectively. The initial post-project studies (1985) indicated that redd distribution was similar to pre-project years (30%).

Seven spawner surveys were conducted in 1990. The surveys consisted of observations from a helicopter over the entire accessible stretch of the Sultan River (from the mouth to the Diversion Dam at River Mile 9.7). Observers noted all redds visible during each flight and redd distributions were compared to those observed in previous years. Water clarity and light conditions ranged from good to excellent throughout the surveys.

A total of 60 redds were observed. This total is higher than in 1989 (46) but lower than the other monitoring years: 109 (1979), 117 (1980), 100 (1985) and 68 (1987). Of the 60 redds observed, 19 (32%) were observed downstream of the powerhouse and 41 (68%) upstream. This distribution is substantially different from the previous post-project years (30% to 50% upstream), and opposite of the two pre-project years (29% and 30%).

Peak spawning activity occurred between April 18 and May 15, when 73% of the total redds were observed. This timing was similar to previous survey years. However, spawning activity downstream of the powerhouse was only slightly later than upstream. In past years the mid-point of the run (when 50% of the redds had been dug) was up to a month later in the lower reach.

A total of six artificial redds were dug and marked during the season to estimate redd-life (duration of visibility). The average redd-life was about 40 days above the powerhouse and greater than 80 days below. The exact duration could not be calculated because 4 of the 6 test redds were still visible on the last survey. These redd-life estimates suggest that all natural redds should have been visible during the course of the season, since the surveys were conducted approximately 2-weeks apart.

The average monthly river flows were moderate during the 1990 steelhead spawning season and similar to the other post-project years. The average monthly contribution of these flows from the powerhouse were also similar to previous post-project years although the season average was slightly higher. On a daily basis, the powerhouse contribution was greater than 50% of the total river flow for all but 13 days during the season. Therefore, even though a "worst-case" flow scenario did not occur, the high powerhouse discharges provided an adequate test of the fish passage concerns. The results of the post-project surveys indicate that over the range of flow patterns observed, project operations do not appear to inhibit the passage of steelhead past the powerhouse.

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INTRODUCTION

BACKGROUND

Completion of the Henry M. Jackson Hydroelectric Project on the Sultan River in northwestern Washington State (Figure 1) occurred in 1984. The facility is owned and operated by the Public Utility District No. 1 of Snohomish County. The project consists of a tunnel and pipeline linking Culmback Dam at river mile (RM) 16.5 to the powerhouse (RM 4.5). Water passing through two of the four turbines is diverted up to Lake Chaplain while water through the other two turbines flows directly into the river. Water sent to Lake Chaplain can be transported back to the Sultan River via another tunnel/pipeline system to provide required in-stream flows, when needed to supplement natural flows, for fish spawning and rearing. This water enters the river upstream, at the Everett Diversion Dam located at (RM) 9.7. The Diversion Dam is the upstream limit to fish migration and spawning.

At the upstream end of the powerhouse is a low-head dam (berm) which creates attraction flows for fish migrating upstream past the powerhouse (Figure 2). The fish passage berm was part of the mitigative measures required by the fish management agencies. The agencies recognized that certain flow regimes may create passage problems for adult fish. The berm is intended to alleviate potential fish passage problems. To evaluate the success of this mitigation measure the District was required to conduct studies, including spawning ground surveys. The Sultan River and its tributaries are used for spawning and rearing by chum, pink, coho, chinook, and steelhead salmon, and sea-run cutthroat trout, and Dolly Vardon. However, the area above the powerhouse is used primarily by chinook and steelhead making them the species of concern.

A study to determine if the passageway successfully facilitated migration past the powerhouse began in 1984. This initial study evaluated the effects on fish passage by comparing the pre-project and post-project spawning distributions. Earlier 1979 and 1980 surveys provide the pre-project data used for these comparisons. The complete results of that study and more explanatory background information are presented in Adult Fish Passage (Powerhouse Berm) Study (1987) prepared for the District by Parametrix, Inc.

The results of the steelhead spawning ground surveys conducted in 1985 as part of the initial study indicated that redd distribution was similar to pre-project years. However, the Washington Department of Game (now Wildlife) requested additional surveys because powerhouse discharge during the 1985 migration was only moderate. The agency believed that higher powerhouse discharge might be more difficult for fish passage than lower flows. To address this concern, the District agreed to conduct three more years of steelhead spawning ground surveys through 1990, if necessary.

The first of these additional surveys was conducted in 1987. These surveys results indicated a higher distribution of redds (50%) upstream from the powerhouse than in pre-project years. For the two years of available pre-project survey data (1979 and 1980) the percentage of redds observed above the powerhouse was 29 and 30 percent, respectively (Washington Department of Game and Snohomish County PUD 1982). The initial post-project study found 30% of the total redds upstream from the powerhouse (Parametrix 1987).

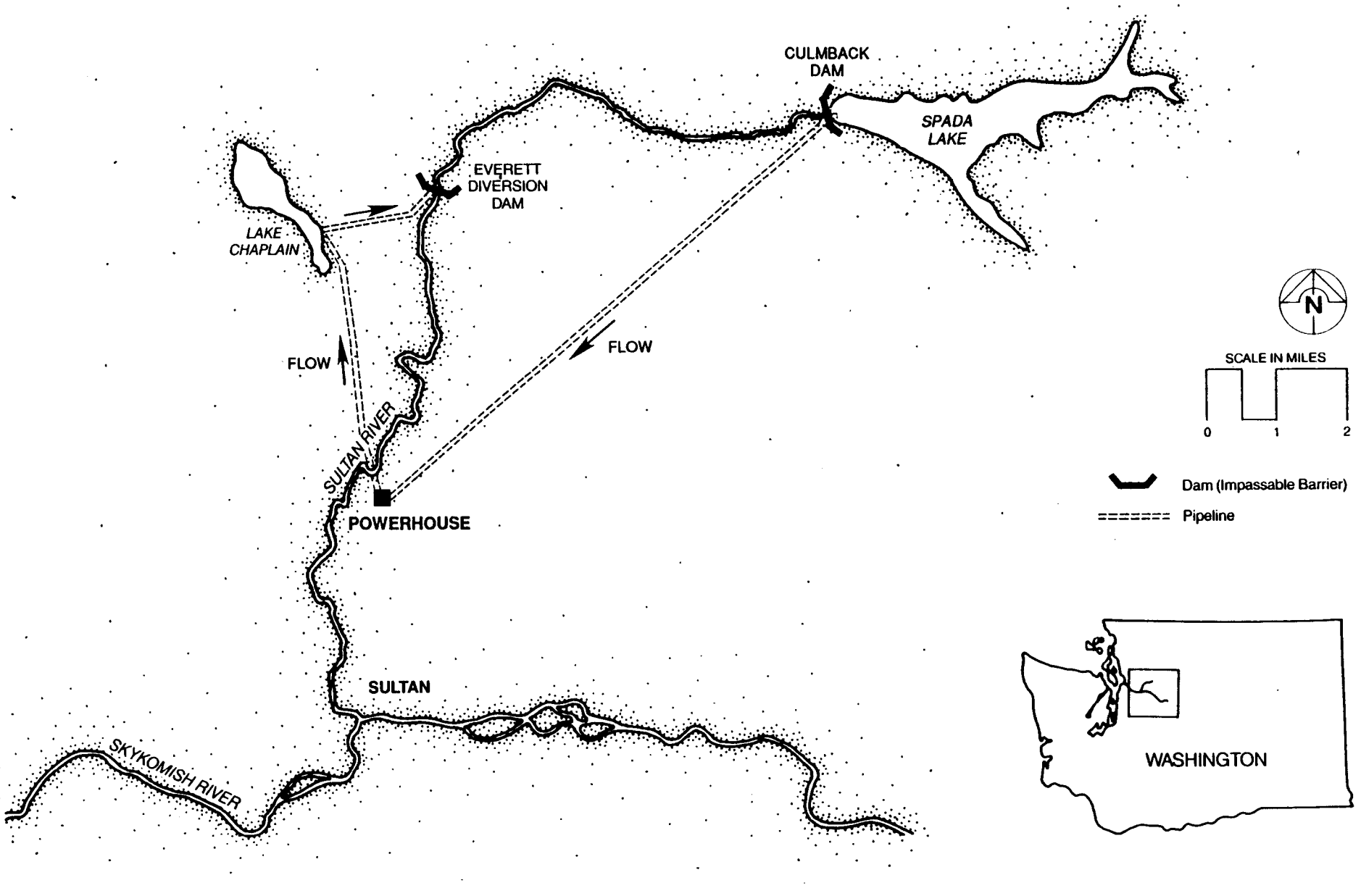


Figure 1. Jackson Project vicinity map.

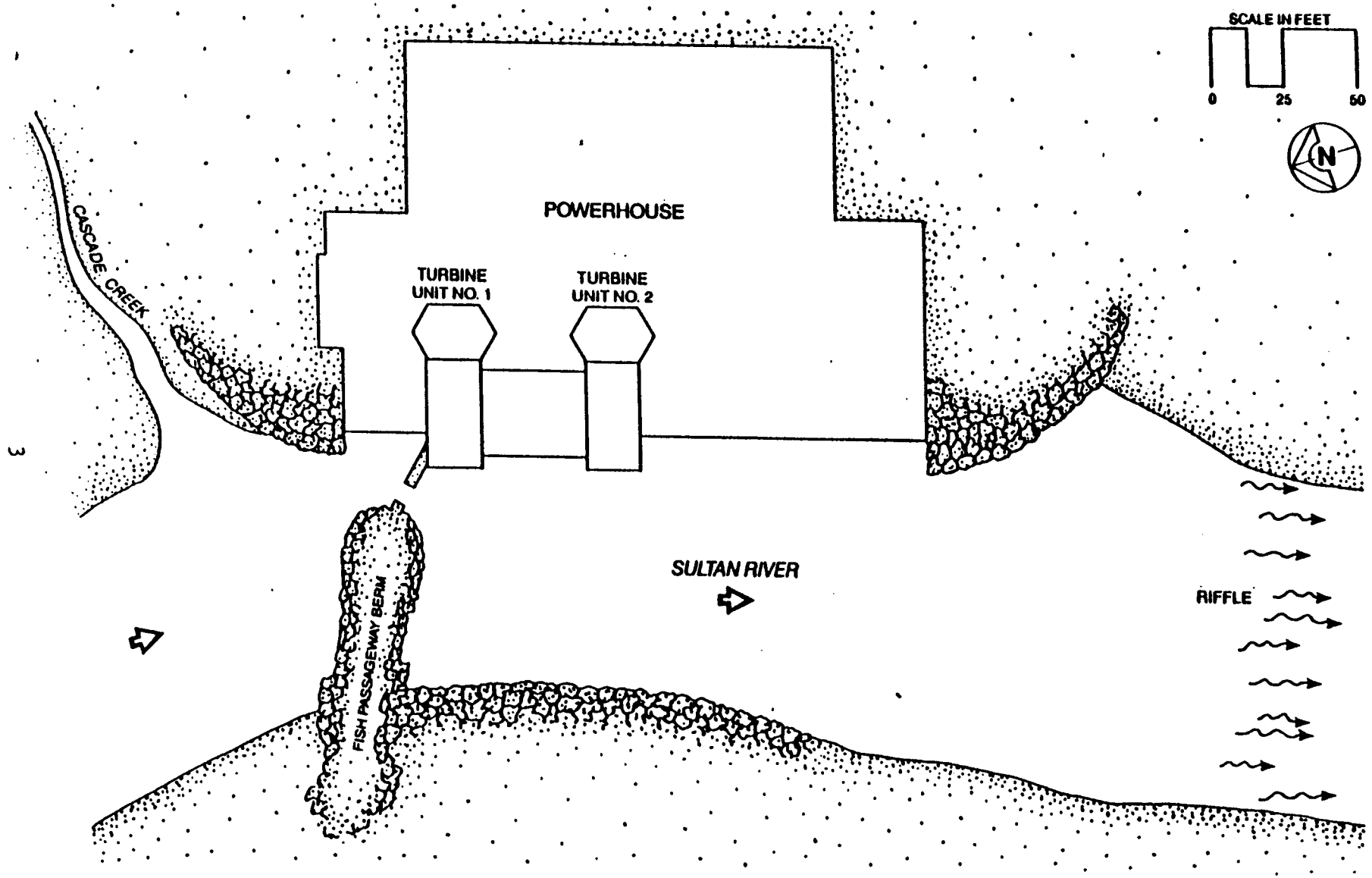


Figure 2. Powerhouse and fish passageway berm.

The second year in the series of additional spawner surveys was to have been 1988. However, low river flows during the migration period were projected because of drought conditions. Since the purpose of the additional surveys is to evaluate spawning distributions during a high flow year, the District and the agencies agreed to postpone the second year of surveys. Therefore, the 1989 survey became the second year in the series of three (Parametrix 1989).

The 1989 surveys showed a higher percentage of total redds (41%) above the powerhouse than either of the pre-project years (29 and 30%). It was also higher than the distribution found in the initial post-project study (30%). However, the second post-project surveys conducted in 1987 had a higher percentage of redds upstream of the powerhouse (50%). Although the powerhouse contributed greater than 50% of the total river flow throughout most of the season, the flows during the 1989 spawning season were still only moderate. As a result, an additional year of monitoring was conducted in 1990. This was the third and final monitoring year requested by the resource agencies and is the subject of this report.

METHODS

Seven surveys were conducted during the 1990 spawning season. Survey dates were March 6, 19 and 30; April 18; May 1 and 15; June 14. Originally eight surveys were proposed, with three to occur in March, two in April and May, and one in June. However, high flows and poor visibility in early April and late May pushed the survey schedule back. The surveys consisted of observations from a helicopter over a length of the Sultan River from the confluence with the Skykomish River (RM 0) to the Diversion Dam (RM 9.7). Observers noted all redds visible during each flight and plotted the number and location on maps of the river channel (Appendix A). This redd distribution was compared to the distributions observed in previous post-project years (Appendix B).

With the use of redd count maps and location notes made during the flight, estimates of natural redd-life could be determined (i.e., the number of days that a redd remained distinctly visible). In addition to these natural redd-life estimates, estimates were also obtained by using artificial redds which were periodically dug and marked with colored rocks. These colored rocks allow the redds to be identified during subsequent surveys to track their detectability through the season. In one instance (5/1/90), a new natural redd was marked. It still had a fish digging on it, but the redd size indicated that it was essentially complete. Marking natural redds is a better method for determining redd-life because they are located in areas that have preferred steelhead spawning habitat. In contrast, artificial redds are dug in areas that are assumed to have suitable habitat. However, since it is usually not possible to find a natural redd that has just been dug, artificial redds are used.

There are two general reasons for estimating redd-life. The first is to eliminate double counts of the same redds seen on consecutive surveys. However, the relatively low redd densities and the use of the river-bed maps minimizes this problem on the Sultan River. The second reason is to provide an indication of the overall accuracy of the seasonal counts.

In other words, if the artificial redds remain visible from one survey to the next it is reasonable to assume that any new redds (natural) that were dug since the previous survey would also have remained visible (i.e., not scoured or algaed over).

Artificial redd detectability was categorized as 100, 75, 50, 25 and 0% visible. When a redd was determined to be less than 50% visible due to scour or algae and silt build up, a new one was constructed and marked. In order to eliminate the bias created by the different flow and light conditions above and below the powerhouse, redds were marked in each reach. The redds were checked during each subsequent flight, as well as from the ground prior to the survey. The ground check provided a relative measurement, to assess the viewing conditions for the flight.

RESULTS

The results of the 1990 steelhead surveys are summarized in Table 1. The table provides the number of redds observed above and below the powerhouse and combined for the entire survey. The total redd count columns represent the number of visible redds observed regardless of whether they had been counted on previous surveys. The "new" redd columns indicate the number of redds observed for the first time during the survey and is indicative of the run timing in the Sultan River. Water clarity and light conditions ranged from good to excellent throughout the surveys.

Table 1. Summary of 1990 steelhead redd observation in the Sultan River.

	Entire Survey Length		Downstream of Powerhouse		Upstream of Powerhouse	
Date	Total Count	New Redds	Total Count	New Redds	Total Count	New Redds
March 6	1	1	0	0	1	1
March 19	3	2	1	1	2	1
March 30	10	7	3	3	7	4
April 18	20	14	3	1	17	13
May 1	29	14	6	6	23	8
May 15	44	16	12	4	32	12
June 14	33	6	12	4	21	2
Totals	140	60	37	19	103	41

A total of 60 redds were observed during the 1990 spawning season. This total is higher than in 1989 (46) but lower than all the other years monitored (Table 2). Redd distribution relative to the powerhouse was 19 (32%) downstream and 41 (68%) upstream. This distribution is substantially different from the previous surveys which ranged from 29 to 50%

upstream of the powerhouse. It is the opposite of what was observed in the two pre-project years and the first year of post-project monitoring (1985). The highest proportion of redds upstream of the powerhouse in the five previous years of monitoring had been 50% (1987).

Table 2. Summary of the total number of steelhead redds observed and the percentages upstream and downstream from the powerhouse.

Year	Total Redds	% Upstream	% Downstream
1979[a]	109	29	71
1980[a]	117	30	70
1985	100	30	70
1987	68	50	50
1989	46	41	59
1990	60	68	32

a/ Pre-project year.

Peak spawning activity for the entire survey reach occurred between April 18 and May 15, when 73% of the total redds were observed. This was similar to the previous survey years (Figure 3). The timing of spawning activity below the powerhouse was only slightly later than above the powerhouse (Figure 4). In past years the mid-point of the run (when 50% of the redds had been dug) was as much as a month later in the lower reach.

Artificial redd data is summarized in Table 3. A total of six artificial redds were dug and marked during the season. In addition, a natural redd in the lower river which appeared to be complete but still had a fish on it, was also marked to evaluate redd-life (test redd # 5). The average redd-life (duration of visibility) was about 40 days above the powerhouse. However, the estimated redd-life below the powerhouse was greater than 80 days. The exact duration could not be calculated because 4 of the 6 test redds were still visible on the last survey. Natural redds were also tracked from survey to survey by comparing notes and map locations. Table 4 shows the average life of natural redds observed above and below the powerhouse in each of the surveys.

The average monthly river flows were moderate during the 1990 steelhead spawning season and similar to the other post-project years (Table 5). The average monthly contribution of these flows from the powerhouse were also similar to previous post-project years although the season average was slightly higher. On a daily basis, the powerhouse contribution was greater than 50% of the total river flow for all but 13 days during the season (Figure 5). These 13 days occurred primarily from the end of March through the first week in April. Total river flows below the powerhouse averaged less than 1,500 cfs throughout the season except for June 11 (Appendix C).

Table 3. Redd-life data for the 1990 winter steelhead run based on the visibility of artificial test redds dug in the reaches above and below the powerhouse.

Test Redd	Date Dug	Date Last Seen	# of Days Visible	Location Above/Below Powerhouse
1	3/06	5/15	70	Above
2[a]	3/06	6/14	>100	Below
2[a]	3/06	6/14	>100	Below
3	3/30	5/01	31	Above
4	4/18	5/15	27	Above
5[b]	5/01	6/14	>44	Below
6	5/15	6/14	>30	Above

a/ Two redds were dug on the same riffle on 3/6/90.
b/ Marked a newly dug natural redd (fish still on it).

Table 4. Estimated redd-life (duration of visibility) of natural redds observed above and below the powerhouse.

Date Observed	# of New Redds Below Powerhouse	Mean # of Days Visible	# of New Redds Above Powerhouse	Mean # of Days Visible
3/6	0	--	1	70.0
3/19	1	11.0	1	57.0
3/30	3	37.0	4	55.2
4/18	1	13.0	14	30.3
5/1	6	39.7	8	35.4
5/15	4	30.0	12	30.0
6/14	4	--	2	--
Mean		26.1		46.3

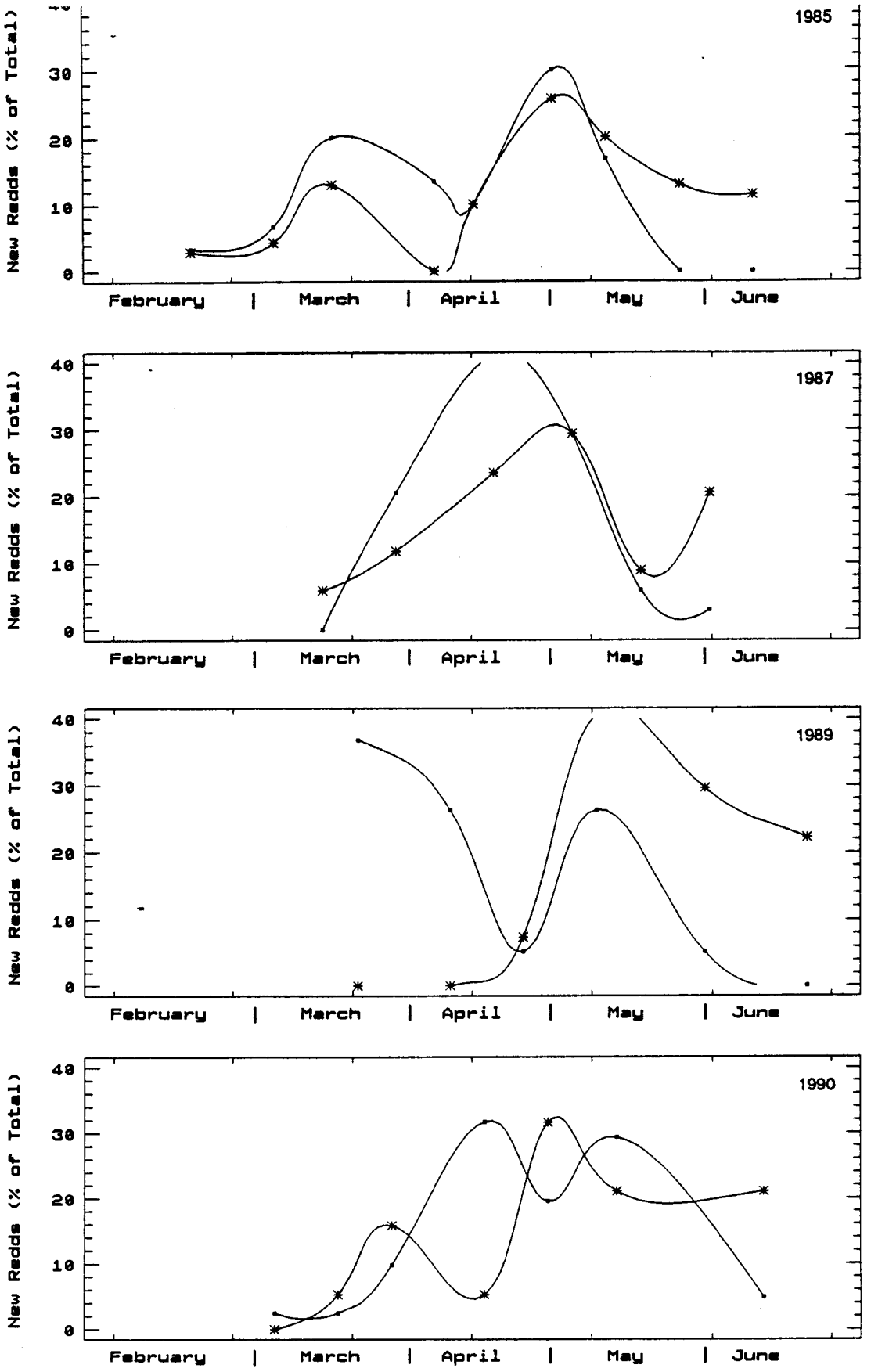


Figure 3. Post-project run timing of winter-run Steelhead upstream (•) and downstream (*) of the Sultan River powerhouse.

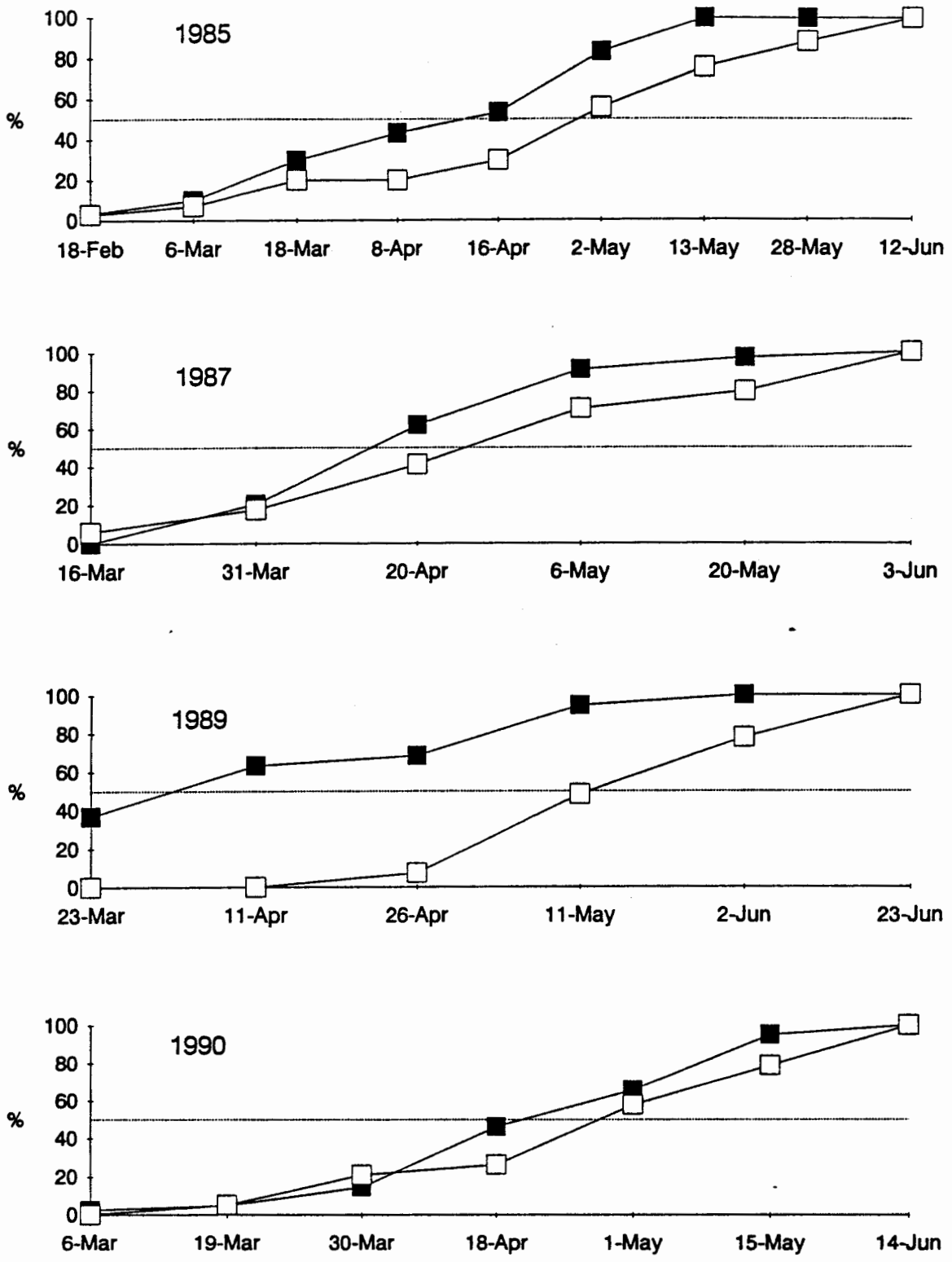


Figure 4. Cumulative steelhead redd counts upstream (■) and downstream (□) of the Sultan River powerhouse in 1985, 1987, 1989, and 1990.

Table 5. Mean monthly river and generation flows and the mean monthly percentage of total river flow through the powerhouse.

	Mean Monthly Percent of Flow Through the Powerhouse			Mean Monthly Generation Flow (cfs)			Mean Monthly Total River Flow (cfs)		
	1987	1989	1990	1987	1989	1990	1987	1989	1990
March	61.4	44.1	59.9	637.4	308.9	449.7	1005.6	601.5	707.7
April	38.1	74.2	67.5	359.3	938.1	643.1	675.5	1191.6	862.3
May	45.4	68.4	65.8	464.7	555.5	439.4	759.8	809.5	663.4
June		62.6	77.2		302.6	701.3		481.7	879.1
Mean	48.3	62.3	67.6	488.5	524.7	556.1	815.1	779.8	776.6

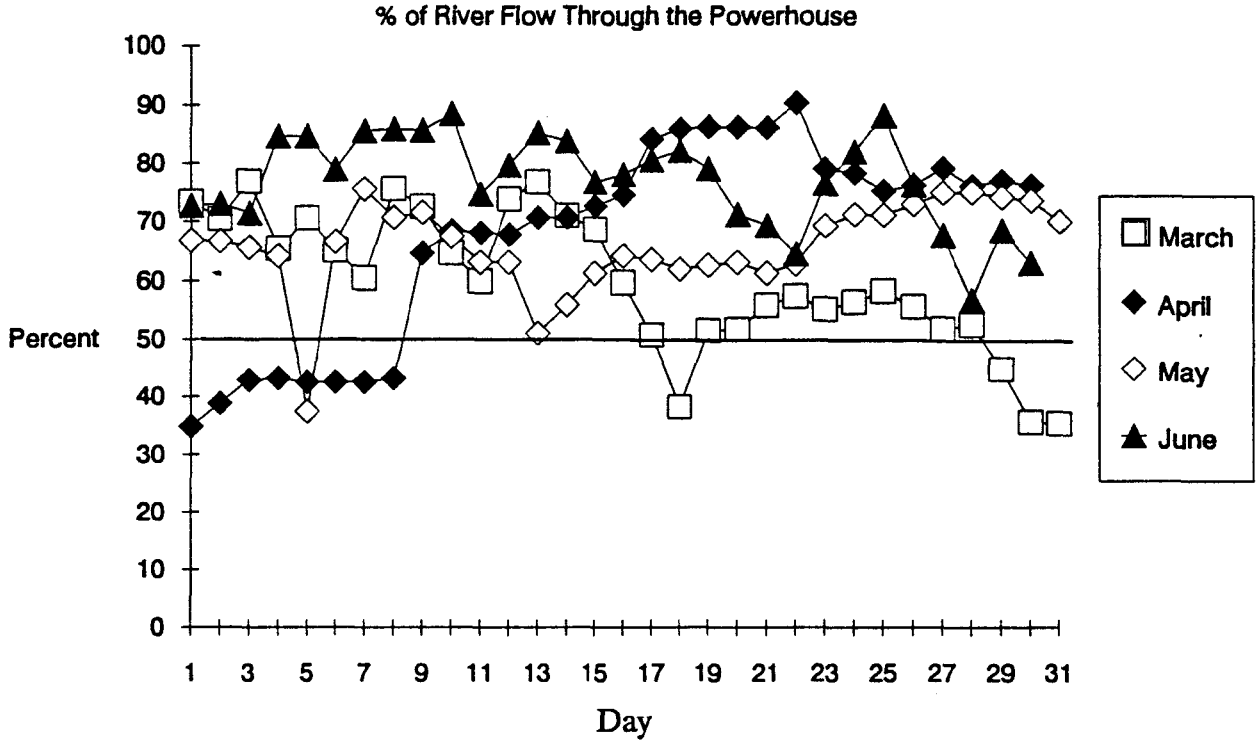


Figure 5. Proportion of the total Sultan River flows contributed by the powerhouse during the steelhead spawning season.

DISCUSSION

The purpose of constructing the berm slot was to provide flows of increased velocity to attract fish to the upper river. The post-project years have shown the same or higher proportions of redds above the powerhouse, as the pre-project distributions. The 1990 distribution had the highest proportion of redds in the upper river (68%) than any other survey year (pre- or post-project). Post-project spawning usage in the upper reach indicates that the project operation in conjunction with the berm has not created a passage problem for winter-run steelhead. The primary concern of this "worst-case" scenario is that fish might be confused by high powerhouse flows and have trouble finding the berm slot resulting in excess delay of their migration. A "worst-case" scenario of high powerhouse and low river discharges has not occurred during post-project monitoring. However, in 1989 and 1990 the powerhouse flows were greater than 50% of total river flow for most of the season.

The average natural redd-life for the upper reach was 46.3 days which is comparable to the 39.5 day estimate from the artificial redd data. However, the lower reach had estimates of 26.1 days for natural redds and 81 days from artificial redds. This discrepancy is probably caused by the particular sites selected for the artificial redds in the lower reach. Two of the lower river artificial redds were on the same riffle and had extraordinarily long redd-life (>100 days). These redds were dug in an area that appeared to have suitable spawning habitat but when water levels rose they may have been in too deep of water to reflect typical scouring rates.

In any case, the long redd-life estimates from natural and artificial redd data indicates the overall accuracy of the total redds counts for the season. Since the surveys were conducted at approximately two week intervals during the peak of the run, it is reasonable to assume that few redds were scoured or algaed over prior to being observed.

Despite only moderate total flows in 1990, the contribution to the total flow by the powerhouse was equal to or greater than 50% for all but 13 days of the season. This situation of higher flows from the powerhouse than the upper river was the reason for constructing the fish passage berm. The idea was to provide attraction flows by channeling the upper river water through a narrow slot thereby increasing the velocity. These higher velocities attract fish to the berm passageway, facilitating upstream migration. Therefore, the high powerhouse flows observed in 1990 provided a good test for the effectiveness of the fish berm at attracting fish and aiding their upstream migration.

CONCLUSIONS

During the four years of post-project monitoring the proportion of steelhead redds upstream of the powerhouse has been the same or higher than in pre-project years. The primary focus of the post-project monitoring was to determine if project operations resulted in a reduction of steelhead utilization above the powerhouse. Of particular concern, was a "worst-case" scenario of an extended period of high powerhouse flows and low river flows. However, this "worst-case" scenario has not occurred during the post-project monitoring.

The 1987 powerhouse flows averaged less than 50% of the total river flow, while the 1989 and 1990 powerhouse flows averaged greater than 60% of the total river flows. The high proportion of redds upstream of the powerhouse during all three years indicates that project operations do not inhibit steelhead migrations past the powerhouse under a variety of flow conditions.

REFERENCES

GeoEngineers. 1984. Phase I Report, River Gravel Quantity Study, Henry M. Jackson Hydroelectric Project (Sultan River Project). Report to Snohomish County PUD, submitted by GeoEngineers, Inc., Bellevue, WA.

Parametrix. 1987. Adult Fish Passage (Powerhouse Berm) Study. Final Project Report to Snohomish County PUD, submitted by Parametrix, Inc., Bellevue, WA.

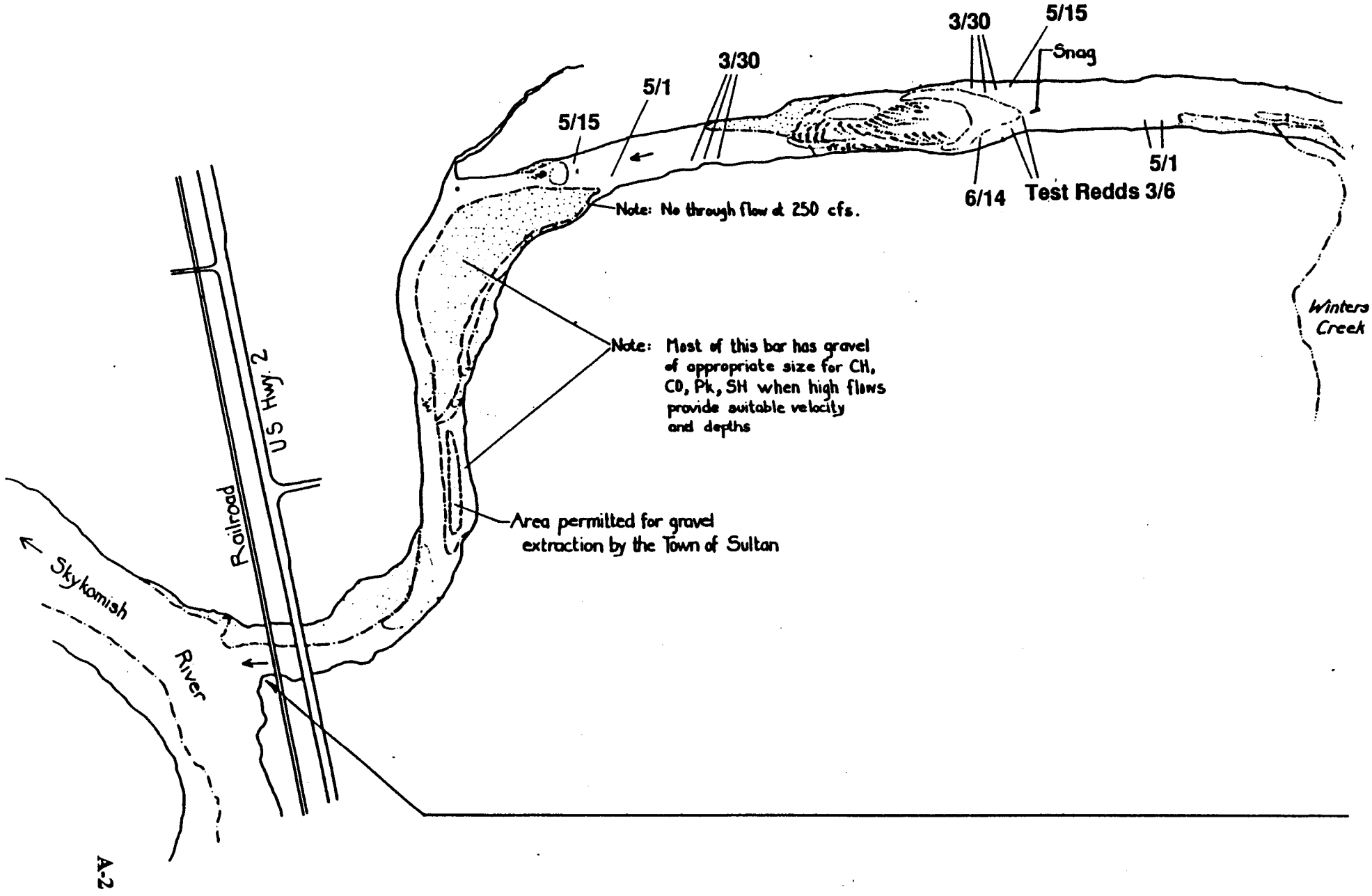
Parametrix. 1987. 1987 Winter Run Steelhead Trout Spawning Survey, Sultan River, Snohomish County, Washington. Final Project Report to Snohomish County PUD, submitted by Parametrix, Inc., Bellevue, WA.

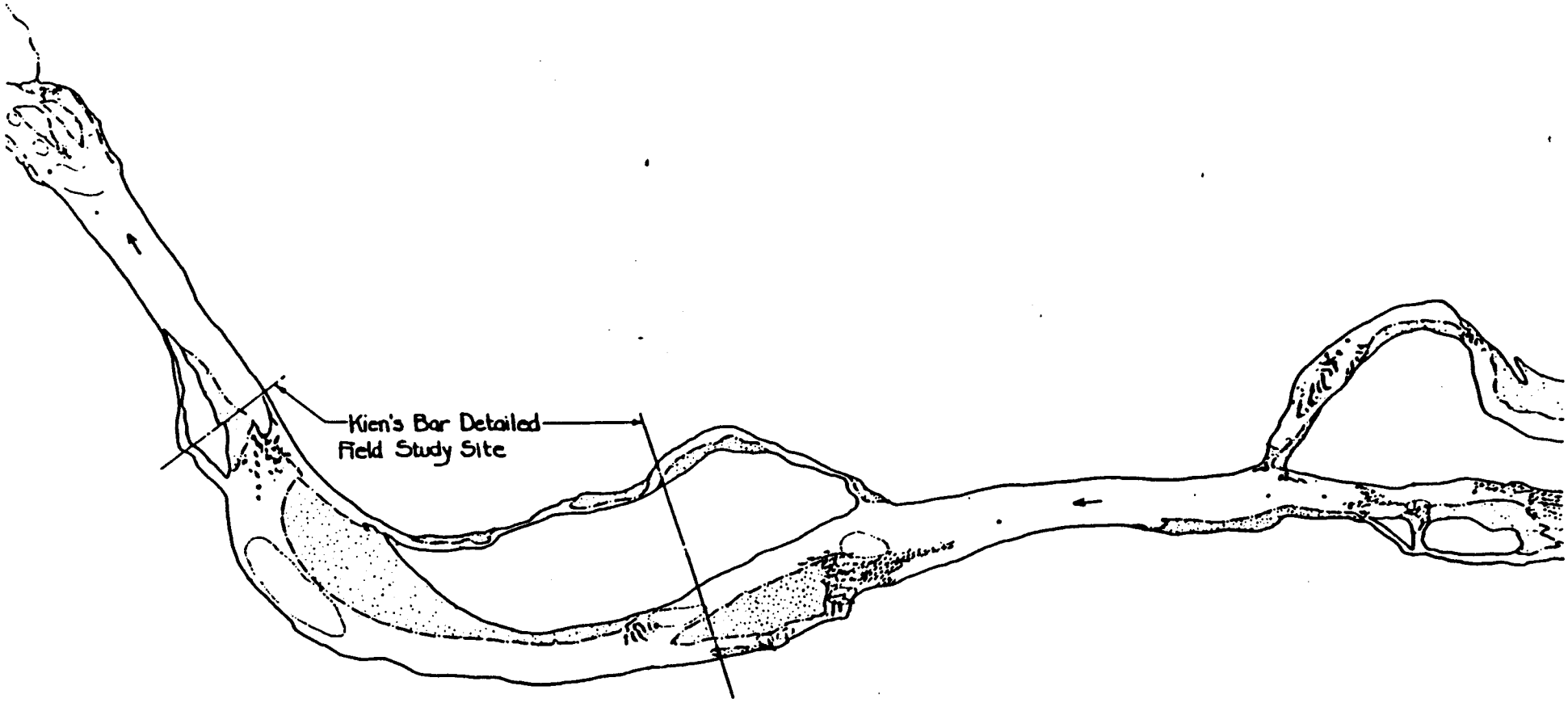
Parametrix. 1989. 1989 Winter Run Steelhead Trout Spawning Survey, Sultan River, Snohomish County, Washington. Final Project Report to Snohomish County PUD, submitted by Parametrix, Inc., Bellevue, WA.

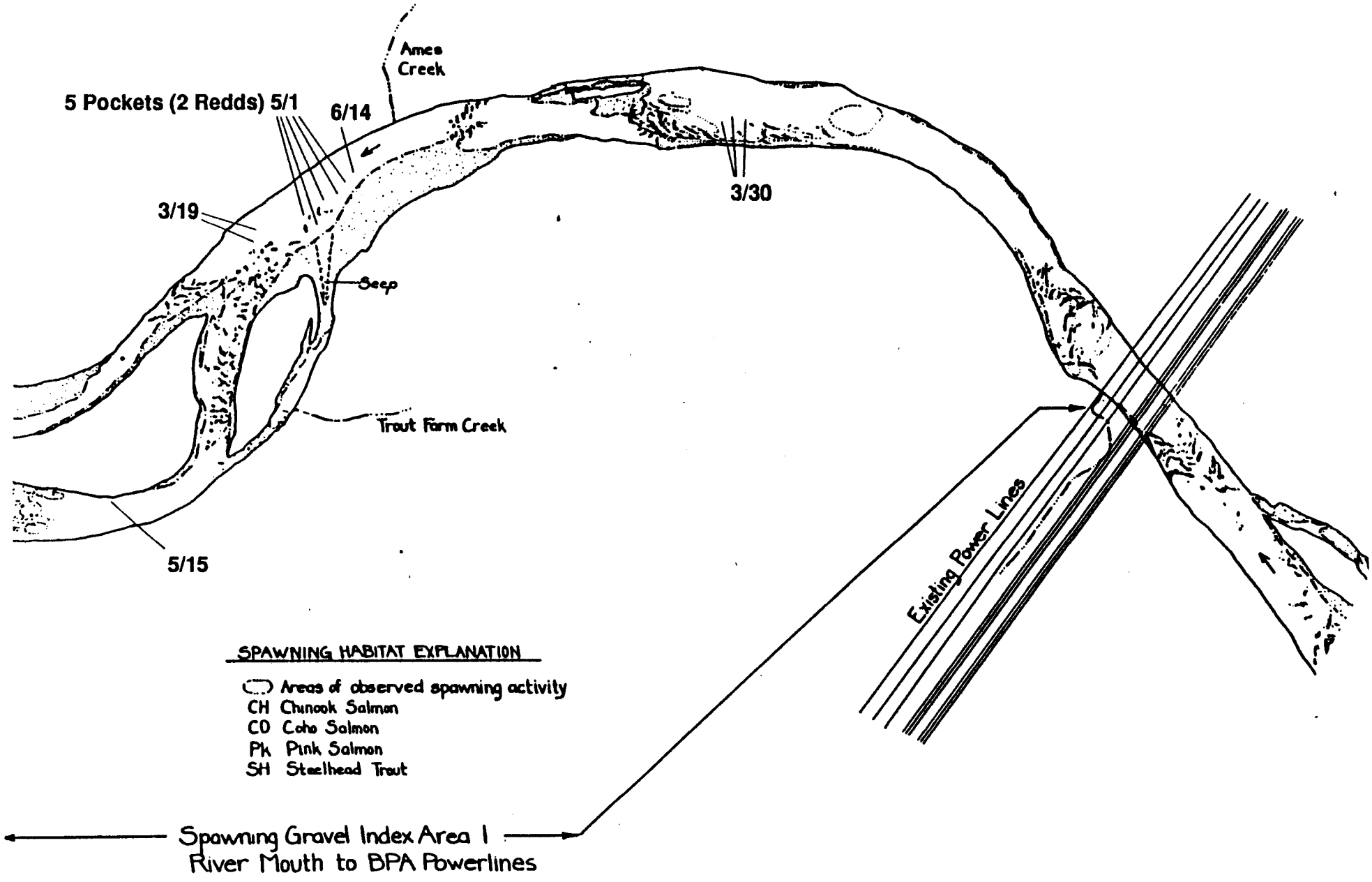
Washington Department of Game and Snohomish County PUD. 1982. Fish and Wildlife Resource Studies, Sultan River Project Stage II Final Report. Washington Department of Game and Eicher Associates, Inc.

Appendix A

Base map of the Sultan River channel used during spawning ground surveys, with the location and first observation date of all redds seen during the 1990 season.
(Map source: GeoEngineers, 1984)

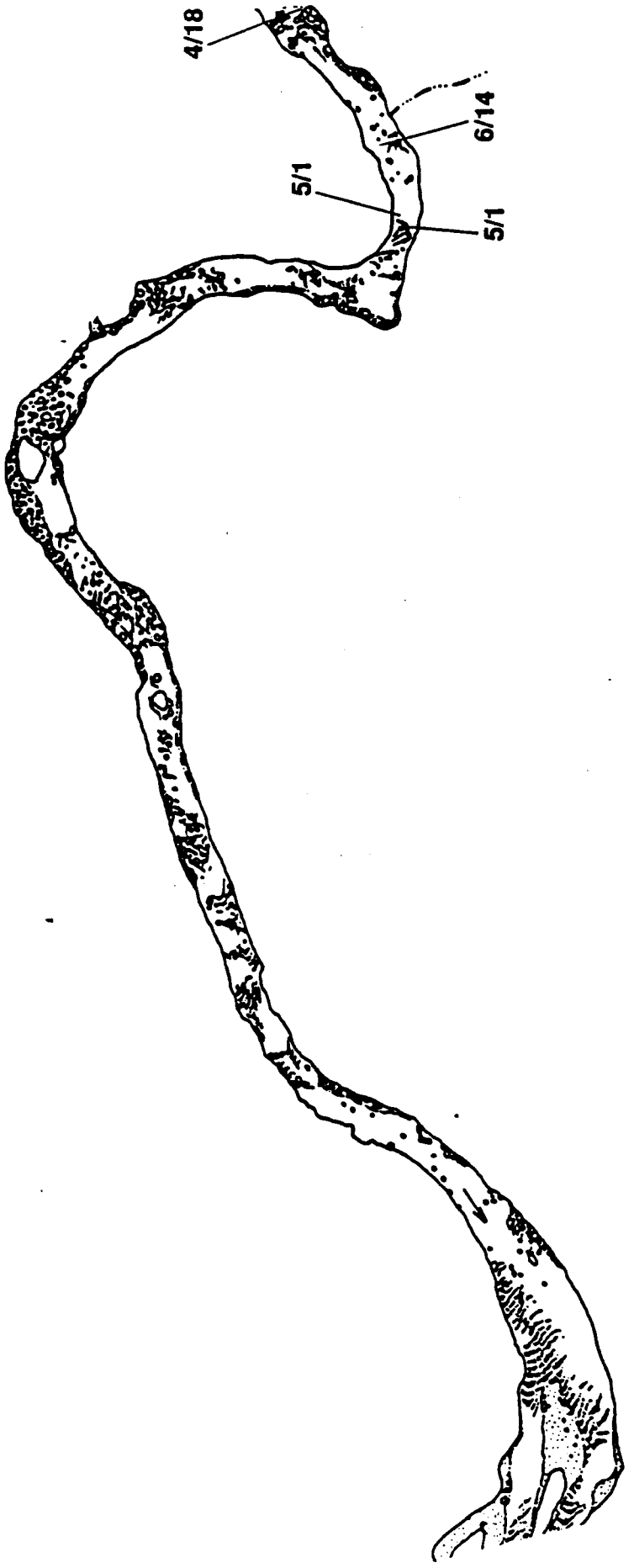

3/30
5/15
Snag
3/30
5/1
5/15
5/1
6/14
Test Redds 3/6
Note: No through flow at 250 cfs.
Winters Creek
Note: Most of this bar has gravel of appropriate size for CH, CO, Pk, SH when high flows provide suitable velocity and depths
US Hwy. 2
Railroad
Area permitted for gravel extraction by the Town of Sultan
Skykomish River

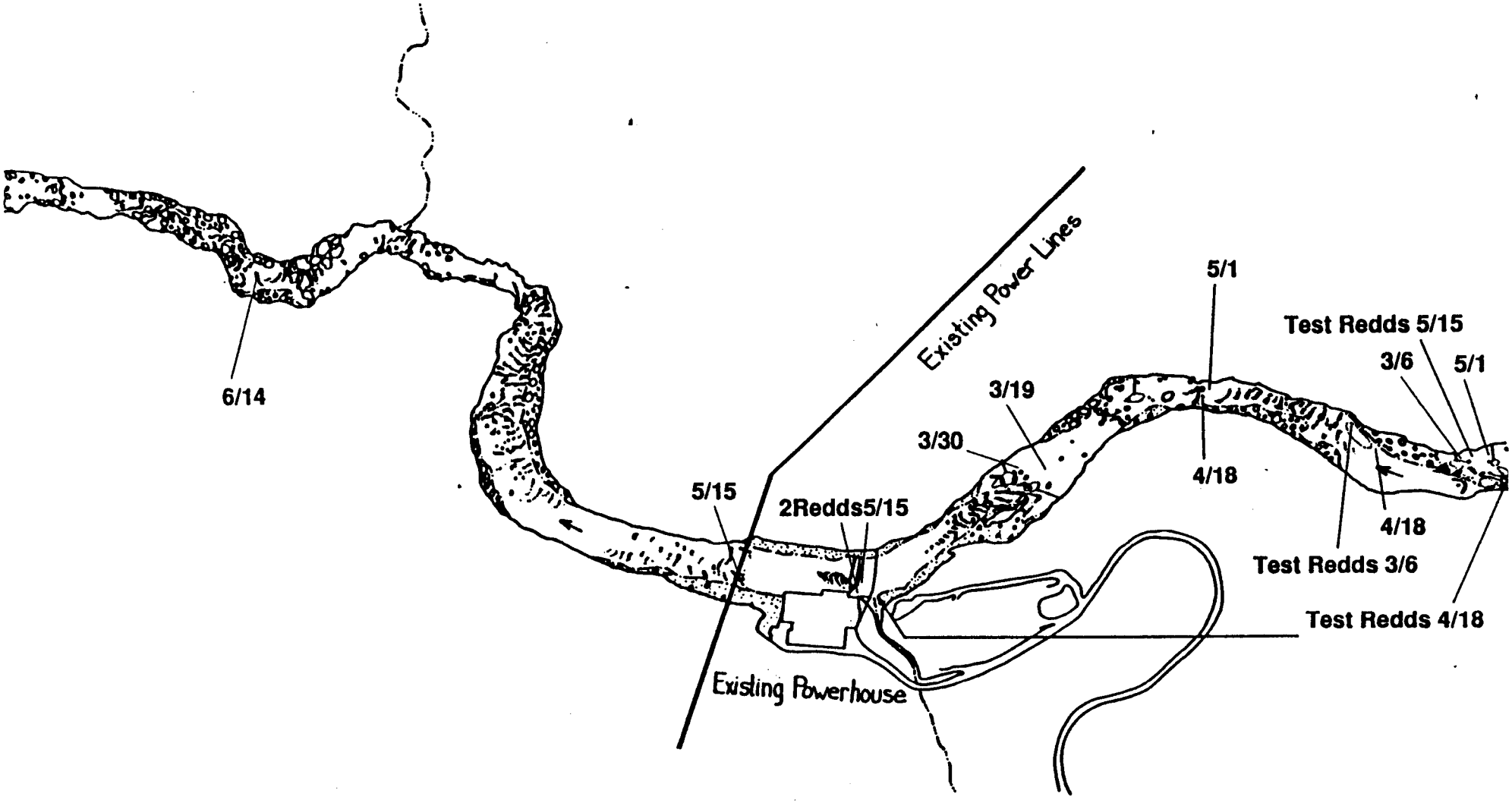

Kien's Bar Detailed
Field Study Site

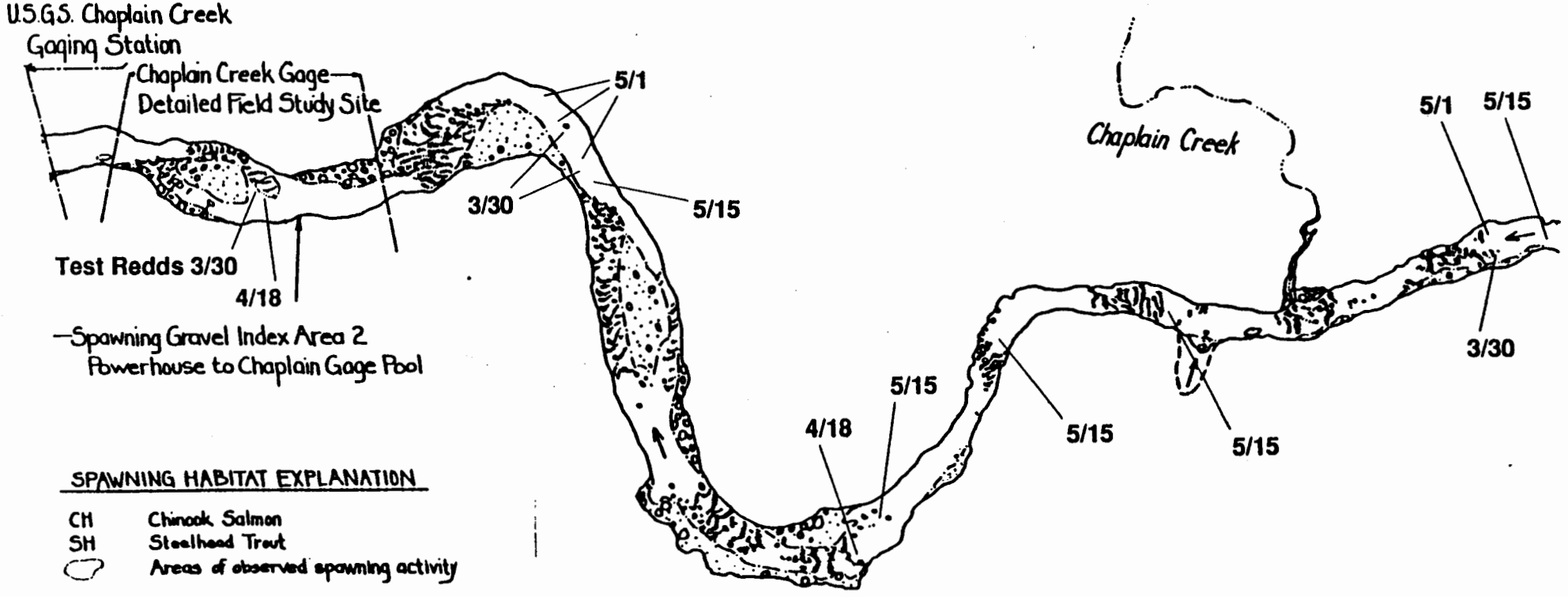


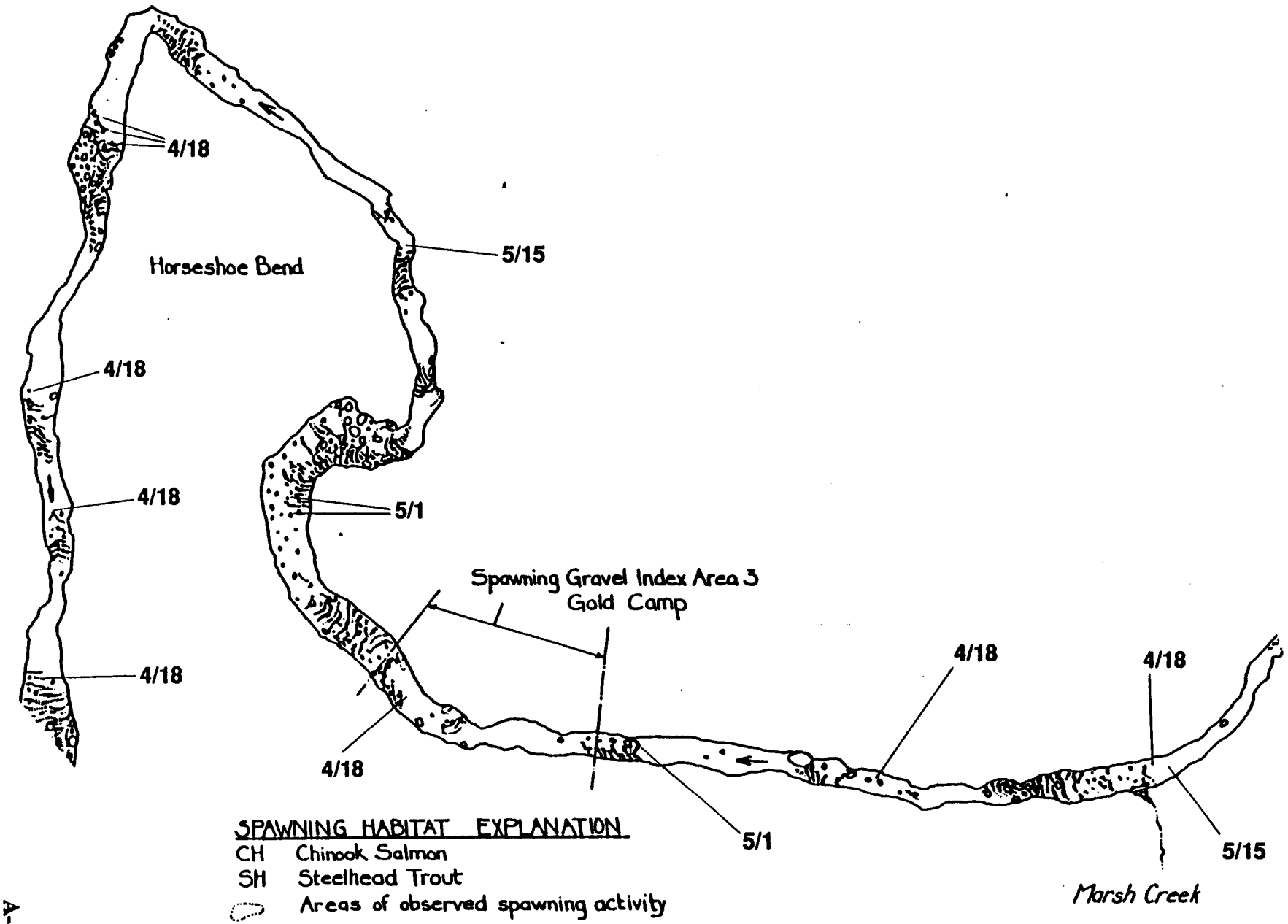
A-4

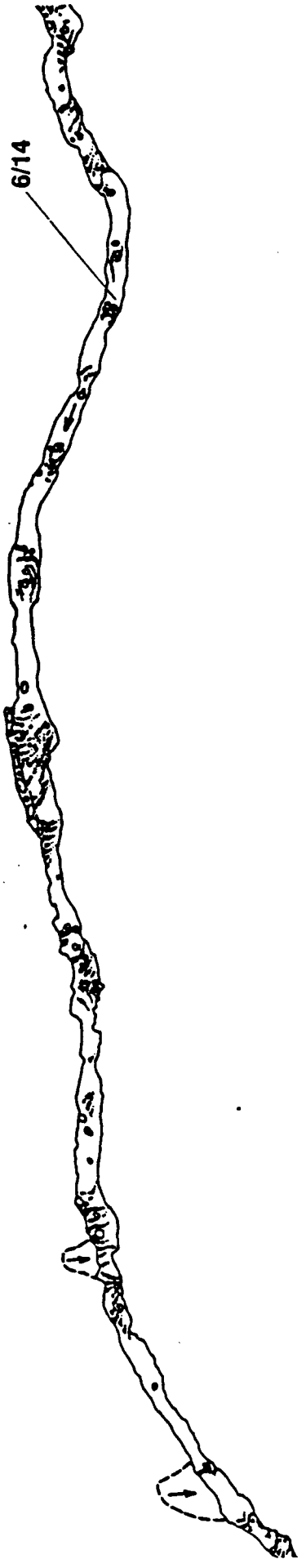
Base photo date: February 7, 1984


4/18
6/14
5/1
5/1


6/14
Existing Power Lines
5/1
Test Redds 5/15
3/6
5/1
3/19
3/30
4/18
5/15
2Redds5/15
4/18
Test Redds 3/6
Test Redds 4/18
Existing Powerhouse


U.S.G.S. Chaplain Creek
Gaging Station
Chaplain Creek Gage
Detailed Field Study Site
Test Redds 3/30
4/18
Spawning Gravel Index Area 2
Powerhouse to Chaplain Gage Pool
5/1
3/30
5/15
Chaplain Creek
5/1
5/15
3/30
4/18
5/15
5/15
5/15
SPAWNING HABITAT EXPLANATION
CH Chinook Salmon
SH Steelhead Trout
Areas of observed spawning activity


4/18
Horseshoe Bend
5/15
4/18
4/18
5/1
Spawning Gravel Index Area 3
Gold Camp
4/18
4/18
4/18
4/18
5/1
5/15
Marsh Creek
SPAWNING HABITAT EXPLANATION
CH Chinook Salmon
SH Steelhead Trout
Areas of observed spawning activity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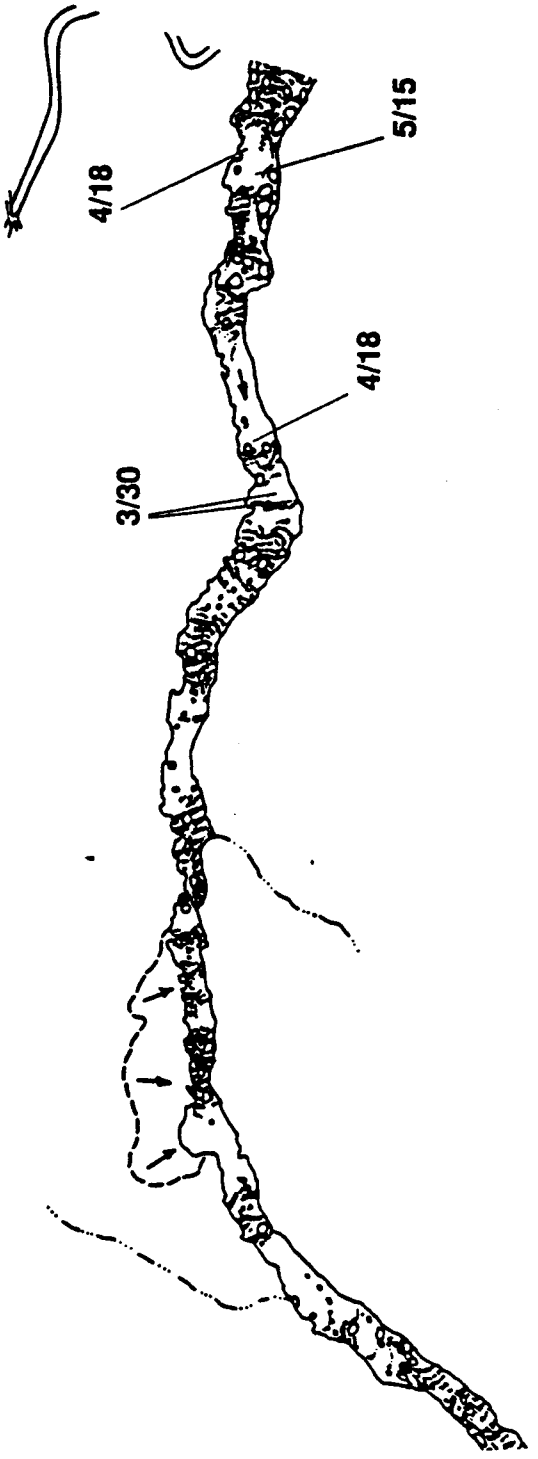
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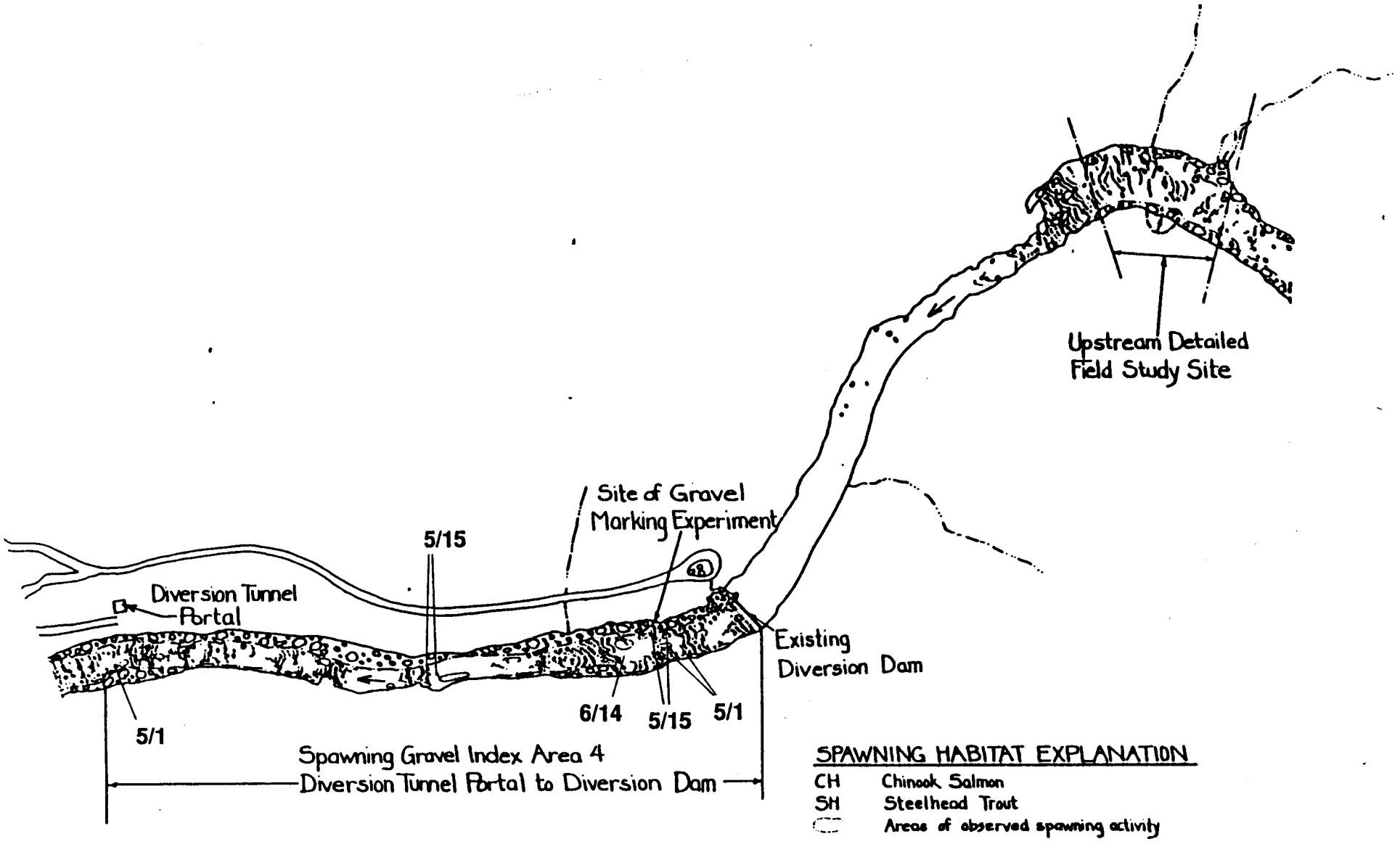
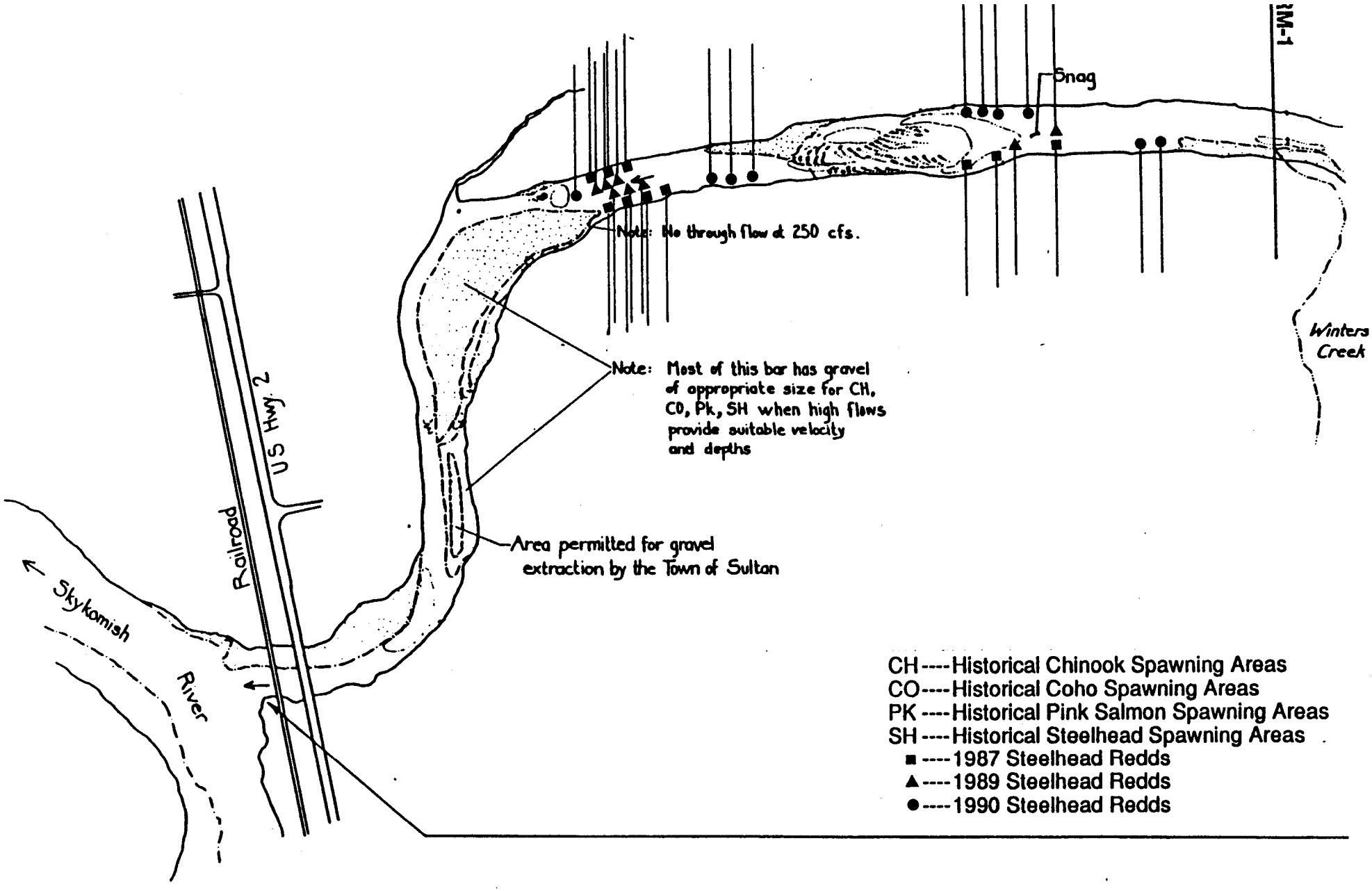
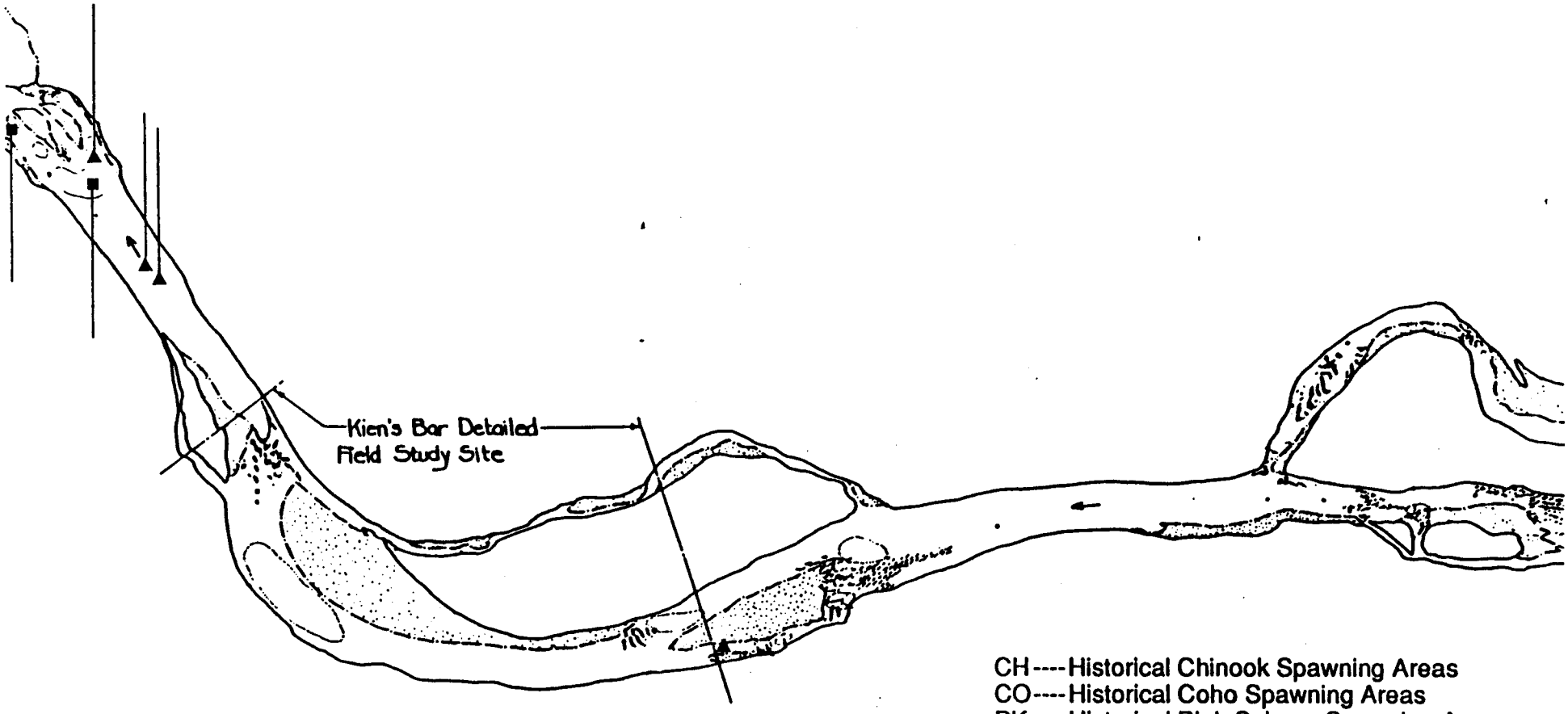
5/15
4/18
3/30

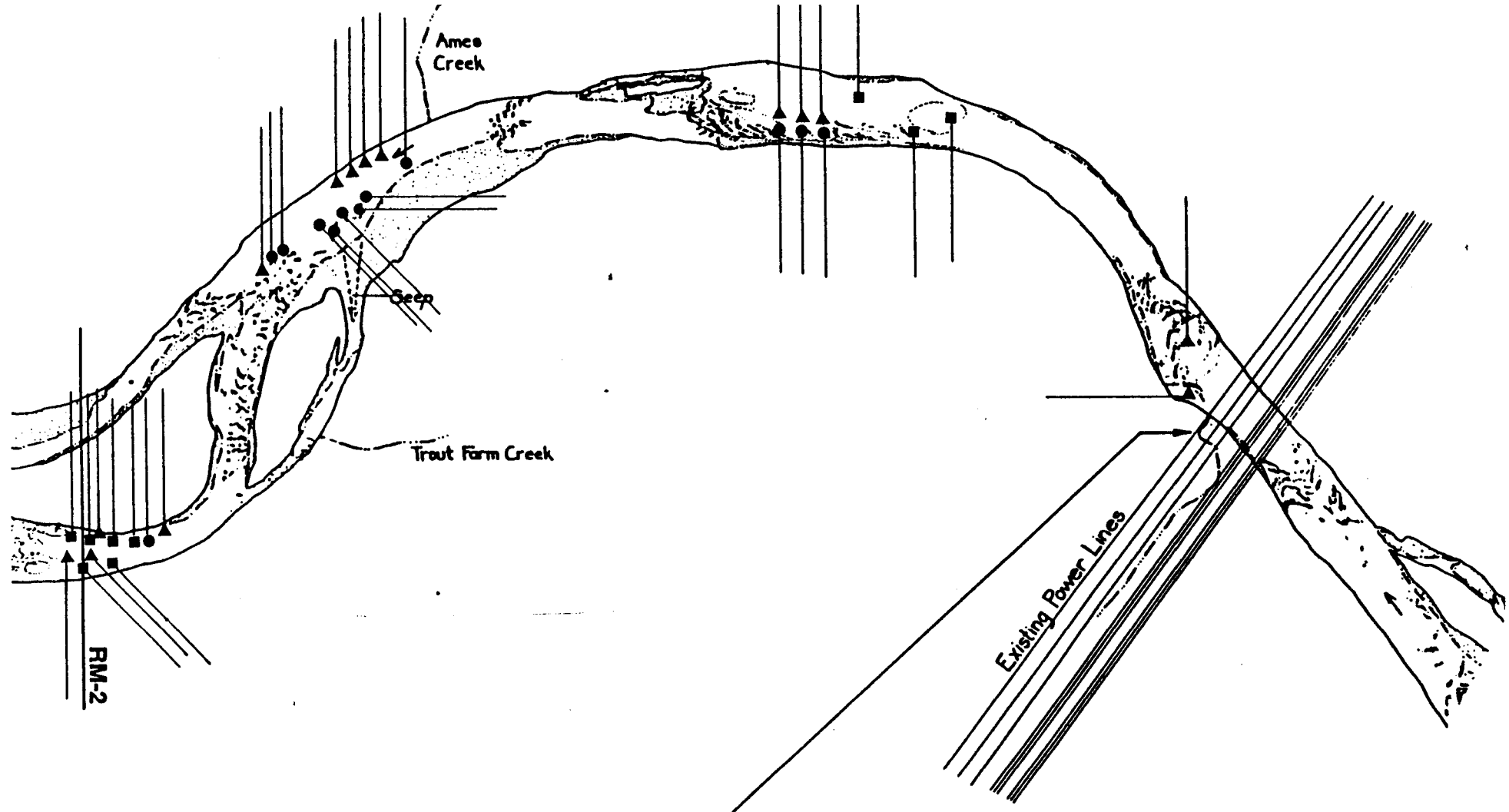

Upstream Detailed
Field Study Site
Site of Gravel
Marking Experiment
5/15
Diversion Tunnel
Portal
Existing
Diversion Dam
6/14
5/15
5/1
5/1
Spawning Gravel Index Area 4
Diversion Tunnel Portal to Diversion Dam
SPAWNING HABITAT EXPLANATION
CH Chinook Salmon
SH Steelhead Trout
Areas of observed spawning activity

Appendix B

Base map of the Sultan River channel with the location of all redds observed during the post-project years (1987, 1989, and 1990) as well as the historical redd location information (1979 and 1980).
(Map source: GeoEngineers, 1984)


RM-1
Snag
Note: No through flow at 250 cfs.
Winters Creek
Note: Most of this bar has gravel of appropriate size for CH, CO, Pk, SH when high flows provide suitable velocity and depths
Area permitted for gravel extraction by the Town of Sulton
US Hwy 2
Railroad
Skykomish River
CH ----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■ ----1987 Steelhead Redds
▲ ----1989 Steelhead Redds
● ----1990 Steelhead Redds

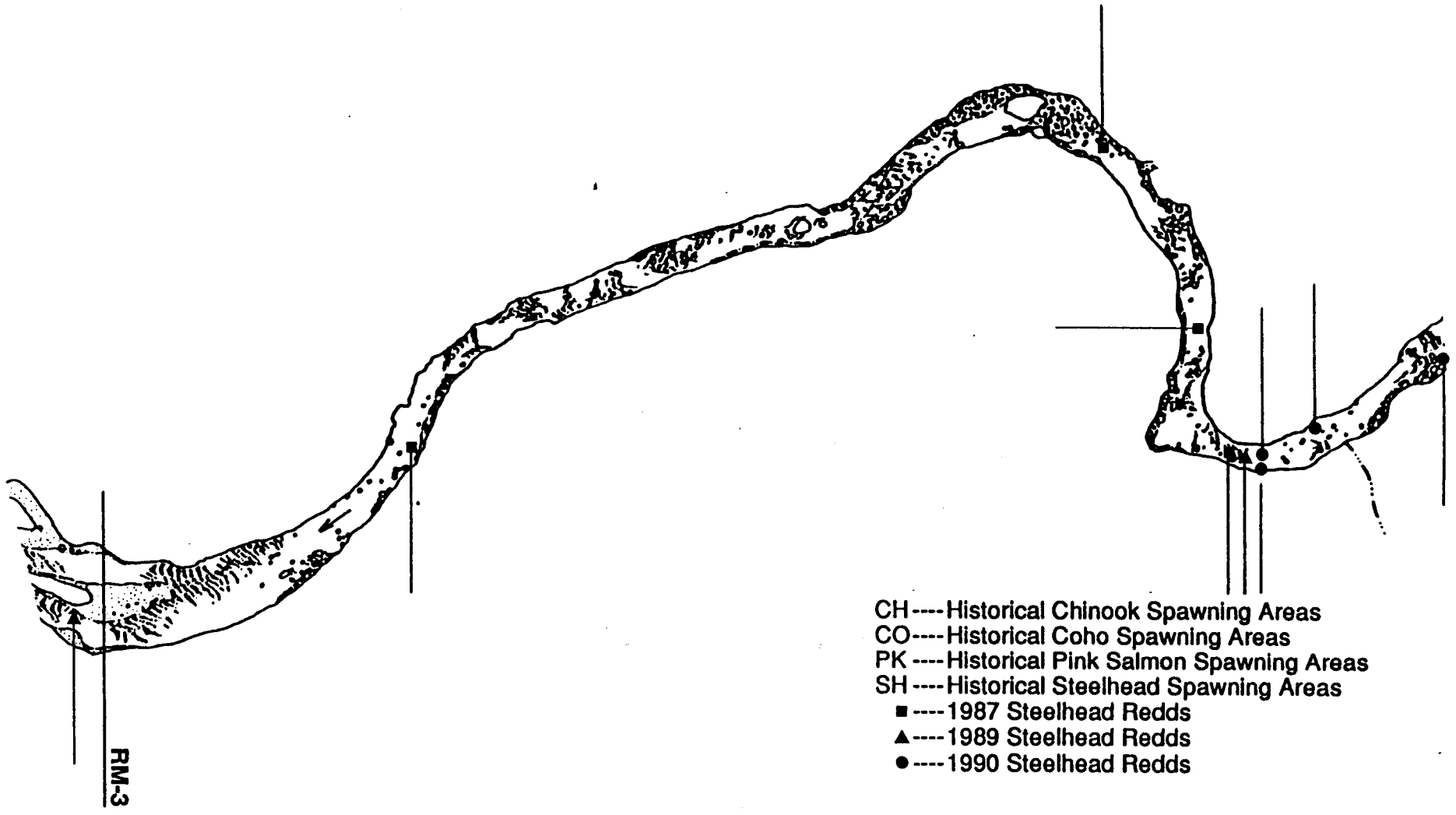

Kien's Bar Detailed
Field Study Site
CH----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK----Historical Pink Salmon Spawning Areas
SH----Historical Steelhead Spawning Areas
■----1987 Steelhead Redds
▲----1989 Steelhead Redds
●----1990 Steelhead Redds

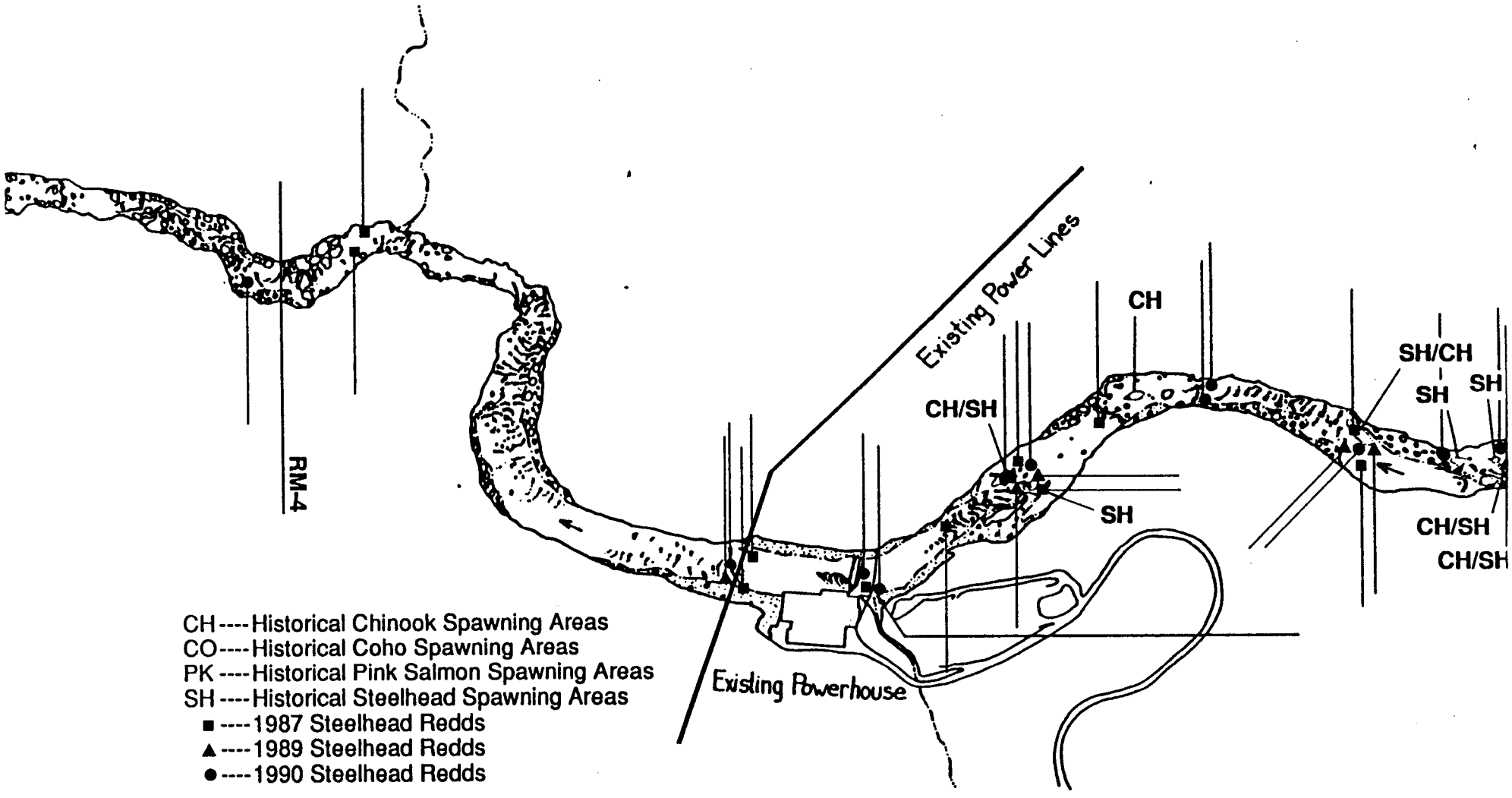


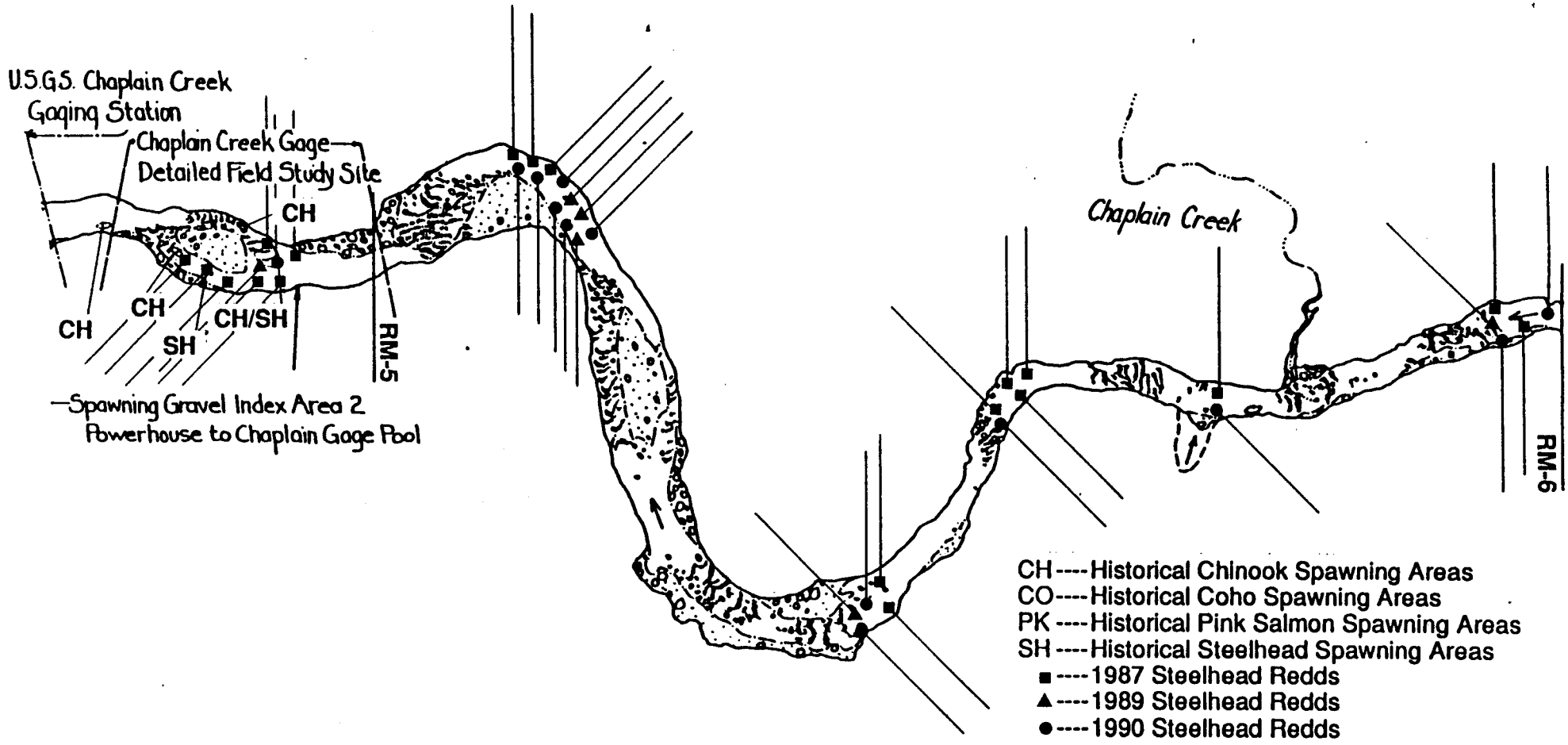
Spawning Gravel Index Area 1
River Mouth to BPA Powerlines

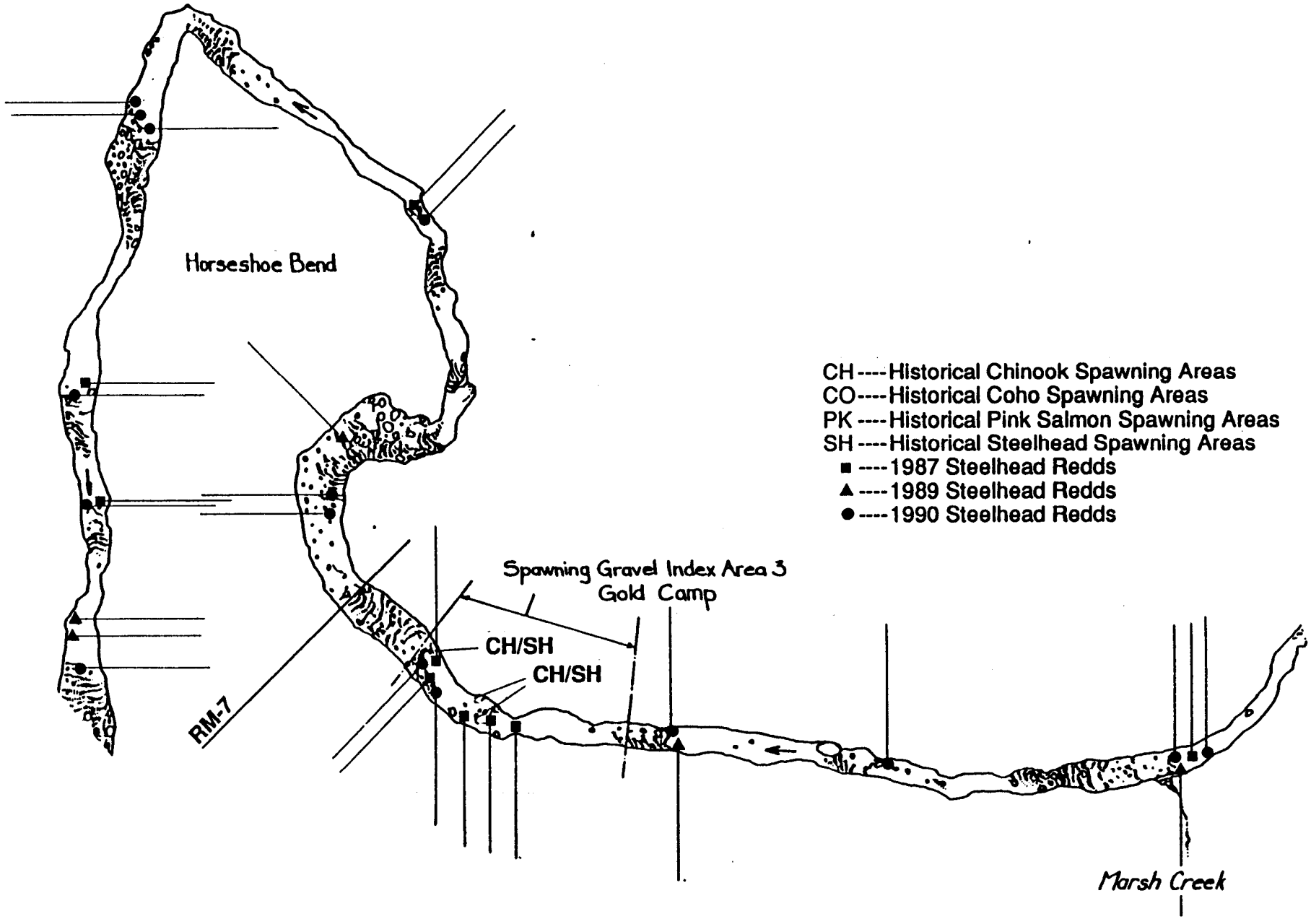
CH ----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■----1987 Steelhead Redds
▲----1989 Steelhead Redds
●----1990 Steelhead Redds

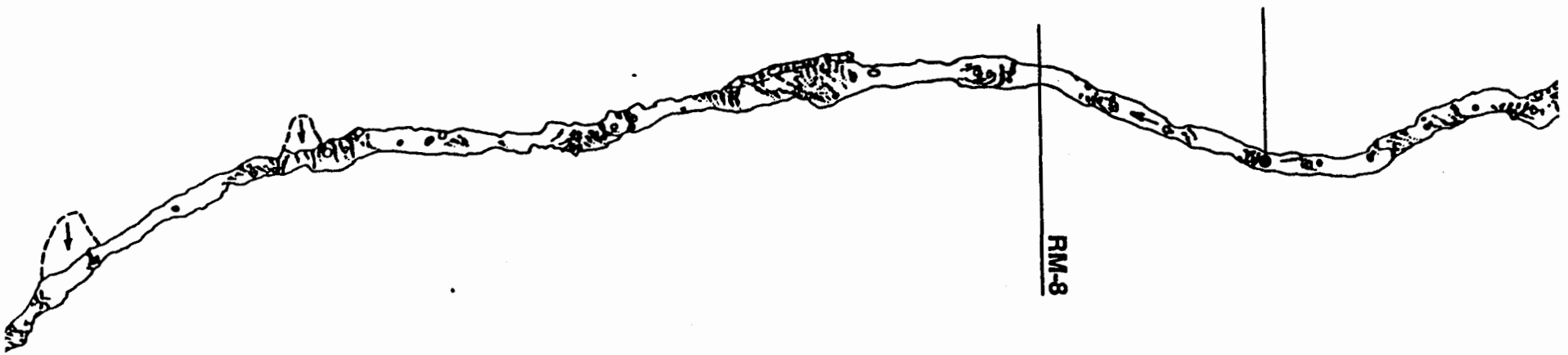
Base photo date: February 7, 1984
Flow 491 cfs.


RM-3
CH----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK----Historical Pink Salmon Spawning Areas
SH----Historical Steelhead Spawning Areas
■----1987 Steelhead Redds
▲----1989 Steelhead Redds
●----1990 Steelhead Redds

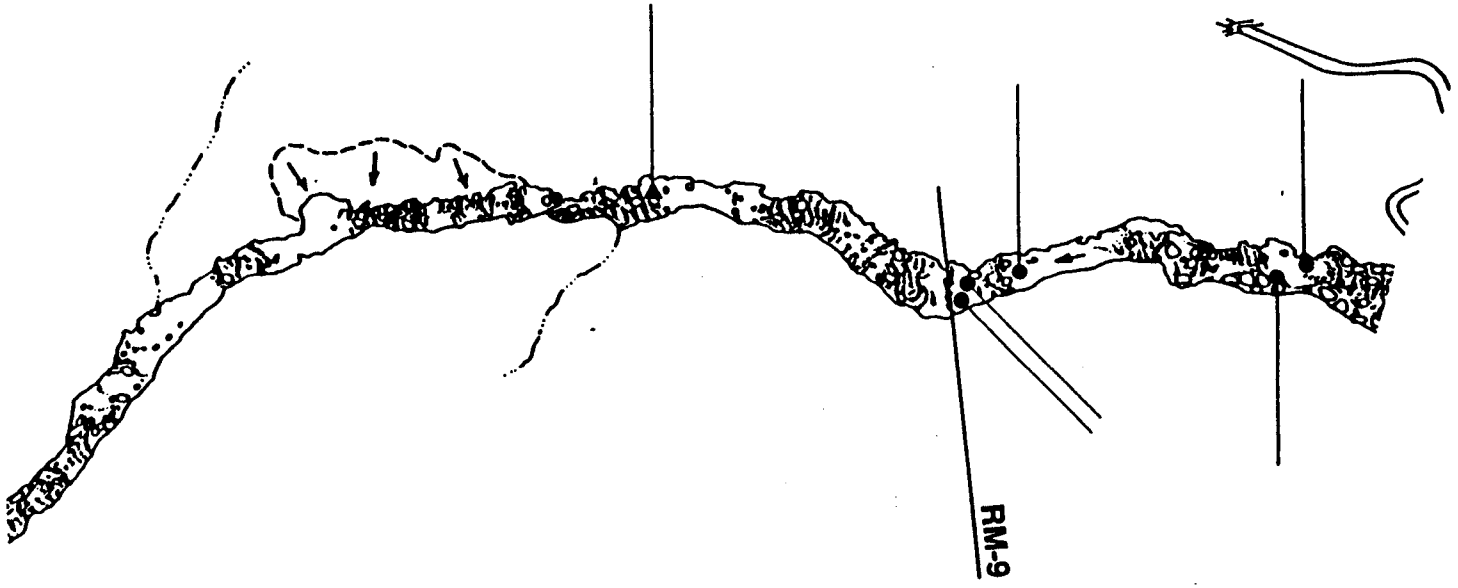

RM-4
Existing Power Lines
CH
SH/CH
SH
SH
CH/SH
SH
CH/SH
CH/SH
Existing Powerhouse
CH----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■ ----1987 Steelhead Redds
▲ ----1989 Steelhead Redds
● ----1990 Steelhead Redds


U.S.G.S. Chaplain Creek
Gaging Station
Chaplain Creek Gage
Detailed Field Study Site
CH
CH
CH
SH
CH/SH
RM-5
Spawning Gravel Index Area 2
Powerhouse to Chaplain Gage Pool
Chaplain Creek
RM-6
CH ----Historical Chinook Spawning Areas
CO ----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■ ----1987 Steelhead Redds
▲ ----1989 Steelhead Redds
● ----1990 Steelhead Redds

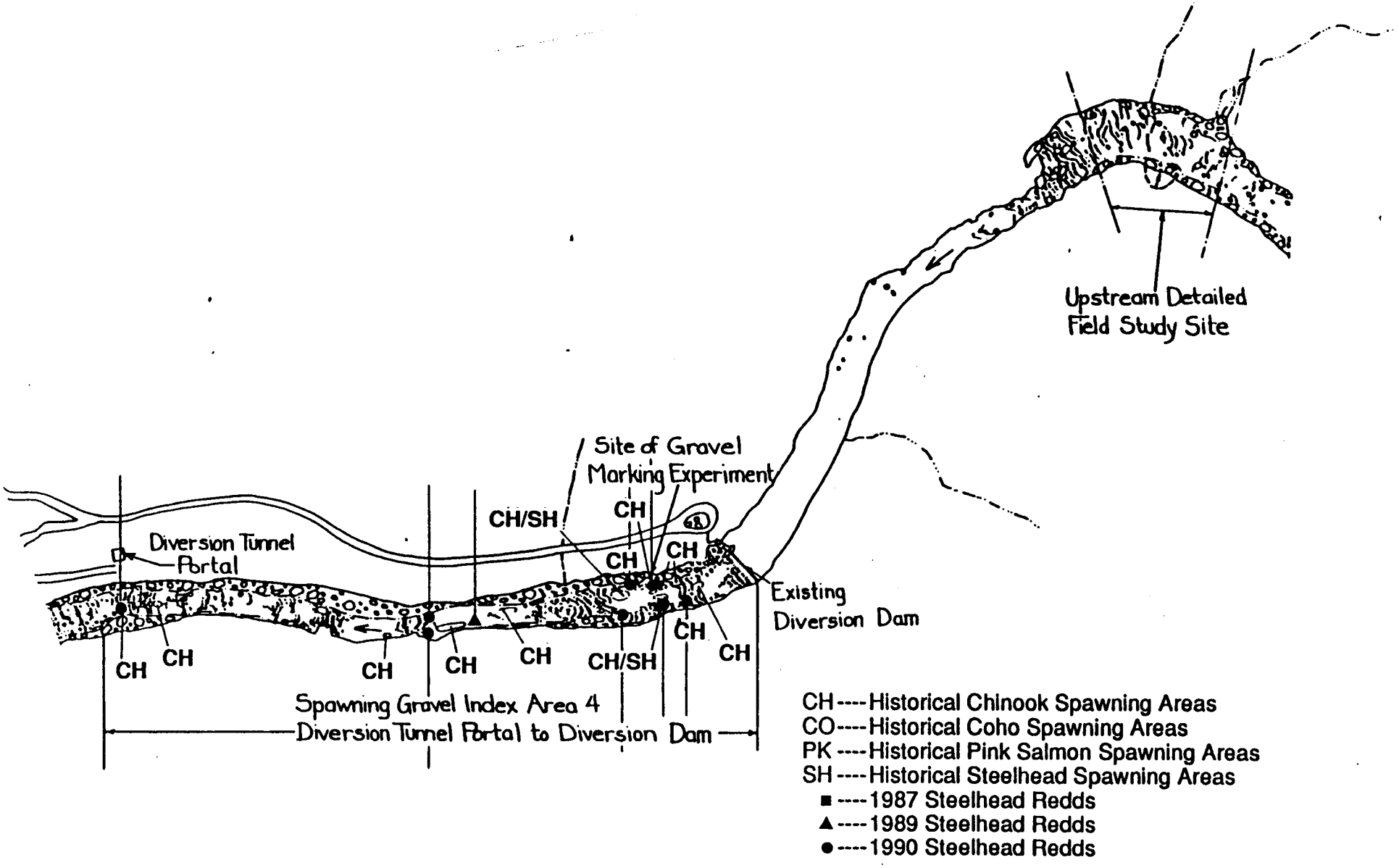

Horseshoe Bend
CH----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■ ----1987 Steelhead Redds
▲ ----1989 Steelhead Redds
● ----1990 Steelhead Redds
Spawning Gravel Index Area 3
Gold Camp
CH/SH
CH/SH
RM-7
Marsh Creek



CH----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■----1987 Steelhead Redds
▲----1989 Steelhead Redds
●----1990 Steelhead Redds



CH ----Historical Chinook Spawning Areas
CO ----Historical Coho Spawning Areas
PK ----Historical Pink Salmon Spawning Areas
SH ----Historical Steelhead Spawning Areas
■ ----1987 Steelhead Redds
▲ ----1989 Steelhead Redds
● ----1990 Steelhead Redds


Upstream Detailed
Field Study Site
Site of Gravel
Marking Experiment
CH/SH
CH
CH
CH
Diversion Tunnel
Portal
Existing
Diversion Dam
CH
CH
CH
CH
CH
CH/SH
CH
CH
Spawning Gravel Index Area 4
Diversion Tunnel Portal to Diversion Dam
CH----Historical Chinook Spawning Areas
CO----Historical Coho Spawning Areas
PK----Historical Pink Salmon Spawning Areas
SH----Historical Steelhead Spawning Areas
■----1987 Steelhead Redds
▲----1989 Steelhead Redds
●----1990 Steelhead Redds

Appendix C

Total river and powerhouse flow rates (cfs) measured at the Henry M. Jackson powerhouse during the 1990 steelhead spawning season (Mar - June).

Henry M. Jackson Hydroelectric Project
Sultan River and Powerhouse Flows (cfs)

March

Day	River Flow	Powerhouse	% of River Flow
1	850	624	73
2	815	574	70
3	967	743	77
4	728	476	65
5	802	566	71
6	722	470	65
7	945	571	60
8	1235	934	76
9	1006	730	73
10	1201	776	65
11	829	496	60
12	1029	760	74
13	1093	839	77
14	1061	754	71
15	930	638	69
16	659	393	60
17	553	281	51
18	487	186	38
19	514	265	52
20	563	291	52
21	525	293	56
22	509	292	57
23	531	293	55
24	520	293	56
25	503	293	58
26	467	260	56
27	432	224	52
28	427	224	52
29	375	168	45
30	331	118	36
31	331	117	35

Henry M. Jackson Hydroelectric Project
Sultan River and Powerhouse Flows (cfs)

April

Day	River Flow	Powerhouse	% of River Flow
1	336	117	35
2	340	132	39
3	352	151	43
4	352	152	43
5	357	152	43
6	357	152	43
7	357	152	43
8	352	152	43
9	559	361	65
10	653	447	68
11	653	445	68
12	716	485	68
13	709	501	71
14	709	501	71
15	690	501	73
16	809	604	75
17	1150	967	84
18	1235	1060	86
19	1227	1057	86
20	1227	1057	86
21	1227	1056	86
22	1193	1078	90
23	1262	998	79
24	1315	1030	78
25	1369	1030	75
26	1434	1094	76
27	1369	1083	79
28	1397	1064	76
29	1167	899	77
30	998	761	76

Henry M. Jackson Hydroelectric Project
Sultan River and Powerhouse Flows (cfs)

May

Day	River Flow	Powerhouse	% of River Flow
1	815	544	67
2	703	469	67
3	671	440	66
4	659	423	64
5	647	242	37
6	635	423	67
7	788	596	76
8	802	567	71
9	623	446	72
10	559	377	67
11	559	353	63
12	559	353	63
13	693	354	51
14	635	355	56
15	611	374	61
16	593	381	64
17	570	362	64
18	570	353	62
19	564	353	63
20	559	353	63
21	576	353	61
22	564	354	63
23	635	440	69
24	728	519	71
25	761	541	71
26	761	555	73
27	741	555	75
28	741	556	75
29	748	555	74
30	735	541	74
31	761	533	70

Henry M. Jackson Hydroelectric Project
Sultan River and Powerhouse Flows (cfs)

June

Day	River Flow	Powerhouse	% of River Flow
1	937	682	73
2	1006	735	73
3	1029	735	71
4	1244	1054	85
5	1297	1099	85
6	1288	1017	79
7	1288	1102	86
8	1270	1090	86
9	1201	1028	86
10	1201	1062	88
11	1560	1166	75
12	1463	1166	80
13	1416	1207	85
14	1244	1043	84
15	945	726	77
16	930	726	78
17	901	726	81
18	788	648	82
19	564	446	79
20	427	304	71
21	366	254	69
22	293	189	65
23	507	388	77
24	647	530	82
25	865	763	88
26	498	380	76
27	312	211	68
28	259	147	57
29	331	227	69
30	297	187	63

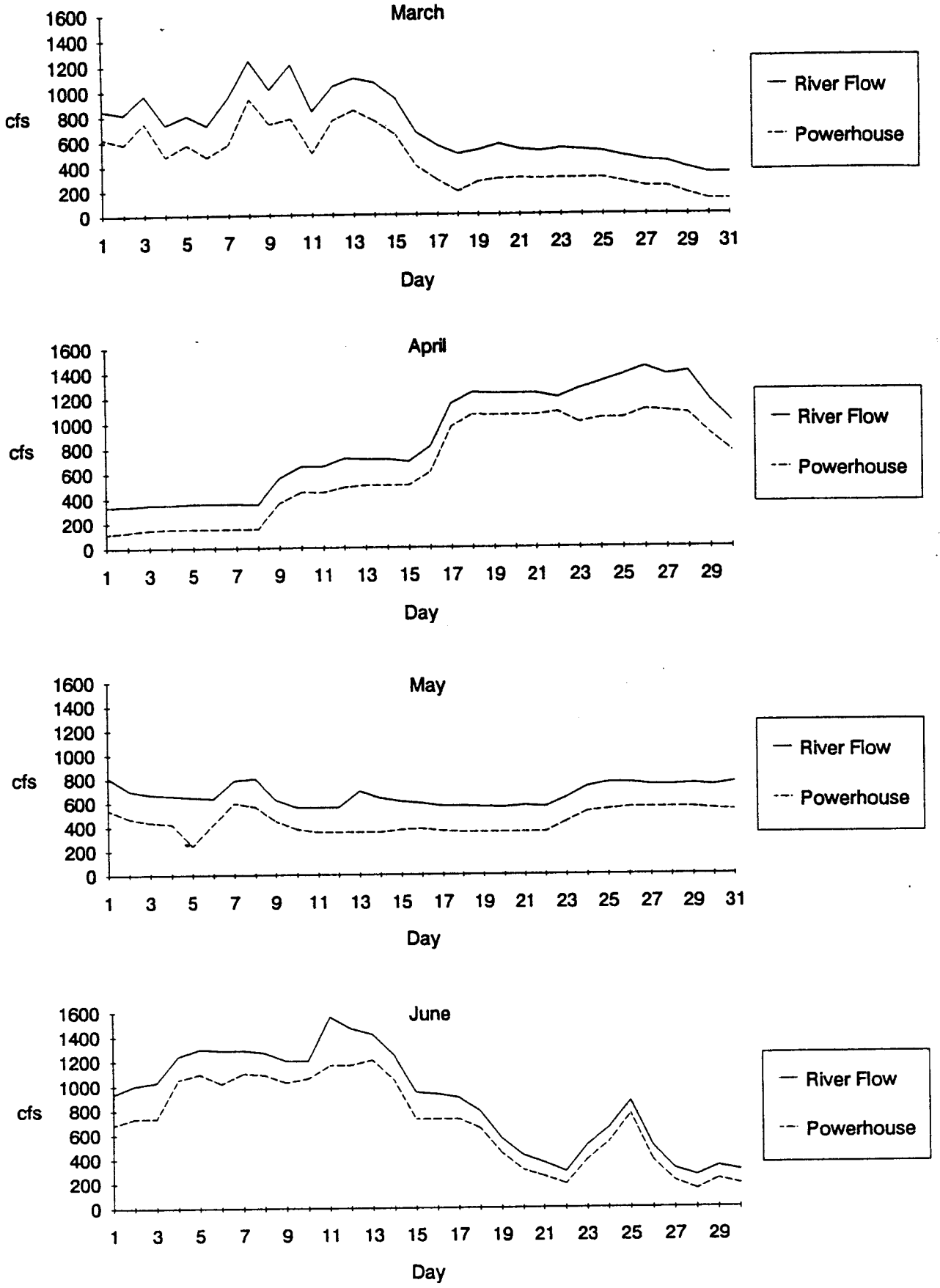


Figure 1. Daily powerhouse flows and total Sultan River flows (cfs) below the powerhouse for March through June, 1990.

C

Appendix D

Agency Consultation Correspondence

r SMITCH
irector

STATE OF WASHINGTON

DEPARTMENT OF WILDLIFE

16018 Mill Creek Blvd., Mill Creek, WA 98012 Tel. (206) 775-1311

February 22, 1990

Jean B. Olson, Manager
Environmental and Engineering Support Services
Snohomish County PUD
P. O. Box 1107
Everett, WA 98206

Re: Henry M. Jackson Hydroelectric Project, FERC 2157,
Steelhead Spawning surveys

Dear Ms. Olson:

In follow-up to my telephone conversation with Bruce Meaker, this will serve to document our request that you arrange to conduct steelhead spawner distribution studies this year. These surveys will include Sultan River from its mouth to the former City of Everett diversion and are for the purpose of determining and documenting that steelhead are able to satisfactorily pass the powerhouse location.

Since the relationship between powerhouse discharge and upstream flow may affect the potential for fish to be delayed or fail to pass, it is important to observe a wide range of conditions. This will be the third of the three surveys that we agreed should be performed.

By the way, I wish to express my appreciation for your prompt attention to making Sultan River flows and fishable levels available to the public through the NOAA Steelheaders' Hotline.

Very truly yours,

R. Gary Engman
Mitigation Coordinator
Region 4 Habitat Management

c: Ted Muller
Gary Fenton
Curt Kraemer
Steve Foley

SNOHOMISH COUNTY
PUD
PUBLIC UTILITY DISTRICT No. 1

2320 California St., Everett, Washington 98201 258-8211
Mailing Address: P. O. Box 1107, Everett, Washington 98206

September 17, 1990
PUD-19302

Mr. Gary Engman
Department of Wildlife
16018 Mill Creek Boulevard
Mill Creek, WA 98012

Mr. Robert Gerke
Department of Fisheries
3939 Cleveland Avenue
Tumwater, WA 98504

Mr. Gwill Ging
U.S. Fish and Wildlife
2625 Parkmont Lane SW
Olympia, WA 98502

Mr. David Somers
Tulalip Tribes, Inc.
6700 Totem Beach Road
Marysville, WA 98270

Mr. Jon Linvog, F/NWR5
Department of Commerce/NOAA
National Marine Fisheries Service
Bin C15700
7600 Sand Point Way NE
Seattle, WA 98115

Gentlemen:

RE: Jackson Hydroelectric Project - FERC #2157
1990 Winter-Run Steelhead Spawning Survey

This is to transmit to you the draft report by Parametrix on the 1990 Steelhead Spawning Survey on the Sultan River. The survey was conducted at the request of Washington Department of Wildlife as the third in a three part series of studies to assess the success of the powerhouse berm to facilitate upstream migration of spawning winter run steelhead.

Powerhouse flows during the 1990 steelhead spawning season were slightly higher than average and greater than 50% of the total river flow for nearly the entire season. Sixty redds were counted with 68% of them occurring upstream of the powerhouse; the largest percentage of any of the pre- and post-project years surveyed. The consultant has concluded that "results of the post- project surveys indicate that over the range of flow patterns observed project operations do not appear to inhibit the passage of steelhead past the powerhouse".

This conclusion mirrors those in the Adult Fish Passage (Powerhouse Berm) Study Final Report submitted to the FERC under License Article 55 and 56 (PUD-19221).

Please review the report for acceptability and submit your comments, if any, to the District by October 30, 1990.

Sincerely,

Original Signed By
R.R. GOODELL
Richard R. Goodell, Manager
Jackson Hydroelectric Project

Attachment
BFM:vr
cc: J. Jones, Bell & Ingram
B. Sullivan, Parametrix
A. Martin, FERC, Portland (w/o attachment)
L. Cashell, FERC, Washington D.C. (w/o attachment)