PGE

Portland General Electric Company
121 SW Salmon Street • Portland, Oregon 97204

OFFICE OF THE SECRETARY FILED
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FEDERAL ENERGY REGULATORY COMMISSION

March 17, 2003

Part 7 of 10

ORIGINAL

Honorable Magalie Roman Salas
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Secretary Salas:

Enclosed for filing with the Commission for Project No. 477 is the information requested in FERC's Request for Additional Information letter to PGE dated February 21, 2003. This filing provides that material requested within 30-days as specified in Schedule A of your request to the specified recipients. Specifically:

1. A single copy of all items listed in item A (1) to the Commission and a single copy to Mr. Alan Mitchnick (transmittal letter enclosed).

2. A single copy of those items listed in item A (2) not containing sensitive cultural materials to the Commission and a single copy to Dr. Frank Winchell. Two copies of those items listed in item A (2) containing sensitive cultural resources information, appropriately marked, is also being filed directly with Dr. Frank Winchell of commission staff (transmittal letter enclosed).

3. An original and 8 copies of the items listed in item A (3), with the exception of Appendix B, which was a placeholder at the time of the MOA. The referenced Finding of Effect submittal was recently sent to SHPO for formal concurrence. PGE expects a reply within 30 days and will send both the submittal and SHPO's response with the Historical Properties Management Plan to be submitted to FERC as required by item B (2).

4. The information requested in item A (4) is actually contained in Sections 1, 2 and 3 of the Decommissioning Plan for the Bull Run Project, included in the Settlement Agreement Document filed with the Bull Run Surrender Application. This description had not yet been drafted when the MOA was framed so Appendix A was referenced as a placeholder. We will correct this reference with the Historical Properties Management Plan to be submitted to FERC as required by item B (2).

An additional (ninth) copy of the filing letters to the commission, Mr. Mitchnick, and Dr. Winchell are also provided as proof of filing, to be dated, time stamped and returned in the enclosed self-addressed, stamped envelope. We would appreciate it if you would date and time-stamp these letters and return them in this envelope.

If you have any questions regarding this filing, please do not hesitate to contact me directly at (503) 464-8864.

Very truly yours,

Julie A. Keil, Director
Hydro Licensing and Water Rights

Encls.

PGE

Portland General Electric Company
121 SW Salmon Street • Portland, Oregon 97204

March 17, 2003

Mr. Alan Mitchnick
Federal Energy Regulatory Commission
888 First Street, N.E. (Room 6A-9)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Mr. Mitchnick:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A of FERC's Request for Additional Information letter to PGE dated February 21, 2003. Specifically, a single copy of each item listed in item A (1) is enclosed.

If you have any questions regarding this filing, please do not hesitate to contact me directly at (503) 464-8864.

Very truly yours,

Julie A. Keil, Director
Hydro Licensing and Water Rights

Encls.

Stillwater Sciences

2532 Durant Avenue, Suite 201, Berkeley, CA 94704 Phone (510) 848-8098 Fax (510) 848-8398

TECHNICAL MEMORANDUM

DATE: July 1, 2002

TO: Bull Run Project Decommissioning Working Group

SUBJECT: Preliminary fish passage monitoring plan for the Sandy River following the removal of Marmot Dam

Summary

This monitoring plan proposes to use channel complexity as an indicator of potential fish barriers following the removal of Marmot Dam. Channel complexity at four monitoring sites will be measured using the standard deviation of channel bed elevation, which will be surveyed annually for at least three years prior to dam removal, and continue annually after the dam removal until the risks of potential passage barrier formation becomes sufficiently small. We selected one site in the Reservoir Reach, two sites in Reach 1, and one site at the top of Reach 3. In the Reservoir Reach and Reach 1, the monitoring duration would be one year plus two consecutive years with (1) no barriers to fish passage, and (2) either improved channel complexity or channel complexity within the range of values prior to dam removal (i.e., monitoring would be conducted for at least three years in these reaches). Reach 3 would be monitored for the duration of monitoring in Reach 1 plus two consecutive years with (1) no barriers to fish passage, and (2) either improved channel complexity or channel complexity within the range of values prior to dam removal (i.e., monitoring would be conducted for at least five years in this reach). Channel bed surveys must be accompanied by reconnaissance trips to assess actual passage conditions in the Sandy River.

Background

A meeting was convened on May 20, 2002 between ODFW, NMFS, USFWS, PGE, and Stillwater Sciences to develop a monitoring plan for fish passage following the removal of Marmot Dam. Stillwater Sciences (2002a) described the theoretical basis of using channel bed complexity rather than the amount of aggradation as an indicator of the potential for future fish passage issues. During the meeting, the participants agreed on a general outline for a monitoring program, which is described below. This document describes the monitoring methods, monitoring locations, duration of monitoring, and the need for direct observation of fish passage conditions.

Strategy

Stillwater Sciences (2002a) described why channels with little bed complexity (e.g., channels that are wide and shallow) have the highest potential to impede fish passage, while complex channels (e.g., channels with defined bars and a thalweg) are less likely to develop fish passage barriers. We further hypothesized that the rate of aggradation controls the channel complexity. For example, a rapidly aggraded surface is more likely to have a channel with a uniform bed than a slowly aggraded surface. If the aggradation occurs over a longer time period in which the river experiences a variety of hydraulic conditions, the channel will be able to recover at least part of its original complexity, and thus reduce the possibility of fish passage barriers. During the May 20 meeting, it was agreed that channel complexity rather than the amount of aggradation should be used to assess future fish passage issues.

We believe that the best metric for assessing channel complexity is the standard deviation of channel cross section elevation. For example, the standard deviation of bed elevation is much lower for a rapidly aggraded surface (shown in Figure 1A) than a slowly aggraded surface (Figure 1B). We propose to use the standard deviation of bed elevation over two pool-riffle complexes to quantify channel complexity over a reach. In areas where the channel is plane-bedded, or has very long pools, we recommend that the monitoring reach be 10 channel widths long, if possible. Because erosion and deposition will alter the channel complexity, bed elevation will be surveyed and the standard deviation of bed elevation will be calculated for at least three years prior to the removal of Marmot Dam to establish the natural range of pre-dam removal bed complexity. Following dam removal, bed elevation will be surveyed annually during the summer low-flow season and the results will be compared with previous surveys. A decrease in the standard deviation of bed elevation reflects reduced channel complexity, which corresponds to an increased likelihood of fish passage barrier formation. An increase in the standard deviation of bed elevation reflects increased channel complexity, which indicates a decreased potential for the formation of fish passage barriers. Following dam removal, if channel complexity has returned to its pre-dam removal condition, or has improved for two consecutive years, we believe that the potential for fish passage barrier development caused by dam removal is low.

To demonstrate how the standard deviation of bed elevation can be used for monitoring, Figure 2 shows four hypothetical examples of the standard deviation of bed elevation following dam removal. In the examples in Figure 2, the standard deviation of bed elevation was monitored for 7 years prior to dam removal and another 5 years following dam removal. The conditions of the years following dam removal are briefly described in Table 1.

Table 1. Brief description of channel complexity for the examples given in Figure 2.

	Example 1	Example 2	Example 3	Example 4
Year 1	Significant decrease in channel complexity			
Year 2	Continued decrease in channel complexity.	Increase in channel complexity to within the range of pre-dam removal conditions.	Increase in channel complexity.	Continued decrease in channel complexity.
Year 3	Increase in channel complexity.	Continued increase in channel complexity within the range of pre-dam removal conditions.	Decrease in channel complexity.	Increase in channel complexity to within the range of pre-dam removal conditions.
Year 4	Slight increase in channel complexity.	Slight decrease in channel complexity, but still within the range of pre-dam removal conditions.	Continued decrease in channel complexity.	Decrease in channel complexity to below the range of pre-dam removal conditions.
Year 5	Continued increase in channel complexity.	Increase in channel complexity within the range of pre-dam removal conditions.	Increase in channel complexity.	Increase in channel complexity to within the range of pre-dam removal conditions.

These examples will be discussed further below in the "Duration of monitoring" section.

Proposed channel complexity monitoring

At each monitoring site, we will establish geo-referenced benchmarks that define the site's upstream and downstream boundaries, to ensure that the survey boundaries are consistent through time. We will survey the topography of the active channel in the defined monitoring site. Bed elevation will be surveyed annually with a Total Station. The Total Station survey will be a two-dimensional grid, and any significant changes in bed slope (i.e. changes of elevation greater than 1 ft) and important geomorphic characteristics will be noted. The longitudinal spacing between grid measurements would be about 1/4 of the channel width. Perpendicular to flow, the survey would be conducted at 10-ft intervals and significant breaks in slope. We will also survey cross sections nested within the topographic surveys. These cross sections will be permanently benchmarked and extend onto terraces, rather than just in the active channel. These cross sections will be spaced 1–2 channel widths apart, depending on the site. Similar to the grid survey, points on each cross section will be surveyed at 10-ft intervals, and also include any significant breaks in slope. Surveys should be conducted during the low-flow season in July to August.

Proposed channel complexity analysis

The data from the surveys will be incorporated into a GIS database, to create a 1-ft contour map of bed elevation for the monitored reach. The survey data will be used to interpolate bed elevation at pre-defined 5-10 ft grid points, which will be used to calculate standard deviation of bed elevation. The interpolation process will ensure the consistency of the standard deviation calculation at different years even if the survey points are not exactly the same for different years. The interpolation and standard deviation calculation will be carried out with a computer program that will be developed in conjunction with the ESA subgroup, once the first set of survey data is available.

Proposed monitoring sites

We have selected four monitoring sites where sediment transport modeling indicated a greater potential for barriers to passage to develop.

- Monitoring Site 1 would be located in the current reservoir reach between the cofferdam and about 1.5 miles upstream of the dam. This reach encompasses two pool-riffle complexes and spans most of the reservoir area.
- Monitoring Site 2 would be located immediately downstream of the dam for a total distance of approximately ten channel widths. This site has a plane bed morphology and we therefore did not include two pool-riffle complexes at this site. The channel planform is relatively simple in this reach, and the expected longitudinal variation in channel complexity is small.
- Monitoring Site 3 would be located close to Site 2, between about RM 29.3 and RM 29.6. This site also has a plane-bed morphology and is located in a relatively wide portion of Reach 1.
- Monitoring Site 4 is located between the exit of the Sandy River Gorge and the cascade upstream of Revenue Bridge. This site contains two pool-riffle complexes and is bounded by the gorge and the cascade.

We did not select a monitoring site in Reach 2 because it is very unlikely that sediment deposition will create a fish passage barrier in the gorge because of the steep slope and high channel confinement. These characteristics also make survey logistics very difficult. In addition, no monitoring sites were selected in Reaches 4 and 5 because sediment transport modeling indicated that there will be insignificant coarse sediment deposition in those reaches.

Duration of monitoring

According to modeling conducted by Stillwater Sciences (2002b), Reach 1 will aggrade in the first year following Marmot Dam removal and will degrade continuously in subsequent years (Figure 3) We believe that post-removal monitoring in the reservoir reach (Reach 0) and Reach 1 should be conducted during the first year following dam removal and continue until there are two successive years with (1) no barriers to fish passage, and (2) either improved channel complexity or channel complexity within the range of values prior to dam removal (i.e., monitoring would be conducted for at least three years in these reaches). Prior to dam removal, channel complexity surveys should occur for at least three years. Based on the modeling results, the highest aggradation rate in Reach 3 would occur in Year 3 following dam removal (Figure 3). To ensure that the highest rate of sediment delivery to Reach 3 has occurred, the monitoring period in Reach 3 should be based on the results of monitoring in Reach 1. Once the monitoring program for Reach 1 has terminated (after one year plus two years of improving or stable complexity as described above), two consecutive years of improving or stable channel complexity and no barriers to fish passage would be required in Reach 3 (i.e., monitoring would occur for at least 5 years following dam removal). According to the model, Reaches 4 and 5 will not have significant coarse sediment aggradation, and are very unlikely to have barriers to fish passage, and thus the monitoring of fish passage in Reaches 4 and 5 should be limited to field inspection and be incorporated into the other monitoring actions identified and agreed upon by the ESA sub-team.

To further explain how to determine the length of the monitoring program, we will use the examples in Figure 2 (Tables 2 and 3). In Table 2, we assume that the data were collected in either Reach 0 or Reach 1. In Table 3, we assumed that the data for the examples were collected in Reach 3, and the monitoring program for Reaches 0 and 1 terminated after Year 3.

Table 2. The end point for the examples in Figure 2 applied to Reaches 0 and 1, assuming that no fish barriers are observed

Example 1	Example 2	Example 3	Example 4
Monitoring could end after Year 4 due to (a)[1]; or monitoring for an additional year if the difference is deemed too small by the Adaptive Management Team.	Monitoring should end after Year 3 due to (a) and (b)[1].	Monitoring should continue after Year 5 because neither (a) nor (b) occurs.	Monitoring should continue after Year 5 because neither (a) nor (b) occurs.

[1] *(a) continued improvement in channel complexity for two consecutive years after Year 1*
(b) channel complexity improved to within the range of conditions observed prior to dam removal

Table 3. The end point for the examples in Figure 2 applied to Reach 3, assuming the monitoring program for Reaches 0 and 1 terminated after Year 3 and no fish barriers are observed in Reach 3.

Example 1	Example 2	Example 3	Example 4
Monitoring should end after Year 5 due to (c)[2].	Monitoring should end after Year 5 due to (d)[2].	Monitoring should continue after Year 5 because neither (c) nor (d) occurs.	Monitoring should continue after Year 5 because neither (c) nor (d) occurs.

[2] *(a) continued improvement in channel complexity for two consecutive years after the termination of the monitoring program in Reaches 0 and 1*
(b) channel complexity improved to within the range of conditions observed prior to dam removal for two consecutive years after the termination of the monitoring program in Reaches 0 and 1

We believe the monitoring period proposed above provides an excellent framework for PGE and the agencies to assess the duration of PGE's monitoring responsibility. Significant improvement, however, can be achieved by integrating the monitoring plan into an adaptive management framework. Using an adaptive management framework will allow PGE and the agencies to adjust the monitoring duration based on observed conditions and survey data. This will be particularly useful in cases where the annual change in standard deviation is small, or the standard deviation is very close to the pre-dam removal values. This can be demonstrated with Examples 1 and 4 in Figure 2. In Example 1, the increase in standard deviation between Years 3 and 4 is very small, and it is uncertain based solely on the data whether an improvement in channel complexity has occurred or if the change is within measurement error. Through an adaptive management framework, PGE and the agencies can decide whether to terminate the monitoring program after Year 4, or continue for another year based on field inspections. In Example 4, the standard deviation of bed elevation decreased in Year 4 to only slightly below the range measured prior to dam removal. The Adaptive Management Team can determine whether to terminate the monitoring program based on field conditions (i.e., it is obvious that passage barriers will not occur), even though neither condition for ending the monitoring program is met based on standard deviation of bed elevation by Year 5.

Proposed field inspection

Annual monitoring of channel bed elevation must be coupled with more frequent biological monitoring of migrating fish in the Sandy River to assess whether passage barriers have developed. Reconnaissance trips to assess passage conditions throughout the Sandy River should occur during the upstream fish migration season in the first year following dam removal, following peak flow events, and during critically low flows. Because of the reduced risks in the following years, the reconnaissance surveys may be conducted at reduced frequency and incorporated into the other monitoring actions identified and agreed upon by the ESA sub-team. If passage barriers are observed during these reconnaissance trips, PGE will provide passage around the blocked area.

Analysis of the Reservoir Reach (Reach 0)

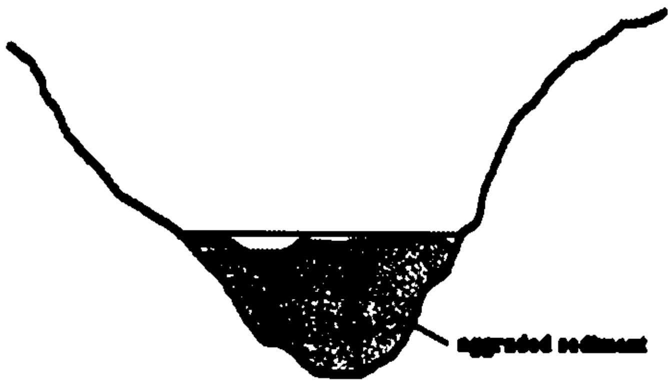
As soon as the dam is removed, channel complexity in the reservoir reach will likely increase immediately once a channel begins to cut into the reservoir deposit. This increase would be reflected in the standard deviation of the bed elevation. This will occur because the reservoir deposit is currently a uniform depth (i.e., low channel complexity), and will begin to erode once the dam is removed. If this erosion creates a thalweg, the standard deviation of depth will increase. In the Reservoir Reach, it is possible that a passage barrier may develop if the banks are unstable and slump into the channel. The potential for slumping may not be reflected in standard deviation measurements. We do believe that bank slumping in unlikely, however, following the first year. The standard deviation measurements can therefore be used to interpret the development of the channel following the first year. If any passage barriers have occurred due to slumping or other processes that cannot be assessed using standard deviation, one of the criteria required to end the monitoring period would not be met. In addition, the Adaptive Management Team can assess the potential for future bank slumping based on the morphological development of the reach, particularly the presence of oversteepened banks.

References

Stillwater Sciences. 2002a. Criteria for fish passage monitoring following the removal of Marmot Dam on the Sandy River, Oregon. Prepared by Stillwater Sciences, Berkeley, California for Portland General Electric Company, Portland, Oregon.

Stillwater Sciences. 2002b. Sediment transport modeling following the removal of Marmot Dam with 125,000 and 300,000 cubic yards of dredging prior to dam removal. Prepared by Stillwater Sciences, Berkeley, California for Portland General Electric Company, Portland, Oregon

A. Rapid sediment aggradation



B. Slow sediment aggradation

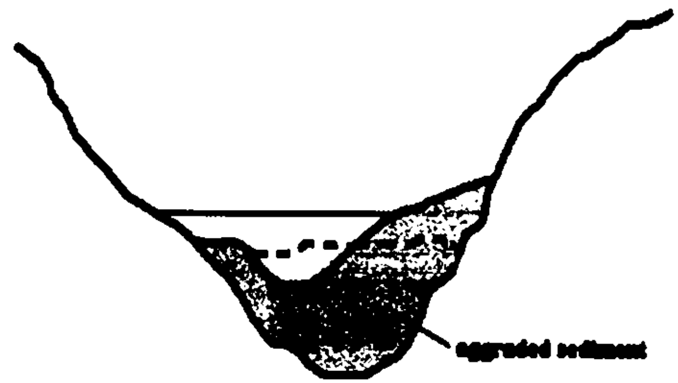


Figure 1. Schematic diagrams of sediment aggradation in the Sandy River following dam removal.

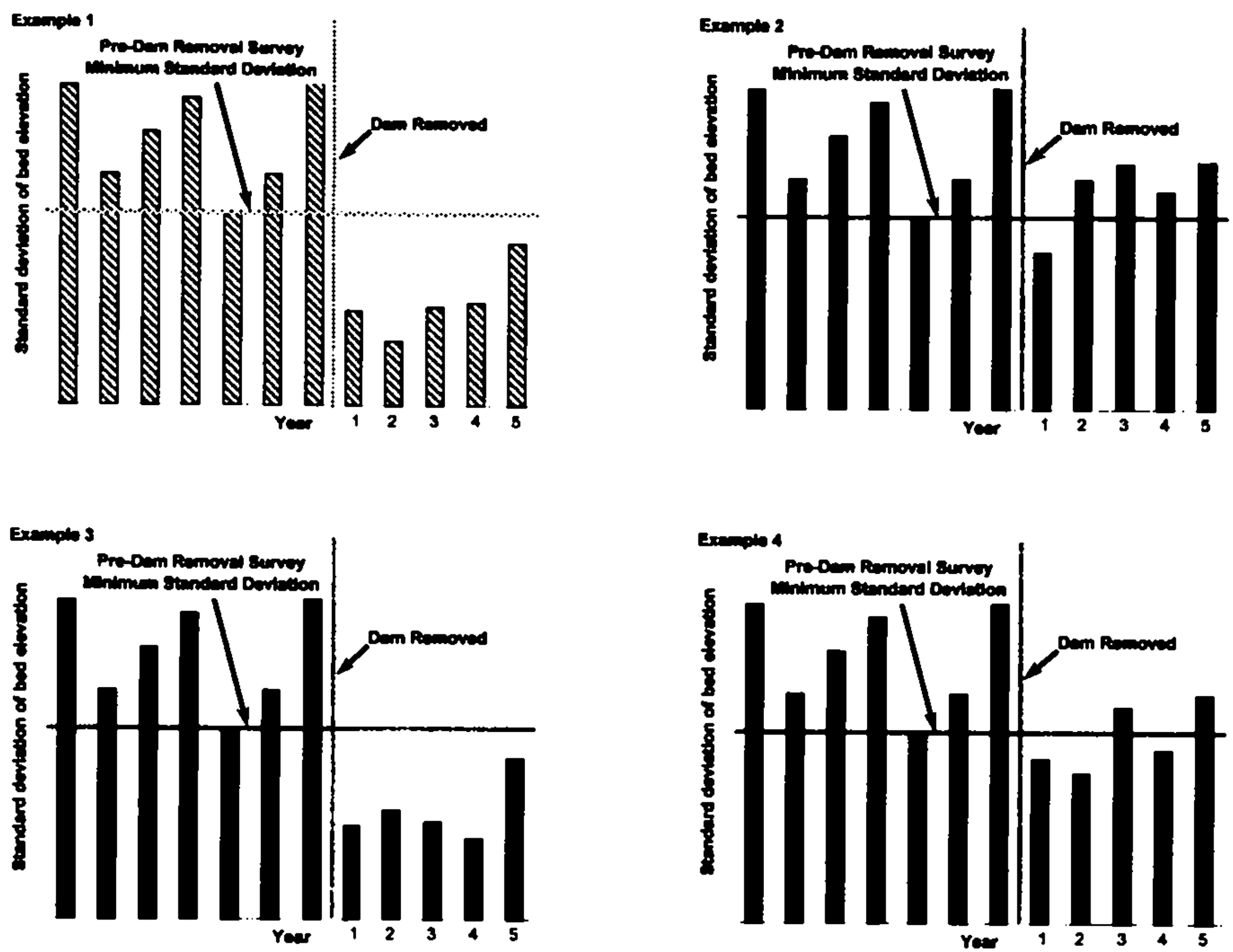


Figure 2. Examples of the standard deviation of bed elevation before and after dam removal.

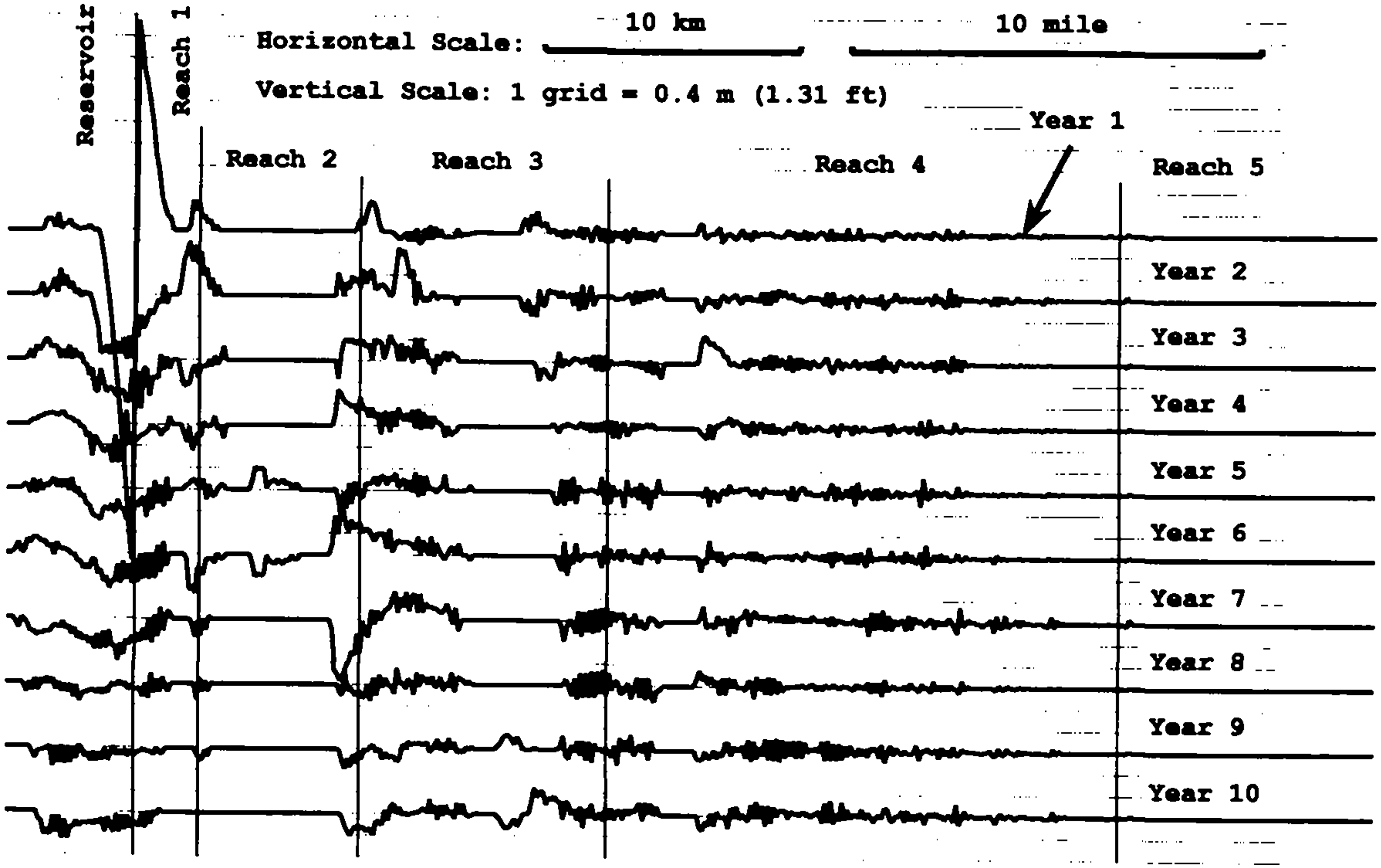


Figure 3. The predicted annual change in bed elevation following the removal of Marmot Dam under Alternative B.

Stillwater Sciences

2532 Durant Avenue, Suite 201, Berkeley, CA 94704 Phone (510) 848-8098 Fax (510) 848-8398

Draft Technical Memorandum

Date: March 12, 2002

To: Portland General Electric, Portland, Oregon

Subject: Sediment transport modeling following the removal of Marmot Dam with 125,000 and 300,000 cubic yards of dredging prior to dam removal

Introduction

On February 19, 2002, Portland General Electric requested that Stillwater Sciences run sediment transport simulations for two additional alternatives for removing Marmot Dam on the Sandy River, Oregon. For this analysis, Stillwater Sciences performed model runs for dredging 125,000 and 300,000 cubic yards of sediment from the reservoir upstream of the dam prior to dam removal. These volumes represent the worst and best possible dredging volumes for one in-water-working-season, respectively (Kevin Marshall, personal communication, Feb. 22, 2002). We previously estimated that 970,000 cubic yards of sediment are stored in the reservoir (Stillwater Science 2000), so the two new alternatives represent 31 % and 13 % removal of the sediment from behind the reservoir, respectively. This technical memorandum presents the results of the new simulations and compares them with the results of earlier simulation results for reference conditions (no sediment release), Alternative B (minimal dredging), and Alternative D (dredging sediment to a point 2,700 ft upstream of the Marmot Dam, or about 720,000–510,000 cubic yards). Portland General Electric engineers have determined that removal of the sediment as called for in Alternative D is not feasible in one season, but the results are presented here so that the new alternatives can be easily compared to alternatives presented in Stillwater Sciences (2000a,b). To facilitate interpretation of the different modeling results, both the current and the earlier simulations used the same average hydrologic series and average grain size distribution as input data. These input data are described in detail in Stillwater Sciences (2000a,b) and Cui and Wilcox (in press). Detailed background information about the geological and hydrological conditions of the Sandy River and the removal of Marmot Dam can also be found in Stillwater Sciences (2000a,b). Detailed information about the sediment transport model can be found in Cui and Wilcox (in press) and in Stillwater Sciences (2000b).

Table 1. Dam removal options presented in this report.

Dam Removal option*	Volume of sediment available for downstream transport (cubic yards)	Stillwater Sciences (2000a)	PGE Current
Single-season dam removal with minimal sediment removal	970,000	Alternative B	Alternative 3
remove sediment to the bottom of the sand layer with sand layer excavation to a point 2,700 ft upstream of Marmot Dam	250,000–460,000	Alternative D	N/A
Remove 125,000 cubic yards of sediment	845,000	N/A	Alternative 1A
Remove 300,000 cubic yards of sediment	670,000	N/A	Alternative 1B
Leave dam in place	0	reference condition	Alternative 2

* *The names of the alternatives have changed since our report (Stillwater Sciences 2000a). This memorandum uses the alternative names in Stillwater Sciences (2000a) so that readers can easily cross reference this memorandum and Stillwater Sciences (2000a).*

In order to assess the upstream extent of excavation of the reservoir deposit, we assumed an average width of 50.5 m and depth as shown in Figure 1. Using these assumptions, sediment excavation was estimated to extend to 200 m and 600 m upstream of the dam for removal volumes of 125,000 and 300,000 cubic yards, respectively.

This analysis presents results from coarse and fine sediment transport models. Results of the coarse sediment simulation are presented as the annual change in bed elevation in Figures 2 to 9, and as deposition thickness in Figures 10 to 17. These model runs show that the bed dynamics downstream will be very similar under the dam removal scenario with minimal sediment removal (Alternative B) and scenarios with removal of 300,000 and 125,000 cubic yards of sediment. Results of the simulations for fine sediment are presented as area and magnitude of deposition in Figures 18 to 22 and as total suspended sediment concentration (TSS) in Figures 23 to 27. In this document, explanations of the results and the comparisons among the alternatives are kept very brief because the diagrams are rather self-explanatory.

Coarse Sediment Modeling Results

The downstream impact of sediment released from behind the dam will include both deposition (as the sediment comes into a site) and erosion (as the sediment wave disperses downstream). The most important factor when considering the potential impact of a coarse sediment pulse to aquatic habitat is the annual change in bed elevation (shown in Figures 2-9). Figures 2 to 6 are plots of annual change in bed elevation under the assumed reference conditions, and for Alternative B (minimal dredging), dredging 125,000 cubic yards, dredging 300,000 cubic yards, and Alternative D. These figures are plotted at the same scale so that they can be easily compared. Additionally, the reference condition and Alternative B (minimal dredging) are plotted on the same graph in Figure 7, and Alternative B, removal of 125,000 cubic yards, and removal of 300,000 cubic yards are shown on the same graph in Figure 8.

Figure 9 shows the annual change in bed elevation for the reference condition and each of the removal alternatives for the first ten years following dam removal. This figure shows that for Alternative B and the removal of 125,000 and 300,000 cubic yards, the annual change in bed elevation (essentially an envelope of erosion and deposition) is similar in all reaches. The coarse sediment dynamics following each of the alternatives is described separately for each reach below.

Figures 10 through 14 are plots of deposition thickness under the assumed reference conditions, Alternative B (minimal dredging), 125,000 cubic yard dredging, 300,000 cubic yard dredging and Alternative D. These plots clearly show the evolution of the reservoir deposit, following dam removal, but the actual impacts to aquatic habitat are better represented by Figures 2-8. Comparisons between Alternative B (minimal dredging) and dredging 125,000 cubic yards, and between Alternative B (minimal dredging) and dredging 300,000 cubic yards are presented in Figures 15 and 16, respectively. These three removal options are shown on the same graph in Figure 17, but the large amount of data makes the graph difficult to interpret. Figure 15 shows that the erosional and depositional patterns for Alternative B (minimal dredging) and dredging 125,000 cubic yards prior to dam removal are very similar, and the difference in the magnitude of channel deposition downstream of the dam is insignificant. Similarly, Figures 16 and 17 show that for dredging 300,000 cubic yards, the erosional and depositional patterns are very similar to those shown for Alternative B (minimal dredging), and that the difference between the two alternatives, in terms of the magnitude of sediment deposition downstream of Reach 1, is insignificant. The amount of deposition in Reach 1 is greater for Alternative B than for dredging of 300,000 cubic yards for the first two years following dam removal. After, Year 2, the difference between the two alternatives is insignificant in Reach 1 (Figures 8, 16, and 17).

Reach by Reach Descriptions

The reservoir reach will experience rapid erosion following dam removal for each of the removal alternatives. The amount of sediment in the reservoir reach is essentially the same after year 4 for the 125,000 cubic yard removal alternative and Alternative B (Figure 15). Similarly the deposit morphology is the same after year 6 for the 300,000 cubic yard removal alternative and Alternative B (Figure 16). After four years the difference between these three removal alternatives is less than 1 m in the reservoir reach (Figure 17).

Reach 1 will be the most seriously impacted of the reaches for each removal option. This reach will be very dynamic, with extensive deposition in the first year following dam removal, and erosion in subsequent years (figures 3-6). Sediment dynamics in Reach 1 are similar to reference conditions starting in year 8. The remainder of the sediment wedge in year 8 may be a permanent deposition that fills in the area where either the spillway caused erosion or sediment was excavated during the construction of the dam.

Generally, the steep slope and narrow width of Reach 2 (the gorge) prevent sediment deposition (and subsequent erosion), rather sediment is delivered to downstream reaches relatively quickly. Some deposition does occur at the upper and lower ends of Reach 2 (Figures 3-6, 10-14). Both locations have lower slopes and slightly wider channel widths, and therefore, sediment deposition is more likely than in the remainder of the gorge. The annual change in bed elevation at the entrance to the gorge under reference conditions is within 1.3 ft (0.4 m) of the current bed elevation. Under Alternative B (minimal dredging), the maximum change in bed elevation at this location increases to about 2.6 ft (0.8 m) in year 2 after dam removal (Figure 3). The sediment would be eroded in subsequent years. The magnitude of deposition at the top of Reach 2 for the alternatives where 125,000 and 300,000 cubic yards of sediment were removed was similar to the amount of deposition under Alternative B. The frequency of deposition and erosion will also increase from the reference conditions. The annual change in bed elevation at the exit of the gorge under reference conditions is within 1.3 ft (0.4 m). The maximum change in bed elevation at this location under Alternative B is about 4 ft (1.2 m), but is generally less than 2.6 ft/yr (0.8 m/yr) (Figure 3). The annual change at this site for removal of 125,000 and 300,000 cubic yards of sediment is similar to Alternative B (Figure 8).

With the exception of over 3.3 ft (1 m) of deposition at the upstream end of Reach 3, sediment dynamics in Reach 3 are similar to reference conditions for the three excavation alternatives (Figures 3-6, 10-14). Additionally, there is little difference between the amount of deposition in Reach 3 under Alternative B versus removing 125,000 or 300,000 cubic yards of sediment (Figures 8 and 17). The magnitude of annual erosion and deposition under Alternative B, however, is similar to that of the reference condition, both at about 3.3 ft (1 m). The upper 3 miles of Reach 3 would be more dynamic following dam removal, with an increased frequency of erosion and deposition for the dam removal alternatives than under reference conditions (Figures 7 and 8).

The magnitude and frequency of coarse sediment dynamics in Reaches 4 and 5 are similar to reference conditions for Alternative B and removal of 125,000 and 300,000 cubic yards of sediment. (Figures 8 and 17).

Fine Sediment

The extent and magnitude of sand deposition are given in Figures 18-22 for the assumed reference conditions, Alternative B (minimal dredging), 125,000 cubic yards of dredging, 300,000 cubic yards of dredging and Alternative D (dredging approximately 730,000 cubic yards). The results indicate that none of the alternatives would result in significant sand deposition from the reference conditions.

Modeling results of TSS concentrations are given in Figures 23 - 27 for the assumed reference conditions, Alternative B (minimal dredging), 125,000 cubic yard dredging, 300,000 cubic yard dredging and Alternative D. The results indicate that the dam removal alternatives resulted in similar TSS for the first two years after the dam removal. The increases of TSS over the assumed reference conditions due to the removal of the dam are relatively low. For example, the maximum TSS downstream of Marmot Dam during the first year increased from under 200 ppm to about 550 ppm, i.e., an increase of less than 300 ppm.

Errata

An error was discovered in Stillwater Sciences (2000b) during the current modeling exercise. Figure 28 in Stillwater Sciences (2000b) is incorrect. A correct replacement for this figure can be found in Stillwater Sciences (2000a, Figure 20), or in this technical memorandum (Figure 24). There are no implications to the explanations and conclusions in Stillwater Sciences (2000b) from this correction.

References

Cui, Y., and A. Wilcox. 2002 (in press). Development and application of numerical modeling of sediment transport associated with dam removal. Sedimentation engineering. ASCE Manual 54, Volume 2, M. Garcia, editor. American Society of Civil Engineers.

Kevin Marshall, personal communication, Feb. 22, 2002. Portland General Electric Engineer

Stillwater Sciences. 2000a. Evaluation of geomorphic effects of removal of Marmot and Little Sandy dams and potential impacts on anadromous salmonids. Preliminary final technical report. Prepared by Stillwater Sciences, Berkeley, California for Portland General Electric Company, Portland, Oregon.

Stillwater Sciences. 2000b. Numerical modeling of sediment transport in the Sandy River, Oregon following removal of Marmot Dam. Technical report. Prepared by Stillwater Sciences, Berkeley, California for Portland General Electric Company, Portland, Oregon.

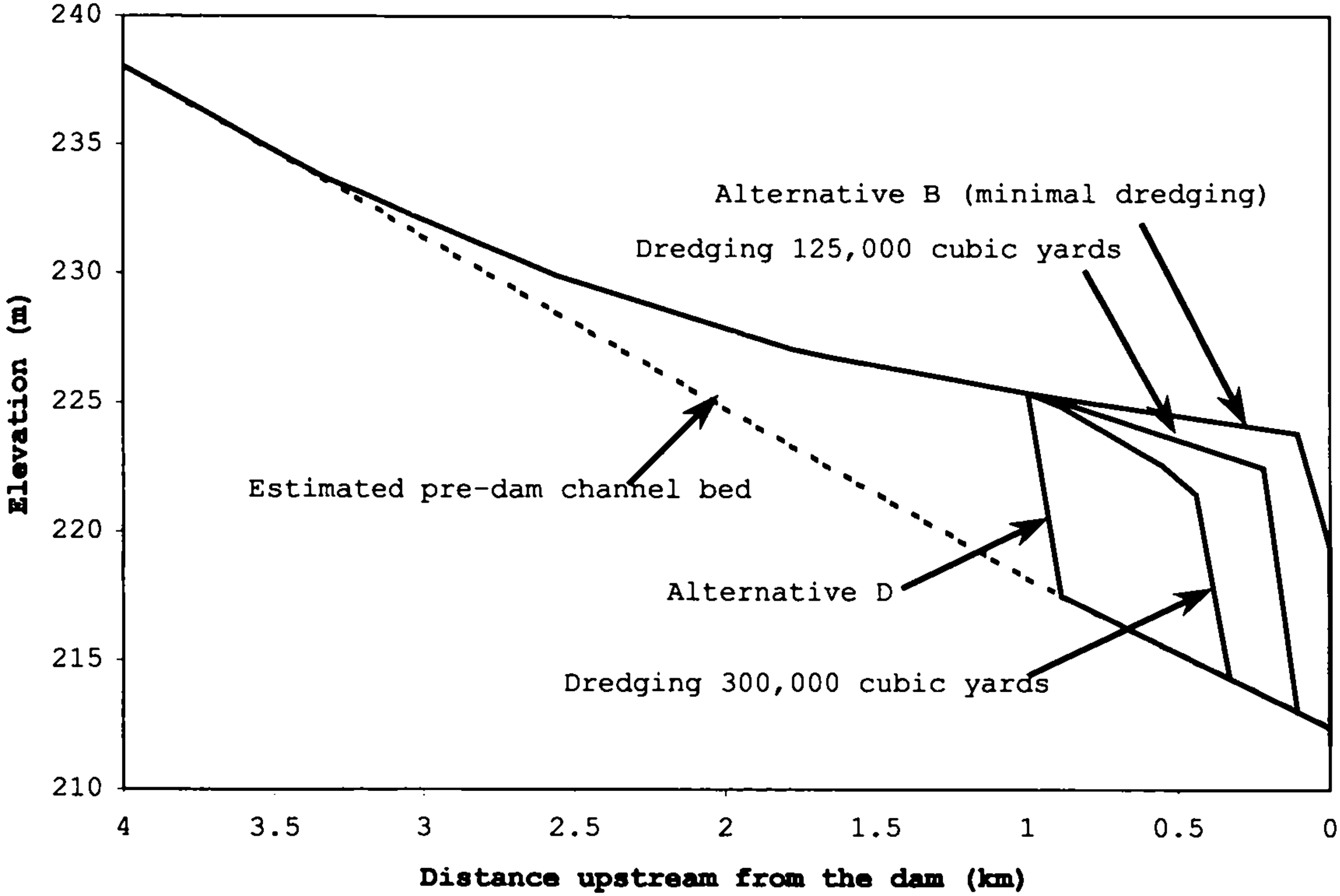


Figure 1. Initial profile in the reservoir for the alternatives presented in this memorandum

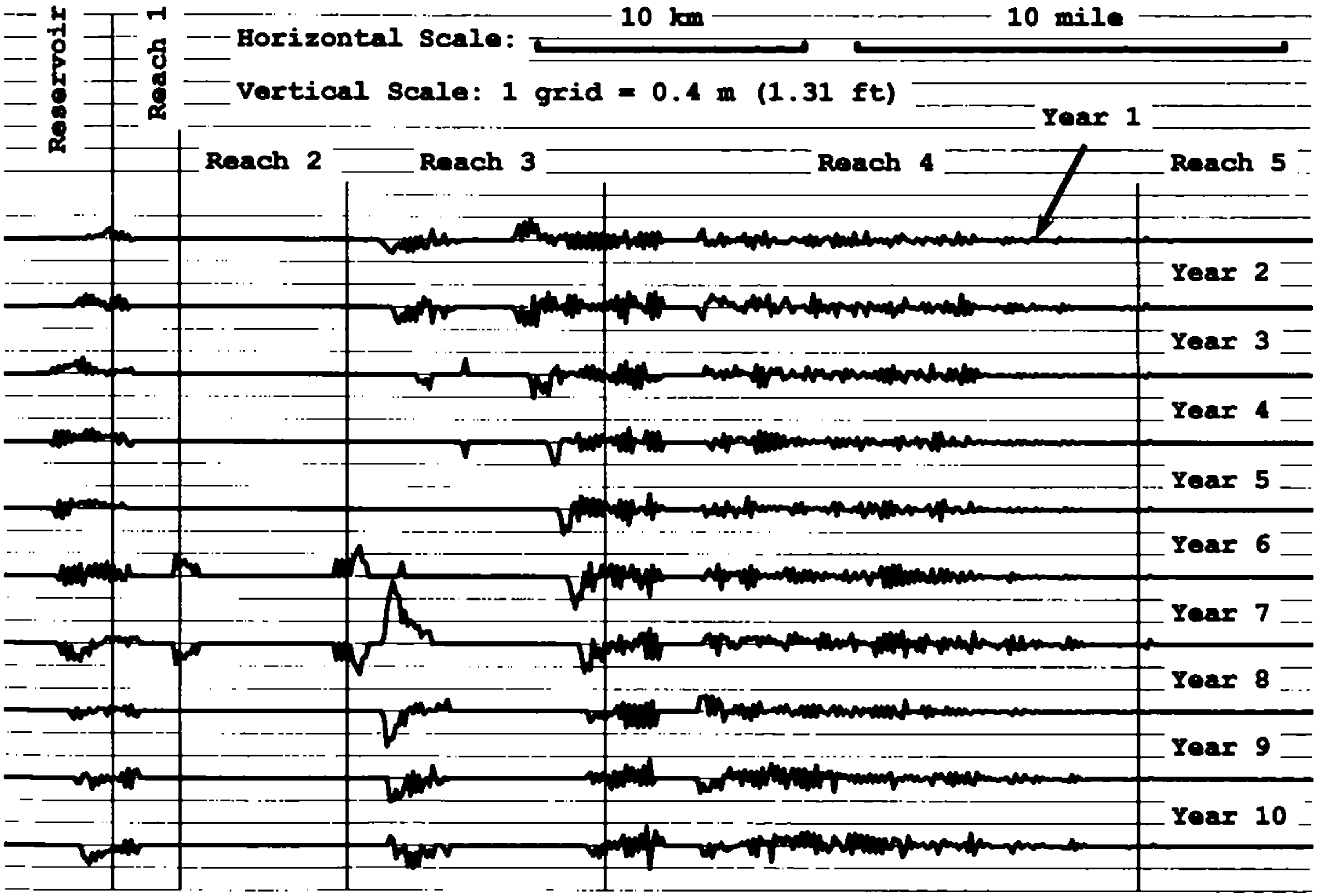


Figure 2. Annual change in bed elevation under reference conditions

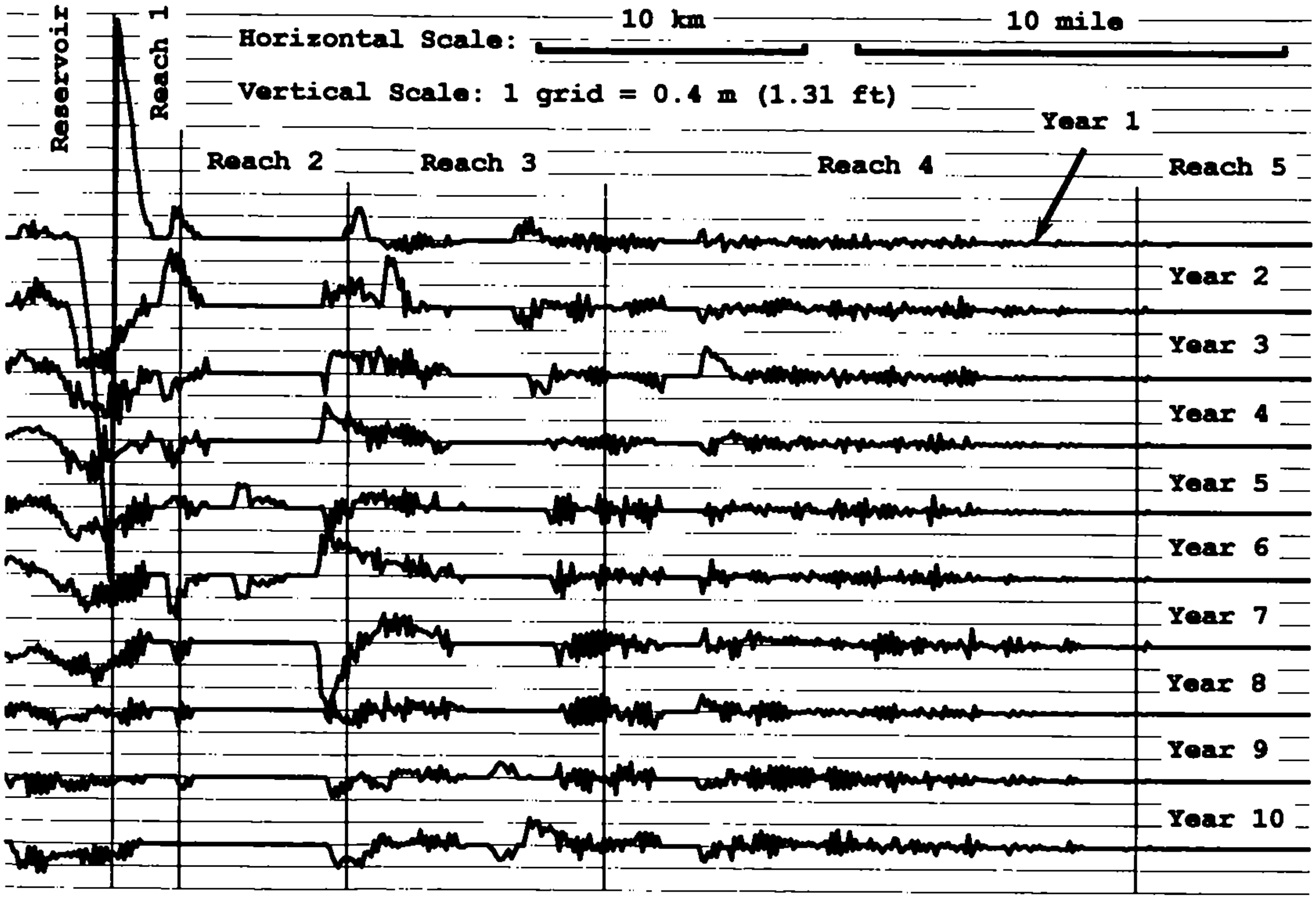
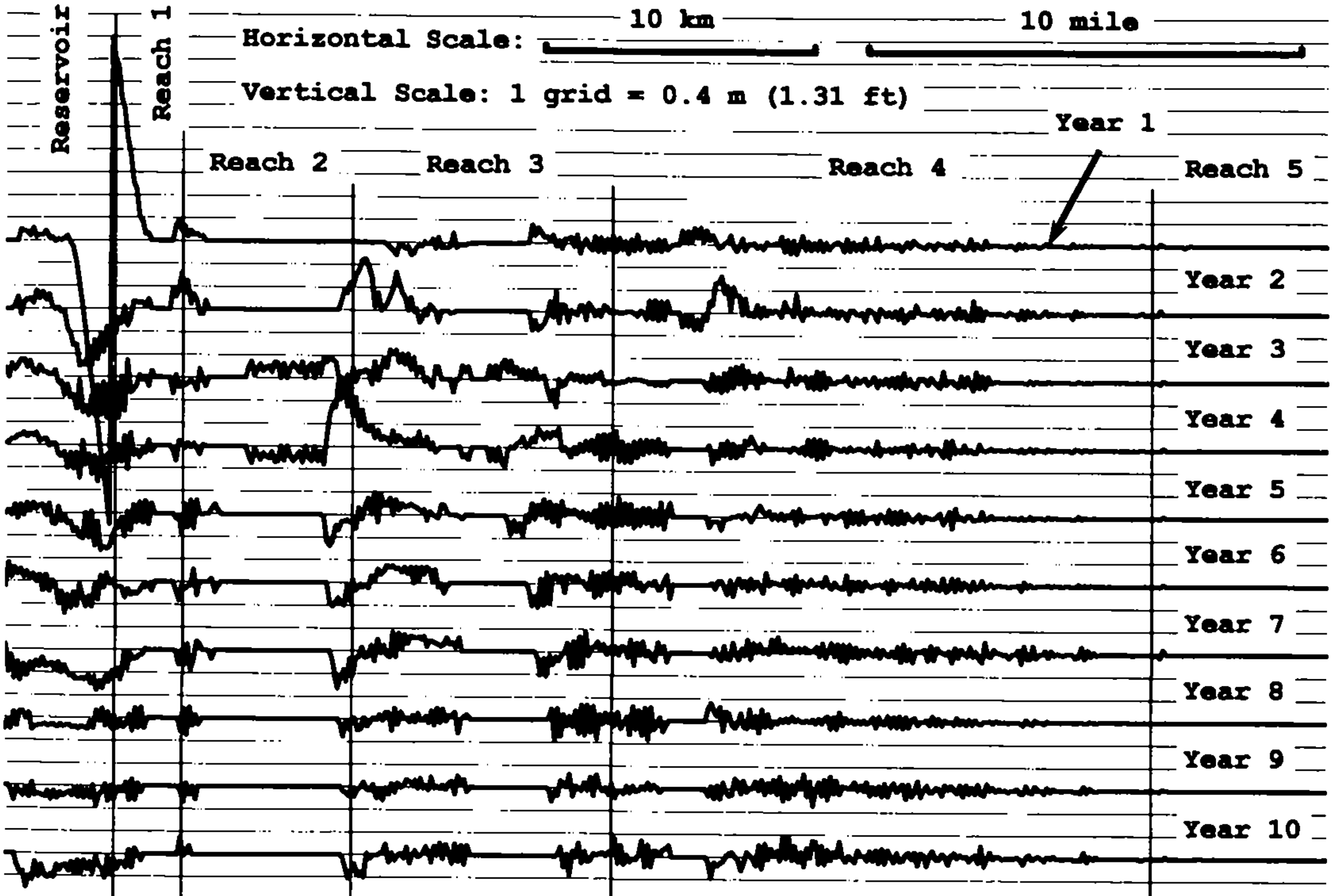


Figure 3. Annual change in bed elevation for Alternative B (minimal dredging)



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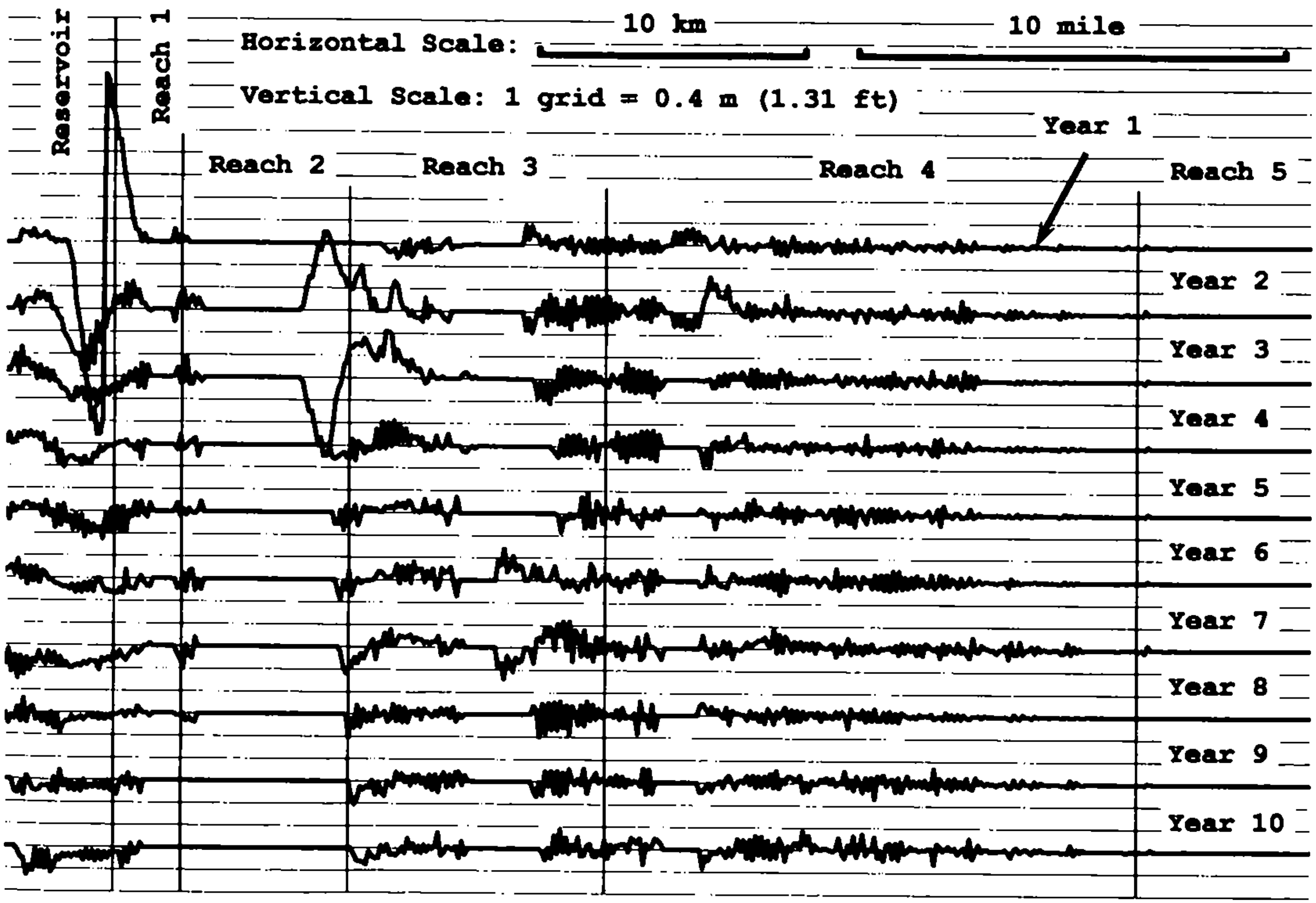

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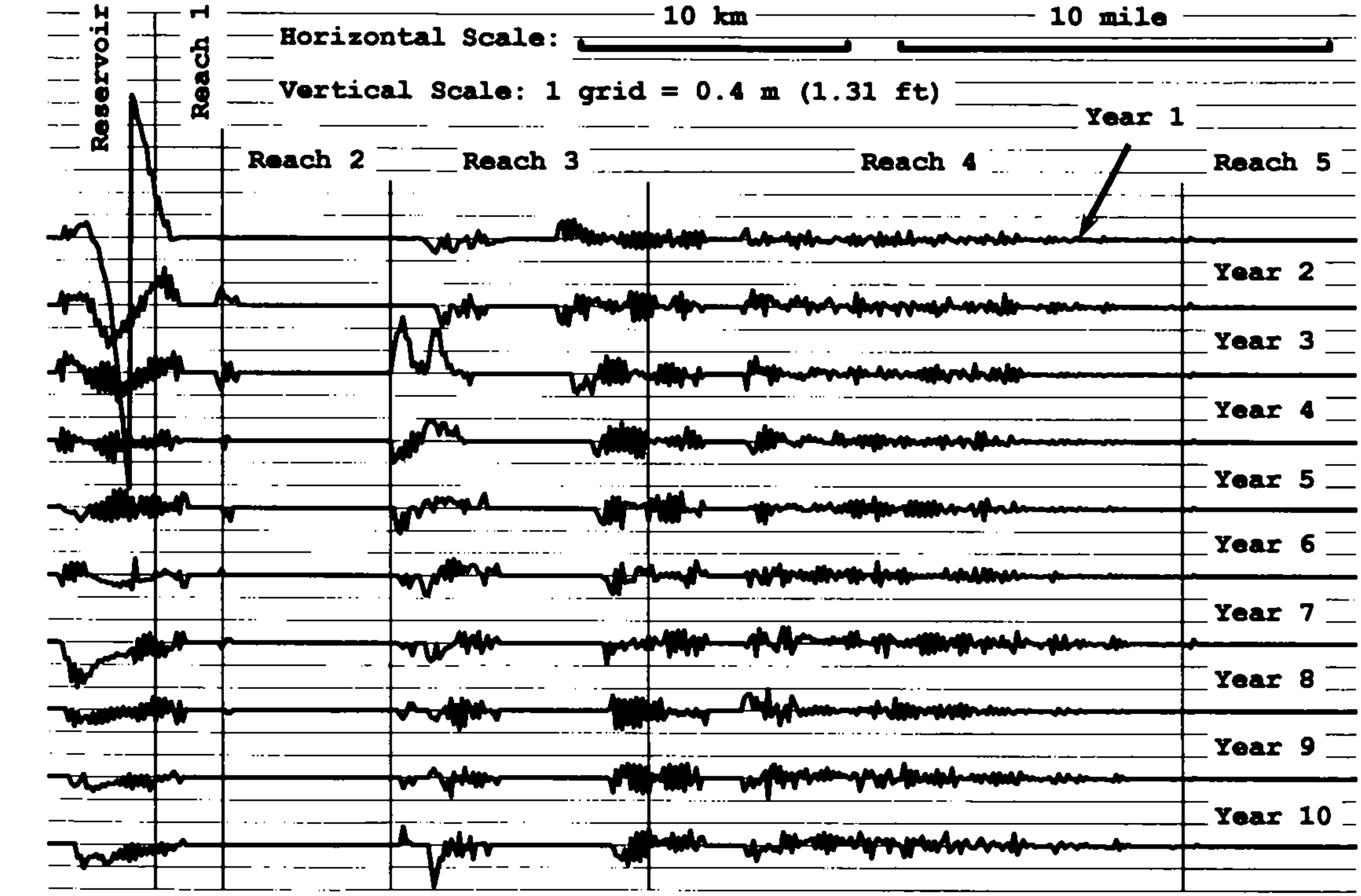

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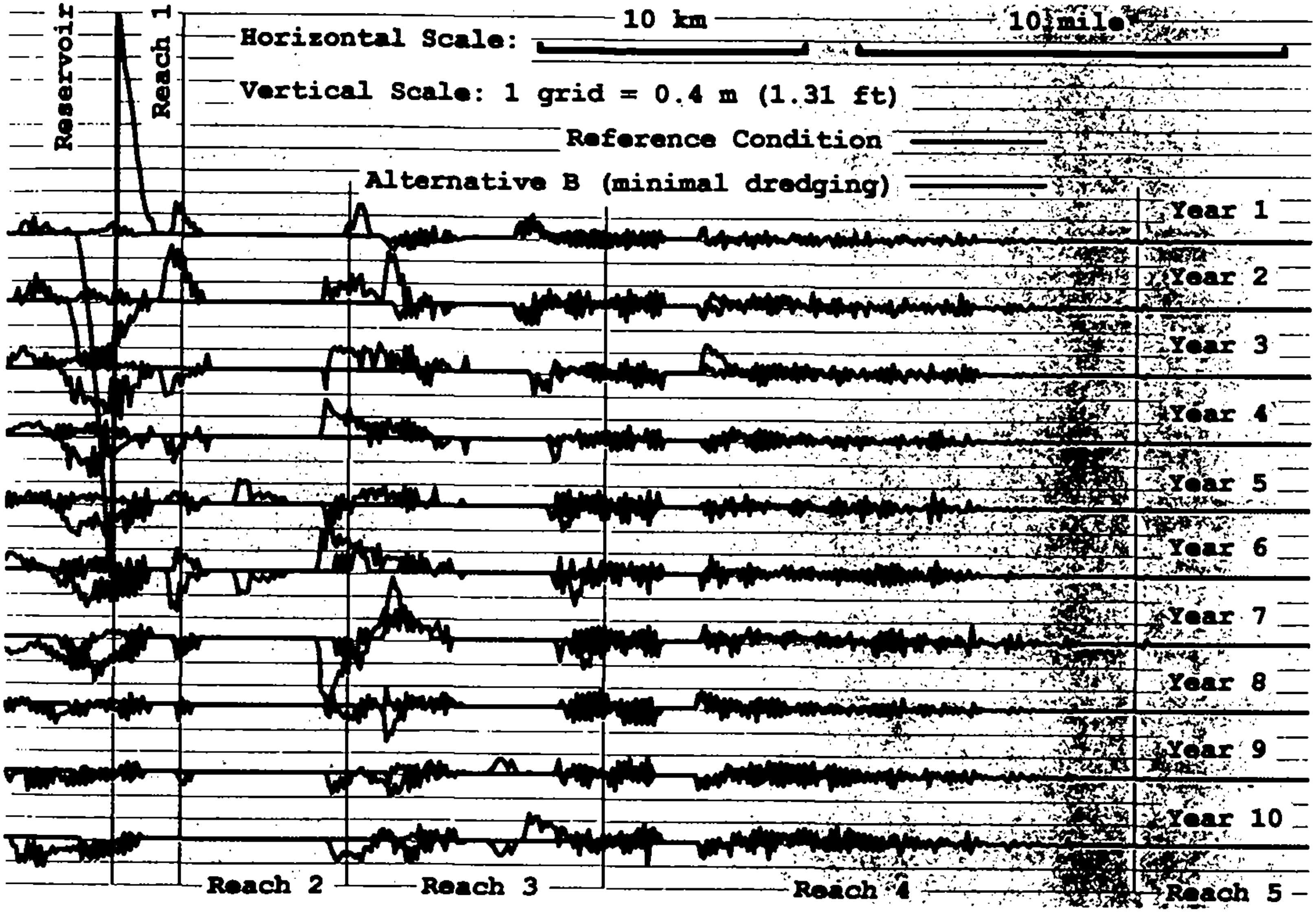

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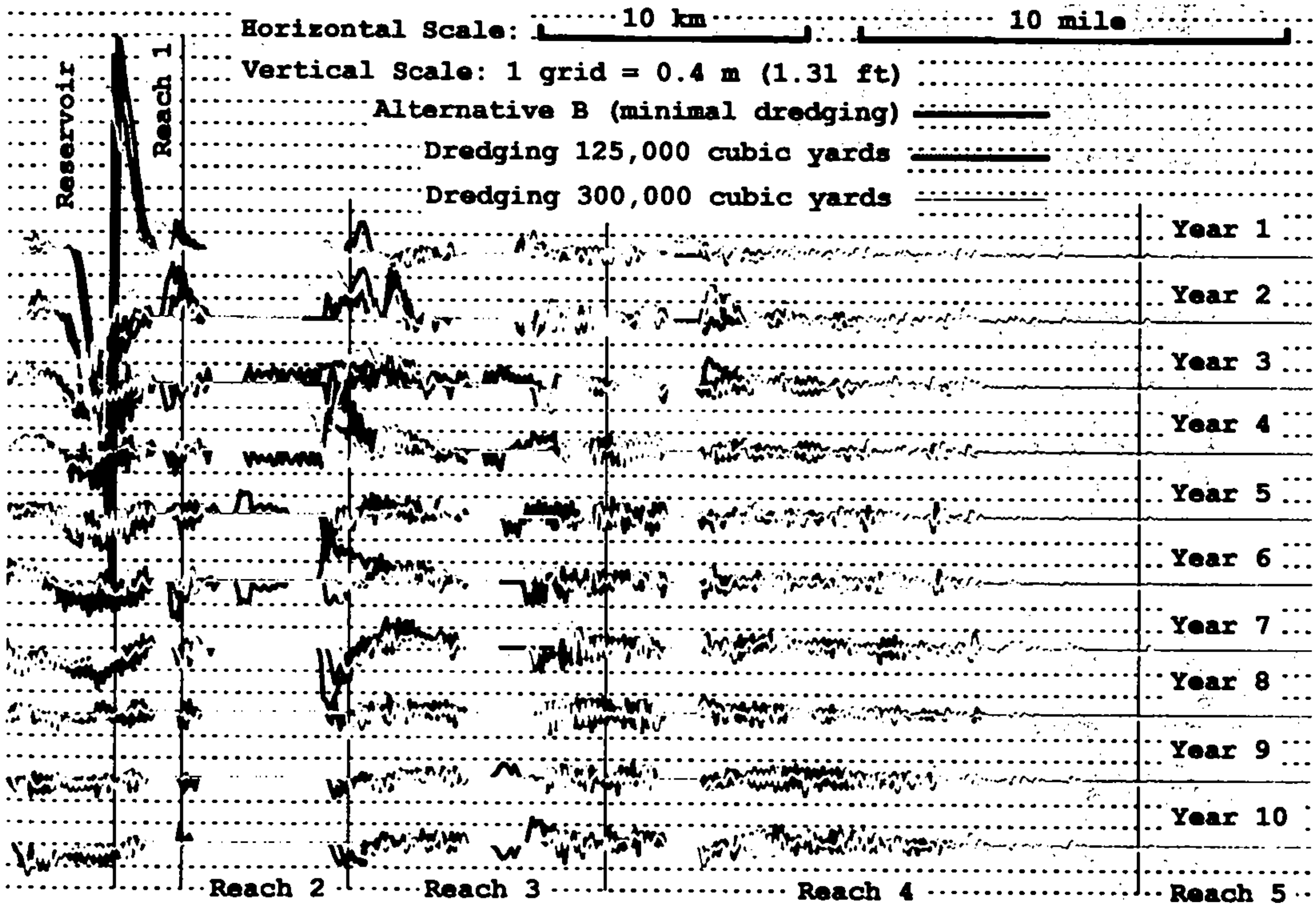

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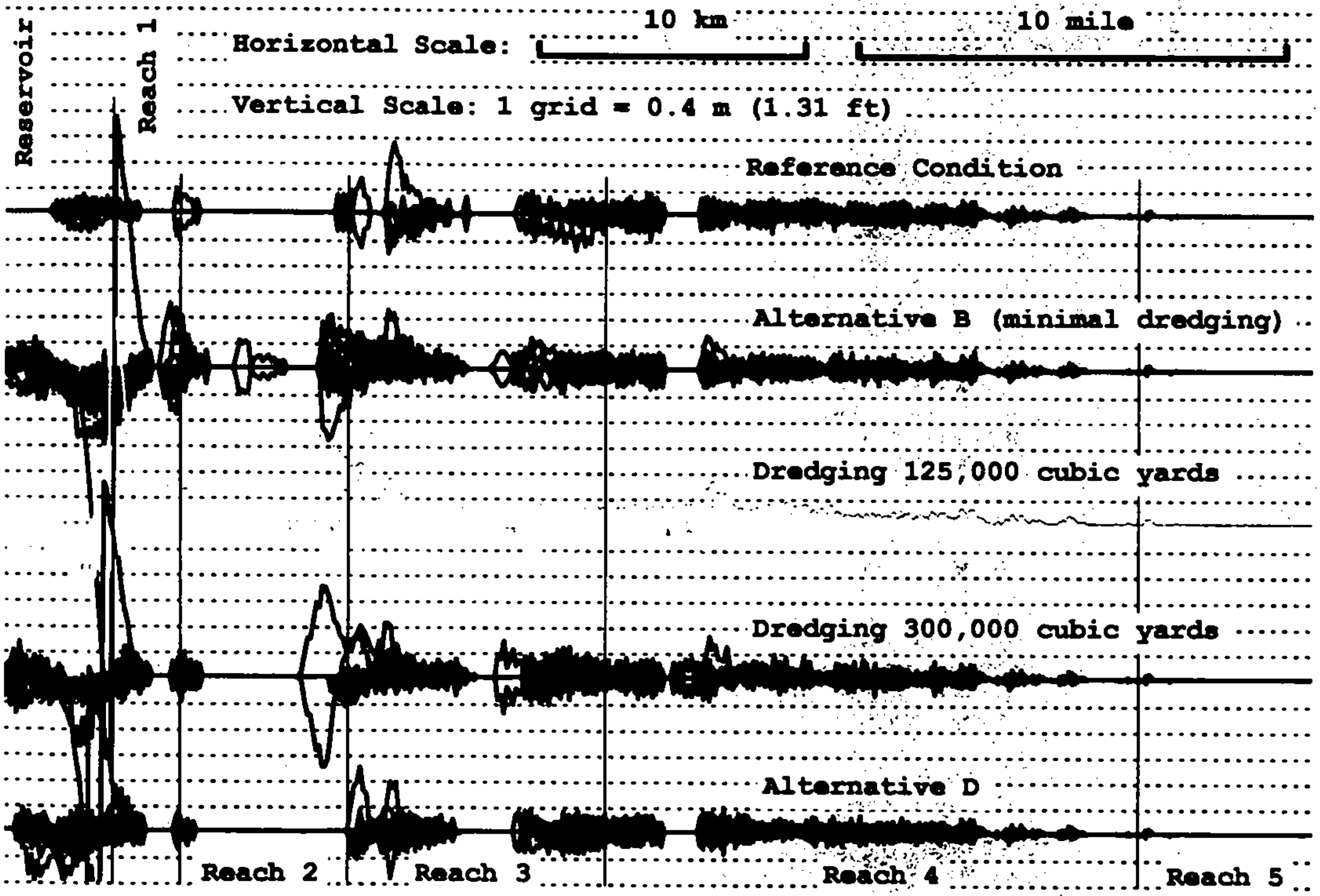

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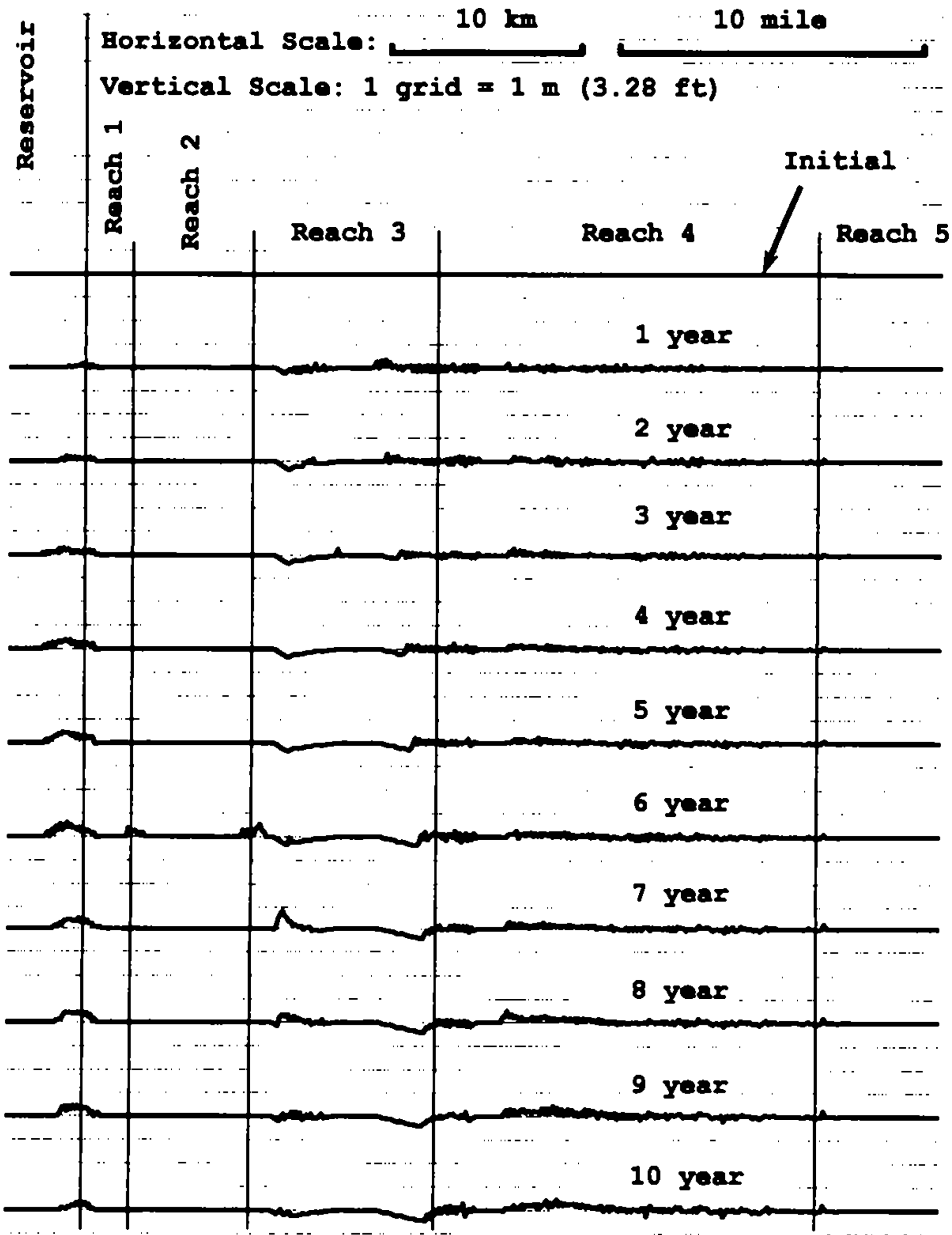

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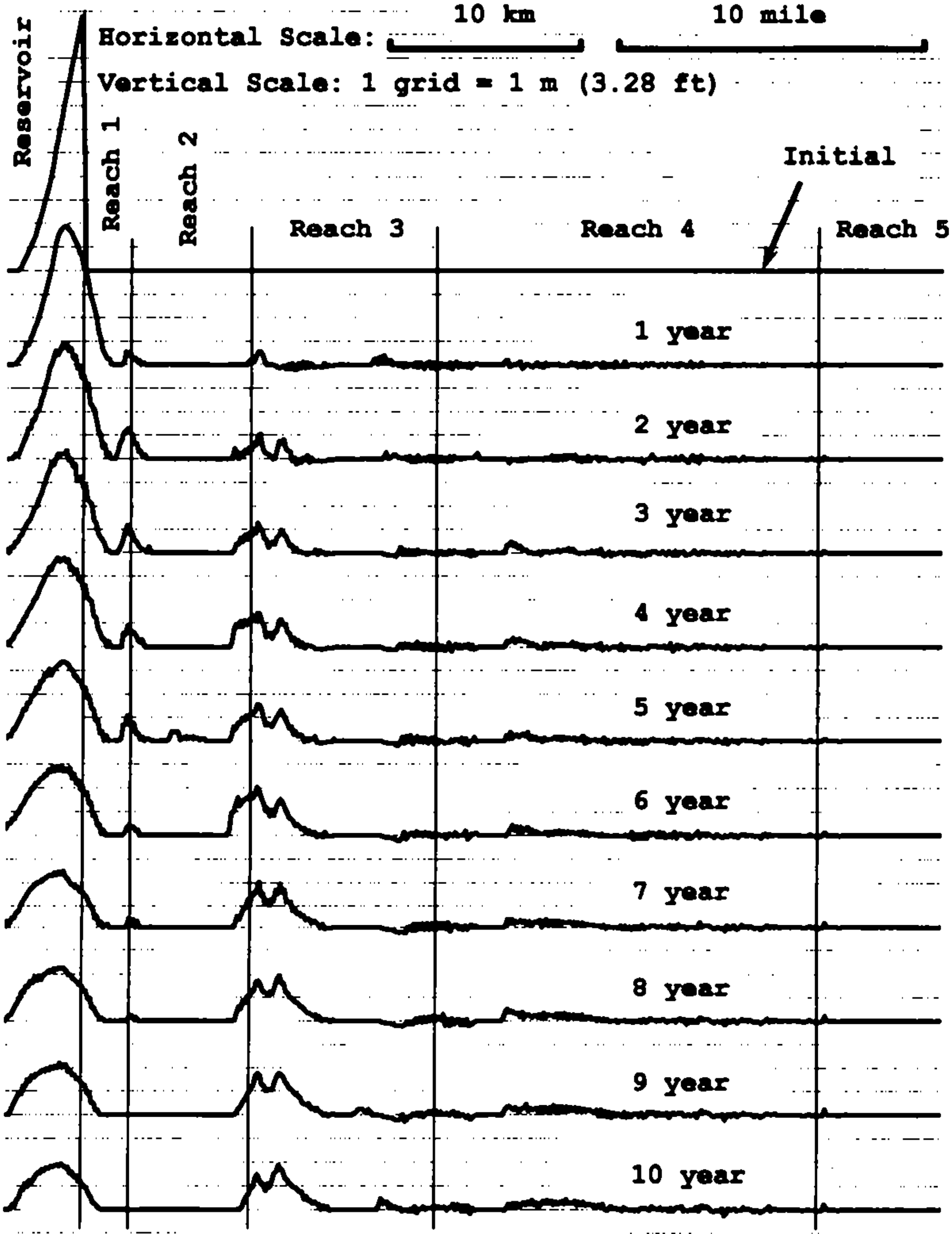

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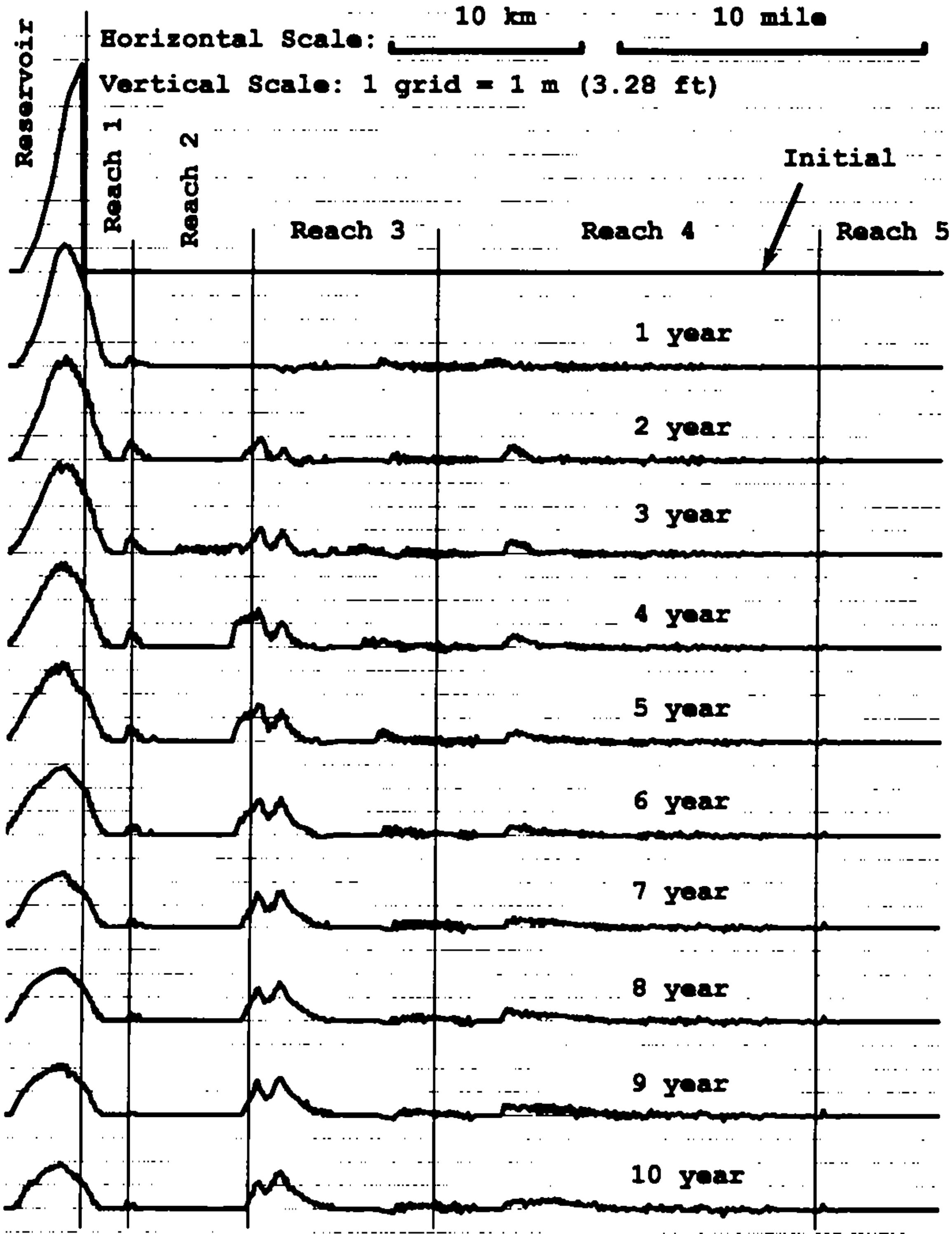

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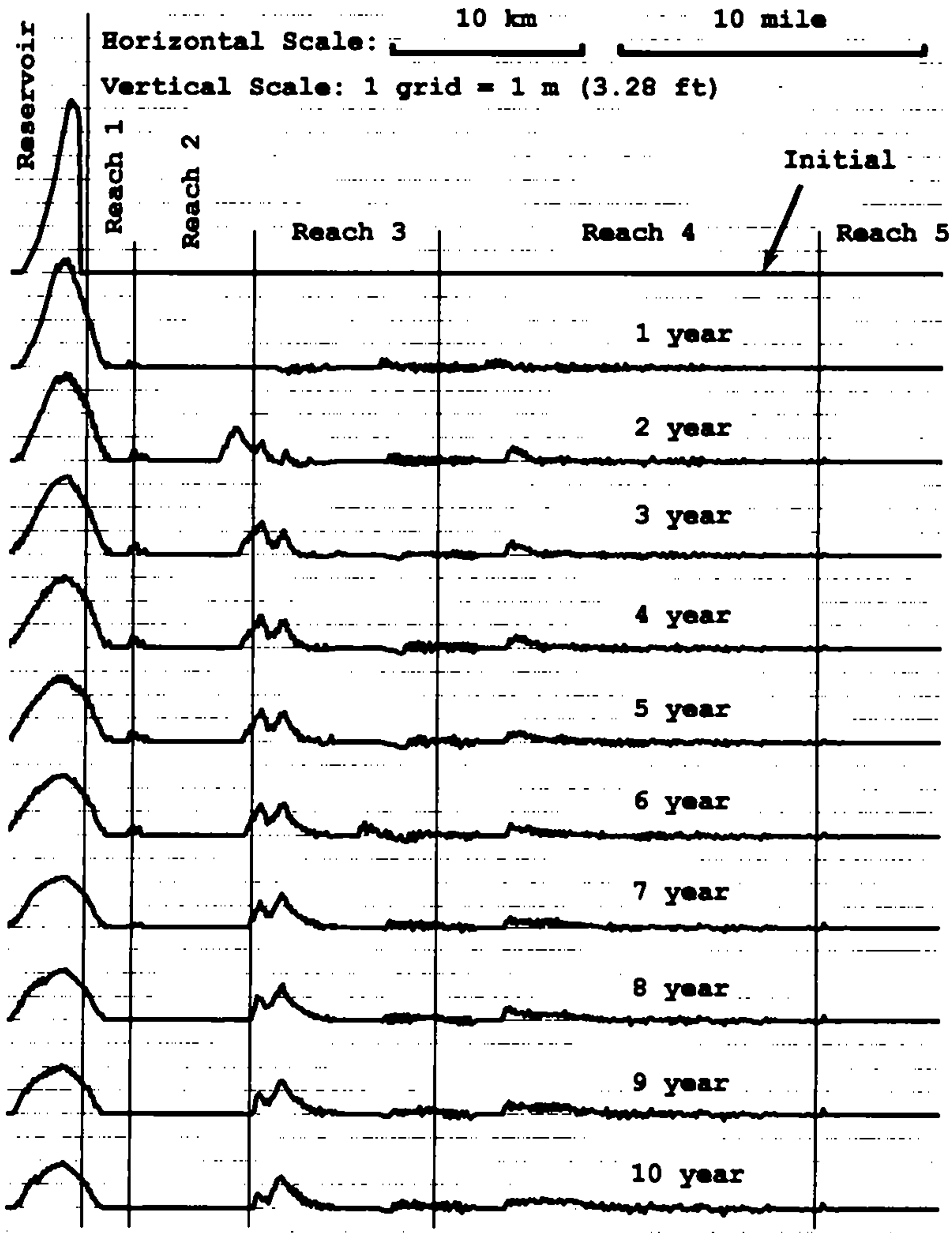

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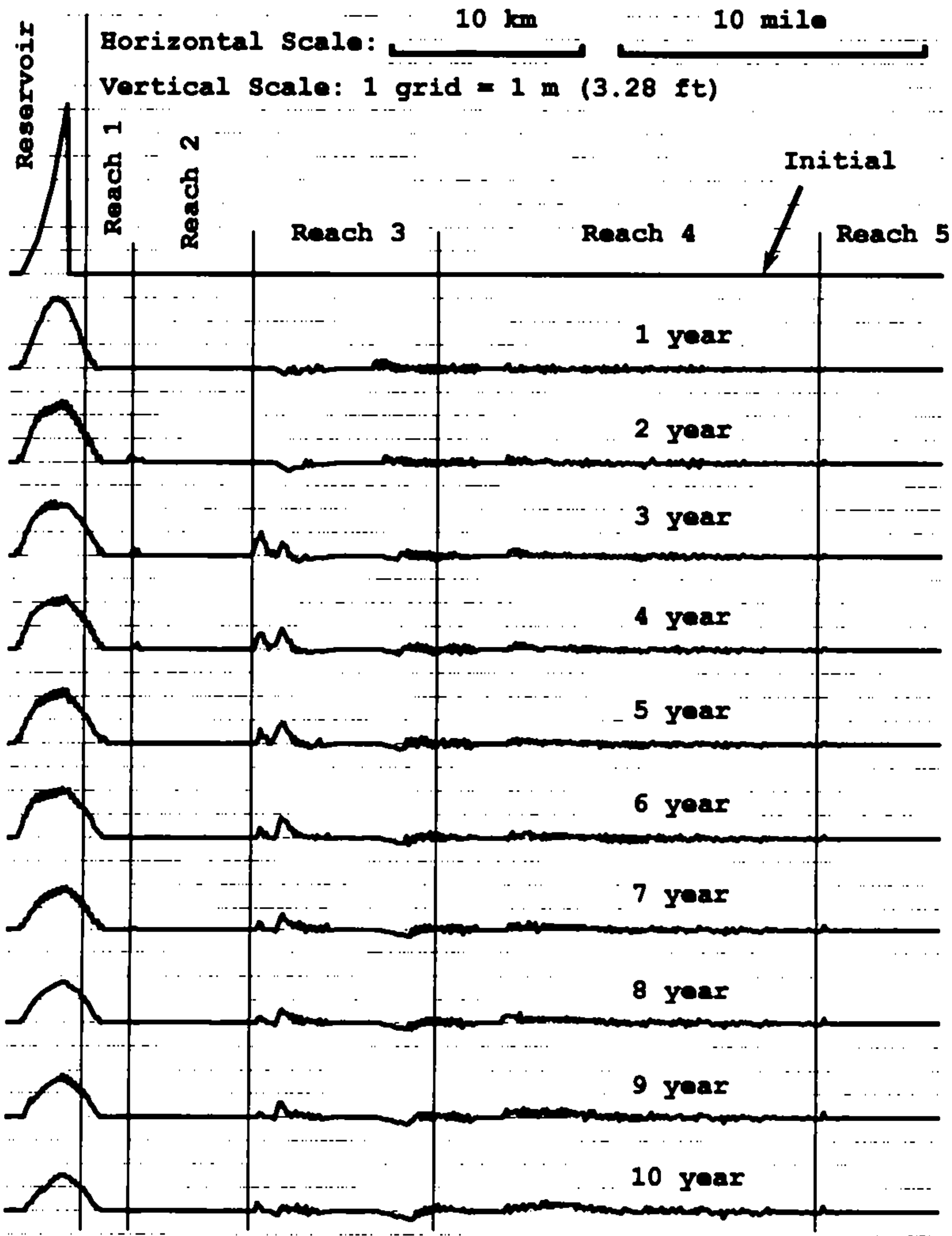

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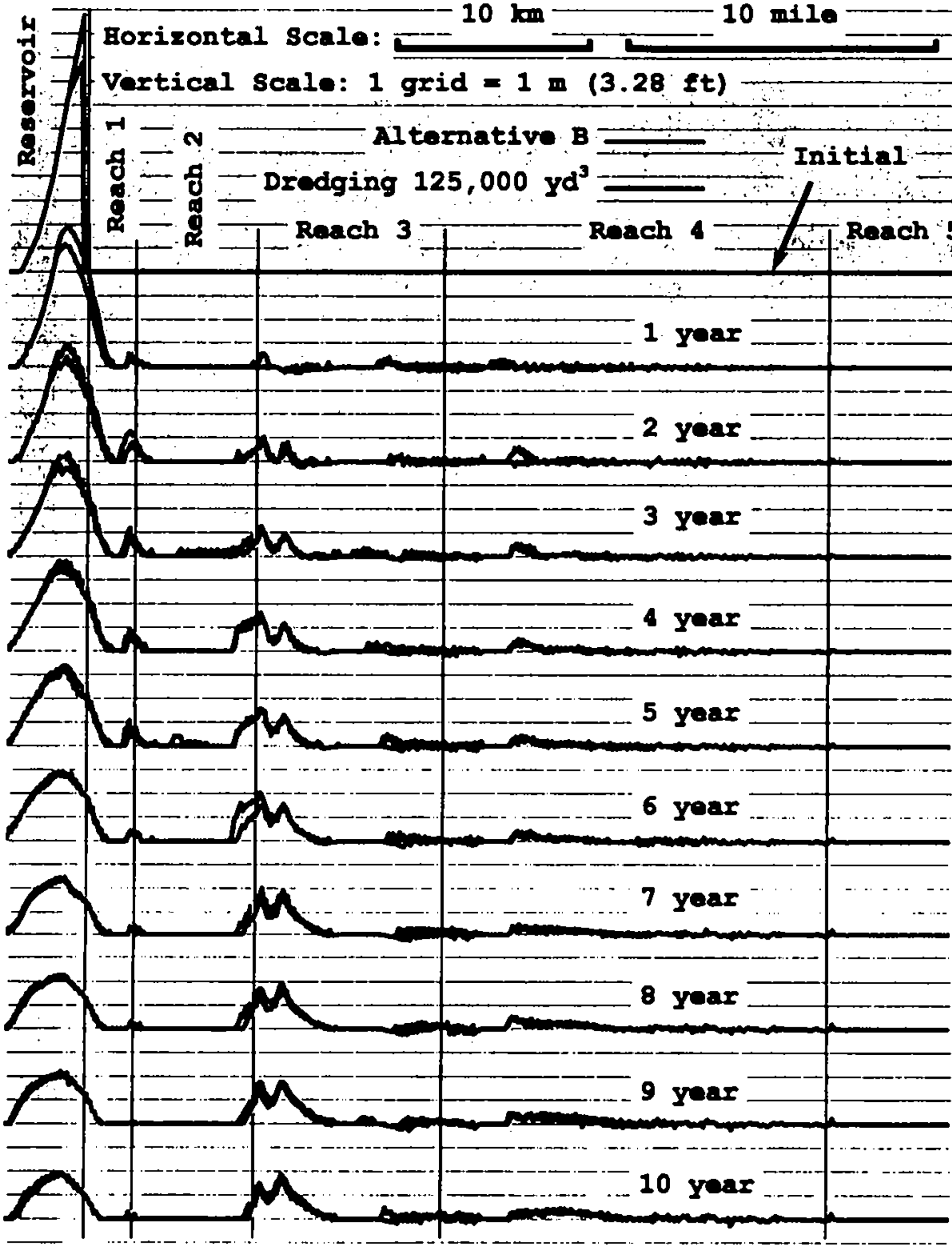

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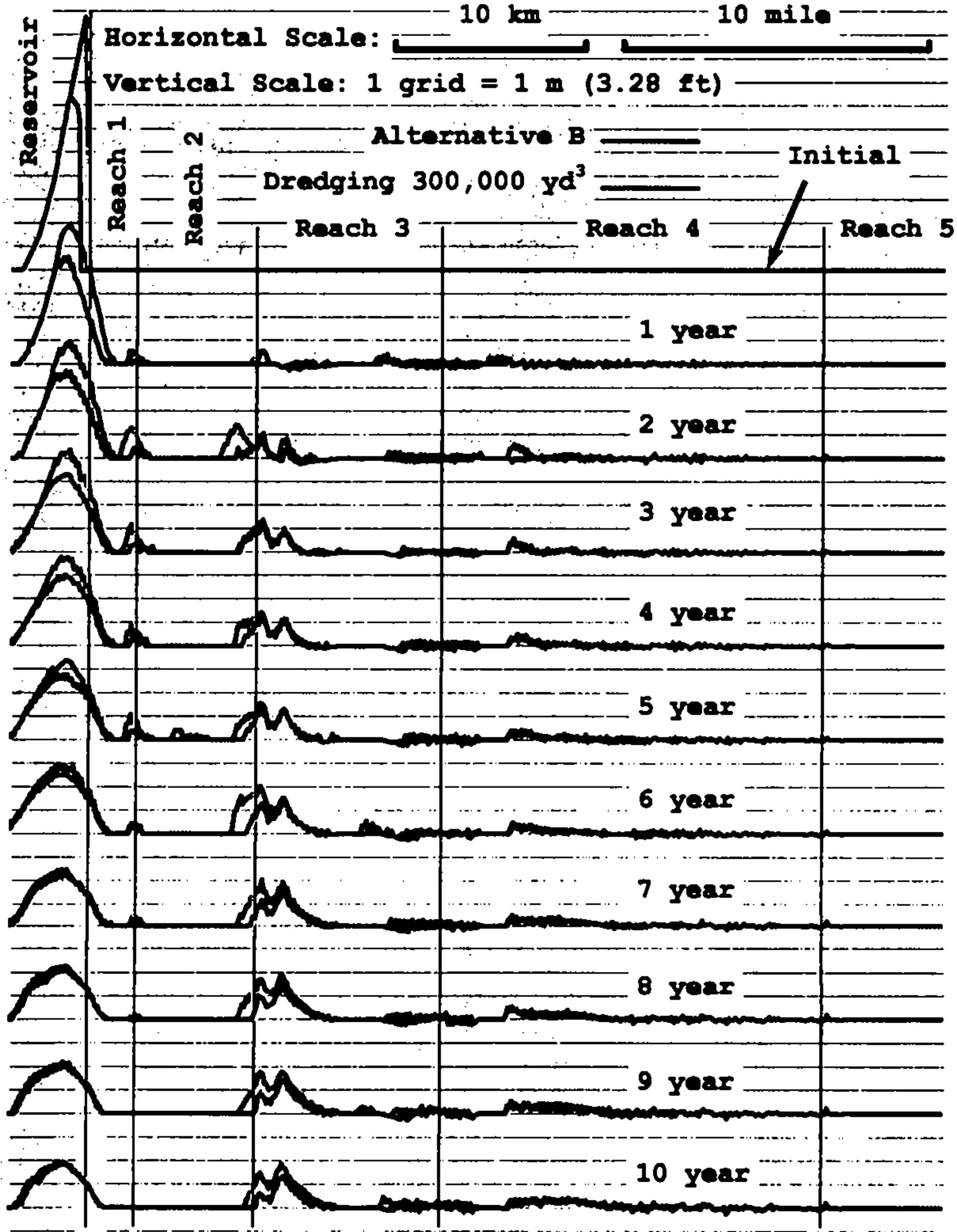

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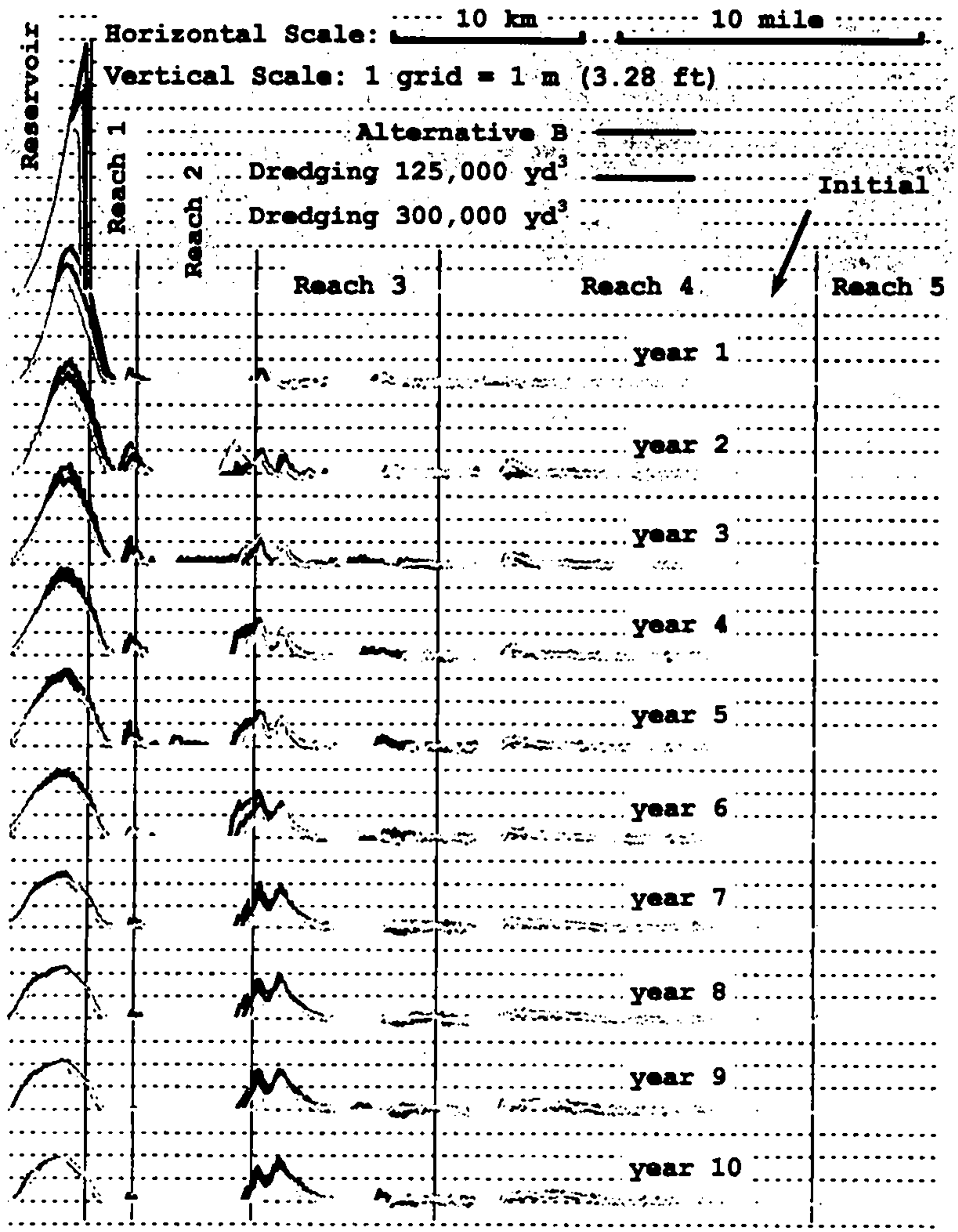

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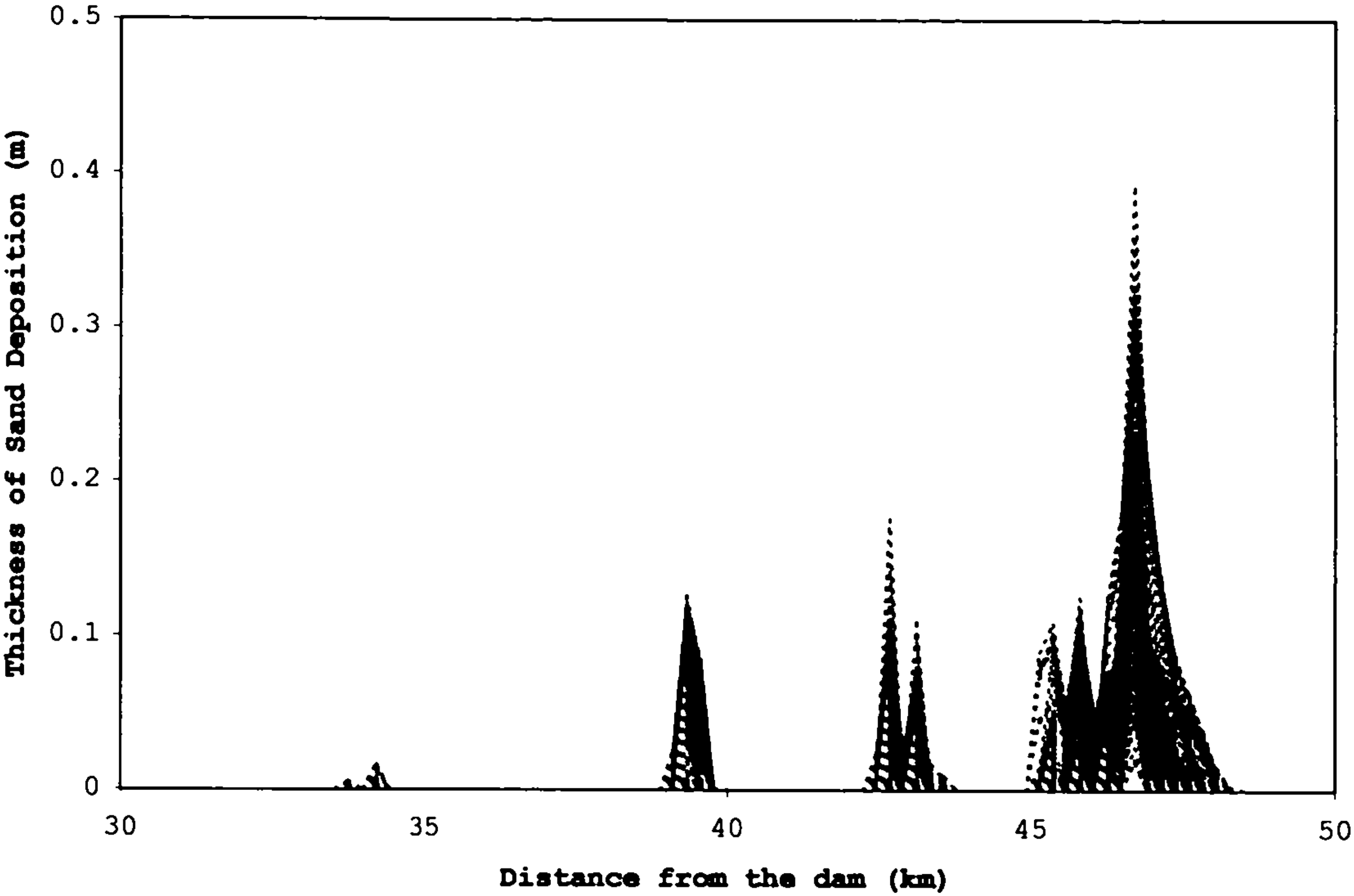

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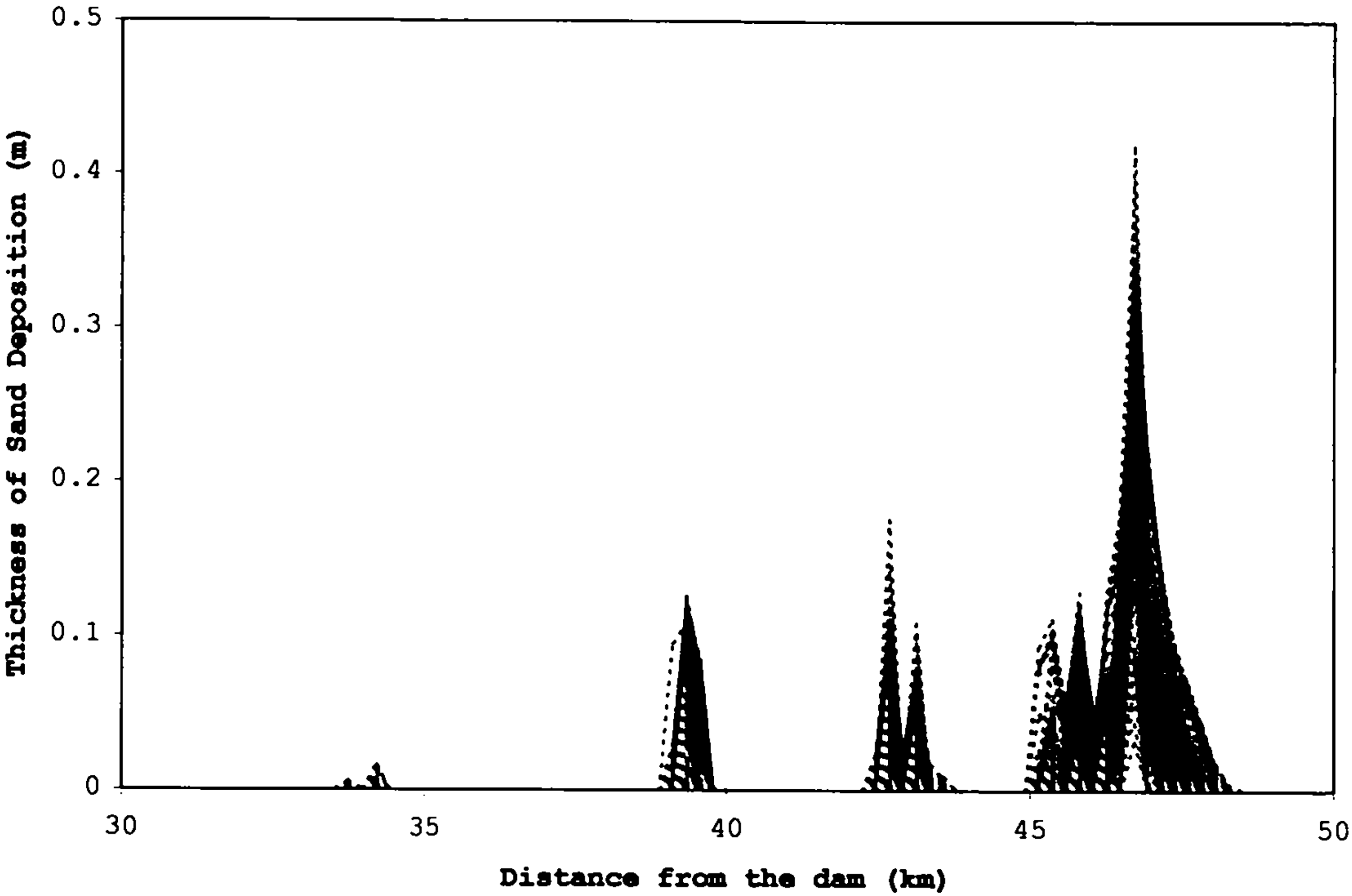

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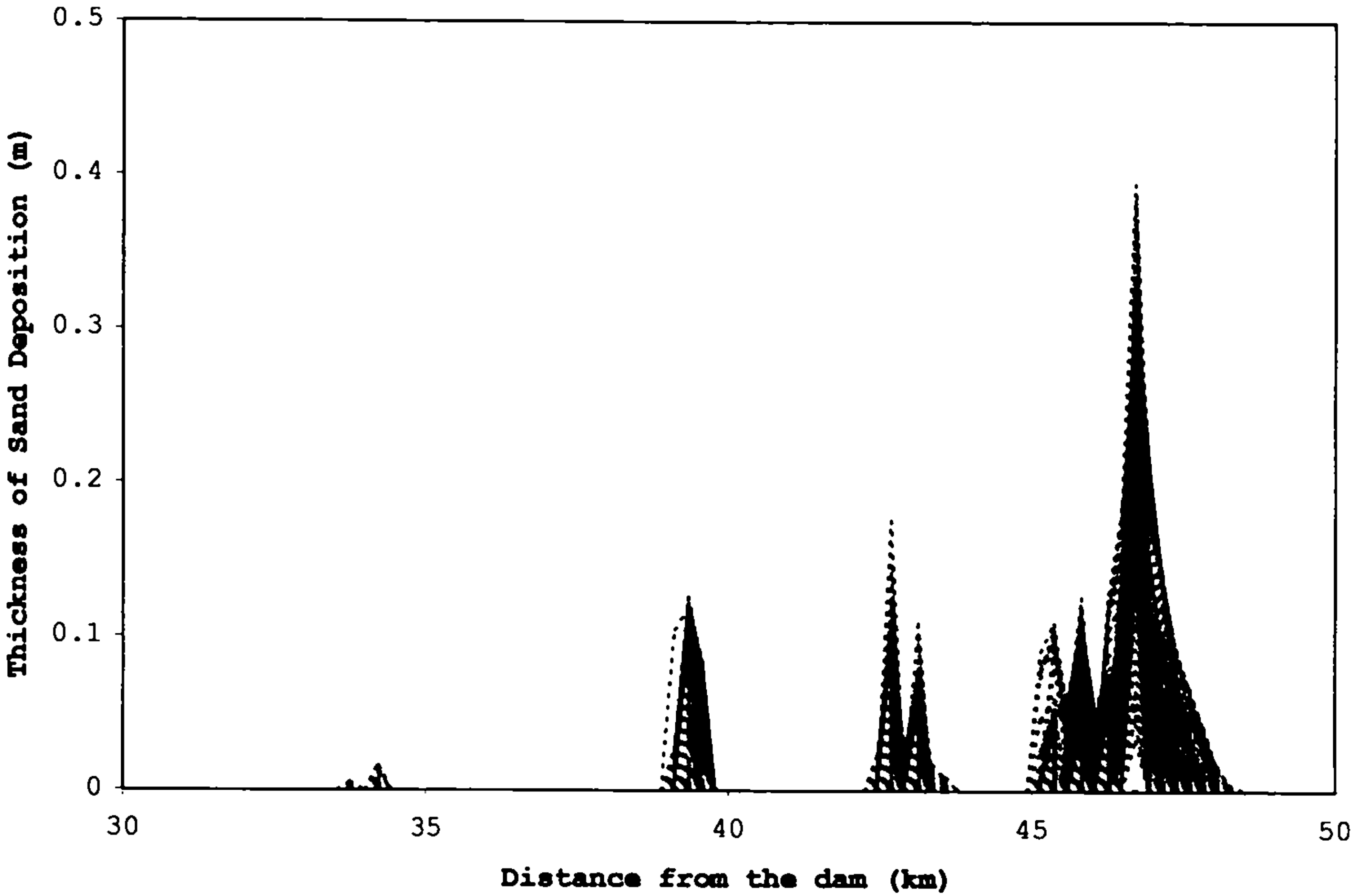

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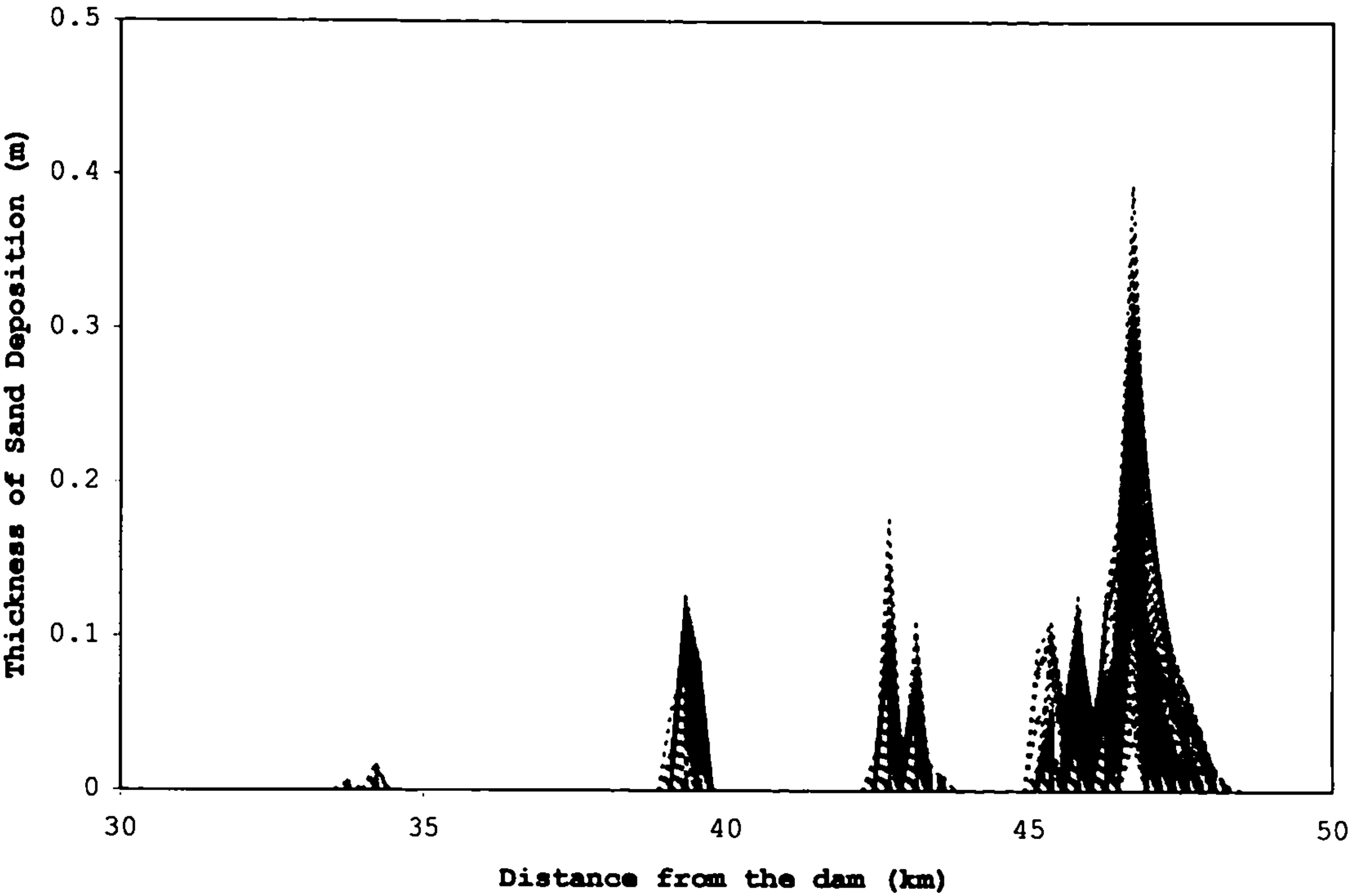

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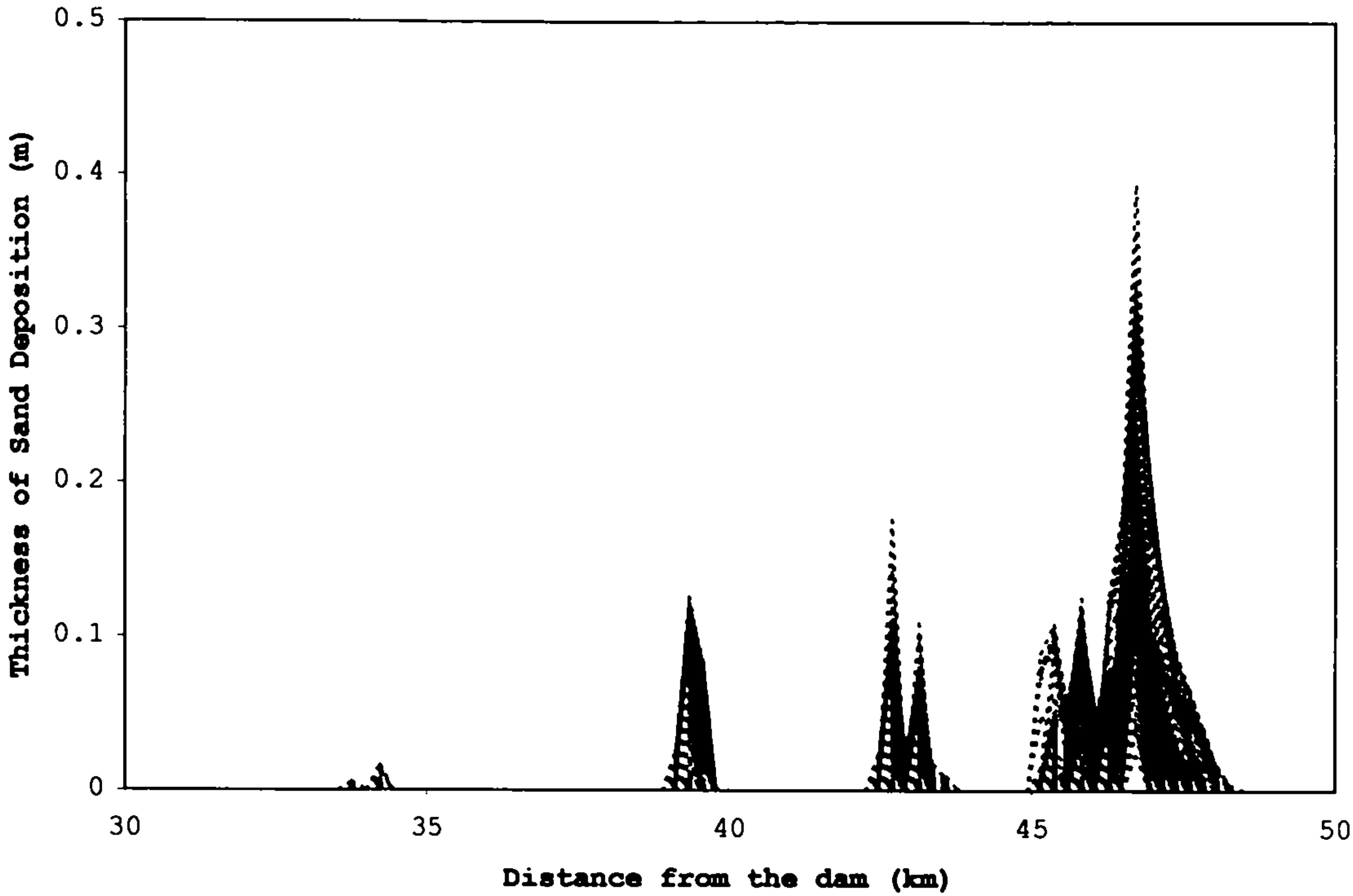

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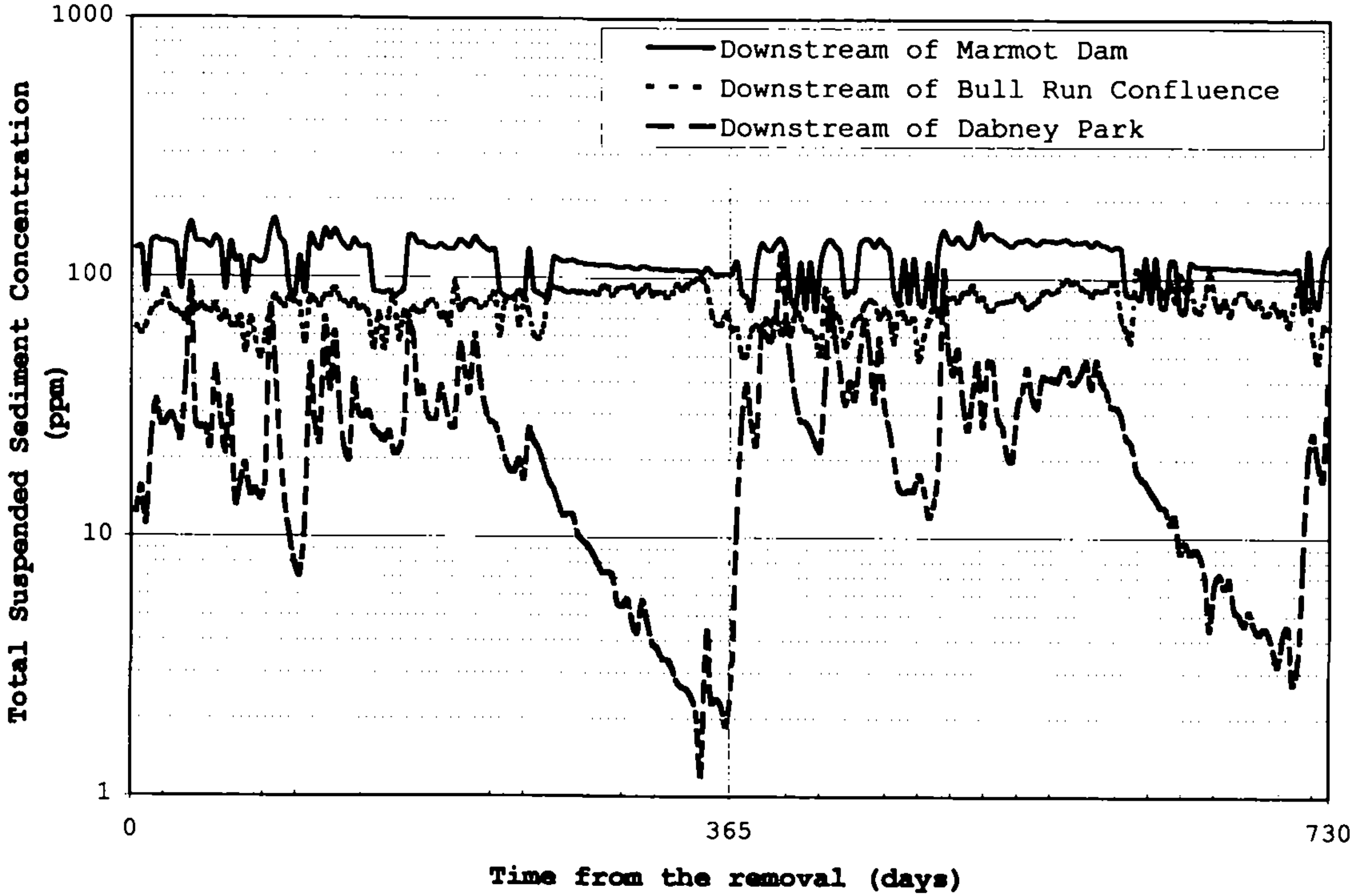

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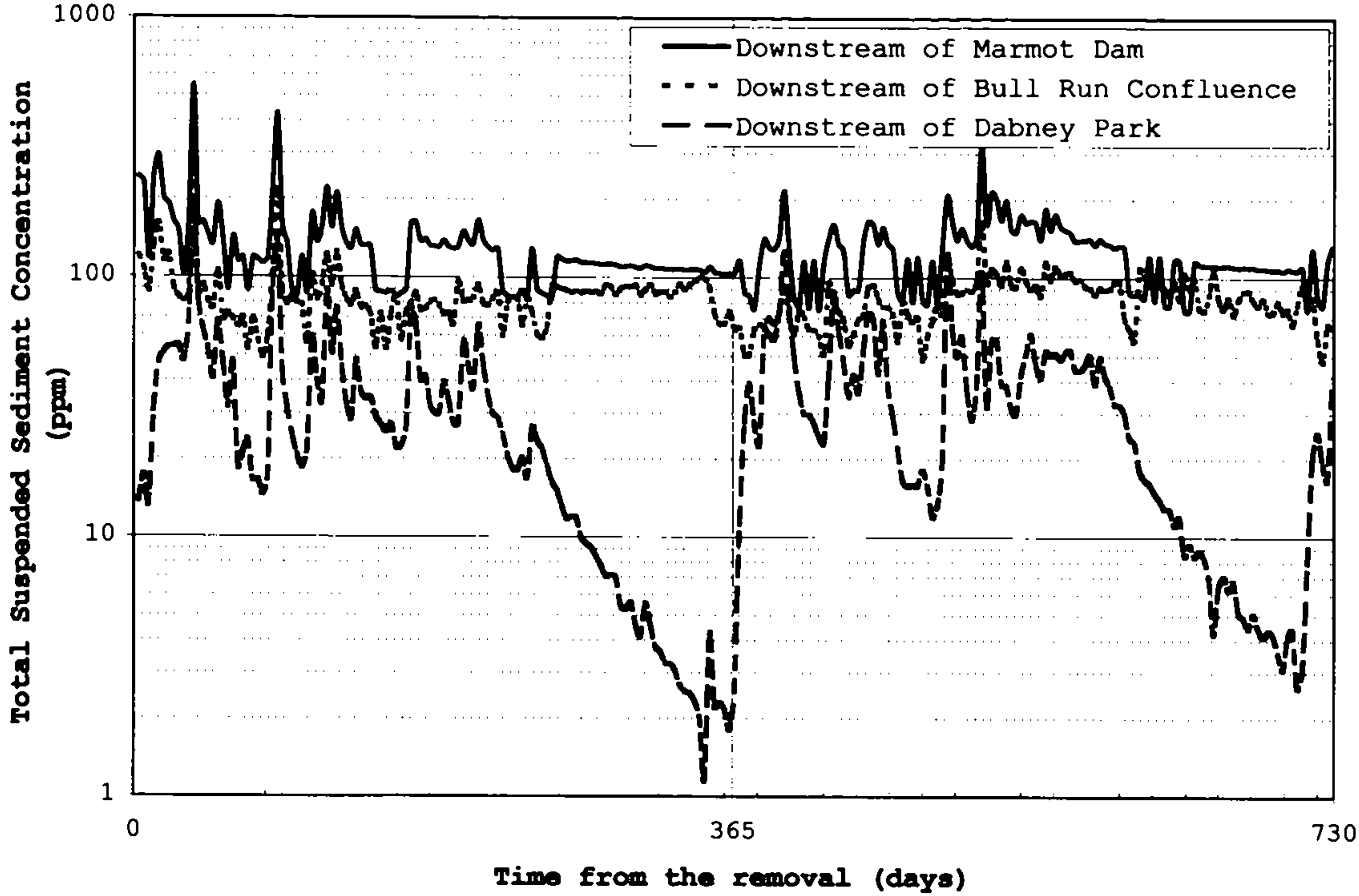

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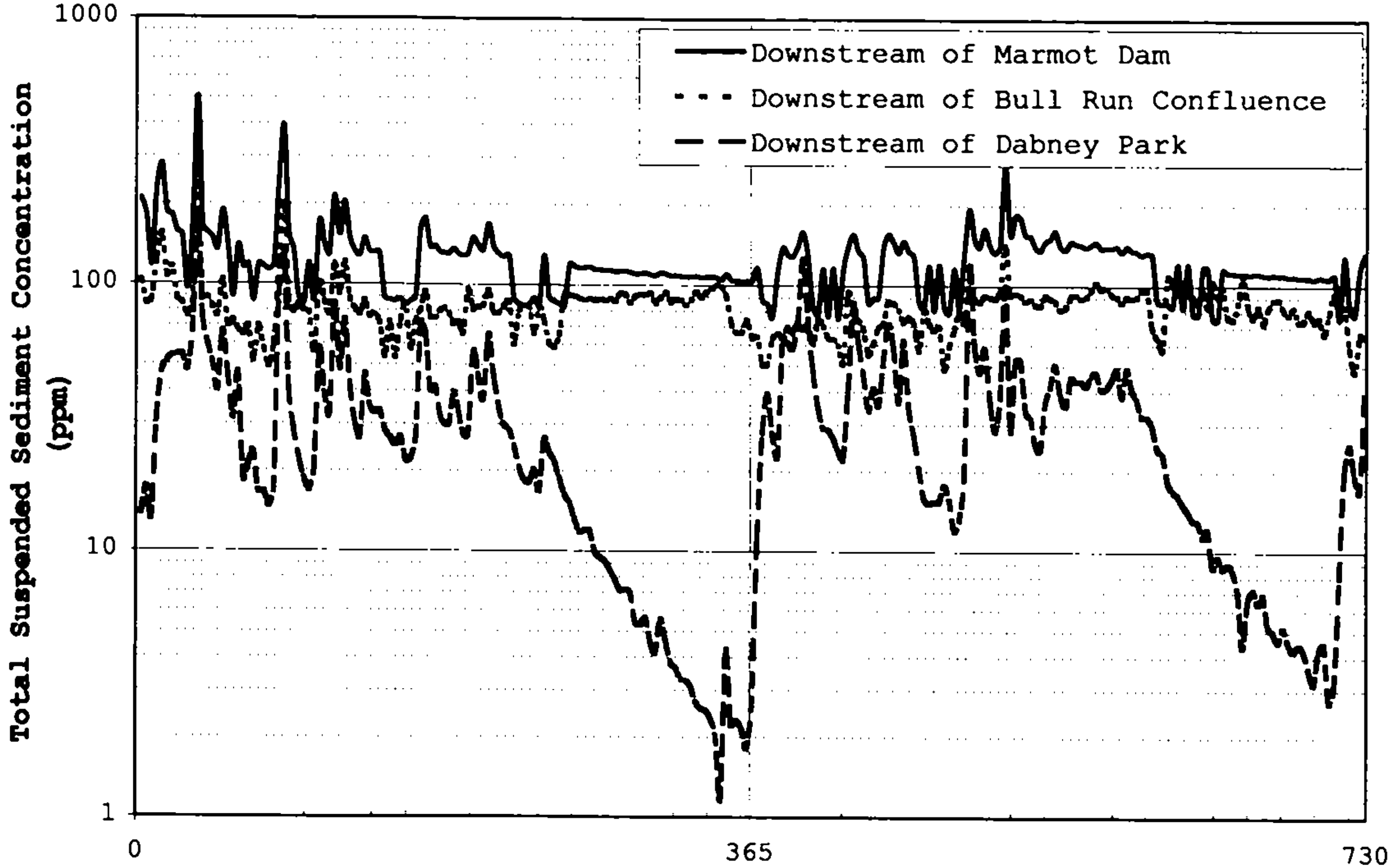

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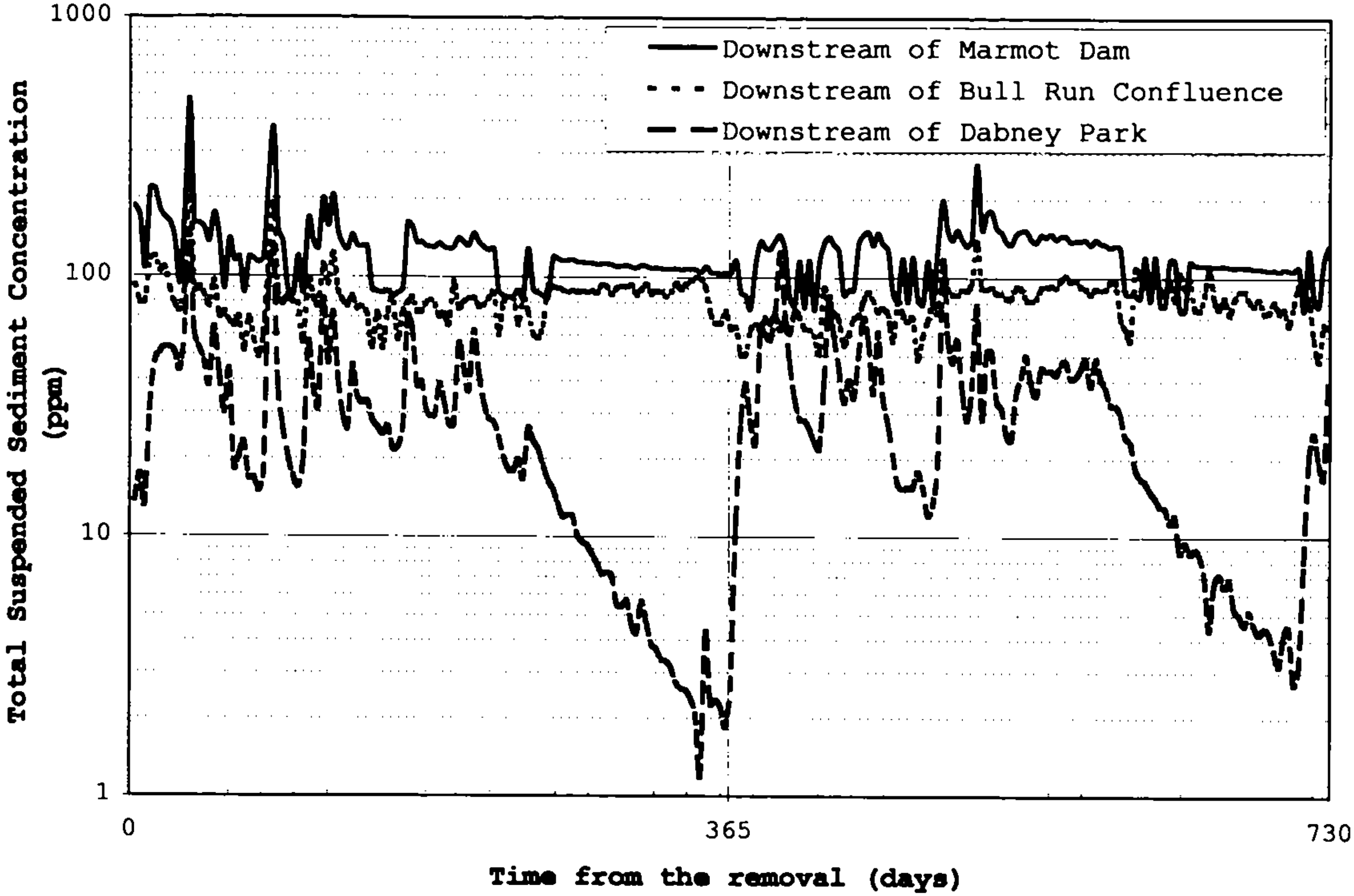

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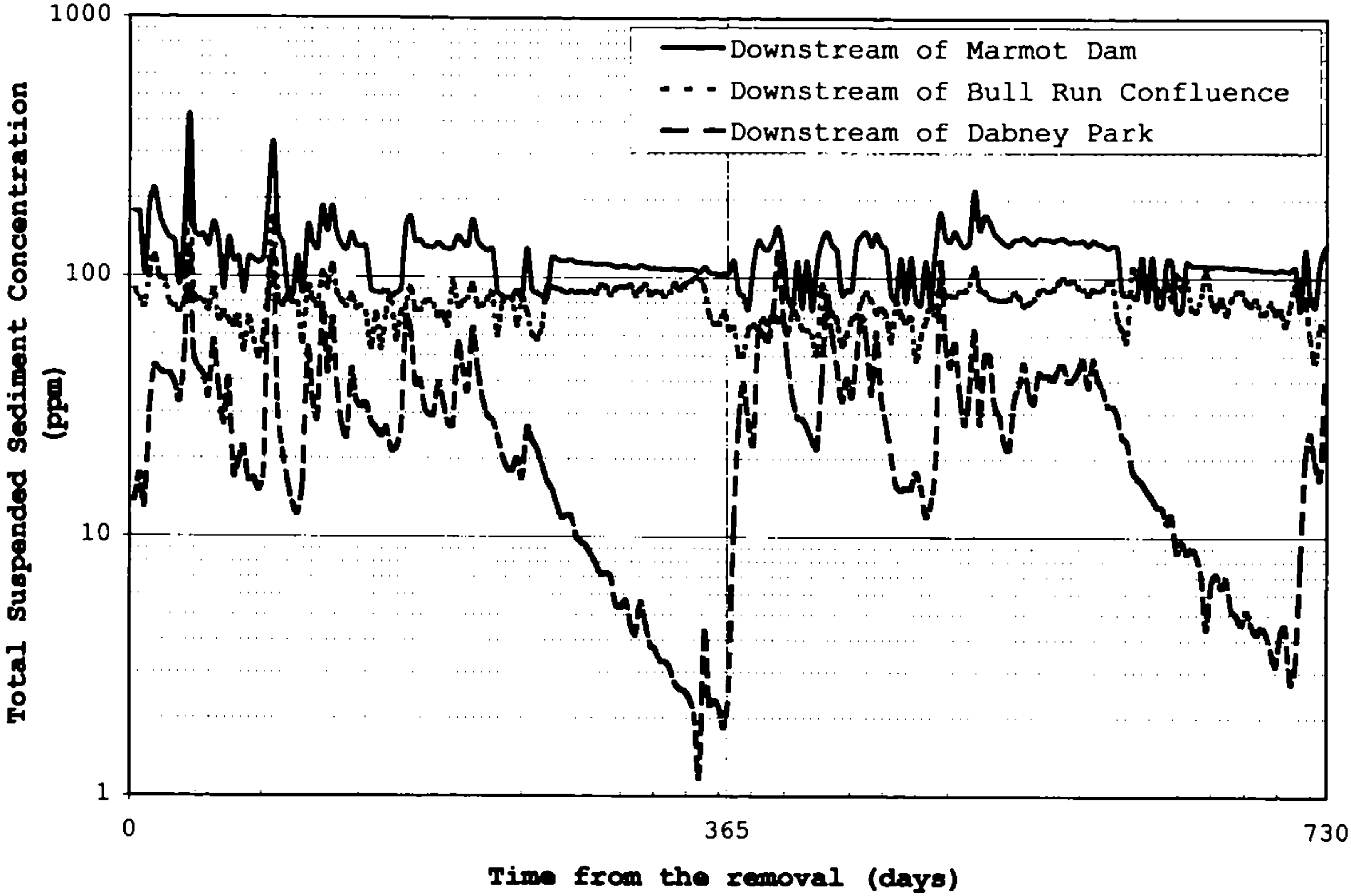

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SALMON AND STEELHEAD RUNS AND RELATED EVENTS OF THE SANDY RIVER BASIN – A HISTORICAL PERSPECTIVE

Prepared for Portland General Electric
Written by Barbara Taylor, Independent Consultant
December 1998

FOREWORD...

Over the past 30 years I have had a chance to hike, fish, snorkel, SCUBA, boat and, on many occasions, fly over most of the Sandy and Clackamas rivers. Once you begin to know an area well, some of the most intriguing conversations are with the people who came before you, the "old timers". Invariably these conversations end up on the subject of fish. The knowledge these people have often brings a new perspective to how we got to where we are today. We can only wonder what it was like before today's "old timers".

Salmon and trout populations are molded by the environments of the watersheds from which they come. To understand the fish populations of today, we must examine the historical record of activities in the watershed. Now, as the concern for the future of salmon and trout populations become more critical, thousands of new people are moving into the area. Their historical perspective of these rivers may be only the past few years. As PGE prepares to relicense its hydroelectric projects on the Sandy and Clackamas rivers, there is an opportunity to compile the historical record related to fish. This should help us all have a common understanding of how the fish populations in these two rivers have evolved to where they are today.

I did not know Barbara before this project, and she did not know the Sandy or Clackamas rivers, which is probably good as she started with no preconceived notions. It has been exciting to see the new information she has found. This was a difficult job as she had to be part detective; the information from the last 100+ years is scattered in various libraries, museums, file cabinets and memories. Sometimes she was frustrated, knowing there had to be more hard information out there, but was unable to find it. Thank you, Barbara, for a job well done.

One thing that we humans seem to do well is manipulate and modify our environment to suit our current needs. Hopefully, as we review our history we can identify pathways for the future that provide for the fish as well as for us.

—Doug Cramer
PGE Biologist

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EXECUTIVE SUMMARY

The Sandy River, stretching from the flanks of Mt. Hood to the Columbia River, has attracted crowds of anglers and picnickers to its banks for more than 100 years. Fishing for spring chinook on the lower Sandy became popular during the late 1800s. More people came in the early 1900s as railroad and road development brought the banks of the scenic lower river within reach of area residents. On warm summer days in the mid-1920s, the railroad often carried hundreds of visitors from the nearby Portland area to picnic along the river's sandy shores, such as at Dodge Park. Visitors also came to fish for steelhead, trout and, at one time, the smelt that returned in large numbers to the river's mouth.

For centuries before these people arrived, the Sandy River Basin supported large runs of salmon and steelhead. Contained by pristine forests and gathering a seemingly endless supply of snowmelt and rainfall, most of its rivers ran cool and steady year-round (ODFW 1997). Fish thrived in its long shallow rapids and deep pools. Historically, the runs ranged as high as 15,000 coho, 20,000 winter steelhead, 10,000 fall chinook and 8,000 to 10,000 spring chinook (Mattson 1955). A small run of chum salmon also returned to the lower river.

Today, the Sandy continues to attract many visitors to fish along its banks or watch spawning fall chinook at Oxbow Park; however, the basin's anadromous fish runs are not what they once were. Salmon and steelhead, except for chum, still return to the river — but the runs have fallen far below historic levels. Comparisons of records from an old hatchery within the Salmon River watershed, along with recent spawning surveys in the Salmon and Zigzag watersheds, suggest that current adult returns are only 10 to 25 percent of 1890 levels, which were already reduced by decades of heavy fishing (USFS 1996). In addition, hatchery-reared fish now dominate the runs.

In many ways, the decline of these runs has been linked to a steady, rapid growth of activity over the last 150 years and a subsequent demand for more timber, water, power, salmon and other resources. The runs began declining in the mid-1800s, primarily due to overharvest by fisheries in the Columbia River. By the late 1870s the spring chinook run to the Columbia River — the preferred fish at the time — had already started dropping. This decline led fish propagators in the Northwest to experiment with fish culture as a means to improve the runs. In 1887, fish propagators built stations on the Sandy and Salmon rivers to collect eggs for hatchery production. These collections, which persisted in the drainage until the late 1950s, captured many would-be-spawners as brood stock for hatcheries in the Sandy Basin and elsewhere.

Other Sandy River salmon and steelhead were harvested in the commercial fisheries that remained steady on the Columbia River and grew heavy over time on the ocean and Sandy River.

Modification of the watershed's pristine spawning and rearing conditions also reduced salmon and steelhead production. During the late 1800s, the booming population of the Willamette Valley and Portland metropolitan area turned toward the Cascades to provide for its growing needs. Logging companies cut large amounts of timber in lower, more accessible parts of the watershed and moved upstream as new roads and railroads permitted access to upper basin forests. Early settlers also removed instream logs and reshaped stream channels to ease the driving of timber downstream to mills or markets and mined lower stream reaches for sand and gravel. Other settlers cultivated the basin's fertile lowlands and plateaus for agricultural production.

Construction and operation of several dams in the basin during the early 1900s further tested the strength of the basin's fish runs. In 1912 and 1913, hydroelectric companies began operating two dams in the Sandy watershed to help meet the region's growing energy demands. They completed the Bull Run project in 1912, which included a powerhouse on the Bull Run River at river mile (RM) 1.5 and a diversion dam on the Little Sandy River (RM 1.7), a lower Bull Run tributary. While the powerhouse created little or no problems for fish passage, the diversion dam on the Little Sandy blocked fish passage to about 6.5 miles of habitat in the upper Little Sandy drainage and reduced production between the dam and the river's mouth. Hydro-related impacts on the basin's fish runs intensified the next year after completion of Marmot Dam on the Sandy River (RM 30). The dam included a fish ladder, but it was usually blocked to capture brood stock for hatchery production. The ladder also suffered repeated flood damage and required regular repair. Additional fish losses occurred when downstream migrating fish were swept into the dam's diversion canal. Streamflow diversions also affected fish migration and production below the dam for many years.

More habitat was lost in 1922 when the city of Portland built Headworks Dam on the Bull Run River (RM 6). While the Bull Run drainage had been earmarked in 1892 to provide high quality drinking water for Portland — and a small dam had existed on the river since 1895 — fish are believed to have continued migrating into the upper drainage until blocked by Headworks Dam. The dam, 22 feet high, stopped all fish migration to the upper Bull Run. In addition, the City began diverting large quantities of water from the river, significantly affecting fish production in the lower river.

By the late 1940s, the historically abundant runs of salmon and steelhead no longer returned to the Sandy River Basin. Spring chinook escapement to the main Sandy River and tributaries is believed to have dropped to no more than 1,500 adults. The coho salmon run had declined to about 2,000-3,000 adult fish and winter steelhead escapement to areas above Marmot Dam had dropped to about 2,200 fish (Mattson 1955). Fall chinook production had also fallen.

Several developments after 1950 influenced efforts to rebuild the runs. Some developments — such as improving fish passage at the Marmot Dam, maintaining minimum streamflows in the lower Sandy River, reducing egg takes, and tightening regulations for fishing and habitat disturbing activities — enhanced salmon and steelhead production and survival. Other developments — such as escalating road construction and timber harvest in the upper basin, stream mining, and channelization of the Sandy and several major tributaries following the flood of 1964 — caused new hardship. Fish managers also started releasing more hatchery fish in the basin at this time to supplement declining native stocks and support fisheries, including a new summer steelhead fishery.

Today, large numbers of winter steelhead, spring and fall chinook, coho and summer steelhead still return to the Sandy River. However, the proportion of native fish in these runs has dropped considerably over the years. Consequently, fish and habitat managers and other interested parties are working together to improve native salmon and steelhead production. Such actions, in concert with changes being made at the regional level, should help rebuild the basin's native fish populations in years to come.

INTRODUCTION

This report provides historical information on the Sandy River, focusing primarily on its salmon and steelhead runs. Portland General Electric has developed this information as part of the relicensing effort for its Bull Run hydroelectric project regulated by the Federal Energy Regulatory Commission.

The report looks at events and developments that have shaped conditions in the Sandy River watershed over the years and influenced the basin's salmon and steelhead runs. It gives an overview of physical conditions in the basin, including hydrology characteristics, geography, water quality and other features that have supported healthy fish runs for centuries, and describes human settlement and development within and outside the watershed since the early 1800s. The discussion focuses on activities such as timber harvest, dam development, and fishing, and discusses how these activities affected salmon and steelhead habitat and production.

Further, the report examines changes in salmon and steelhead production from the early 1800s to present times. This discussion is separated into three distinct periods. The first period, which covers salmon and steelhead production before 1900, includes the beginning of commercial fisheries and extensive egg takes for hatchery operations in the basin. The second period, extending from 1900 to 1950, shows changes in fish production over years when hydroelectric operations, municipal water supply development, timber harvest and other activities altered habitat conditions and blocked fish migration to historical habitat areas. The third period, from 1950 to the present, discusses efforts to rebuild salmon and steelhead production in the upper basin and hardships caused by escalating activities in the area.

Information available for this analysis, particularly describing salmon and steelhead runs and human developments in the Sandy River Basin before the middle 1900s, was often sketchy and limited in its scope. The report attempts to link various accounts of events in the basin over the years. As a result, it relies heavily on early records by fish propagators, harvesters and historians to depict the size and health of the runs before fish counts became available. It presents only limited information on coho and steelhead runs as the early reports (and activities) generally focused on chinook salmon, the preferred fish at the time.

THE PHYSICAL SETTING

THE RIVER SYSTEM

High on the west slope of Mt. Hood, the Sandy begins as a small intermittent stream. Gathering rainfall and snowmelt, it winds more than 55 miles toward the northwest where it joins the Columbia River. Its watershed covers an area of about 508 square miles. Major tributaries to the Sandy River include the Zigzag River, Still Creek and Salmon River in the upper basin, and the Bull Run River, Gordon Creek and Beaver Creek in the lower basin (Figure 1).

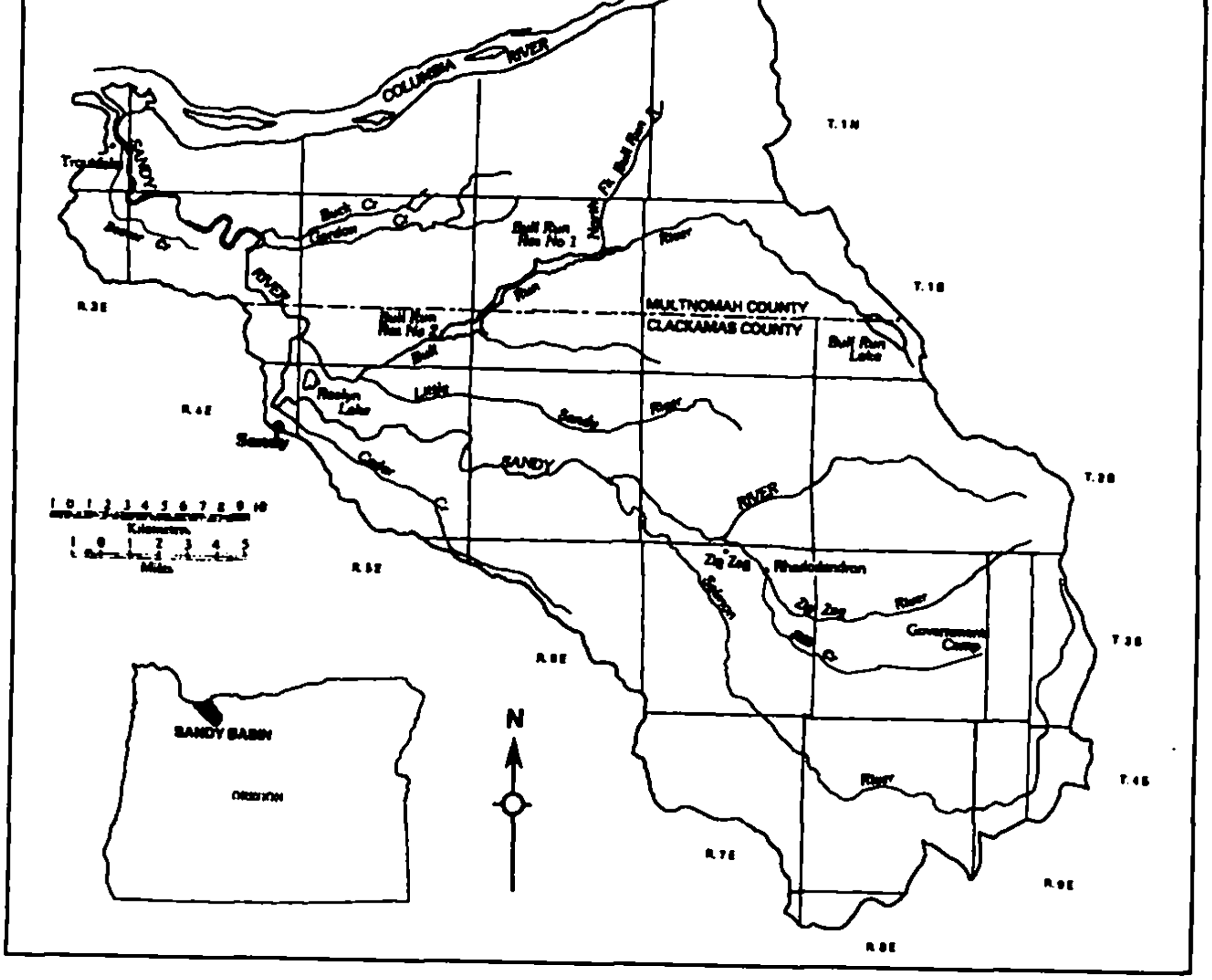
From its headwaters above the treeline at an elevation of about 6,200 feet, the Sandy drops sharply, reaching an elevation of 1,600 feet in the first 13 miles. The river's gradient exceeds 1,000 feet per mile in several places. The upper Sandy River and several tributaries, including the upper Zigzag and Salmon rivers, carve through miles of unstable volcanic ash and rock deposits before reaching less steep ground. Several of these reaches, including the upper Sandy above the Clear Fork, the upper Zigzag River and Clear Creek, have reaches that are too steep for fish production. Waterfalls also obstruct fish migration on the Salmon River above RM 14.

Leaving this steep upper reach, much of which lies within the Mt. Hood Wilderness Area, the Sandy River slows as it crosses a broad flat plain above its confluence with the Zigzag River (RM 43). This part of the glacially-carved upper river valley, known as Old Maid Flats, has been partially filled by past volcanic flows. The area displays soil conditions and vegetation, such as lodgepole pine and edible mushrooms, that are rare elsewhere within the Mt. Hood National Forest. The Sandy River widens below Old Maid Flats and the mouth of the Zigzag River and slows again as it nears Marmot Dam (RM 30) (Figure 2). Soils here are generally unstable, composed of loose alluvial rock and very susceptible to erosion during high flows.

Below Marmot Dam the Sandy enters a five-mile-long scenic narrow gorge with steep canyon walls and constrained chutes. Deep pools in this reach provide good, cool rearing habitat for migrating spring chinook. The river becomes wider below Revenue Bridge (RM 24) and bends between high bluffs that rise more than 200 feet in some areas.

At Dodge Park (RM 18.5) the Sandy merges with the Bull Run River and descends into the rugged and remote Sandy River Gorge. The upper stretch of the gorge displays long steep rapids and large pools contained by high bluffs. Below Indian John Island (RM 15) the river channel begins to meander. This reach of the river, which includes Oxbow Regional Park (RM 13), contains significant fall chinook

Figure 1. Sandy River Basin



spawning and rearing habitat. The Sandy River continues to slowly twist and bend toward Dabney State Park (RM 6). The scenic 12.5-mile reach between Dodge Park and Dabney State Park is designated a federal Wild and Scenic River and a state Scenic Waterway.

Below Dabney Park, the Sandy River again widens as it slowly meanders to its confluence with the Columbia River. This river reach has shifted often over the years during periods of high flow. Much of the reach is now armored with riprap to protect private property and roads. The reach contains many large sand deposits that historically provided spawning habitat for the great schools of smelt that once returned annually to the Sandy River. Nearing its confluence with the Columbia River, the Sandy River becomes shallow as it flows through a large delta of sand and other fine sediments that have accumulated over thousands of years. Flows at the river's mouth are affected by tidal influence from the Columbia River and are believed to provide adequate fish passage even during summer months (ODFW 1997). The Sandy River Delta is part of the Columbia River Gorge Scenic Area.

LAND USE

Forests cover about 78 percent of the Sandy River Basin, including most of the upper and middle watershed. About three-quarters of this forested land is in public ownership and managed as part of the Mt. Hood National Forest. The watershed contains several wilderness areas. These include the Salmon-Huckleberry Wilderness Area (44,600 acres, with one small corner draining a Clackamas River tributary) and the Mt. Hood Wilderness Area (47,160 acres). In addition, the Bull Run River drainage is protected to provide high-quality drinking water for the city of Portland.

Fertile plateaus and rolling hills cover much of the lower watershed. These lands are generally privately owned and support timber, agriculture or residential uses. Above the town of Sandy, most private lands support timber production, Christmas trees and some livestock use. Private forest lands in the basin cover 71,000 acres and stretch from the Sandy River to public forest lands in the middle watershed and east of the Sandy River in the lower watershed. Below the town of Sandy, agricultural uses are common, with widespread nursery stock production on the plateaus east and north of Gresham and south of Troutdale. The hills north of the lower Sandy River also support some agricultural use.

CLIMATE

Climatic patterns in the Sandy drainage vary from alpine conditions to those typically found along the shores of the lower Columbia River. This variation is reflected in precipitation and temperature records for the basin. Annual precipitation ranges from 70 inches near the river's mouth to 110 inches near its headwaters (ODFW 1997). The lower and middle portions of the Sandy River Basin generally experience seasonally mild temperatures and wet winters. At higher elevations, temperatures drop significantly and much of the precipitation falls as snow. For example, in the Bull Run subbasin, it rarely snows at elevations below 2,000 feet, but often accumulates to a depth of 6-10 feet in areas above 4,000 feet. Several glaciers, including the Reid, Zigzag and Sandy glaciers, have developed on the west and northwest slopes of Mt. Hood, which receives up to 300 inches of snow each year. The watershed's middle and lower areas receive more rainfall than snow. Most of the rainfall occurs between November and January.

These variations in temperature and precipitation play a significant role in determining patterns of streamflow. In watersheds with large snow accumulation, flows usually peak in late spring when streams swell with snowmelt. Streamflows in lower elevation watersheds receive mostly rainfall and may peak several times during the winter in response to storm events (USFS 1996).

Samplings of trees covering a large geographic area in the Columbia River Basin suggest that climatic changes may have affected conditions within the Sandy River watershed — and elsewhere in the region — during the late 1800s and early 1900s. Studies show that the region received a higher level of precipitation around 1900. This wet period was followed by a drier climate through the 1920s, 1930s and 1940s. Reconstruction of historic temperatures in the Andrew Forest in Oregon's Central Cascades shows periods of cool temperatures in 1892-1920 and warmer temperatures in 1921-1946 (Lichatowich and Mobrand 1995). Such large-scale climatic changes likely affected the quality of fish habitat in both freshwater and marine environments during 1900-1940 (Lichatowich and Mobrand 1995).

HYDROLOGY

The snows falling on Mount Hood, combined with glacier ice melts, usually maintain good streamflows in the Sandy River all year. The glaciers and heavy snowpack store water over the winter months and supplement flows in the spring and summer. Large groundwater contributions associated with basin size and gains in elevation may also contribute to runoff.

Glacial influence is particularly noticeable in the upper Sandy and several tributaries, including the Salmon, Muddy Fork and Zigzag rivers, which are fed by glacial melt. In these river systems, moderate and low flows are tempered by the glaciers. They are not as "flashy" or quick to respond to runoff.

Streamflows fluctuate more in the lower Sandy, which also collects flows from many lower elevation tributaries, such as the Little Sandy River, that receive more rainfall than snow. As a result, streamflows in the lower Sandy River can range widely between days, particularly during the rainy, mid-winter months. The river typically runs higher from March through May, the spring snowmelt season. Average monthly flows in the Sandy at its confluence with the Bull Run River (RM 18.5), the lowest gauge site on the river, range from a low flow of 377 cfs in September to a high flow of 3,437 cfs in February. Peak flows generally happen during major storm events, such as during the flood of February 1964 when the highest flow ever, 84,400 cfs at a height of 22.3 ft, was recorded at the gauge. A high flow of 68,600 cfs was measured at the gauge during the Flood of 1996, at a height of 22.59 ft (USGS 1996). No gauge station exists below RM 18.5, but the Sandy was carrying an estimated flow of 85,000 cfs when it entered the

Columbia River during this flood. This topped the estimated high flow of 82,000 cfs during the 1964 flood (ODFW 1997).

Water allocations for agriculture and other out-of-stream uses are limited along much of the river by geography. As discussed previously, below Marmot Dam the Sandy River enters a gorge and is contained by high walls where land use is confined. Above Marmot Dam, water is primarily removed from the river for domestic purposes. Water right allocations in the Alder Creek and Cedar Creek drainages, however, exceed available streamflows. In Alder Creek, the city of Sandy holds the largest water right for its municipal water supply. Once the city removes its allocated supply, little water remains in the lower section of Alder Creek below the diversion. Water allocations generally do not affect flows in Cedar Creek since a large portion of the water rights in the Cedar Creek subbasin are for fisheries and may not be removed from the stream.

Below Marmot Dam, water diversions to the Bull Run River powerhouse alter the Sandy River's natural flow regime. Up to 800 cfs may be diverted from the Sandy and Little Sandy rivers in any combination for the project, with up to approximately 600 cfs taken from the Sandy River. Water diverted at Marmot Dam (RM 30) is released into the lower Bull Run River at the powerhouse and flows back into the Sandy at the confluence of the Bull Run and Sandy rivers (RM 18.5).

Before minimum streamflows were established for the river in 1973, flow diversions for power production sometimes left little water in the Sandy below Marmot Dam. Low flows in the 11-mile reach kept many spring chinook and other species from migrating upstream from early summer through early fall. Peaking operations at the facility also affected fish by causing wide fluctuations in the flow below the dam. Large daily, and sometimes hourly, changes in flow were typical (ODFW 1997).

Since 1974, minimum flows have been maintained in the Sandy River below Marmot Dam to provide fish passage and increase rearing areas. Minimum streamflow requirements for the Sandy River below Marmot Dam are:

- 200 cfs (June 16 through October 15)
- 400 cfs (October 16 through October 31)
- 460 cfs (November 1 through June 15)

The improved flows provide spring chinook and other fish with adequate water for upstream migration in summer and fall. They also create additional rearing area in the river below the dam. In addition, peaking operations at the dam are now controlled to reduce wide fluctuations in streamflows.

To provide minimum streamflows in the Sandy River but still meet hydropower needs, Portland General Electric normally diverts all the water from the Little Sandy, where the average flow is about 140 cfs. As a result, flows in the 1.7-mile stretch of the Little Sandy below the diversion drop to between 2 cfs and 14 cfs, which is provided through leakage and accretion. If more water is needed, up to 600 cfs can be diverted from the Sandy River once minimum flow requirements are met. Efforts are made not to spill any water past the Little Sandy diversion dam that might falsely attract fish to the stream. Water diverted at Marmot Dam is released into the Bull Run River about one mile below the mouth of the Little Sandy. The Bull Run River then joins the Sandy River about one mile below the powerhouse. The diversions alter flows in the Sandy River more during the months of June through October when less Little Sandy River water is available.

Before the early 1920s, streamflows from the Bull Run Basin contributed a significant volume of water to the lower Sandy River. Now most of the water produced in the basin is stored and diverted out of the basin, providing the Portland metropolitan area with high-quality drinking water. The city of Portland also sells surplus water annually to Portland General Electric for power production at its powerhouse on the lower Bull Run River. Water in the basin collects in the city's storage reservoirs through the spring and summer months. Surplus water in the basin is spilled in the fall and winter months after the reservoirs are filled. Decreased flows from the Bull Run River reduce the amount of available spawning and rearing habitat in the lower Sandy River during dry summer months. Streamflow diversions from the Bull Run River also contribute to higher water temperatures in the lower Sandy River (ODFW 1997).

WATER QUALITY

During spring and summer months, streamflows in the upper Sandy and Zigzag rivers are often turbid from the melting of either snow or glaciers on Mt. Hood. Fine suspended sediment, known as glacial silt or "flour" is particularly noticeable in the Sandy River mainstem from mid-to-late summer. This sediment results from the grinding of rocks under the weight of the glaciers. The Sandy River has one of the highest percentages of glacial melt of all major Oregon rivers. Some fish specialists believe that high levels of glacial flour in a stream reach — such as in the Muddy Fork of the Sandy River, upper Sandy River and the Zigzag River — reduce salmon and steelhead production, and that the turbid reaches serve primarily as corridors to better habitat in nearby clearwater tributaries (ODFW 1997).

Sedimentation concerns exist in several parts of the drainage, especially in those areas that contain unstable and easily erodible soils. For instance, several tributaries to the upper Sandy River flow through the unstable volcanic deposits on Mt. Hood. These tributaries, such as the Muddy Fork of the Sandy River (appropriately named) and Lost Creek gather large amounts of sediment as they carve through the steep, easily erodible drainages. The areas introduce large amounts of sediment into the stream system that settles out in lower gradient areas.

Water quality problems in some Sandy River tributaries can be attributed to land use practices. For example, turbidity, erosion and poor stream structure in the Lost and Clear creek drainages are largely attributed to landslides and debris torrents caused by road building, timber harvest and fires in the drainages (USFS 1996). Erosion from agricultural lands in the lower system also affects water quality and limits potential spawning and rearing area. Erosion and resulting turbidity weaken stream stability and reduce the quality of fish habitat. Sediment in a stream channel alters the structure and width of the streambanks and adjacent riparian zones. Spawning and rearing habitat is also affected when the sediment settles over spawning gravels.

Water temperatures in the upper Sandy and many of its tributaries remain cool most of the year because of snowmelt from the glaciers. Stream temperature readings, while limited, show that water temperatures in the upper basin typically range from 55° to 65°F in the summer (ODFW 1997). The water becomes even cooler near the headwaters where snowmelt enters the system. These temperatures favor fish production and survival in many Sandy River streams.

High summer water temperatures are evident in some upper basin streams. Data from the Storage and Retrieval (STORET) Database, which is maintained by the Environmental Protection Agency, shows that water temperatures exceed the state standard for salmonid spawning, egg incubation and fry emergence in several Sandy River tributaries, including Clear, Chance and Alder creeks, and the middle and lower sections of the Clear Fork (USFS 1996).

Stream temperatures are also higher in the lower basin. Below Marmot Dam, water in the Sandy River usually ranges from 60° to 70°F, but temperatures may exceed 70°F during summer months when long, hot weather persists. Some lower river tributaries, including Beaver Creek, also display high water temperatures in late summer. During winter months, water temperatures in the Sandy River range between 40° and 50°F.

In addition, a thermal difference sometimes occurs at the confluence of the Bull Run and Sandy rivers. For instance, in August 1993 water temperatures rose to as high as 70°F in the Sandy River just above its confluence with the Bull Run River. At the same time, flows in the lower Bull Run River only reached a temperature of 63°F. Flows in the lower Bull Run River likely remain cooler than flows in the Sandy

River because they are largely made up of water diverted from the Sandy at Marmot Dam. Natural streamflows in the lower Bull Run are otherwise significantly reduced as the city of Portland stores most of the water upstream for municipal purposes. Once the water leaves the Sandy River at Marmot Dam, it enters a network of flumes and underground canals that prevent water temperatures from rising. The water is exposed to the sun for a short time in Roslyn Lake but thermal gains are minor. Water remaining in the Sandy River is exposed to the thermal effects of sunlight for a longer period (ODFW 1997).

Sodium chloride is a water quality concern in the Sandy River during certain times of the year. Sodium chloride is applied in spring and summer months at the rate of 600,000 to 1,200,000 lb per year to maintain skiing conditions on the face of Mt. Hood (USFS 1996). Chloride and specific conductance levels are elevated moderately above background levels in streams that drain the salted areas. Most of the snowfield drains into the Salmon River, and a small amount drains into Still Creek, a Zigzag River tributary. The effect of these salt concentrations on fish production is unknown. The concentrations decrease downstream as the flow is diluted with additional surface and groundwater.

SUMMARY

Generally, natural physical conditions in the Sandy River Basin provide good to excellent habitat for fish. Salmon and steelhead thrive in the river system's clear waters with ample spawning and rearing area. People have also recognized the value of the Sandy basin's natural resources. As is discussed in the coming sections, mounting demands for timber, salmon, power, water and other resources in the basin over the last 150 years have significantly impacted the Sandy River system and its salmon and steelhead runs.

A CHANGING LANDSCAPE

INTRODUCTION

In 1800, much of the Sandy River Basin remained untouched by human development. The ecosystem, as discussed in the last chapter, provided a healthy environment for salmon and steelhead production. A diverse growth of trees and understory vegetation still armored most stretches of the Sandy River and its tributaries. The river ran cool and steady through the year supporting strong populations of salmon, steelhead and resident fish. This ecosystem was not absolutely stable. As in all river systems, natural events caused regular and sporadic changes in the ecosystem over time. For example, seasonal floods often caused the stream channel to move or create meanders. Still, the channel maintained a long term balance as its overall health allowed it to recover from naturally occurring disturbances.

Human activities, especially those after the early 1800s, changed this ecosystem. As more people moved into the area, the natural landscape and river system were developed and harnessed to provide for their growing needs. They harvested riparian forests, removed instream logs and other wood, extracted sand and gravel from the stream channel, built dams, and diverted streamflows, thus altering habitat conditions that supported Sandy River salmon and steelhead populations. By changing conditions in the watershed, they contributed to a dramatic decline in salmon and steelhead production.

This section reviews settlement and development in the basin over time. It provides a context for understanding how a combination of actions through the years contributed to the degradation of wild salmon and steelhead runs in the Sandy River Basin.

USE BY INDIANS

> *"From time before history the Indians had roved the wilds, fished the rivers, garnered the natural vegetables and fruits, and hunted game for food and clothing (Lynch 1973)."*

Indians and other native people lived along the lower Columbia River as early as 10,000 years ago. Evidence found by archaeologists shows that these early residents of the area inhabited the lower Columbia floodplain, especially near The Dalles area, which lies east of the mouth of the Sandy River on the Columbia and eventually became an important trade center (USFS 1993). Signs of their presence in the northern Oregon Cascades also date back at least 8,000 to 10,000 years (Burtchard et al. 1993). These early residents were often transient, moving through the region with the different harvest seasons. They gathered huckleberries and other food on upland meadows, fished for salmon, and hunted elk and deer.

Indian people also peeled bark from trees for making baskets, clothing, bandages and other items. Research suggests that the Indians established their villages on floodplains and traveled in small groups to upland harvest areas. Thus, while no evidence exists, it is highly likely that Indians from the lower Columbia River made trips up the Sandy River (USFS 1996). Traces of these early inhabitants include the petroglyphs carved into the basaltic rocks of the Columbia River Gorge.

Within the last few thousand years, the Indians built a trail network that extended across the Cascade Range around Mt. Hood. The travel route provided access to and from the trading center, Wascopam, near The Dalles that attracted Indians from around the region, including the Willamette Valley (USFS 1993). One popular trail extended up the Sandy River and over Lolo Pass. Another early trail, which later became the Barlow Road, joined the trail to Lolo Pass near the confluences of the Zigzag, Sandy and Salmon rivers (USFS 1996). The Indians would return by the same trails to their harvest areas year after year. Large mortars, too heavy to carry, have been found at the old campsites along Cedar, Eagle and Deep creeks (Strong 1973). Indians from villages along the Columbia, Clackamas and other rivers also boated to the Sandy River area to harvest salmon, berries, nuts and roots.

SETTLEMENT AND USE BY EUROAMERICANS

The interior valley of the Columbia River Basin, including the Sandy River drainage, remained largely unexplored by Europeans and Americans until Lewis and Clark came over the Rockies in 1805. Explorers visited the Sandy River Basin periodically in the early 1800s. They would boat up the river or follow the old Indian trails into unexplored country, as they knew the best paths would have been found over the years. Trappers also visited the area, but their use was limited since trapping was more plentiful in the Willamette Valley.

Daniel Lee, son of missionary Jason Lee, made one of the first documented visits to the area. In 1838, Daniel Lee followed the existing trail over Lolo Pass when he drove cattle from a Methodist mission in the Willamette Valley to a newly established mission at Wascopam. The trail was subsequently used by other pioneers to drive their livestock over the Cascades. The first wagons arrived over the Cascades in 1840 (Lynch 1973).

In 1843, the great immigration to the Oregon Territory began. The Barlow Road, following an old trail, opened in 1846 and soon became a popular route for bringing emigrants across the Cascades. A branch of the Barlow Road followed the ridge called Devil's Backbone between the Sandy and Little Sandy basins to the northeast corner of Roslyn Lake. Most emigrants headed for the rich agricultural lands in the

Willamette Valley, but some settled on lands along the Sandy River. As the area grew, many old Indian trails became roads. Some of these roads, called "corduroy" roads, were widened and covered with split logs laid crosswise (Lynch 1973).

Access to the Bull Run River[1] area improved in 1887 when the city of Portland began investigating the river as a main source for the city's water supply. A small community, "Unavilla", was established in the area around 1893. The name of the community was changed to Bull Run in 1895 (McAurthur 1982). The 1915 *Oregon Almanac* describes the community as including about 100 residents who supported themselves through timber harvest, farming, dairying and raising potatoes. The community, situated on the Bull Run River and at the terminus of the Mt. Hood division of the Portland Railway Light and Power Company railroad, had privately owned electric lighting and water systems. It is described as surrounded by rich agricultural land (including a nearby large-scale commercial flower bulb farm, the Crissey "Gladiolus Farm"), beautiful forests and river scenery (EDAW 1998). Today, the community of Bull Run remains an unincorporated town within Clackamas County.

The development of areas east of the Cascades for agricultural use spurred activities in the Sandy River Basin. Demand grew for a better transportation corridor over the mountains, and the Barlow Road was improved from a one-way, east-to-west route to allow two-way traffic. As traffic increased along the road, entrepreneurs moved into the area to provide accommodations and other services for the travelers. New settlers established homesteads along the road and in the lower Sandy River valley, particularly near the present cities of Sandy, Gresham and Troutdale. The Sandy post office was established in 1873 (McAurthur 1982).

At the turn of the century, most of the Sandy watershed remained a remote wilderness area and trails were the primary source of access to the upper basin. Thus, when the Mt. Hood Railway and Power Company began work on the Bull Run hydroelectric project in 1906, it had to develop road and then rail access to the site. Initially, it took three hours by stage to get to Bull Run from the electric interurban depot at Boring. The roads from Sandy to Bull Run, and from Bull Run to the Marmot Dam area had to be planked during periods of heavy rain to support traffic. Travel conditions improved in June 1911 when the railroad was completed, running 20 miles from Montavilla to the Bull Run powerhouse. The Portland Railway, Light and Power Company electrified the route in 1913 from Montavilla to Ruby Junction on the Troutdale line.

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1 McAurthur, author of "Oregon Geographic Names", suggests that the name Bull Run River "may have started from the presence of wild cattle on that river in the pioneer period (1849-55). Cattle escaped from immigrants . . . and ran wild a number of years".

Development of the railroad line lured more people to the area. As discussed below, regular rail service between Portland and Bull Run made it easy for residents to transport timber, farm crops, livestock and other products to city markets.

> *Cordwood, brick, fir logs, gravel, and crushed rock were imported from along the Springwater and Mt. Hood divisions, which extended to Troutdale, Gresham, Cazadero and Bull Run. Perishables — fruits, vegetables and dairy products — were soon hauled into the city this way, opening new markets for surrounding farmers. Businesses in smaller cities prospered as the system provided same-day service for supplies (PGE 1989).*

Public demand for access to recreational areas in the upper watershed led to the completion of the Mt. Hood Loop Highway by the 1920s. The road brought new recreational areas within reach of area residents. The rail line was abandoned in 1927 as more areas became accessible by roads and people began to travel mostly by auto.

The basin's population expanded rapidly after 1950. Road improvements and the expansion of the transportation network provided better access, especially to lands in the upper watershed. Forest Road 18, built in the 1950s, connected Highway 26 to Hood River County and allowed construction of the Big Eddy/Troutdale transmission line from The Dalles Dam. The road also provided better access to the Bull Run watershed. Road 18 became a primary road on the Mt. Hood National Forest, carrying visitors to campgrounds, trailheads and other locations.

Improved access also attracted new residents. People found they could live in the basin's beautiful mountainous and rural settings, and commute to jobs and city life in the close by Portland metropolitan area. As a result, the area's population continued to grow. The 1990 census data revealed a 9 percent population jump from 1980 within the Mt. Hood corridor — which stretches from Brightwood up to Government Camp. During the decade, a 41 percent increase in housing units also occurred (USFS 1996).

TIMBER HARVEST

By the mid-1800s, settlers in the Willamette Valley began looking toward the Cascades to meet increasing demands for lumber, firewood and other resources. The demand for timber, particularly in the booming Portland metropolitan area, brought extensive timber harvest to the more readily accessible parts of the Sandy watershed.

Timber harvest in the lower basin began by the late 1850s. The first mill in the basin was built on Cedar Creek in 1858 and another mill was built soon after on Deep Creek (Strong 1973). Many logged areas, such as near the community of Sandy, were later cleared and cultivated for agricultural use or as private tree farms.

Logging intensified in the early 1900s, and by 1907 many sawmill operations existed in the lower Sandy River Basin. These early sawmill operations sprung up around the areas of Sandy, Firwood, Dover, Eagle Creek, Boring, Marmot, Pleasant Home, Welches and Brightwood. In 1907, a mill built on Tickle Creek south of Sandy was one of the first large mills to be built within walking distance of the town of Sandy (Strong 1973). When possible, many early loggers floated the wood downstream to mill sites and markets.

Arrival of the railroad allowed logging activities to expand further in the lower basin and into higher elevations, including the Cedar and Badger creek drainages. Logging companies constructed railroad spurs reaching as far as the headwaters of Cedar Creek. This allowed some loggers to ship their logs by rail.

Beginning in the 1950s, the Forest Service constructed a number of roads to reach timber in the upper watershed. It built about 48 miles of road to provide access to Wildcat Creek/Wildcat Mountain, Alder Creek and other higher elevation areas. It also built roads to reach timber in the lower watershed and along the north and south forks of the Sandy River.

Road construction in the watershed continued after 1960. The Forest Service built about 26 miles of new road in the upper Sandy watershed during the 1960s, including Forest Road 2609, which provided access to Cedar Creek. It also built several secondary roads into the Lost Creek and Horseshoe Creek drainages. More roads were built in the upper watershed through the 1980s, including 25 miles of road into the middle Clear Fork drainage during the 1970s and another 16 miles near Cedar and Alder creeks and into the Wildcat and North mountains during the 1980s.

Major road development also took place after 1960 in the Bull Run watershed. During the 1960s and 1970s, the Forest Service constructed nearly two-thirds of the forest roads now existing in the Bull Run drainage — more than 170 miles. The Forest Service built most of the mainline roads in the watershed during the 1960s and expanded from them in the 1970s. It added another 12 miles during the 1980s and 1990s. Currently, the Bull Run watershed contains 320 miles of road.

Road construction and timber harvest practices over the years damaged fish habitat in the basin. In the early years, valuable timber covered much of the watershed and harvest was generally unrestricted. Consequently, harvesters located their operations along streambanks where logs could easily be floated downstream to mills. Logging in riparian areas was common until the 1970s when scientists recognized the importance of riparian vegetation in maintaining healthy river systems. Timber was also removed from many accessible sensitive slopes. In addition, downed wood and boulders were regularly removed from navigable waters to ease the driving of logs downstream.

Reports published by Oregon's Master Fish Warden describe extensive logging in the basin. An agent for the Salmon River Hatchery wrote:

> *"at one time, this station was one of the best we had, but for the past few years it has succeeded in taking but a small number of eggs. There is so much logging done on the Sandy River . . . that I am sure the salmon are kept out of the stream (Oregon Department of Fisheries, 1909)."*

Another report written in 1911 states:

> *"as a large amount of saw mills and logging camps have operated on the Sandy River for years past, preventing the salmon from entering the stream, the number of eggs secured does not justify the expense of maintaining the hatchery. Next year I will move further downstream where an eyeing station will be located (Oregon Department of Fisheries, 1911)."*

Other reports discuss the effect of such activities on water quality. In 1890, sawdust and other mill waste were common pollutants in any stream in the state (Oregon Fish Commission 1889-1890).

Extensive road construction and timber harvest in the upper Sandy watershed after 1950 damaged fish habitat in many stream reaches. The roads increased soil erosion and carried sediment to stream channels where it filled pools and clogged spawning gravels. Other damage resulted when road culverts became blocked with debris or otherwise barred fish from reaching spawning grounds. Road construction and timber harvest also altered natural hydrological conditions by increasing surface runoff.

Today, timber harvest continues to be one of the most important industries in the area. However, harvest practices have improved. Current harvest and regeneration techniques are designed to reduce impacts on the watershed. For example, the treatment of harvest areas improved in the mid-1980s when forest personnel began applying new methods to increase new tree growth and survival. These methods included using fertilizers and planting higher quality trees in harvested areas.

Still, timber-related activities over the past 100 years caused significant changes in the Sandy River watershed. Intense timber harvest and road building in the upper and middle basin created large open patches that now dominate the structure and function of the landscape. In addition, riparian areas are often smaller, contain fewer diverse vegetative communities, and provide less of a buffer against high streamflows (USFS 1996).

MINING

Sand and gravel operations, particularly along the lower Sandy River, occurred periodically for many years. Generally, these operations changed conditions within the mined stream reaches. They affected fish production and reduced habitat complexity through removal of undercut streambanks, degradation of channel stability, extraction of spawning gravels and by creating barriers to migration. Mining in the delta area stopped when it became part of the Columbia River Gorge Scenic Area.

AGRICULTURE

During the mid- to late-1800s, new settlers began cultivating the lower basin's rich stream bottom land, fertile plateaus and rolling hills. By the late 1800s agricultural use was common in the lower basin below the town of Sandy and along the plateaus of the lower Sandy River and tributaries such as Beaver Creek. Early farmers grew vegetables, berries, fruits and grain and often sold their products in Portland area markets.

Over the years, the lower basin has continued to support agricultural uses. However, in addition to producing vegetables, berries, fruits and grains, farmers also grow ornamental plants and trees. Further, many once productive parcels of agricultural land have been converted to residential or commercial use to support the area's growing population.

Cultivation of lands in the lower basin for agricultural use impacted habitat conditions along the lower river and tributaries. Conditions in the lower watershed changed as wetlands and floodplains were drained and filled. Stream stability and habitat diversity were also affected by removal of riparian vegetation and, in some drainages, streamflows for irrigation purposes. Such impacts are evident along Beaver Creek, a large lower basin tributary.

RECREATION

By the mid-1800s the peaks of Mt. Hood were already challenging early mountaineers. Government Camp, a campground for pioneers after Samuel Barlow left wagons there in 1845, became the starting point for many Mt. Hood climbers. Joel Palmer reached the top of the mountain in 1845. Many other climbers soon followed in his footsteps. During an outing in July 1896, a group of about 350 climbers from all over Oregon met at Government Camp. They traveled to the camp in four-horse-drawn coaches. Before cars, travelers to Government Camp followed Foster Road to Sandy, dropped down to cross the Sandy River, climbed up a hill on the river's other side just below the Devil's Backbone to Marmot, and then went through Cherryville, Brightwood, Wemme, Zigzag, Rhododendron and up Laurel Hill to the mountain (Lynch 1973).

Recreation continued to grow in the 1900s with expansion of the railroad. Roads generally remained in poor shape, but the railroad provided relatively quick and comfortable transportation to recreation sites. For instance, people from the Portland areas could take the trolley to Bull Run Park[2] (Dodge Park) at the confluence of the Bull Run and Sandy rivers and return home that evening. Thus, the park received heavy use, particularly on weekends. According to one report,

> *"a conservative estimate of visitors during the last summer would be thirty thousand . . . at times there was hardly room enough to accommodate the crowds that poured into the park on Sundays . . . hundreds enjoyed swimming in the hole below the bridges" (Portland Bureau of Water Works 1926).*

The turn of the century also saw more visitors to the white peaks of Mt. Hood. However, before the late 1920s — when car access improved — recreational use in the upper watershed was limited. A trip to the Government Camp area, a popular destination, remained long and tiresome until the 1920s when the Mt. Hood Loop Highway was completed. Once the highway was built, summer and weekend visitors came to picnic and explore the area. Recreation facilities improved in the 1930s when the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA) built campgrounds and trails in the watershed. Several summer cabins were also built in the forest at this time. Generally, however, activities in the upper Sandy watershed remained limited by the lack of access until after 1950 when the road network in the forest was expanded.

MUNICIPAL WATER SUPPLY DEVELOPMENT

In 1891, the city of Portland — which had grown into a thriving metropolis — began efforts to secure a continuous supply of clean water from the Bull Run River, a pristine tributary of the Sandy River. President Benjamin Harrison established the Bull Run Reserve in 1892, protecting the high-quality supply

2 The park was originally known as Bull Run Park, but was renamed Dodge Park in 1918 in honor of Frank T. Dodge of Portland's Bureau of Water Works.

of potable drinking water for Portland. On January 1, 1895, the city finished building its first conduit and water diversion at the site of the present Headworks Dam (RM 6) on the Bull Run River and started transferring water to Portland.

The city built several new structures in the Bull Run watershed in the early 1900s. In 1911 it completed a second conduit to carry Bull Run water to Portland. Then, in 1915 it built a 10-foot-high rock and log crib structure at the outlet of Bull Run Lake, a natural water body in the headwaters of the Bull Run watershed. The structure raised the lake's storage capacity to about 4 billion gallons of water. In 1922, the city built Headworks Dam, 20 feet high with no fish passage facilities. It constructed a second dam, the Ben Morrow Dam (Bull Run Dam No.1), in 1929 near the confluence of Bear Creek and the Bull Run River (RM 11). The structure, about 200 feet high, impounded about 10 billion gallons of water. The city also built a small reservoir, Boody Lake, on the North Fork of the Bull Run River near the headwaters that stored about 0.4 billion gallons of water.

Early records do not discuss whether the dam built in 1895 on the lower Bull Run River hindered salmon and steelhead migration. However, biologists generally believe that many fish could have passed over the dam, which stood less than 10 feet high. This migration ended in 1922. Since then, Headworks Dam (RM 6) has blocked all salmon and steelhead access to the upper Bull Run system, about 37 miles of high-quality habitat in the mainstem and tributaries. In addition, water diversions at Headworks Dam have damaged habitat conditions in the six miles of free-flowing river below the dam. The diversions reduce flows in the lower Bull Run River from late spring to fall, and limit recruitment of gravel and large woody materials that had once created healthy, diverse fish habitat.

HYDROELECTRIC DEVELOPMENT

Incredible population and industrial growth in the Portland metropolitan area during the early 1900s created a hunger for a larger electric power supply. Power was needed to fuel the extensive system of interurban railroads and trolleys spreading south from the Columbia River to Salem in the middle Willamette Valley. The region also needed power to bolster growing industrial and residential developments. Electric requirements increased at a rapid rate and low-cost hydroelectric generation became more attractive for bulk power supply.

Hydro developers directed their attention to the Sandy River at the turn of the century. Hydroelectric power development on the Sandy and Little Sandy rivers began in September 1906, with the incorporation of the Mt. Hood Railway and Power Company (Mt. Hood Company). Actions by this company soon ignited the competitive interest of two other companies, the Portland and Sandy River Electric Company and the United Railways. Following the Mt. Hood Company's lead, these companies quickly began investigating potential hydropower sites on the Sandy River. The investigations led to the development of several hydropower projects on the Sandy. The projects are discussed briefly below.

Bull Run Project

In 1906, the Mt. Hood Company started work on the Bull Run project. This project included construction of a powerhouse on the lower Bull Run River (RM 1.5) and a diversion dam on the Little Sandy River (RM 1.7), a tributary of the lower Bull Run River. The Little Sandy diversion dam stood about 16 feet high and diverted water through a 17,000-foot-long wood box flume to Roslyn Lake, which covered approximately 140 acres and formed the forebay for the Bull Run Powerhouse. The Mt. Hood Company began operating the powerhouse on Little Sandy River water in 1912. That same year, it merged with the Portland Railway Light and Power Company, Portland General Electric's predecessor.

Construction and operation of the Little Sandy diversion dam reduced natural fish production in the Little Sandy River, a system that is believed to have once contained good anadromous fish habitat. The diversion dam blocked salmon and steelhead access to about 6.5 miles of habitat above the dam. It also reduced streamflows in the 1.7-mile reach between the dam's lower end and the river's confluence with the Bull Run River.

Marmot Dam

In 1913, the company completed construction of Marmot Dam on the Sandy River (RM 30). The 30-foot-high dam diverted water from the Sandy River to the Little Sandy River via a network of canals and tunnels. The longest tunnel, 4,690 feet, ran under a mountain ridge connecting the two basins.

That year, the company started diverting up to 600 cubic feet per second (cfs) of water from the Sandy River to the Little Sandy River just above its diversion dam. The combined waters were then diverted to Roslyn Lake through a wood box flume that ran along the Little Sandy River's south bank and carried up to 800 cfs of water.

Upon completion, Marmot Dam was provided with a wooden fish ladder. However, the ladder entrance was damaged by flood water during its first season of use and the company had to extend the entrance upstream. Floods in the following years repeated the damage. The company regularly repaired and improved the ladder, though it was being used extensively to trap adult salmon and steelhead for hatchery production. Correspondence between the company and state fishery managers suggests that the game warden wanted the ladder to permit fish migration over the dam, but the fish warden wanted modifications to help the capture of fish for hatchery purposes. A fish and game commission report on the repair problem, for instance, referred to a Deputy Fish Warden *"who has charge of the hatchery work below your dam."* The company received another letter from the Master Fish Warden in July 1913 that referred to *"the superintendent of our egg taking station at your dam on the Big Sandy."* However, a letter from the Fish Warden the following March commented on high water damage requiring *"that immediate steps are taken to repair this fishway . . . so that the fish will be able to reach the water above the dam (PGE 1982)."*

Between 1913 and 1933, the company rebuilt and improved the ladder often to enhance fish passage. In 1918, the company reconstructed 15 pools at the lower end of the ladder and reinforced them with concrete. It also rebuilt and improved the upper 16 wooden pools. In 1926, the company installed two concrete pools at the lower end of the ladder and raised the wall height on the previously installed 15 pools. The remaining wood sections were replaced with reinforced concrete pools in 1930. By 1933, improvements to the fishway had cost 13 times that of the original structure. While these changes improved fish passage at the dam, egg-taking operations at or below Marmot Dam until the early 1950s, ladder damage, and low flows persisted in hindering fish migration to the upper basin through the 1950s.

More changes took place in the 1970s. In 1971, the company installed an exit gate to the ladder with a submerged weir that adjusted to the rise and fall of the river level and stopped bed load from entering the ladder. Then in 1974, upon request by Oregon's fish and game commissions, the company began leaving more water in the Sandy River below Marmot Dam to improve fish passage and increase rearing area in the lower Sandy River.

Portland General Electric continued to improve the fish passage facilities. In 1983, the company upgraded the fish ladder on the south bank of Marmot Dam for upstream fish passage. It also installed a fish counter at the facility to provide daily fish counts. This counter was replaced in 1996 when the previous counter was determined unreliable. Because of these changes, Marmot Dam's fish ladder now allows adequate upstream fish passage (ODFW 1997).

Over the years, efforts have also been made to reduce impacts on downstream migrants, which were often swept into the Sandy River diversion canal. In 1948, Oregon's fish and game commissions asked the company to install screens in the diversion canal to prevent downstream migrants from reaching Roslyn

Lake. The company soon began engineering and design studies. The screen became operable in 1951 and has been improved several times over the years. The downstream juvenile bypass system was further improved in the 1980s. Ten collection ports in the side walls and in the metal beams separating the screens diverted the fish into a chamber under the screens and then into a pipe. The pipe, about 36 inches in diameter and 200 feet long, emptied into a plunge pool near the shoreline of the Sandy River below Marmot Dam. Water from the plunge pool directed the fish into the Sandy River or into a trap where biologists could monitor juvenile downstream fish passage.

Today, the company continues to monitor salmonid mortality and effects on migration at the project's facilities. Because of these studies, conducted in coordination with fish managers, the bypass system has been modified several times. The company has placed baffles upstream from the screens to provide a uniform flow at the screen surface. It has also refinished the inside of the transport pipe, deepened the plunge pool, built a trap and enlarged the bypass ports to increase the flow of water through each port.

Dam operations have also been adjusted to maximize fish survival at the rotating screens and downstream juvenile bypass facility. Currently, the bypass system is operated under the following criteria:

- The fish bypass operates on a continuous basis whenever water is diverted into the canal.
- Canal screens run all year, but are rotated from March 1 through May 31 when fry are present.
- Screen wash spray pressure is kept at 30 psi from March 1 to May 31.
- Bypass flow is maintained at 60 cfs so water enters ports at 2 feet per second.
- When many smolts are observed in front of the screens, canal flows are lowered to flush fish through the bypass and back into the river.

Studies of the downstream juvenile migrant bypass facility at Marmot Dam show that survival is now high. Cramer (1993) concluded that, though the proportion of downstream migrants diverted into the canal is unknown, an estimated 95.4 percent of the fry (fish smaller than 50 mm) that enter the bypass facility survive. When biologists released hatchery smolts into the system, they found that about 97.3 percent of the steelhead test smolts and 95 percent of the spring chinook test smolts survived passage through the bypass system. Survival of wild steelhead smolts was near 99 percent, though there were not sufficient numbers for a full test. Today, the company continues to address remaining concerns to improve downstream migration through the bypass system. Most recently, in 1998 the company added a new surface collector system for fry. The effectiveness of this system is presently being evaluated.

FISH HARVEST

Salmon and steelhead runs to the Sandy River began dropping by the late 1800s with the expansion of the fishing industry. Fishing parties on the Columbia and lower Sandy rivers caught scores of fish bound for the basin's spawning grounds.

In the early days, harvest focused on spring chinook. Commercial harvest of spring chinook began on the Columbia River in the mid-1800s and grew quickly until it peaked around 1873 with a take of about 43 million pounds (Oregon Game Commission 1951). Spring chinook harvest on the Columbia then declined significantly, suggesting that the river's spring chinook run had already been weakened by overharvest. Records show that in 1877 more than 1,000 drift nets were in the Columbia, each 1,200 feet long (U.S. Commission of Fish and Fisheries 1877). Commercial gear regulations were not adopted on the Columbia until 1878.

Heavy fishing on the Columbia River persisted into the 1900s, but an important change took place. Commercial fisheries continued to harvest about 25 million pounds of fish each year until 1922, but spring chinook made up less and less of the catch. Around 1880, spring and summer chinook salmon runs started declining and harvest shifted to fall chinook salmon. By 1912 spring and summer chinook comprised 75 percent of the fish in the harvest and by 1920, the catch was estimated to be 50 percent fall chinook (Lichatowich and Mobrand 1995). Harvest emphasis also moved to steelhead (1890 to 1900) and then to coho (1920s). Peak commercial catches for chinook and coho occurred in 1883 and 1925, respectively (Lichatowich and Mobrand 1995). Generally, commercial harvest of all species declined steadily after 1923, with an average annual harvest of 15 million pounds from 1923 to 1958 (Lichatowich and Mobrand 1995). By 1945, production of all species had declined significantly.

Many other salmon and steelhead from the Sandy River were harvested in ocean fisheries. In 1912, the ocean troll fishery (towing a hook and line behind a boat) began competing with the Columbia River fishery. The troll fishery initially began off the mouth of the Columbia River. The number of boats doubled from about 500 in 1915 to about 1,000 in 1919 (Northwest Power Planning Council 1987). The ocean troll fishery expanded through the 1920s and peaked in the mid-1930s. During this time, it took a significant portion of the fall chinook, spring chinook and coho destined for the Columbia River Basin (ODFW 1997). Until 1948, there were few restrictions on the ocean fisheries.

Ocean and Columbia River fisheries expanded again in the early 1960s when the wild salmon and steelhead production of the previous decades was replaced by improved hatchery production. The fisheries climbed significantly in the 1970s, but have steadily declined since then (ODFW 1997). Some fisheries continued to affect Sandy River runs into the 1990s. Coho harvest records, for instance, show that before 1993 commercial fisheries in the ocean and Columbia River intercepted many Sandy Hatchery coho. For the 12-year period 1981-1992, total ocean commercial harvest of Sandy Hatchery coho averaged about 19,170 fish annually, about 43.5 percent of the total Sandy Hatchery coho available (ODFW 1997).

Today, fisheries outside the basin continue to harvest many Sandy River salmon and steelhead. Harvest rates and overall contribution of Sandy River spring chinook to various fisheries outside the basin are unknown, but are believed to resemble harvest rates on Willamette basin stocks. Records show that approximately 67 percent of the Willamette spring chinook harvested in ocean fisheries are caught in British Columbia and about 33 percent are caught in southeast Alaskan waters (ODFW 1997). Out-of-basin fisheries also harvest many Sandy River fall chinook. In addition, studies suggest that commercial and sports fisheries outside the basin, including ocean fisheries, may harvest up to 50 percent of the native fall chinook run destined for the Sandy River based on harvest rates reported for wild fall chinook from the Lewis River, a lower Columbia River tributary in Washington (brood years 1982-87: adult return years 1984-93) (ODFW 1997).

Salmon and steelhead runs have also been targeted for harvest in the Sandy River. While the river system has always attracted anglers, fishing for spring chinook on the lower Sandy grew in popularity during the late 1800s and early 1900s as the region's population expanded. The development of the railway, roads and easily accessible sites, such as Dodge Park, on the lower Sandy River created more fishing opportunities. Fishing pressure in the basin continued to grow for many years as the region's population expanded and the construction of new roads provided better access.

Present salmon and steelhead runs still support popular sport fisheries in the Sandy River Basin. In-river sport coho harvest data shows that sport anglers caught an estimated average of 1,263 coho annually in the Sandy River for the 12-year period 1981-1992. Sandy River spring chinook also support a substantial sport fishery in the river, primarily below Marmot Dam (RM 0-30). This fishery has increased in parallel with hatchery smolt releases in the basin over the last 15 years. Fall chinook fishing in the Sandy River Basin is generally limited by natural conditions, since by the time the adults return to the river to spawn, their condition and meat quality has deteriorated.

Winter steelhead continue to be the most popular game fish in the Sandy River. Before catch-and-release regulations were started in 1990, in-basin harvest of winter steelhead significantly affected spawning and escapement of wild winter steelhead into the upper basin. Today, hatchery winter steelhead are released at popular angling spots such as Oxbow and Dabney parks on the lower river. Such releases concentrate adult returns in the areas where most harvest takes place and protect the native stock from competition in important upper basin spawning and rearing areas.

SUMMARY

The Sandy River Basin has seen significant changes since the middle 1800s. Over the last 150 years, large amounts of timber have been removed from basin forests. Other lands have been cultivated for agricultural production or otherwise developed to accommodate increasing residential and industrial growth. The Sandy River and many tributaries have also been transformed. Since the mid-1800s, human efforts to extract and harness resources have disturbed natural stream hydrology, streamflow patterns, channel structure and water quality within the Sandy River system. Human impacts include the building of dams, removal of streamflows, stream channelization, extraction of instream gravels and downed wood, loss of riparian vegetation, and the destruction of side channels and wetlands. Together, these changes have contributed to dramatic losses of salmon and steelhead habitat and productivity. Basin salmon and steelhead runs have also been greatly reduced by harvest activities in the Columbia River, ocean and Sandy River.

The following sections discuss salmon and steelhead production in the Sandy River basin through the years. Human activities and developments discussed in this section directly influenced these runs and actions taken to improve them. Consequently, the key events that shaped conditions in the drainage during each period are often mentioned in the discussions and are summarized at the end of each section.

SALMON AND STEELHEAD RUNS BEFORE 1900

INTRODUCTION

Before the 1800s, Sandy River anadromous and resident fish populations flourished in a pristine environment full of shallow gravel beds, deep pools, and cool mountain streamflows. Winter steelhead and coho spawned and reared in most accessible reaches of the basin and spring chinook were abundant in the main Sandy, Salmon, Zigzag and Bull Run rivers. Fall chinook ranged through the lower Sandy and tributaries such as Gordon and Trout creeks and the Bull Run River, and into the upper Sandy and large tributaries including the Salmon River. A small number of chum also returned to the lower Sandy River (Mattson 1955).

As discussed previously, salmon and steelhead runs to the Sandy River and other Columbia River tributaries began to drop by the early 1870s — most likely because of overfishing on the Columbia River. Developments within the Sandy River Basin also began to affect fish production. By the late 1800s, widespread timber harvest and other developments in the lower basin had already damaged some habitat areas. Human activities also hindered salmon and steelhead migration to traditional spawning and rearing grounds. Hatchery egg-take operations on the Salmon and Sandy rivers began to impede salmon and steelhead access to upper basin spawning grounds in the late 1880s. In addition, the City of Portland's first diversion dam on the Bull Run River (RM 6), built in 1895, may have restricted some upstream fish migration to spawning and rearing grounds in the upper Bull Run system.

FISH PRODUCTION

Historically, salmon and steelhead ranged throughout most of the Sandy River Basin. Reports by Mattson, a specialist on the Sandy River system in the 1950s, estimate that runs as high as 15,000 coho, 20,000 winter steelhead, 10,000 fall chinook and 8,000-10,000 spring chinook once returned each year to spawn in the Sandy and tributaries (Mattson 1955). The river system may have also supported a small native summer steelhead run. Large populations of cutthroat trout, rainbow trout, mountain whitefish and other resident fish also resided in the basin.

The decline in salmon returns to the Columbia River led to the development of fish culture operations in the late 1800s. Hatchery production in the Sandy River Basin dates from 1887 when fish propagators built temporary egg-taking stations on the Sandy and Salmon rivers (Oregon Dept. of Fisheries c1990). Their efforts focused on spring chinook, the preferred fish at the time. Fish propagators knew little about spawning, hatching and growing fish and generally learned by doing. To gather brood stock, they placed racks, or fences, with long pickets across streams. The rack, placed in the stream before the fish arrived, kept the adults from passing above that point. As the fish neared the spawning period, they were driven downstream into collection traps. This method was an adaption of Indian fishing methods. Gill nets were also used to catch fish at the racks or in deep holes, such as at the base of dams.

Once caught, the female and male salmon were stripped for eggs and milt. The fish propagators then fertilized the eggs and incubated them until they hatched. However, unlike today, early hatchery operators generally hatched millions of fry and then released the unfed fry soon after they hatched. This practice resulted in high mortality. Problems with disease, water supplies, and food sources also reduced hatchery successes.

In 1892, fish propagators established a field station in the drainage with an obstruction rack and water supply for egg development. They started taking eggs in October 1893 and continued for 30 days, collecting 1,179,000 eggs from 253 fish. The eggs were transferred to a station on the Clackamas River. Egg-takes at the Sandy site intensified in 1894 when hatchery personnel stopped egg collections at the Clackamas station because of poor supply and became more dependent on eggs from the Sandy (U.S. Commission of Fish and Fisheries 1895).

Records from 1895 describe some difficulties that early propagators experienced when trying to collect eggs. In 1895 they built a rack, 400 feet long, across the Sandy River to capture migrating chinook salmon. However, operating the rack was difficult because of the large amount of wood in the river. The propagators tried to resolve the problem by constructing a gate in the rack for logs and other wood to pass through. They also built a boom 600 feet above the rack directing the logs to the gate. Once the gate was working, they built a small temporary hatchery and hatching troughs for salmon production. Their problems returned in early September when heavy rains brought down a large amount of wood and logs. The material broke the boom and carried away a large part of the rack, permitting the salmon to escape. The propagators repaired the rack and collected 23,000 eggs from six salmon in mid-September, but more rain on October 1 carried the rack away again. They suspended their egg-taking operations after all the salmon below the rack escaped and left the 23,000 eggs to hatch in a small brook that emptied into the Sandy River (U.S. Commission of Fish and Fisheries 1895).

In 1896, propagators built a more permanent facility, a small hatchery station at the mouth of Boulder Creek on the Salmon River. They collected about 2,600,000 eggs that fall from 492 females. About

1,066,600 eggs were collected at the station in September 1897 and sent to the Clackamas Hatchery. Such egg-taking operations at the hatchery often blocked migration of chinook and coho salmon and steelhead to major spawning areas in the upper Salmon River drainage.

Table 1. Egg Collection at Salmon River Hatchery (ODFW 1997)

Year[3]	Spring Chinook[4]	Winter Steelhead
1896	2,600,000	
1897	1,216,000	
1898	745,200	22,000
1899	600,000	

Success in their egg collection efforts led propagators to establish the Salmon River Hatchery in 1898. For several years this hatchery was considered one of the best in the state because of the large amount of spawn secured. It was also regarded as one of two places where chinook salmon eggs could be collected as early as July (the other site was on the upper Clackamas River). Winter steelhead eggs were also collected in 1898.

SUMMARY

Salmon and steelhead runs to the Sandy River dropped below historical levels during the 1800s. While this decline has been largely attributed to overfishing in the Columbia River, activities in the basin during the middle to late 1800s probably contributed to reduced fish production. Escalating timber harvest and related activities after 1850, such as the driving of logs downriver to mills, degraded naturally pristine habitat conditions along parts of the lower Sandy River and tributaries. In addition, many would-be spawners were captured by fishing parties and egg-take operations in the basin. Nevertheless, while below historic levels, the success of egg-takes at a station on one Sandy River tributary, the Salmon River, in the late 1890s — 2,600,000 spring chinook eggs from 492 females in 1896 — suggests that the runs remained strong.

Many key events and developments that occurred in and outside the basin before 1900 are recapped below. Together these events provide a snapshot of activities that likely caused salmon and steelhead runs in the Sandy River Basin to enter a period of decline.

3 Records of egg takes before 1896 are incomplete.

4 Some mixing of spring and fall chinook is possible.

Key Events and Developments Before 1900

1700	Explorations and settlement by Indians.
1805	Lewis and Clark explore lower Columbia River and tributaries. Other Euroamerican explorers soon begin scouting Sandy River Basin.
1838	Daniel Lee drives cattle over Lolo Pass.
1840	First wagons arrive over Cascade Mountains.
1845	Joel Palmer reaches top of Mt. Hood.
1846	Barlow Road opens, bringing emigrants across mountains.
1858	First sawmill built in lower basin on Cedar Creek. Other mills built soon after as timber harvest in area increases.
1870	Concern grows that overfishing on Columbia River may deplete salmon runs.
1873	Commercial spring chinook harvest on Columbia River peaks at 43 million pounds.
1877	More than 1,000 drift nets in Columbia River, each net about 1,200 feet long.
1887	Fish propagators build temporary egg-taking stations on Sandy and Salmon rivers.
1890	Sawdust and other mill waste common pollutants in many streams.
1890	Harvest of steelhead on Columbia River increases as spring chinook run declines.
1891	City of Portland begins efforts to secure water from Bull Run River.
1892	President Harrison establishes Bull Run Reserve to protect high-quality drinking water supply for Portland.
1892	Fish propagators build field station for egg-taking and development.
1894	Egg-taking in Sandy drainage intensifies when fish propagators at Clackamas Hatchery stop egg-takes on Clackamas and depend more on Sandy for supply.
1895	Fish propagators build 400-foot-long rack across Sandy River. Egg-take operations hindered by floating logs and high streamflows.
1895	City of Portland completes diversion bringing Bull Run water to the city.
1896	Fish propagators build small hatchery at the mouth of Boulder Creek on Salmon River. They collect 2.6 million eggs that fall from 492 females.
1898	Salmon River Hatchery established.

SALMON AND STEELHEAD RUNS, 1900 TO 1950

INTRODUCTION

The resilience of the Sandy River's salmon and steelhead runs was further tested in the early 1900s. Fishing pressure remained steady on the Columbia River and grew on the ocean and Sandy River. Inside the basin, habitat degradation in the Sandy and many lower tributary drainages escalated as timber harvest, road building, agricultural production, hydroelectric development, and other activities increased in the lower basin and slowly spread upriver. Brood stock collection for hatchery production also continued to reduce natural salmonid production. Egg-taking for hatchery production often blocked migration of chinook and coho salmon and steelhead to the upper Salmon and Sandy rivers. The building and operating of several dams in the basin during the early 1900s also seriously affected the runs.

Naturally occurring changes in watershed conditions may have also impacted fish production. According to fire history maps, at the turn of the century approximately half of Clackamas County south of the Bull Run area — including the upper Sandy area — was classified as burned (USFS 1996). Several other fires occurred in the early- and mid-1900s, burning large sections of the upper Sandy, Salmon, Zigzag and Bull Run drainages. While detailed information on the fires is not available, they would have created large openings in the forest canopy. This change may have increased peak streamflows, since exposed snow would melt more quickly. It may have also increased water temperatures in the uncovered streams. Further, the forest fires would have removed forest understory vegetation leaving soils more exposed to erosion and increasing water turbidity.

Climatic changes also occurred. As discussed previously, the area experienced cool temperatures in 1892 to 1920 and warmer temperatures in 1921 to 1946. Such large-scale climatic changes may have affected the quality of fish habitat in both freshwater and marine environments during 1900-1940 (Lichatowich and Mobrand 1995). These changes — in concert with losses due to municipal water supply development, hydroelectric power operations, hatchery egg-takes, timber harvest and agricultural uses during the early 1900s — likely contributed to a decline in fish productivity.

FISH PRODUCTION

While below historic levels, large runs of salmon and steelhead continued to ascend the Sandy River in the early 1900s. According to several people who were familiar with the river before the construction of Marmot Dam, spring chinook were quite abundant in the main river and in the Salmon and Zigzag rivers before the dam (Mattson 1955). Estimates by Mattson (1955) suggest that spring chinook spawning runs to the mainstem ranged between 3,000 and 5,000 fish per year, though no reliable data existed to calculate actual run sizes. Past residents also observed runs of at least 900 adult coho salmon and several hundred fall chinook during some years at the Salmon River Hatchery weir before construction of Marmot Dam (Mattson 1955).

Hatchery records also suggest that many salmon and steelhead returned to the basin in the early 1900s. After the turn of the century, operators of the Salmon River Hatchery experienced some of their best years. In 1903, they collected 3,551,000 spring chinook eggs, a record number at the hatchery (ODFW 1997). The next year, 1904, they collected about 1,745,000 chinook, 1,327,300 coho, and 175,200 steelhead eggs. This was the largest collection of coho eggs at the station. In 1905, their collections reached 1,230,000 chinook, 1,066,300 steelhead and 300,000 coho eggs (Mattson 1955).

Hatchery operators during this time continued to experience mixed success in their attempts at fish production. Fish culture remained more art than science, and the operators learned by experimenting with different techniques and adapting them based on their successes and failures. They encountered problems finding the right foods for the growing fish and struggled with disease outbreaks.

Fish production in the basin declined temporarily around 1904 after floodwaters deposited large amounts of sediment and debris near the Sandy's mouth. As explained in the 1913 Biennial Report of the Department of Fisheries to the 27th Oregon Legislature, *"during the flood of 1904 a great mass of sediment and drift lodged at the mouth of the Sandy, causing it to form a new channel that emptied into the Columbia in an upstream direction, making it difficult for the fish to find."*

When fish returns remained low in 1911, residents along the Sandy appealed to the Oregon Department of Fisheries for assistance in restoring the stream to its old channel. They received 500 pounds of blasting powder from the Master Fish Warden and used it to reopen the channel. The fish returned to the Sandy River in 1912 after the barrier to migration was removed (Oregon Department of Fisheries 1913).

Egg-take records reflect the decline in salmon migration. In 1911, after low adult returns for several years, hatchery operators decided to stop using the Salmon River Hatchery. They resumed operations in 1912 after fish migration was restored and spawners again ascended the river. That year, according to a Master Fish Warden report, ". . . *the take of eggs (chinook) proved a record-breaker over that of several years* *past, having secured 2,009,000 of the early variety and 417,550 spawn of the later run of chinooks."* The eggs were shipped to other hatcheries. None were planted in the Salmon River that year.

Construction and operation of several dams after 1910 created new problems for fish. On the Little Sandy River, salmon and steelhead lost access to about 6.5 miles of spawning and rearing habitat after construction of a diversion dam on the Little Sandy River (RM 1.7) in 1912. The Little Sandy River system is believed to have once supported runs of spring chinook, coho and steelhead (Mattson 1955). More fish habitat was lost in 1922 when Headworks Dam was built on the Bull Run River (RM 6) for City of Portland municipal water. The dam, 20 feet high with no fish passage facilities, blocked salmon and steelhead from about 37 miles of habitat in the upper Bull Run drainage. Flow diversions at both dams also restricted fish production in the lower river sections.

Construction of Marmot Dam on the main Sandy River (RM 30) in 1913 also influenced salmon and steelhead. The dam's wooden fish ladder was routinely used as a trap to obtain brood stock for hatchery production. Periodic damage from flood waters further restricted fish migration while the damaged ladder was being repaired. Dam operations also affected fish production in the Sandy River below the dam. During low flow periods, diversions at the dam left as little as 30 cfs in the lower river. For many years after 1913, low flows in the 11-mile reach of the Sandy between Marmot Dam and the mouth of the Bull Run River (where the water diverted at Marmot Dam was returned to the Sandy River) kept many spring chinook and other species from migrating upstream from early summer through early fall. The low flows also reduced habitat quality and availability to support fall chinook and other lower river fish populations. In addition, the diversions affected downstream migrants. Until the diversion was screened in 1951, many downstream migrants were swept into the canal and carried to Roslyn Lake, which had no outlet but through penstocks and turbines.

Operations associated with the Bull Run Powerhouse, which used water diverted from the Little Sandy and Sandy rivers, initially had little or no effect on fish production or migration in the lower Bull Run River. The volume of water released into the lower Bull Run River at the powerhouse was small compared to the much larger flow already in the Bull Run River. However, with the completion, and subsequent operation of Headworks Dam, the City of Portland began diverting large quantities of Bull Run River water at the Headworks Dam. Releases of Little Sandy and Sandy River water below the Bull Run Powerhouse then made up most of the streamflow in the lower Bull Run River during the migration season. These flows falsely attracted some salmon and steelhead into the Bull Run and delayed their migration to upriver habitat in the Sandy River.

Once Marmot Dam was completed, hatchery operators abandoned the Salmon River facility and moved to the Sandy River below the dam. That year, in 1913, fish propagators built a rack spanning the Sandy River below the dam to trap spring chinook, coho and winter steelhead. They collected chinook salmon eggs at the site in many years from 1913 to 1955. The number of spring chinook eggs collected varied from a low of 10,280 eggs in 1955 to a high of about 2.7 million eggs in 1913 (ODFW 1997). Steelhead and coho eggs were also collected between 1913 and 1946 (USFS 1996).

From 1913 to 1925, spring and fall chinook salmon were also raised at several other locations on the Sandy River. While dates and locations are unclear, records show activities at "Lower Sandy River Hatchery", "Big Sandy River Hatchery", and the "Bull Run Feeding Ponds" from 1913 to 1918. Records from 1919 to 1925 refer to the "Sandy River Hatchery" with no mention as to the location (Wallis 1962). A lack of records for the period between 1925 and 1933 suggests that possibly no hatchery production occurred on the Sandy River for 11 years after operations at the facility below Marmot Dam ended in 1925 (ODFW 1997). From 1933 through 1936, salmon fry produced at Bonneville Hatchery were released into the Sandy, Bull Run and Salmon rivers.

Table 2. Salmon and Steelhead Egg Collection in the Sandy River Basin, 1900-1950 (ODFW 1997)

Site	Year	Spring Chinook[5]	Fall Chinook	Steelhead	Coho
Salmon River Hatchery, Boulder Cr.	1896	2,600,000			
	1897	1,216,000			
	1898	745,200		22,000	
	1899	600,000			
	1900	1,260,000		250,000	
	1901	1,742,000		409,000	
	1902	1,586,600		205,000	1,327,300
	1903	3,551,000	100,000	410,100	300,000
	1904	1,745,000		175,200	412,000
	1905	1,230,000	(F+S mixed)	1,066,300	
	1906	875,000	(F+S mixed)	447,000	
	1907	565,000	(F+S mixed)	508,000	76,500
	1908	553,340			
	1909	500,936	180,400	595,091	
	1910	269,140	120,570		
	1911				
	1912	2,009,000	417,550	493,000	
Marmot Dam	1913	2,782,258	(1,430,716)	966,100	
	1914		Sandy River	449,500	
	--		3 RM above		
	1921	1,637,000	Troutdale		330,600
	1922	461,900		634,000	
	1923			832,600	
	1924	1,823,918	2,595,820		
	1925				
	--				
	1938	10,904			583,324
	1939	1,614,451		827,634	485,900
	1940	604,800		858,500	238,900
	1941			1,378,000	297,400
	1942	238,000		1,176,690	39,000
	1943	12,000		299,370	49,000
	1944			175,000	10,000
	1945	435,200			14,400
	1946	1,067,387		238,532	
	1947	43,550			
	1948	441,000			
	1949				

In 1938, fish managers began operating a small hatchery, the Sandy River Station, immediately below Marmot Dam. They produced salmon and steelhead at the station until 1948 with water supplied by gravity

5 Some mixing of fall and spring chinook eggs is possible.

from the power canal. The station's success prompted staff with the Oregon Fish Commission to send Portland General Electric the following report in November 1939:

> *"During the year there were collected 583,324 silver salmon eggs, 1,514,451 chinook and 827,634 steelhead eggs. The resulting fingerlings are being released into the river below the dam, where they apparently find, in the reduced flow of water in the river's channel, ideal nursery conditions. It is now felt that the migratory fishes will be preserved, and I trust the numbers increased through uninterrupted operation of the hatchery. Further, there will be nothing gained by screening the diversion above the dam, now that fishes of a migratory nature are not permitted to proceed to the upper reaches of the Sandy River."*

State fish managers decided to change their program in the late 1940s when production at the facility began to fall. Records show that the number of coho eggs collected at the facility dropped steadily from 500,000 eggs in 1939 to less than 15,000 eggs in 1945 (ODFW 1997). The records do not indicate whether a decline in the coho run triggered the drop in egg collections or if some coho were allowed to continue upstream to spawn (ODFW 1997). Faced with recurring problems, in 1947 staff with the fish commission reported:

> *"The water supply at the Sandy River Station is not considered satisfactory. There are also detrimental features which make the operation of this station difficult and uncertain. Studies are being conducted on other sites, and it is expected that the present location will be abandoned for one more favorable to fish culture operations."*

By 1948, the state was operating the station strictly for egg collection. Fish propagators gathered about 441,000 spring chinook eggs at the station in 1948 and shipped them to Bonneville Hatchery. They collected nearly 600,000 eggs at the site in 1950 and transferred them to Bonneville as well.

SUMMARY

By the late 1940s, Sandy River salmon and steelhead had lost access to several once important habitat areas and the remaining runs had declined significantly. Spring chinook escapement to the main Sandy River and tributaries was estimated at the time to have fallen to no more than 1,500 adults. Coho salmon runs had declined to about 2,000-3,000 adult fish, and winter steelhead escapement to areas above Marmot Dam had dropped to about 2,200 fish (Mattson 1955). Fall chinook production had also declined significantly.

In many ways, the decline of these runs was linked to the region's growth in population and to a subsequent demand for more timber, power, water, salmon and other resources. Habitat changes generated by fires in the upper watershed and by a shift in climate conditions may have added to the decline. Key events that shaped conditions in the Sandy River Basin during this time are recapped below.

Key Events and Developments From 1900 to 1950

1903	About 3,551,000 spring chinook eggs collected at Salmon River Hatchery.
1904	Floodwaters deposit material at Sandy River mouth, hindering fish passage.
1904	About 1,327,300 coho eggs spawned at Salmon River Hatchery.
1905	More than 1 million steelhead eggs spawned at Salmon River Hatchery.
1906	Hydropower development on the Sandy and Little Sandy rivers begins.
1907	Many sawmills operate in the lower Sandy River Basin, logging escalates.
1908	Operator of Sandy River Hatchery reports that "there is so much logging on the Sandy River that I am sure the salmon are kept out of the stream."
1908	Forest fires burn much of the upper watershed from late 1800s to 1920.
1911	Salmon River Hatchery operations stop.
1911	Railroad operates 20-mile line from Montavilla to Bull Run powerhouse.
1911	Residents of Sandy restore lower river channel and reopen fish passage.
1912	Anadromous fish runs return to river after barrier near mouth is removed.
1912	Operations at Salmon River Hatchery resume. About 2,009,000 spring chinook eggs and 417,550 fall chinook eggs taken at station. Hatchery is abandoned after the season, operations are moved below Marmot Dam.
1912	Marmot Dam completed. Facility includes fish ladder, but flood damage and egg-take operations at the ladder hinder fish passage to upper basin.
1912	Little Sandy diversion dam completed. Dam blocks fish passage to areas above dam and water diversions affect production below the dam.
1913	About 2.7 million spring chinook eggs collected below Marmot Dam.
1913	Railroad line electrified from Montavilla to Ruby Junction. Logging companies expand line, building spurs into headwaters of Cedar Creek.
1915	City of Portland builds 10-foot high structure at outlet of Bull Run Lake.
1918	Ladder at Marmot Dam rebuilt and improved after repeated flood damage.
1918	Trolley line brings many visitors from Portland to areas along Sandy River, including Dodge Park at confluence of Sandy and Bull Run rivers.
1920	Construction under way on Mt. Hood Loop Highway.
1922	City of Portland builds Headworks Dam, 22 feet high, creates fish barrier.
1926	Ladder at Marmot Dam improved and new pools installed.
1927	Rail line to Bull Run Park abandoned as people travel more by auto.
1929	City of Portland builds Ben Morrow Dam (Bull Run Dam No. 1) on Bull Run.
1930	Several campgrounds and trails constructed in watershed.
1938	Small hatchery (Sandy River Station) built immediately below Marmot Dam.
1939	Egg-takes at station include 583,324 coho eggs, 1,514,451 chinook eggs, and 827,634 steelhead eggs. Fingerlings are released in river below dam.
1940	Production at Sandy River Station begins to decline.
1948	Sandy River Station operated strictly for egg collection.

SALMON AND STEELHEAD RUNS, 1950 TO PRESENT

INTRODUCTION

In 1950, salmon and steelhead runs to the Sandy River faced many obstacles to production. Operations at Marmot Dam continued to hinder upstream and downstream migrations and limit production in the lower Sandy River. Salmon and steelhead access to significant historic habitat areas in the Bull Run drainage — possibly exceeding the Salmon River in fish production potential — remained blocked by Headworks Dam on the Bull Run River and a diversion dam on the Little Sandy River. Water withdrawals in the lower Bull Run and Little Sandy rivers curbed fish production in the lower river reaches. In addition, hatchery operators continued to collect large numbers of salmon and steelhead eggs in the basin.

Portland General Electric made several improvements at Marmot Dam after 1950 to improve fish passage. In 1951, the company began operating screens in the Sandy River diversion canal at the Oregon Fish and Game Commission's request. The screens were designed to prevent downstream migrants from entering the canal and being carried to Lake Roslyn, which had no outlet for fish except through the penstock and turbines. Studies by the Oregon State Game Commission in the early 1950s indicated that the screens were effective with regard to fish several inches in length — and had considerably reduced losses of seaward migrants — but were less successful in diverting fry or small fingerlings (Mattson 1955). This system was improved repeatedly during the following years. The fish ladder at Marmot Dam was also rebuilt several times after 1955 to ease upstream migration. Other gains for salmon and steelhead came in 1973 when the company began maintaining minimum streamflows below Marmot Dam. Then, in 1989 the company eliminated many remaining fish passage problems when it rebuilt Marmot Dam, a 60-year-old wood crib rock-filled structure, with a new concrete dam.

Fish returning to upper basin spawning and rearing grounds during this period, however, did not necessarily find the pristine conditions that had supported their ancestors. Timber harvest, road construction, urbanization, mining and other activities continued to spread along the lower Sandy and tributaries. After 1950, road construction and timber harvest in the upper Sandy watershed escalated and remained heavy through the 1980s. Other habitat damage resulted after the 1964 flood.

Fishing pressure also continued to affect salmon and steelhead production. Ocean and Columbia River harvest began climbing again in the 1950s, and expanded through the 1960s and 1970s as the declining wild runs were replaced by hatchery production. Sport fishing on the Sandy River also rose steadily through the years.

FISH PRODUCTION

Generally, by 1950 salmon and steelhead runs in the Sandy River Basin had fallen to low levels. The following excerpts from Chester Mattson's report, *The Sandy River and Its Anadromous Salmonid Populations*, which was written for the Oregon Fish Commission in 1955 (Mattson 1955), may best describe the status of the runs in the early 1950s.

Spring Chinook *"During recent years the escapements into the mainstem and tributaries have not exceeded 1,500 spring chinook salmon. The calculated run up to the Marmot Dam during the spring of 1954 was in the neighborhood of 400 fish according to an Oregon State Game Commission report. In addition possibly 200 to 300 salmon had remained in the main river below. The range in recent years has been between 750 and 1,500 adult fish."*

Coho *"At present the (coho) runs probably do not exceed 2,000 to 3,000 adult fish, of which only a small and undetermined proportion spawn in the mainstem. Several hundred fish ascend annually above Marmot Dam and utilize areas of the upper watershed."*

Fall Chinook *"(Fall chinook spawning and rearing) has been limited in the lower 12 to 15 miles, more so with the dewattering of the main stem for 12 miles below Marmot Dam. Prior to the construction of this dam, several hundred fish had been observed within the lower several miles of the Salmon River. The maximum spawning escapement within the last eight years has been estimated at approximately 500 to 2,500 fish."*

Winter Steelhead *"In recent years considerable numbers (of steelhead), 2,200 fish in 1954, have ascended Marmot Dam and spawned in available areas above. Perhaps an equal number have utilized the suitable areas of the lower river below Marmot Dam."*

Data collected from a fish trap installed at Marmot Dam in 1953 provides further information about the runs after 1950. This data suggests that winter steelhead escapement above the dam increased after passage facilities were improved and egg-taking operations declined. Records from 1954 to 1958 show a five-year cumulative escapement of 11,241 winter steelhead passing Marmot Dam from March to June. About 97 percent (10,913) of the fish were determined to be wild (ODFW 1997). Winter steelhead escapement at Marmot Dam continued to increase in the early 1960s. From 1961 to 1965, the five-year cumulative escapement of winter steelhead passing Marmot Dam was 19,903 fish, of which about 75 percent migrated at the end of February (ODFW 1997).

Marmot Dam data, however, indicates that the basin's spring chinook and coho runs continued to drop for several years. Records show that spring chinook passage to the upper basin declined after 1950, sometimes dwindling near zero. A minimum of 336 adult spring chinook escaped annually to the Sandy River during the 1950s. This estimate reflects harvest in the lower basin and escapement at Marmot Dam. It does not include adult spring chinook that spawned in the lower river below Marmot Dam during this period. The dam counts fell to an average of 168 adults in the 1960s (ODFW 1997).

As discussed earlier, several factors contributed to these low returns. Trapping of adult spring chinook at Marmot Dam for hatchery brood stock continued through the 1950s. Many other adults were caught in commercial and sport fisheries in the ocean, Columbia River and lower Sandy River. In addition, reduced flows in the Sandy River below Marmot Dam until the 1970s may have restricted some adult spring chinook migration (ODFW 1997).

Conditions along the Sandy River and many tributaries — often already altered by road construction, timber harvest and other activities — changed again during and after the flood of 1964. At the flood's peak, the Sandy River contained about 82,000 cfs of flow at its confluence with the Columbia River. These high flows scoured and altered stream channels as they gushed through the watershed.

Post-flood channelization efforts boosted the damage. After the flood, the Army Corps of Engineers and local communities joined efforts and channelized several miles of the lower reaches of the Salmon, Zigzag and Sandy rivers and Still Creek. They channelized the Sandy River from the confluence with Clear Fork to the Sleepy Hollow area just upstream from the confluence with Alder Creek. The workers used heavy equipment to reconfigure and straighten the stream channels and remove most large obstructions and boulders from the streambeds. They built berms with rocks to contain the streambanks, destroying riparian vegetation along the streams and blocking many side channels.

While well intended, the channelization projects affected the timing, variability and duration of floodplain and wetland inundation in the area. They reduced biological productivity along the channelized stream corridors, and significantly degraded the quality of spawning and rearing habitat for native winter steelhead, coho, spring chinook, fall chinook, cutthroat and resident trout. The instream channelization work also lowered habitat complexity in the stream channels and blocked fish passage into many side channels that historically had provided substantial rearing and spawning habitat. These side channels and backwater areas had been especially important for winter-rearing juvenile anadromous fish, including juvenile steelhead, which would seek the slower velocities found in these areas and hide under large logs, undercut banks and other protected areas. The projects also increased flow velocities within the channelized reaches, which scoured spawning gravels from the streambed (ODFW 1997).

As natural salmon and steelhead production dropped, however, hatchery production increased. In the 1950s and early 1960s, hatchery production programs became more successful as the operators acquired new knowledge about fish culture. Fish propagators began feeding fish better diets and using improved fish rearing and release strategies. They also learned more about disease prevention and treatment. As a result, the hatchery fish were healthier and had a better chance of surviving than those released in the early 1900s.

In 1950, the Sandy River Hatchery was constructed on Cedar Creek, about ½ mile above its confluence with the Sandy River. The hatchery prevented fish passage to about five miles of habitat in upper Cedar Creek, but boosted artificial production in the Sandy basin. Initially, the hatchery's operators relied heavily on eggs shipped in from Bonneville and other hatcheries for their production. The facility began operating in 1951 with 2,009,000 fall chinook eggs and 250,000 coho eggs from the Bonneville Hatchery, and 530,530 spring chinook eggs collected near Marmot Dam. In 1952, hatchery operators collected 135,030 spring chinook eggs near Marmot Dam and brought in nearly 8.5 million fall chinook eggs from the Bonneville and Oxbow hatcheries. It also received 294,000 coho eggs from Bonneville Hatchery (Mattson 1955).

From 1954 until the early 1960s, hatchery personnel worked to rebuild the runs using primarily Sandy River stock and reduced shipments of other stocks into the system. During the next few years, they continued gathering spring chinook eggs below Marmot Dam. In 1954, they collected fall chinook at a rack near the mouth of the Bull Run River at Dodge Park. Coho eggs were gathered at Cedar Creek (Mattson 1955). Hatchery operators again started receiving fall chinook eggs from other hatcheries in the 1960s. Coho and spring chinook production continued to rely primarily on Sandy River brood stock through the mid-1960s. Winter steelhead were also raised at the hatchery for several years to support an early winter sport fishery.

Table 3. Egg collection in the Sandy River Basin, 1950-1960[6] (ODFW 1997)

Site	Year	Spring Chinook[7]	Fall Chinook	Steelhead	Coho
Marmot Dam	1950	597,520			
	1951	530,530			
	1952	135,030			
	1953	175,105			
Cedar Creek	1953				196,425
Marmot Dam	1954	502,480			
Bull Run River	1954		92,865		
Cedar Creek	1954			118,765	716,000
Marmot Dam	1955	10,280			
Bull Run River	1955		134,220		
Cedar Creek	1955			119,711	
Cedar Creek	1956	84,385	(F+S mixed)	108,245	
Bull Run River	1956		438,485		
Cedar Creek	1957	1,619,650	(F+S mixed)	404,800	
Bull Run River	1957		290,810		
Bull Run River	1958		126,872		
Cedar Creek	1958			116,567	
Cedar Creek	1959	81,256	184,237		
Cedar Creek	1960		494,078	29,000	
Gordon Creek	1960		16,457		

Since the late 1970s, the state has used the Sandy Hatchery exclusively to raise coho. Production of fall chinook, spring chinook and steelhead at the hatchery ended in 1976, 1975 and 1974, respectively. Spring chinook production at the hatchery was hindered because low flows in Cedar Creek during the migration period kept many adult spawners from returning to the station (ODFW 1997). Coho releases at the facility grew from a release of 250,000 smolts the first year to about 500,000-800,000 smolts, and then stabilized at 1 million smolts until 1995 (ODFW 1997). Today the Sandy Hatchery is used to raise early-run coho with brood stock gathered from adult hatchery returns. Most of the coho are released on-station as smolts.

As discussed earlier, several actions initiated after 1970 improved fish production in the basin. In 1973, Portland General Electric began maintaining minimum streamflows in the Sandy River below Marmot Dam to provide spring chinook and other fish with adequate water for upstream migration in summer and fall, and to support spawning and rearing below the dam. The company also adjusted flow diversions to reduce wide fluctuations in lower river streamflows and continued improving conditions at the dams to enhance upstream and downstream fish migration. Further, the Forest Service, Bureau of Reclamation and

6 Table includes data from several reports (Mattson 1955, Wallis 1966, Collin 1974, Pirtle 1953, Craig and Suomela 1940). Some discrepancies between reports exist.

7 Some mixing of fall and spring chinook eggs is possible.

others began improving habitat conditions and otherwise undoing damages caused by past timber harvest and by channelization efforts following the 1964 flood.

Larger releases of hatchery fish contributed to the growth of sport fisheries in the Sandy River Basin and on the Columbia River. Fish managers boosted hatchery releases of winter steelhead in the late 1960s as natural steelhead escapement to the basin dropped and interest in sport harvest increased. Then they introduced summer steelhead to the Sandy River in 1975, creating a very popular fishery in both the upper and lower river. They also raised hatchery releases of spring chinook and coho during the 1970s. Spring chinook releases expanded again in the 1980s when state fish managers launched an aggressive program to supplement the declining native spring chinook run with Willamette stock from the Clackamas Hatchery. Portland General Electric and the City of Portland provided funds for this program to compensate the state for fish losses at the dams.

CURRENT RUNS

Today, large numbers of winter steelhead, spring and fall chinook, coho, and summer steelhead still return to the Sandy River. However, the proportion of wild fish in these runs has dropped considerably over the years. The current runs are discussed briefly below.

Winter Steelhead

The Sandy River consistently rates as one of Oregon's top 10 winter steelhead producers. In recent years about 10,180 winter steelhead returned each year to the Sandy River. This average run, including both hatchery and wild fish, was estimated at 10,179 for run years 1987-1988 to 1991-1992 based on harvest in the lower river and escapement over Marmot Dam. During this period, anglers caught an average of 7,563 winter steelhead and about 2,616 adult winter steelhead escaped annually to upper basin spawning grounds. More recently, the number of adults passing Marmot Dam has ranged from a high of 2,918 fish for the 1991-1992 run year to a low of 537 fish for the 1995-1996 run year. Winter steelhead passage at the dam then increased, reaching 1,426 fish in the 1996-1997 run year (ODFW 1997).

Virtually every passable reach of the basin contains winter steelhead spawning habitat. In the upper basin, good winter steelhead production exists in the Salmon River system below Final Falls, and in Still Creek and many small upper basin tributaries. Production also occurs in turbid stream reaches such as the Muddy Fork of the Sandy River, the upper Sandy River and the Zigzag River where glacial flour is evident. Many steelhead also spawn and rear in the lower basin. Recent surveys show significant spawning in the lower Sandy River. However, little is currently known about winter steelhead populations in the lower basin (Cramer, personal communication 1998).

Information collected at Marmot Dam and from anglers suggests that the basin's wild winter steelhead run has declined over the years. Consequently, the National Marine Fisheries Service recently listed the stock as "Threatened". The Oregon Department of Fish and Wildlife manages wild Sandy River winter steelhead as a Stock of Concern.

Fish managers are currently addressing factors that might be limiting wild winter steelhead production in the basin. Their concerns include the possibility that introductions and straying of hatchery fish above Marmot Dam may be influencing the wild run. Until 1963, primarily wild winter steelhead escaped over Marmot Dam. However, in 1964 hatchery operators started releasing hatchery steelhead above the dam and hatchery stock escapement to the upper river increased. From the early 1980s to the early 1990s, the percentage of natives in the Sandy's total winter steelhead run declined from 28 percent to 18 percent. This suggests that introductions and straying of earlier returning hatchery stocks may be influencing the wild run (USFS 1996; ODFW 1994). Releases of summer steelhead since 1975 to provide a summer fishery above Marmot Dam may also be affecting winter steelhead production if summer steelhead smolts compete with native winter steelhead for space and food. Further, increased trout angling pressure in the upper basin may have increased mortality of incidentally caught juvenile winter steelhead. Currently, hatchery managers are releasing hatchery-produced winter steelhead below Marmot Dam to reduce mixing between the stocks and competition for habitat in the upper basin.

Coho Salmon

The Sandy River Basin supports two coho stocks: a native late-spawning stock (November-February) and an early-spawning hatchery stock (September-November). The basin's native coho population generally spawns and rears in the clearwater tributaries above Marmot Dam, though some production also occurs in the lower basin. Studies show that coho salmon prefer areas with low water velocities, such as low gradient small and medium-sized streams, side channels and the margins of mainstem rivers (ODFW 1997).

The upper watershed contains many miles of suitable coho habitat, particularly in the Wild and Scenic River segments of the basin and/or within the bounds of wilderness areas. Primary habitat exists in the Salmon River and tributaries below Final Falls, and in Still Creek. The mainstem Sandy River and side channels also support some coho production (ODFW 1997).

Coho counts at Marmot Dam suggest that the native run is stable, but has recently declined. The counts averaged 1,201 adults and jacks annually for the 10-year period 1985 to 1994. However, estimated coho escapement at the dam declined to an average of 794 fish for the five-year period 1991 to 1995, ranging from a high of 1,492 fish in 1991 to a low of 220 fish in 1993 (ODFW 1997). Native Sandy River coho are listed as sensitive by the State of Oregon. The National Marine Fisheries Service considers the native Sandy River coho stock a candidate species for listing and plans to review its status in 2001.

The basin's early returning coho run is produced at the Sandy Hatchery from native Sandy stock. Hatchery operators release about 700,000 hatchery coho smolts annually into the Sandy River. These releases support commercial and sport harvest in the ocean and Columbia River fisheries and sport angling in the Sandy River.

Spring Chinook

The Sandy's spring chinook population has increased significantly over the last 15 years, primarily due to hatchery releases in the watershed. In the early 1970s, fish managers started supplementing natural spring chinook production with hatchery releases of Willamette stock smolts and pre-smolts. They expanded the releases in the 1980s. Currently, they release about 460,000 hatchery spring chinook smolts annually in the Sandy River. The estimated five-year average return for run years 1990 to 1994 was 5,118 fish.

Presently it is unknown whether the indigenous stock of Sandy River spring chinook has sustained itself as a separate subpopulation from the introduced Willamette stock (ODFW 1997). Genetic research is currently under way to learn if a wild Sandy River spring chinook stock exists. Meanwhile, since 1994 fish managers have tried to promote natural spring chinook production in the upper basin by releasing all hatchery spring chinook below Marmot Dam. Currently, the National Marine Fisheries Service is considering listing all wild lower Columbia River chinook, including wild Sandy River spring chinook, as Threatened.

Most naturally producing Sandy River spring chinook spawn in the upper watershed above Marmot Dam. Primary spawning areas include the Salmon River up to Final Falls (RM 14) and the lower three miles of Still Creek. Spring chinook also spawn in the Zigzag River, upper Sandy River and the lower reaches of several tributaries when flows permit. Generally, chinook salmon prefer large pools in low gradient areas within the mainstem and large tributaries. They are not usually found in smaller tributaries or side channels (ODFW 1997).

Summer Steelhead

In 1975, fish managers began releasing summer steelhead in the basin, creating a popular sport fishery. Past observations suggest that a small native run may have existed prior to these releases. For instance, in the 1950s (before hatchery releases were initiated) a few steelhead were found in the Bull Run River during September and October. A few steelhead were also counted passing Marmot Dam during these same months in the 1960s and 1970s. Managers do not know whether the fish were native to the Sandy River, strays from other lower Columbia River tributaries, or late-returning winter steelhead that had stayed in pools below the dam until flows for migration improved. Angling reports from the 1950s also show some steelhead being caught in the Sandy River (ODFW 1997).

Today, the summer steelhead run provides angling opportunities from April to December. The fish are currently released in the Zigzag, Salmon, and Sandy rivers. Until recently, they were also released in Still Creek. During the five-year period from 1989-1990 to 1993-1994, an average of 4,544 summer steelhead returned annually to the Sandy River. The run ranged from a high of 6,994 fish in 1992-1993 to a low of 3,142 fish in 1993-1994. These returns reflect angler punch card data and Marmot Dam counts (ODFW 1997).

Fall Chinook

Sandy River fall chinook are divided into two runs — a wild late-maturing run and an early-maturing "tule" run. The wild late-maturing population is the dominant fall chinook run to the Sandy. The run is considered depressed but stable, and like all lower Columbia River chinook, is regarded as a sensitive species by the State of Oregon. The National Marine Fisheries Services is considering listing all lower Columbia River chinook, including wild Sandy River spring and fall chinook, as Threatened. The early-maturing tule run consists of a few to several hundred fall chinook that return each year to the Sandy River to spawn. These fish are believed to be remnants of hatchery releases made before 1977 or strays from other systems. No hatchery fall chinook have been released in the Sandy or its tributaries since 1976 (ODFW 1997).

Between 1984 and 1994, an average of at least 1,503 fall chinook returned to the Sandy River. This estimate, based on redd counts and sport harvest data, is considered a minimum run size. Actual spawning escapement to the basin was probably higher in most years since some spawning also occurs outside the standard survey areas. Fall chinook spawn in the lower Sandy River near Oxbow Park and in lower tributaries, including Gordon and Trout creeks. Like spring chinook, they generally prefer large pools in low gradient areas within the mainstem and large tributaries.

Resident Fish

The Sandy River Basin also contains several resident fish populations, including cutthroat trout, rainbow trout, whitefish, and brook trout. These populations are discussed briefly below.

Cutthroat trout are the most common trout species in the basin and are native to the Sandy River. Currently, the basin supports both resident and anadromous forms of cutthroat. Resident cutthroat trout are generally abundant in the Sandy's smaller and average-sized tributaries. Production of anadromous cutthroat in the basin is now believed to be very low, but reports by past anglers suggest that sea-run cutthroat once provided a significant sport fishery in the lower basin (ODFW 1997). Currently, fish managers only release hatchery cutthroat in the basin's isolated high mountain lakes.

Rainbow trout are also native to the Sandy River Basin. They are currently found in the mainstem and many larger tributaries throughout the watershed, including the Bull Run River. Rainbow usually reside below barriers to anadromous fish, but some tributaries also contain small populations above barriers. Until 1997, hatchery rainbow were released in several tributaries of the Sandy to provide angling opportunities. Since 1997 these releases have been limited to standing water bodies to protect the wild rainbow population.

Studies in the basin show that rainbow occasionally mate with cutthroat trout. During a genetics study conducted in 1994 and 1995, researchers documented hybridization between resident cutthroat and rainbow trout in some upper basin tributaries (ODFW 1997).

Mountain whitefish are indigenous to the Sandy River Basin. They reside in the Sandy River and most large tributaries. The basin's mountain whitefish population is considered healthy and stable.

Brook trout are not native to Oregon. They entered the basin during the late 1800s when they were released in several high mountain lakes and a few streams to provide angling opportunities. Recently, brook trout have been observed in Mud Creek above and below Trillium Lake. They are believed to be descendants from early hatchery releases in Trillium Lake. They have also been documented in the upper Salmon River and in the lower reaches of Ghost Creek. These populations probably originated from hatchery releases made in the upper Salmon River near Highway 26. In the past, brook trout have also been found in Camp Creek, a tributary of the Zigzag River, and in the Little Sandy River above RM 13.3. These brook trout populations are not being encouraged. Currently, flowing waters in the basin are managed to enhance native trout production (ODFW 1997).

SUMMARY

At the turn of the century, the Sandy River supported runs of spring chinook, fall chinook, coho, steelhead and chum. Today, except for chum, these fish still return to the river — though the runs are far below historic levels. Comparisons of records from an old hatchery within the Salmon River watershed, along with recent spawning surveys in the Salmon and Zigzag watersheds, suggest that current spawning returns are only 10-25 percent of 1890s levels, which were already reduced by decades of heavy fishing (USFS 1996). In addition, hatchery-produced fish now make up a large percentage of the basin's winter steelhead, coho and spring chinook runs.

As discussed previously, many factors have influenced salmon and steelhead production in the Sandy River Basin during the last 150 years, including;

- Overharvest in commercial and sport fisheries
- Habitat degradation from logging, agricultural practices, mining and road development
- Lost natural production from egg-take operations at various sites in the basin since the late 1800s
- Loss of historically significant habitat due to municipal water supply development in the Bull Run Basin
- Flow and fish passage restrictions from hydroelectric operations and diversions at Marmot Dam and the Little Sandy dam
- Habitat losses during and after the 1964 flood
- Competition from introduced hatchery fish.
- Habitat alterations due to naturally occurring fires and large climatic changes.

Now, efforts are under way to restore the basin's native fish populations while maintaining fishing opportunities inside and outside the Sandy River Basin. Fish managers are reviewing releases of hatchery winter steelhead, spring chinook, and coho to reduce competition between hatchery and wild fish. They are also restricting some angling opportunities, primarily in the upper basin, to protect the wild runs. At the same time, various public and private interest groups are working with basin habitat managers to improve spawning and rearing conditions in the upper basin above Marmot Dam. Projects are also ongoing to improve upstream and downstream fish migration past Marmot Dam and to reopen side channels and other lost historic habitat areas. Further, managers are examining opportunities to restore salmon and steelhead access to the upper Little Sandy River and Cedar Creek drainages and are weighing potential gains of such actions against the impacts on existing programs.

Several key events influenced the basin's salmon and steelhead runs after 1950, including the following:

Key Events and Developments After 1950

1950	Road development increases in upper basin to provide access to potential timber harvest areas.
1950	Sandy River Hatchery completed.
1951	Sandy river Hatchery begins operating.
1951	PGE screens Sandy River diversion canal and constructs juvenile bypass facility in the Marmot Dam diversion canal.
1955	Egg-taking operations at Marmot Dam cease. Salmon and steelhead runs regain access to upper basin habitat.
1960	Road development continues in the upper basin.
1961	Hatchery releases increased to rebuild coho runs in the upper watershed.
1964	Floodwaters scour and alter stream channels as they gush through the watershed. Channelization projects on the lower Salmon, Zigzag and Sandy rivers and Still Creek further reduced fish habitat in the basin.
1965	Winter steelhead escapement drops after rebounding since 1950. The drop is largely attributed to the flood and channelization efforts and/or overharvest.
1970	Spring chinook production in the basin increases substantially after fish managers start an aggressive hatchery production program.
1974	Minimum streamflows are maintained in the Sandy River below Marmot Dam to provide fish passage and increase rearing areas.
1983	PGE rebuilds the fish ladder at Marmot Dam and installs a fish counter.

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REFERENCES

Bennett, Donald E. 1997. 1995 Willamette River Spring Chinook Salmon Run. Oregon Department of Fish and Wildlife, Columbia River Management. March 1997.

Burtchard, Greg C.; Werth, Dennis R.; Snyder, Sandra L. 1993. Clackamas Wild and Scenic River Cultural Resource Inventory Project. Report for U.S.D.A. Forest Service, Mt. Hood National Forest. January 1993.

Cramer, D.P. 1993. Evaluation of the Marmot Dam canal downstream migrant bypass system, final report. Portland General Electric. 1993.

EDAW, Inc. 1998. PGE Westside Projects Cultural Resources Study, Draft Report. February 1998.

Eicher, George J. 1977. Clackamas Dams and Anadromous Fish. A History of Fish and Dams on the Clackamas River in Oregon. Portland General Electric Company. July 1977.

Ellis, David V. 1997. Cultural Resources Survey of the Proposed Timber Park Trail, Estacada, Oregon. Archaeological Investigations Northwest, Inc. Report for Portland General Electric. July 2, 1997.

Farnell, James E., Ph.D., Division of State Lands. 1979. Clackamas River Navigability Study. February 1979.

Hubbard, W.F. 1898. Report from Clackamas Station, Oregon and on Upper Clackamas station. Report of Commissioner of Fish and Fisheries, 1898.

Lichatowich, James A. and Moband, Lars E. 1995. Analysis of Chinook Salmon in the Columbia River from an Ecosystem Perspective. Prepared for Bonneville Power Administration. January 1995.

Lynch, Vera Martin. 1973. Free Land for Free Men; A Story of Clackamas County. Artline Print, Portland, Oregon. 1973

Loy, W.G. 1976. Atlas of Oregon. University of Oregon, Eugene.

Massey, Jay and Keeley, Pat. 1996. Fish Management Review, Columbia Region. Lower Willamette Fish District, ODFW. April 3, 1996.

Mattson, Chester R. (c1950). Abstracts and Notes from Reports of U.S. Commission of fish and Fisheries and Successors Regarding Operations on Clackamas River, 1877- 1902. Report written for Oregon Fish Commission.

Mattson, Chester R. 1955. Sandy River and Its Anadromous Salmonid Populations

McAurthur, 1982. Oregon Geographic Names.

McGuire. 1894. Second annual report of the fish and game protector to the Governor.

Northwest Power Planning Council. 1987. Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin, Appendix D of the 1987 Columbia River Basin Fish and Wildlife Program. March 1987.

Oregon Department of Fish and Wildlife. 1997. Draft Sandy River Basin Fish Management Plan. 1997.

Oregon Department of Fisheries. 1909. Annual Report of Master Fish Warden for 1907 and 1908.

Oregon Department of Fisheries. 1911. Annual Report of Master Fish Warden for 1909 and 1910.

Oregon Department of Fisheries. 1913. Report of Master Fish Warden for 1912.

Oregon Department of Fisheries. (c1990). Summary of Columbia River Fish Culture.

Oregon Fish Commission. 1889-1890. Third and Fourth Annual Reports to the Governor of Oregon.

Oregon Fish Commission. 1960. Environmental Survey Report Pertaining to Salmon and Steelhead in Certain Rivers of Eastern Oregon and the Willamette River and its Tributaries.

Oregon Game Commission. 1951.

Oregon Water Resources Institute. 1995. Gravel Disturbance Impacts on Salmon Habitat and Stream Health. Prepared for the Oregon Division of State Lands. April 1995.

The Oregonian, 1940. Articles in Portland, Oregon newspaper — The Future of the Sandy and Sandy Hatchery Action Due Soon. March 18, 1940.

Portland Bureau of Water Works. 1926. Annual Report of the Superintendent of the Bureau. 1926.

Portland General Electric (PGE). 1982. History of Portland General Electric Company 1889-1981. March 1982.

PGE. 1989. Bringing Power to Ideas, 1989.

PGE. 1997. Fish Runs and the PGE Hydroelectric System. February 1997.

Seaman, N.G. 1946. Indian Relics of the Pacific Northwest.

Strong, Emory. 1973. Sandy Pioneers, Early Settlers and Barlow Road Days.

U.S. Commission of Fish and Fisheries. 1877. Report of Commissioner, 1877.

U.S. Commission of Fish and Fisheries. 1895. Report on Clackamas County, Fisheries of the Pacific Coast in 1895. Report of Commissioner.

U.S. Commission of Fish and Fisheries. 1899. Report on Clackamas Station. Report of Commissioner, 1899.

USDA-Forest Service, Mt. Hood National Forest. 1988. Draft Environmental Impact Statement and Proposed Land and Resource Management Plan for Mt. Hood National Forest. 1988.

USDA-Forest Service, Mt. Hood National Forest. 1993. Upper Sandy National Wild and Scenic River, Environmental Assessment. December 1993.

USDA-Forest Service, Mt. Hood National Forest. 1994. Upper Sandy National Wild and Scenic River, Management Plan. March 1994.

USDA-Forest Service, Pacific Northwest Region. 1996. Upper Sandy Watershed Analysis. Mt. Hood National Forest. 1996.

USDA-Forest Service, Pacific Northwest Region. 1997. Bull Run Watershed Analysis. Mt. Hood National Forest. 1997.

USGS-U.S. Geological Survey. 1996. Geological Survey-Water Data Report. OR-96-1.

Wallis, Joe. 1962. An Evaluation of the Sandy River Salmon Hatchery.

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PGE
Portland General Electric Company
121 SW Salmon Street • Portland, Oregon 97204

March 17, 2003

Dr. Frank Winchell
Federal Energy Regulatory Commission
888 First Street, N.E. (Room 61-10)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

Where the requested material contains sensitive cultural resources information, two copies are provided directly to you as specified in the submittal instructions.

If you have any questions regarding this filing, please do not hesitate to contact me directly at (503) 464-8864.

Very truly yours,

Julie A. Keil, Director
Hydro Licensing and Water Rights

Encls.

Portland General Electric Company
121 SW Salmon Street • Portland, Oregon 97204

March 17, 2003

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Federal Energy Regulatory Commission
888 First Street, N.E. (Room 61-10)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

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Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

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March 17, 2003

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Federal Energy Regulatory Commission
888 First Street, N.E. (Room 61-10)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

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March 17, 2003

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Federal Energy Regulatory Commission
888 First Street, N.E. (Room 61-10)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

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March 17, 2003

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Federal Energy Regulatory Commission
888 First Street, N.E. (Room 61-10)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

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March 17, 2003

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888 First Street, N.E. (Room 61-10)
Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

Dear Dr. Winchell:

This letter provides that material requested to be sent to you within 30-days as specified in Schedule A, item A (2) of FERC's Request for Additional Information letter to PGE dated February 21, 2003.

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Washington, D.C. 20426

Re: Bull Run Hydroelectric Project,
Project No. 477
Additional Information Request Materials

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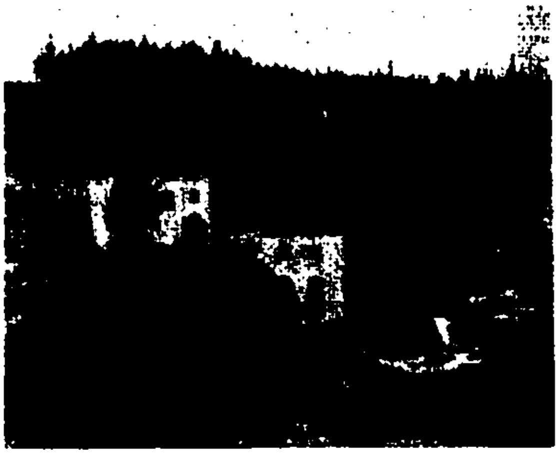
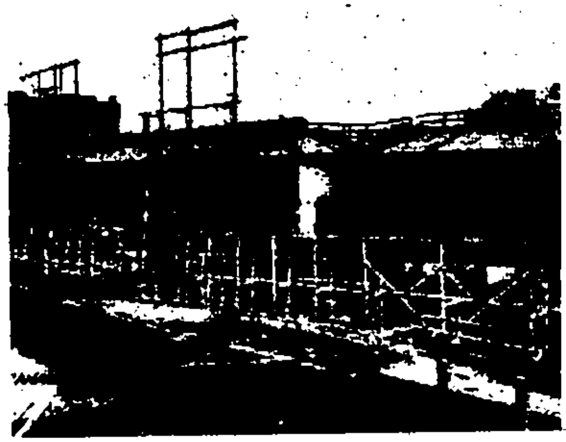
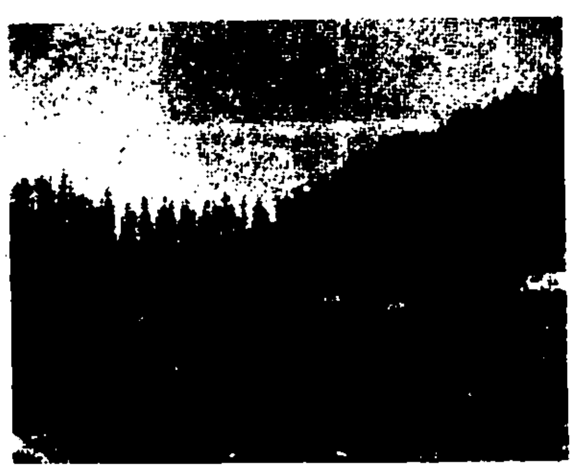


Portland General Electric
Westside Hydroelectric Projects

Cultural Resources Management Guide





EDAW Team
April, 1998

CULTURAL RESOURCES MANAGEMENT GUIDE

Portland General Electric Westside Hydroelectric Projects

Prepared by
EDAW, Inc.
1505 Western Ave.
Seattle, WA 98112

Prepared for
Portland General Electric
121 SW Salmon
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April, 1998

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Appendix A: Constraints on Alterations to PGE Westside Hydroelectric Project Structures and Components

List of Abbreviation and Acronyms

ARPA	Archaeological Resources Protection Act
DOE	Determination of Eligibility
CFR	Code of Federal Regulations
CRIS	Cultural Resources Information System
CRMG	Cultural Resources Management Guide
CRMP	Cultural Resources Management Plan
CRMS	Cultural Resource Management System
FERC	Federal Energy Regulatory Commission
HABS	Historic American Buildings Survey
HPC	Historic Preservation Coordinator
NR	National Register
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
MOA	Memorandum of Agreement
MPS	Multiple Property Submission
ORS	Oregon Rules and Statutes
PGE	Portland General Electric
SHPO	State Historic Preservation Officer
TCP	Traditional Cultural Property

1.0 INTRODUCTION

Portland General Electric (PGE) has conducted a survey of cultural resources at four hydroelectric projects, collectively known as the PGE Westside Projects. These projects include and the Bull Run Hydroelectric Project, the Willamette Falls Hydroelectric Project, and two projects along the Clackamas River (the North Fork Project, which includes the North Fork Development, the Faraday Development, and the River Mill Development, and the Oak Grove Hydroelectric Project).

This section describes the purpose of the PGE Westside Projects Cultural Resources Management Guide (CRMG), identifies the users of the Guide, provides goals and objectives for cultural resource protection, and describes the project locations. Section 2.0 identifies the historic resources and assigns various levels of constraints depending on their level of historic significance. This section also provides management guidelines and review procedures for the PGE Westside cultural resources, as well as sample project modifications. Section 3.0 provides a management guide for archeological resources. Finally, Section 4.0 describes the PGE Cultural Resources Management System (CRMS).

1.1 Purpose of the CRMG

Under the National Historic Preservation Act (NHPA) of 1966 and as part of the relicensing effort regulated by the Federal Energy Regulatory Commission (FERC), PGE recognizes the need to identify, protect, and preserve cultural resources associated with its Westside Projects. Cultural resources are defined as historic resources (buildings, structures, sites, objects, or districts), archeological resources, and traditional cultural properties (TCPs). As an initial part of the relicensing effort, PGE conducted a cultural resources study in 1997-8 for its Westside Projects. The purpose of this study was to identify and assess the significance of cultural resources found on PGE Westside Project lands which may be eligible for listing in the National Register of Historic Places (NRHP). The culmination of this effort was three documents: 1) PGE Westside Cultural Resources Study - T.W. Sullivan Hydroelectric Project, 2) PGE Westside Cultural Resources Study - Bull Run Hydroelectric Project, and 3) PGE Westside Cultural Resources Study - Clackamas River Hydroelectric Project (PGE 1998). The NHPA also requires that all federally licensed entities, such as PGE, address the effects of their operations on cultural resources that may be eligible for listing in the National Register. The purpose of this Guide is to address the management of the projects' operation to avoid effects on the cultural resources identified in the initial study. This Guide establishes general guidelines and review procedures for protecting cultural resources, and outlines consultation proceedings with the appropriate agencies.

This Guide will serve as an interim document until a Cultural Resources Management Plan (CRMP) is written. The CRMP, to be written as part of the application for a new license and to fulfill the legal obligations of FERC and the NHPA, will incorporate the guidelines and review procedures described in this Guide.

1.2 Intended Users of the Cultural Resources Management Guide

The intended users of the CRMG are the plant managers of the various PGE Westside Projects who make the day-to-day decisions about facility upgrades, modifications, and maintenance projects which may affect historic and archeological resources. In addition, this Guide will provide PGE management with the tools to evaluate a proposed project's effects on cultural resources before actual implementation. Finally, this Guide is intended to assist maintenance staff and field crews in appropriate maintenance practices related to the protection of cultural resources.

1.3 Goals And Objectives

The purpose of the CRMG is to outline PGE's plans for meeting cultural resource management goals for protecting and preserving the historic resources associated with the projects while meeting the operational objectives of the projects.

PGE has two primary cultural resource management goals for the Westside Projects. The goals are listed below:

- Minimize the potential for effects on cultural resources from operation and maintenance of the existing projects;
- Avoid or mitigate impacts on cultural resources from proposed modifications to the project, including construction staging areas and construction activities.

1.4 Project Location and Description

The PGE Westside Projects include four hydroelectric plants and their associated components or facilities, which were studied as an entire system (see Table 1). In order from east to west, they are: 1) the Willamette Falls Hydroelectric Plant, 2) the Bull Run Hydroelectric Project, and 3) the Clackamas River Hydroelectric Projects (which include two hydroelectric projects). Each project is described briefly in the sections that follow.

Table 1. Components and Associated Features of the PGE Westside Hydroelectric Projects

Project Name	Components and Associated Features
Willamette Falls Hydroelectric Project	T.W. Sullivan Plant
	Dam
	Forebay
	Fish Ladder
	Smurfit Powerhouse
	West Linn Paper Co. Grinder Rooms No. 2 and 3
Bull Run Hydroelectric Project	Powerhouse
	Transformer Building
	Machine Shop
	Big Sandy Dam (Marmot Dam)
	Little Sandy Dam
	Forebay (Roslyn Lake)
	Penstocks/Surgetanks
	Canal/flume/tunnel system, and flume maintenance area
	Roslyn Lake Park Structures
Clackamas River Hydroelectric Projects	
River Mill Hydroelectric Development	Powerhouse/gatehouse
	Dam
	Forebay
	Fish ladder
	River Mill Park and Structures
Faraday Hydroelectric Development	Powerhouse
	Machine shop
	Faraday Dam
	Forebay (Faraday Lake)
	Penstocks
	Vehicular Bridge
North Fork Hydroelectric Development	Powerhouse
	Dam
	Forebay (N. Fork Reservoir)
	Fish ladder
Oak Grove Hydroelectric Project	Powerhouse
	Machine Shop
	Three Lynx Housing

Table 1 continued

Project Name	Components and Associated Features
Oak Grove Hydroelectric Project (continued)	Transmission line to Faraday
	Penstocks/surge tanks/pipelines
	Frog Lake (Forebay)
	Lake Harriet and diversion dam
	Timothy Lake Complex

1.4.1 Willamette Falls Hydroelectric Project

The T.W Sullivan Hydroelectric Plant, built in 1895, is located in Oregon City, Oregon, on the western shore of the Willamette River adjacent to Willamette Falls (see Figure 1). The plant is within a larger industrial complex that includes pulp and paper mills and other industrial facilities. The study area for cultural resources includes all operational buildings and structures related to the Willamette Falls Hydroelectric Project, including a low head concrete dam, forebay, penstocks, the powerhouse containing turbines and generators, a step-up transformer, switchgear, and associated mechanical and electrical facilities. The study area also includes the east side of Willamette Falls, including the Smurfit Powerhouse, and other PGE-owned lands that are historically connected to the Willamette Falls Project. The total acreage for the entire study area encompasses approximately 95 acres.

1.4.2 Bull Run Hydroelectric Project

The Bull Run Hydroelectric Project, built 1906 - 1913, is located on the Bull Run River approximately 1.5 miles northeast of the town of Sandy, Oregon and about 30 miles east of Portland (see Figure 2). The study area for cultural resources includes all operational buildings and structures including diversion dams on the Sandy River (Marmot) and the Little Sandy River, a forebay (Lake Roslyn), two penstocks, a powerhouse with a total installed capacity of 21,000 kilowatts, a transformer building, a switchyard, a transmission line, and appurtenant facilities on a project site of approximately 600 acres. Also part of the study area are the project's elaborate system of canals, flumes, and tunnels, as well as the park structures associated with Roslyn Lake Park.

1.4.3 Clackamas River Hydroelectric Projects

The projects within the Clackamas River system, which were built from 1907 - 1958, are the Faraday Hydroelectric Development (1907), the River Mill Hydroelectric Development (1911), the Oak Grove Hydroelectric Project (1921-

24), and the North Fork Hydroelectric Development (1956-58). These projects extend along the Clackamas River from the town of Estacada, Oregon, approximately 25 miles southeast from Portland to Timothy Lake near the headwaters of the Oak Grove Fork of the Clackamas River, approximately 70 miles from Portland (see Figure 3). Included in the Oak Grove Hydroelectric Project are the Three Lynx Housing area, the Oak Grove Powerhouse, Frog Lake, Lake Harriet, Timothy Lake, the transmission line that runs from Oak Grove to Faraday for 18.7 miles, as well as the extensive system of pipelines which stretch for approximately 15 miles through the Mt. Hood National Forest.

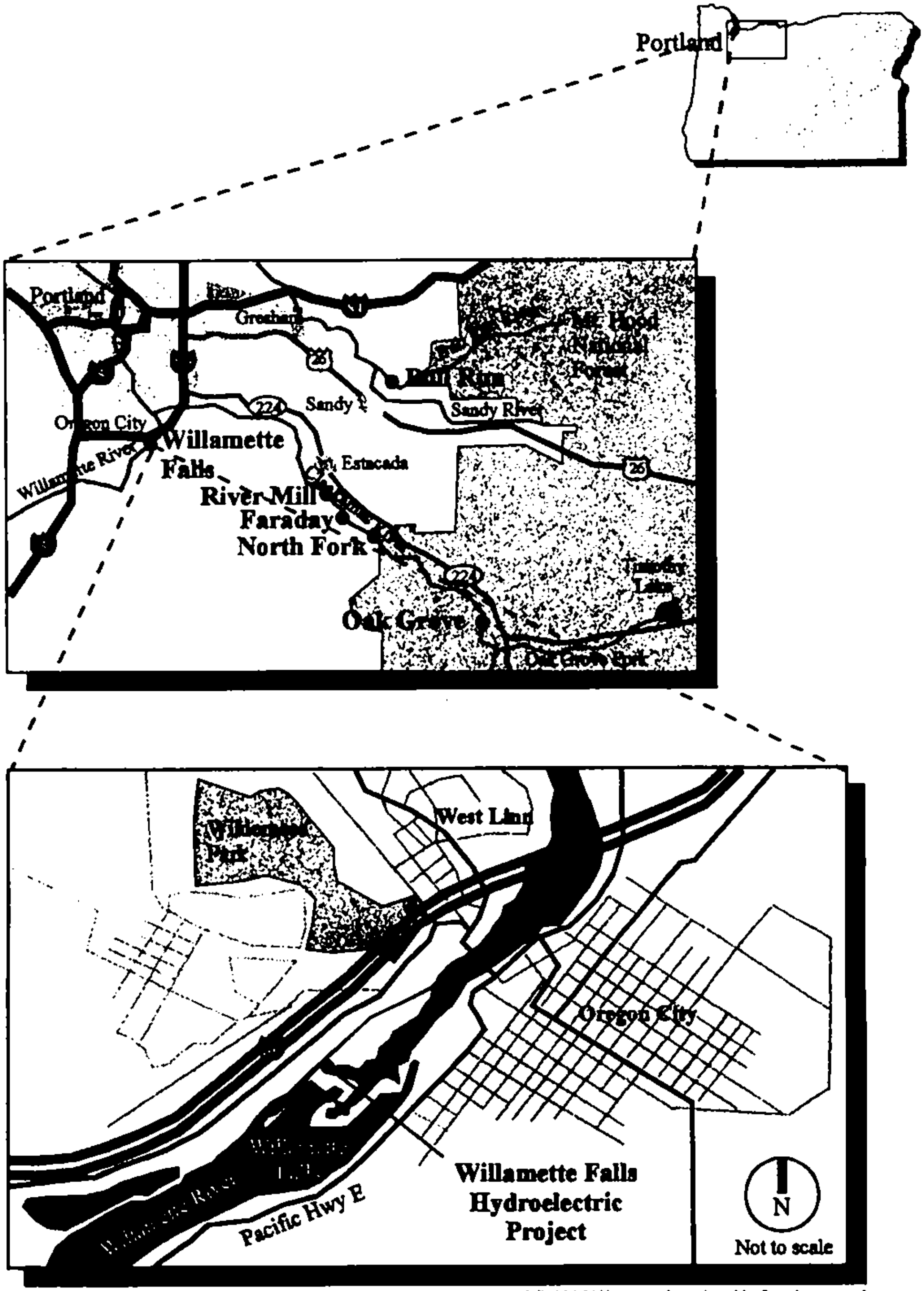

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Figure 1. Location of the Willamette Falls Hydroelectric Project

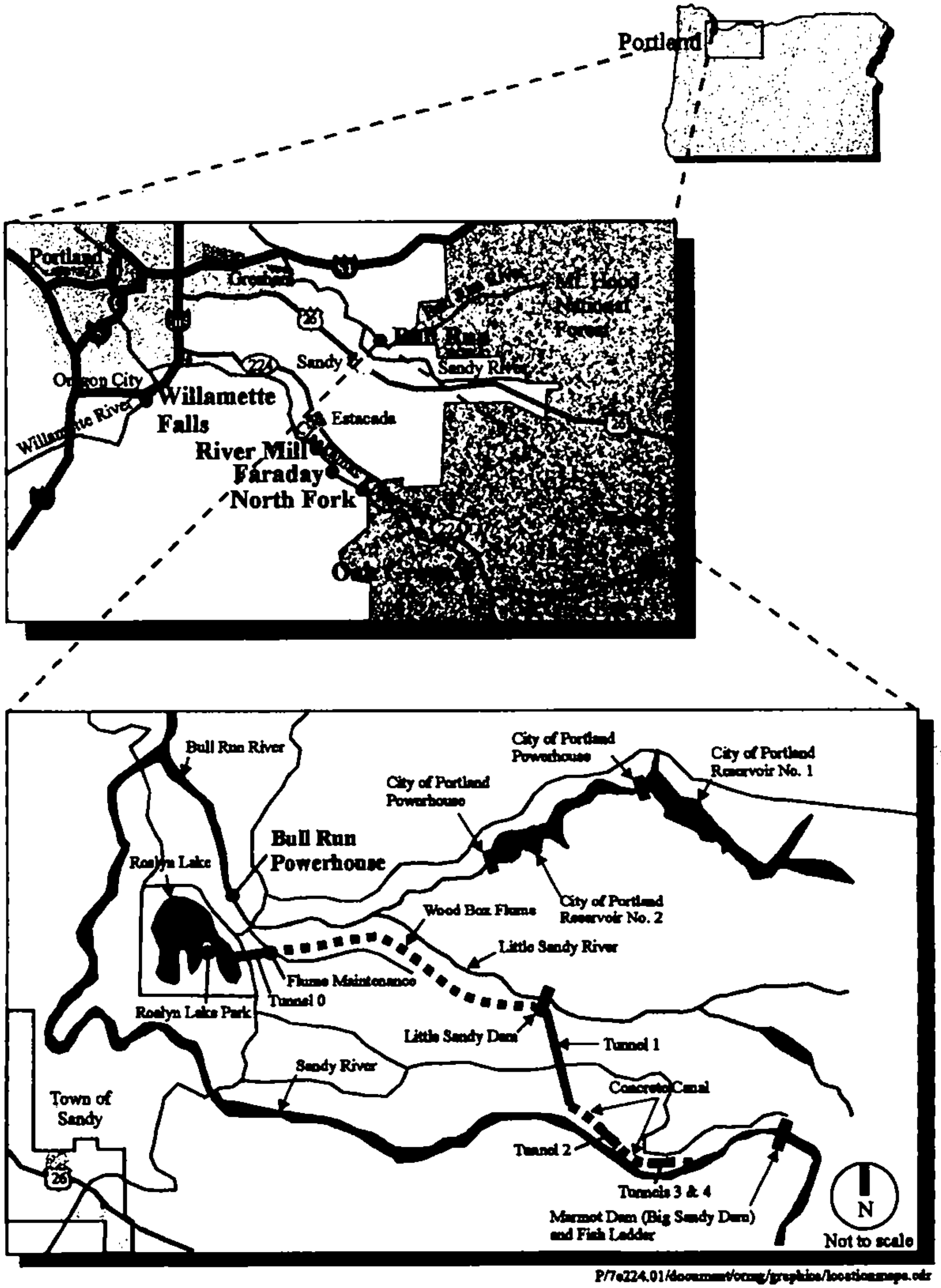


Figure 2. Location of the Bull Run Hydroelectric Project

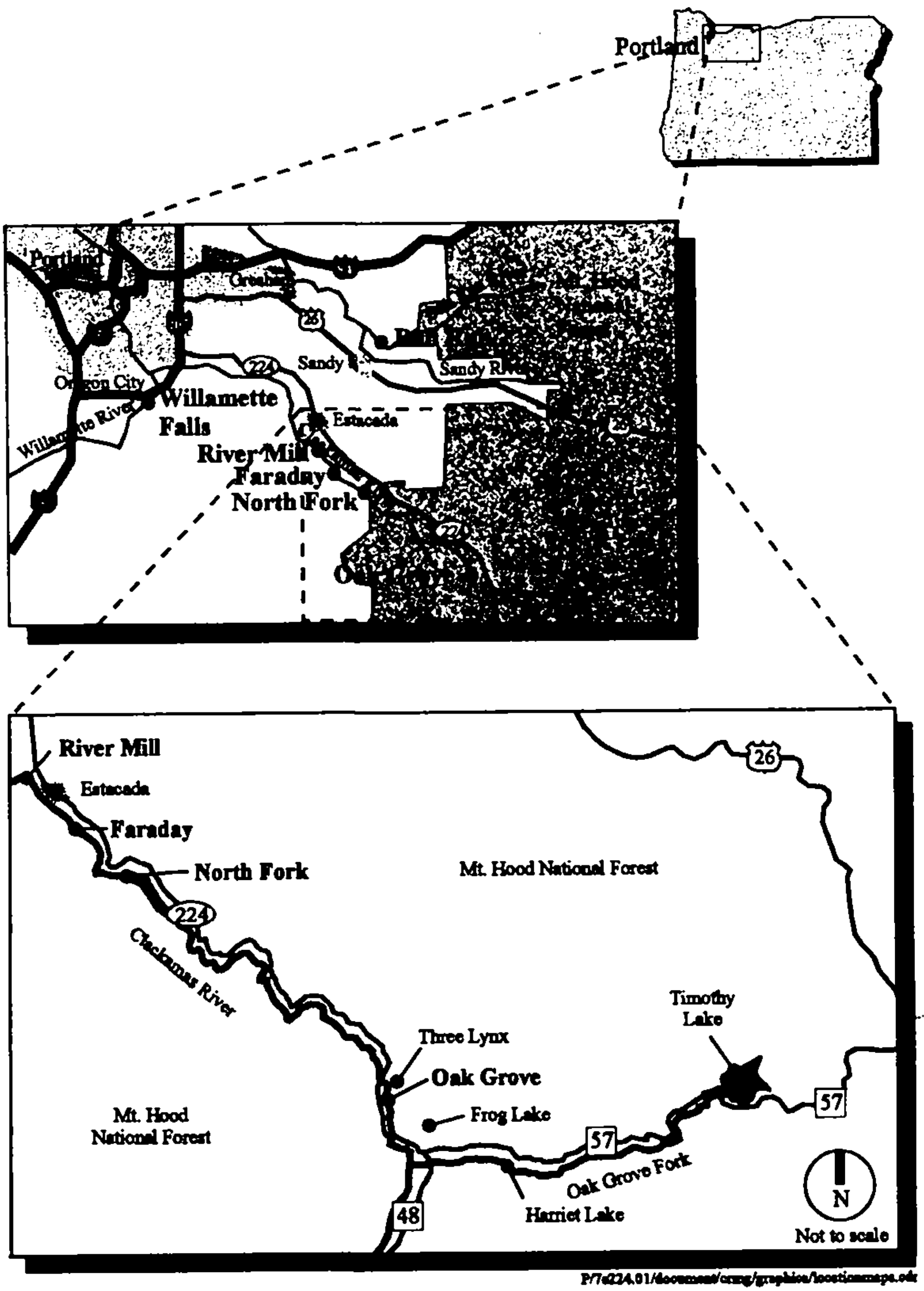


Figure 3. Location of the Clackamas River Hydroelectric Projects

2.0 MANAGEMENT OF HISTORIC HYDROELECTRIC FACILITIES

This section includes a discussion of the eligibility of the PGE Westside Hydroelectric Projects for listing in the National Register of Historic Places (NRHP), and assigns various levels of constraints depending on their level of historic significance. This section also provides management guidelines and review procedures for the PGE Westside Projects cultural resources, as well as sample project modifications.

2.1 Eligibility for Listing in the National Register

The PGE Westside Cultural Resources Studies (PGE 1998) made three broad recommendations regarding the potential eligibility for listing in the NRHP, as described below. Please refer to the three cultural resources documents for further descriptions of eligibility criteria as defined by the NRHP.

1. The Willamette Falls Hydroelectric Project includes a number of resources in the immediate area that are linked historically. These include the T. W. Sullivan Plant, the dam at Willamette Falls, the fish ladder, the Smurfit Powerhouse on the east side of the Falls, and the West Linn Paper Company buildings directly adjacent to the Plant.

   The T.W. Sullivan Plant was completed in 1895 as Station B of the pioneer Portland-area electric utility, the Willamette Falls Electric Company. Renamed and modernized in 1953, the building remains the oldest hydroelectric generation facility in Oregon and is one of the longest (possibly the longest) continuously operating powerhouse in the western United States. With strong connections to the earliest days of electric generation and representing pioneer firms and individuals significant within the history of electrical technology, the Sullivan Project played a pivotal role in the history of Portland and the upper Willamette Valley area. As the single largest provider of electricity in that area from 1895 to the opening of the first of the Clackamas River plants in 1907, ***the T.W. Sullivan Hydroelectric Plant [Station B] is considered eligible for listing in the National Register of Historic Places under Criterion A.***

   The dam and fish ladder at Willamette Falls represent the latest of the series that have existed at these locations and are historically associated with the Willamette Falls Hydroelectric Project. The dam, which is at least 50 years old or older, is considered eligible to the National Register of Historic Places under Criterion A. While the fish ladder also represents the latest a series that have existed at this location, it was constructed in 1966-1971 and does not currently meet the age requirement for eligibility. For this reason, the fish ladder is not considered eligible for listing in the National Register.

The Smurfit Powerhouse on the east bank of the Willamette River occupies the general site of Station A, Oregon's first hydroelectric plant. The Powerhouse was constructed in 1916 to provide power for the Hawley Pulp and Paper Company (now Smurfit Paper). It appears likely that the Powerhouse will prove eligible for listing in the National Register under Criterion A due to its age, its long-term operation, and relatively high integrity. However, additional research will be required to completely document the historic development and potential significance of the entire hydroelectric and paper mill development on the east bank of the Willamette River which includes the Smurfit Powerhouse. The West Linn Paper Company buildings directly adjacent to the T.W. Sullivan Plant have already received a Determination of Eligibility (DOE) by the Oregon SHPO.

2. The Bull Run Hydroelectric Project was first designed by the Mt. Hood Railway and Power Company in 1906 and was completed in 1912-1913 following the acquisition of that company by Portland Railway Light & Power Company, a predecessor to the present owner. The construction and operation of the Bull Run Project had a significant effect on the cities and towns along the Portland-Gresham to Bull Run electric trolley line that it created. A non-historic recreational facility at Lake Roslyn (the project forebay) was constructed between 1956 and the mid-1960s, and provides a popular boating and fishing area. For its significant role in the development of Clackamas County and its relationship to both the Mt. Hood Railway and Power Company and the important transportation line that it brought to this area for much of the first half of the 20th century, ***the Bull Run Hydroelectric Project is considered eligible to the National Register of Historic Places under Criterion A.***

3. The four individual generation facilities that constitute the Clackamas River Hydroelectric Projects developed by PGE and its corporate predecessors are significant under Criterion A of the standards for eligibility to the National Register of Historic Places. Evaluated under the guidelines for Multiple Property Submission, the resources of the Clackamas Projects demonstrate significance in the areas of engineering and technology and, more importantly, within the broad theme of regional settlement, transportation, commercial, and urban development. ***The Clackamas River Hydroelectric Projects are***

considered eligible as a Multiple Property Submission to the National Register of Historic Places as a collection of hydroelectric generation facilities and related support structures that provided the majority of power to Portland and the Upper Willamette Valley during an era of crucial growth. Additionally, the Clackamas River Hydroelectric Projects provided the power source for the urban transportation system allowing the expansion of settlement in the Clackamas Valley and the areas east of Portland.

2.2 Historic Resource Assessment

The six hydroelectric facilities as a system are recommended eligible for listing in the NRHP based on the rationales summarized in Section 2.1. Table 2 lists the hydroelectric developments and identifies those specific buildings and structures which fall into one of three categories, described below.

- Primary Historic - buildings or components that were constructed before the primary period of significance (1893-1935) and contribute directly to the project's historic significance;

- Secondary Historic/Compatible - buildings or components that were constructed after the primary period of significance (post-1935) but were constructed in a manner compatible with their historic counterparts. This category also includes those resources that fall into the secondary, post-war period of significance (1953-1958); and

- Non-Historic - buildings or components that were constructed after the primary period of significance and were not constructed in a manner compatible with their historic counterparts.

The historic assessments provided below categorize all the PGE Westside Projects hydroelectric buildings and components into the three categories listed above. As this Guide is an interim document with further historical research to be conducted as part of the relicensing process, these historic assessments should not be considered final and definitive. The research effort related to future relicensing, culminating in a CRMP, may alter some of the historic assessments found in this document.

Table 2. Historic Assessment of PGE Westside Hydroelectric Projects

Building or Structure	Date of Construction	Historic Assessment	Color Code (See Sec 2.3)
Willamette Falls Hydroelectric Project			
T.W. Sullivan Plant*	1893-95, modified 1953	Primary Historic	Red
Dam	1943 - latest in a series in this location	Primary Historic	Red
Forebay	1893-95	Primary Historic	Red
Fish Ladder	1912, replaced 1966-71	Non- Historic	Green
Smurfit Powerhouse	1916	Primary Historic	Red
West Linn Paper Co. Grinder Rooms No. 2 and 3*	1905, 1920	Primary Historic	Red
Bull Run Hydroelectric Development, North Fork Hydroelectric Project			
Powerhouse	1911-12	Primary Historic	Red
Transformer Building	1911-12	Primary Historic	Red
Machine Shop	1911-12	Primary Historic	Red
Big Sandy Dam (Marmot Dam)	1913, replaced 1989	Non-Historic	
Little Sandy Dam	1912	Primary Historic	Red
Forebay (Roslyn Lake)	1912, modified 1996	Primary Historic	Red
Penstocks/Surge tanks	1911-12	Primary Historic	Red
Canals/Flume/ Tunnel system	1912-1913, various sections replaced 1926, 1929, 1948, 1953, 1968, 1996	Primary Historic	Red
Roslyn Lake Park Structures	1957, 1962-63	Non-historic	Green
Clackamas River Hydroelectric Projects			
River Mill Hydroelectric Development, North Fork Hydroelectric Project			
Dam/Powerhouse	1911	Primary Historic	Red
Forebay	1911	Primary Historic	Red
Fish ladder	1913, modified 1970, 1985	Secondary Historic -Compatible	Yellow
River Mill Park and Structures	c1965	Non-Historic	Green
Faraday Hydroelectric Development, North Fork Hydroelectric Project			
Powerhouse	1907, modified 1956-8	Primary Historic	Red
Machine shop	1907, modified 1956-8	Primary Historic	Red
Faraday Dam	1907, replaced 1966	Non-Historic	Green
Forebay (Faraday Lake)	1907, later modified	Primary Historic	Red
Penstocks	1907	Primary Historic	Red
Vehicular Bridge	c1907, later modified	Secondary Historic -Compatible	Yellow
North Fork Hydroelectric Development, North Fork Hydroelectric Project			
Powerhouse/Dam	1958	Secondary Historic -Compatible	Yellow

*Previously received a Determination of Eligibility (DOE) by the Oregon SHPO

Table 2 (continued)

Building or Structure	Date of Construction	Historic Assessment	Color Code (See Sec 2.3)
Forebay (N. Fork Reservoir)	1958	Secondary Historic -Compatible	Yellow
Fish ladder	1958	Secondary Historic -Compatible	Yellow
Oak Grove Hydroelectric Project			
Powerhouse	1924, 1931	Primary Historic	Red
Machine Shop	1924	Primary Historic	Red
Three Lynx Housing*	1924, 1927, later additions	Primary Historic	Red
Transmission line to Faraday	1924, minor later replacements	Primary Historic	Red
Penstocks/surge tanks/pipelines	1924	Primary Historic	Red
Frog Lake**	1956, modified 1997	Non-Historic	Green
Lake Harriet and diversion dam	1924, modified 1988	Secondary Historic -Compatible	Yellow
Timothy Lake Dam and powerhouse	1956, modified 1997	Secondary Historic -Compatible	Yellow
Timothy Lake lodge structures	1953	Secondary Historic -Compatible	Yellow

*Previously received a Determination of Eligibility (DOE) by the Oregon SHPO

** Previously determined to be not eligible by the Oregon SHPO.

2.2.1 Non-Historic Support Buildings

The PGE Westside Projects include numerous support buildings or components that were constructed after the primary period of significance and were not constructed in a manner compatible with their historic counterparts. These buildings or components, therefore, are considered non-historic. Table 3 lists them below by project vicinity. The exact dates of construction and historic assessments of many of these support facilities are to be determined (TBD) as part of future survey efforts.

Table 3. Non-Historic Support Buildings and Structures

Building or Structure	Date Constructed	Description	Color Code (See Sec 2.3)
Bull Run Hydroelectric Project			
Office/garage	c1960s	Metal shed	Green
River Mill Park Buildings	1957, 1962-63	Wood board and batten/gable front	Green
Flume Maintenance Area	c1960s	Wooden sheds	Green

Table 3 continued

Building or Structure	Date Constructed	Description	Color Code (See Sec 2.3)
Faraday Hydroelectric Development			
Hydro offices and maintenance area	c1975	Metal sheds	Green
Garage	TBD	Open wooden shed	Green
Faraday Diversion Dam:			
Electrical Gear Building	c1966	Metal shed	Green
Intake structure	c1966	Steel/concrete	Green
Oak Grove Hydroelectric Project			
Three Lynx Housing :			
Storage Building	c1950s-60s	Metal shed	Green
School Superintendent's House	TBD	TBD	TBD
Office	c1980s	Metal shed	Green
Pool/pumphouse	c1960s	Concrete	Green
Timothy Lake			
Storage/Pumphouse Buildings	c1953	Wood, gable front	Green
Switchgear Building	1996	Metal shed	Green
Emergency Generator Building	1997	Metal shed	Green
Microwave Building	TBD	TBD	Green
Camping Facilities/Fishing Dock	TBD	TBD	TBD
Frog Lake			
Support buildings	TBD	TBD	TBD
Lake Harriet			
Support buildings	TBD	TBD	TBD
North Fork Hydroelectric Development			
Electrical Gear Building	c1958	TBD	TBD
Promontory Park			
Rock stoves/BBQ's	TBD	Masonry	TBD
Park buildings	c1965	Wood board and batten	Green

2.3 Constraints On Alterations To Historic Buildings

To protect the character of historic buildings and structures, some constraints must be placed on activities that may affect that character. This section identifies the types of constraints placed on the buildings and structures at the PGE Westside Projects. Many buildings and facilities have no constraints placed on them, while others may be highly constrained. Three levels of historic constraints are present, depending on the historic significance of the buildings. As shown in Appendix A, the level of constraint for each building is denoted by color, as described below.

Red - Primary Historic Buildings or Components. These were constructed during the primary period of significance (1893-1935) and contribute directly to the projects' historic significance. These buildings or components are likely eligible for listing in the National Register of Historic Places. For these resources, the most stringent level of protection should be pursued, and any proposed changes or alterations should closely adhere to the Secretary of Interior's Standards for Rehabilitation (Department of the Interior 1983). See Section 2.4 for further detail on the Standards.

Yellow - Secondary Historic/Compatible Building or Component. These buildings or structures were constructed after the primary period of significance (post-1935) but were constructed in a manner compatible with their historic counterparts in terms of design, materials, style, and function. These resources may also be ancillary or minor buildings (such as a garage). Buildings or components in this category may also fall into the secondary post-war period of significance (1953-1958) and are considered contributing elements to the historic significance of the overall hydroelectric system. A lesser level of constraint is assigned for these resources and more flexibility in the Standards' interpretation and implementation is allowable.

Green - Non-Historic. These buildings or components were constructed after the primary period of significance. Generally, these resources were constructed in a manner that was not compatible in terms of design, materials, or style with the historic resources. This category also includes non-historic support buildings, such as pumphouses and sheds. No constraint is placed on maintenance practices for these buildings and components; however, PGE should continue the sensitive maintenance and treatment practices they currently have in place when buildings are located adjacent to an historic resource.

2.4 Management Guidelines

This section defines the general guidelines and procedures by which the cultural resources at the various PGE Westside Projects will be maintained and managed. Guidelines for project-specific modifications currently planned by PGE are addressed in Section 2.6.

2.4.1 Secretary of Interior's Standards for Rehabilitation

The Secretary of the Interior is responsible for establishing standards for the preservation and rehabilitation of historic properties listed in, or eligible for listing in, the National Register of Historic Places. The Secretary's Standards for Rehabilitation have been developed to guide work undertaken on historic buildings and address the most prevalent rehabilitation issues and accepted treatment procedures. The PGE Westside Projects contain numerous buildings or components that are recommended eligible for the National Register, many of which may require changes and alterations in the future to remain functional. The preferred treatment for any National Register-eligible resource at PGE requiring modification is *rehabilitation*. The Secretary of the Interior defines rehabilitation as "the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values." The Secretary of the Interior's Standards for Rehabilitation are shown below.

1. A property shall be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.

2. The historic character of a property shall be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, shall not be undertaken.

4. Changes to a property that have acquired historic significance in their own right shall be retained and preserved.

5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and where possible, materials. Replacement of missing features shall be substantiated by documentary and physical evidence.

7. Chemical or physical treatments, if appropriate, shall be undertaken using the gentlest means possible. Treatments that cause damage to historic materials shall not be used.

8. Archeological resources shall be protected and preserved in place. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and shall be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environments would be unimpaired (Department of the Interior 1983).

2.4.2 Levels of Intervention

The management and continued use of resources involves various levels of activity, each with its own set of implications on continued historic integrity. Complementing the general guidelines for rehabilitation listed above, the Secretary of the Interior lists various levels of intervention on historic resources, from the least intrusive to the most intrusive.

1. Protect and Maintain

Protection generally involves the least degree of intervention and is used to stabilize a structure or its materials to reduce deterioration. For example, protection includes the maintenance of historic material through treatments such as rust removal, caulking, limited paint removal, and re-application of protective coatings; the cyclical cleaning of roof gutter systems; or installation of fencing, protective plywood, alarm systems, and other protective measures.

2. Repair

Next, when the physical condition of character defining features warrants additional work, repairing is prescribed. Guidance for the repair of historic materials such as masonry, wood, and architectural metals again begins with the least degree of intervention possible such as patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading according to recognized preservation methods. Repairing also includes the limited replacement in kind, or with compatible substitute material, for extensively deteriorated or missing features when there are surviving prototypes. Although using the same kind of material is always the preferred option, substitute material is acceptable if the form and design as well and the material itself convey the visual appearance of the remaining parts of the feature.

3. Replace

Following repair in the hierarchy, guidance is provided for replacing an entire character-defining feature with new material because the level of deterioration or damage of material precludes repair. If the essential form and detailing are still evident so that the physical evidence can be used to re-establish the feature as an integral part of the rehabilitation project, then its replacement is appropriate. Like the guidance for repair, the preferred option is always replacement in kind, that is, with the same material or compatible substitute material.

4. Alterations/Additions to Historic Building

Some exterior and interior alterations to the historic building may be needed to ensure its continued use, but it is most important that such alteration does not radically change, obscure, or destroy major features. Typical alterations might include, for example, opening a new entrance or adding windows on secondary elevations, installing a new mechanical system, or the creation of an additional floor level. The construction of an exterior addition to an historic building should generally be avoided, if possible, and considered only after it is determined that those needs cannot be met by altering non-character defining interior spaces. If after a thorough evaluation of interior solutions an exterior addition is still judged to be the only viable alternative, it should be designed and constructed to be clearly differentiated form the historic building and so that the character defining features are not radically changed, obscured, damaged, or destroyed.

2.4.3 Application of the Secretary of Interior's Standards to PGE's Cultural Resources

While a formal, building-by-building determination of significance and a detailed discussion of character-defining features and appropriate maintenance and alteration strategies will be developed as an element of the final CRMP, certain character-defining features by resource type can be identified to assist PGE in its ongoing management of the historic Westside Projects resources. While general in nature, the following elements of design should be considered essential to maintaining historic integrity and be factored into any potential construction activity prior to the completion of the final CRMP.

Dams, Spillways And Related "In-Channel" Features

In general, these features are characterized by massive concrete construction with exposed ribbing; integral structural members; and large scale metal valves, ports, covers and similar features. Modifications and additions should utilize similar materials, including exposed tooling or construction character, to the greatest extent possible. Visual divisions, such as horizontal sills, banding, or other clear "breaks" between new and old work, are encouraged to document and reflect change. Entirely new features or replacements (e.g. the replaced Marmot Dam or a new fishway) should be designed in simple industrial fashion, using traditional exposed concrete materials. Specific character-defining features include but are not necessarily limited to:

- Massive Scale
- Exposed, un-painted, raw concrete, often with evidence of construction markings
- Integral structure members, ribs, buttresses, etc.
- Primer-painted metal gates, valves, covers and similar features

Flumes, Penstocks, Surge Towers

Varying from project to project, open wood or concrete flumes, bored rock tunnels, as well as large diameter welded steel piping, all are used to convey water on the Westside Projects. Repairs and modifications should retain consistent materials (e.g. wood repaired with wood, etc.) and finish characteristics to the greatest extent feasible. Where the installation of new material is unavoidable, simple industrial treatments, including paint color, should be used to minimize visual impact. For example, if metal banding is required to bind a weakened area of the wooden flume at Bull Run, metal bands with exposed bolts, nuts or other mechanical fasteners should be used, painted a typical primer red. Specific character-defining features include but are not necessarily limited to:

- Simple construction materials with exposed fasteners
- Open trestlework of compatible materials
- Mixed raw concrete, painted metal and creosote impregnated wood, all simply finished
- Simply detailed stairs, ladders and other access features

Powerhouses

The several powerhouses of the Westside Projects share a number of typical features characteristic of early industrial buildings. Again, site specific treatments should reflect the historic use of materials, (e.g. brick repaired with brick, etc.). Specific character-defining features include but are not necessarily limited to:

Exterior:

- Painted concrete or brick exterior surfaces (light green appears have been the
  PGE standard color for painted exteriors during the historic period)
- Multi-pane metal sash windows, often with arched transom panels
- Exposed sills and deep window recesses, articulated surface decoration (engaged columns or pilasters, string courses, dentil bands and similar)
- Decorative parapet detailing, markers, identification blocks
- Mixed glass and wood entry doors, large wood or metal freight doors.

Interior:

- Painted or raw concrete flooring with open metal decking for upper levels.
  (Flooring is most typically painted deep umber/red or light gray)
- Industrial type balusters and railings
- Light gray or pale green walls
- Regular, orderly placement of project elements (transformers, switching stations etc.)
- High open trussed ceilings with gantry crane and support railings

Support Buildings (housing, warehouse, mechanical, office and related)

Power generation support buildings constructed during the primary period, such as the transformer building at Bull Run or the tool shed at Faraday, are generally of masonry construction, detailed as simple versions of the associated powerhouse. Later, secondary period structures tend to be even more utilitarian in design, with wood or metal structural systems and applied corrugated metal siding. Housing and recreational facilities are generally of wood frame construction with asphalt or wood shingle roofing. In all cases, alterations should reflect the original design character and maintain compatibility as per the Secretary's Standards. Specific character-defining features for support structures include but are not necessarily limited to:

Generation Support: Primary Period
- Poured concrete or brick construction
- Metal, multi-pane industrial windows

Generation Support: Secondary Period
- Concrete block or wood-frame construction
- Multi-pane wood sash windows

Housing:
- Wood-frame construction
- Painted horizontal wood siding (narrow board)
- Gable roofs, wood or asphalt shingle
- Wood, multi-pane windows
- Open porches

Later Housing, Recreational area (Timothy Lake)
- Wood shingle exteriors
- Wood sash windows
- Dark, natural, semi-transparent stain finish

Transmission Lines

The only potentially historic transmission line of the Westside Projects is the line running along the Clackamas River from the Oak Grove Powerhouse to the Faraday Switching Station. It is characterized by a variety of tower support designs depending upon location, repair history, and other factors. All potentially historic towers, however, share the same essential characteristics. These include but are not necessarily limited to;

- Unpainted galvanized or zinc-primer painted steel construction
- Open, lattice-type, construction with internal "x-type" cross bracing
- Flared bases set in concrete
- Projecting upper elements to carry transmission lines
- Overall, a generally open "transparent" appearance, resulting from a multi-element "constructed" design. (This is in stark contrast to the single vertical "installed" form of modern "tubular" power pole designs)

In utilizing these character-defining features as a guide for future project modifications, some flexibility is inherently required depending upon the original period of construction, integrity, and potential significance of the resource. As mentioned in Section 2.3, the most significant historic buildings are highly constrained and are color-coded red. For these buildings, the most stringent level of protection should be pursued, and any proposed changes or alterations should closely adhere to the Secretary of Interior's Standards. Protection, maintenance, and repair of historic resources and components should be emphasized over replacement and alteration.

A lesser level of constraint is assigned for buildings that are not historic but are compatible with the historic buildings, and are color coded yellow. For these buildings the Standards also apply; however, more flexibility in their interpretation and implementation is allowable. While protection, maintenance, and repair should also be pursued, replacements and alterations that are compatible with the original building or component are allowable. No constraint is placed on non-historic buildings; these are color-coded green. PGE should continued their current treatment practices for these buildings.

2.5 Management Review Procedures

The ongoing operation of the PGE Westside Projects entails numerous tasks and activities including general maintenance, scheduled maintenance and construction, and emergencies (unexpected conditions that threaten life or property). Many of these activities have the potential to affect cultural resources. When cultural resources may be affected by an activity, certain restrictions and procedures must be followed.

Section 2.3 identifies constrained buildings or components within each project, while Section 2.4 outlines the general guidelines for the treatment of cultural resources which fall into one of three categories (red, yellow, green). If at any point an activity cannot be conducted in accordance with these procedures and restrictions, it requires review by an Historic Preservation Coordinator (HPC). This section discusses: (1) the duties of the HPC and other PGE staff; (2) the review process that the HPC will follow; and (3) the procedures for conducting the review of particular actions, including notification and consultation with relevant agencies.

2.5.1 Responsibilities of the Historic Preservation Coordinator

PGE will create a role for an Historic Preservation Coordinator (HPC). The individual designated as the HPC will normally be a member of the Hydro Production Support or Hydro Relicensing Departments. The current HPC is Bob Steele, Hydro Support. The alternative HPC is Deb Schallert, Hydro Relicensing. These individuals will assist with reviews of projects that may impact cultural resources. They will also provide guidance regarding protection and preservation of cultural resources to PGE Westside Hydro Projects management and personnel. The HPC will perform the following duties:

- Conduct and facilitate reviews of any activity with the potential to affect the cultural resources.
- Serve as PGE's primary point of contact with the Oregon State Historic Preservation Officer (SHPO).
- Assist with compliance to the standards and guidelines covered in this Guide, and consult with the Oregon SHPO in matters not covered in this Guide.
- Serve as a liaison to other PGE managers, hydroelectric plant managers, and the Oregon SHPO on historic preservation concerns.
- Provide support and assistance with implementation.
- Maintain files of all projects requiring review and/or consultation, and the results of reviews and consultations.

2.5.2 Responsibilities of PGE Management

- Plan maintenance activities and inform the HPC of any activities that may have the potential to affect the historic district or its contributing resources.
- Review HPC's recommendations and provide direction where applicable.
- Ensure that HPC's recommendations and agreements resulting from consultation are followed by field crews and contractors.
- Inform contractors of the restrictions/procedures and make sure they are aware of the legal consequences of ignoring the restrictions and disturbing archaeological sites.

2.5.3 Responsibilities of Project Foreman/Field Crews

- Conduct activities according to restrictions/procedures.

- Report any willful destruction of property affecting cultural resources to the Westside Hydro Manager, who in turn notifies the HPC.

- Report and respond to property damage and maintenance problems affecting cultural resources to the Westside Hydro Manager, who in turn notifies the HPC.

- Report unanticipated discoveries of archeological resources to the Westside Hydro Manager, who in turn notifies the HPC.

2.5.4 Procedures for Review of Operation, Maintenance, and Construction Activities

Under normal circumstances, all operation, maintenance, and construction activities at PGE undergo an internal review process. At this initial review stage, project proponents such as PGE Managers or Westside Hydro Manager must determine if the proposed activity has the potential to affect cultural resources, such as known archeological sites or structures labeled in **red or yellow**, as shown in Tables 2 - 3, and Appendix A. If the project avoids these resources, the proposal shall proceed through the normal channels of the PGE review process, and no historic preservation review is required. **If the project has the potential to affect cultural resources labeled red or yellow or known archeological sites, the project must be referred to the HPC to begin historic preservation review.** Regular maintenance activities generally are scheduled well in advance. Review of these activities should occur as soon as the activity is scheduled to allow the HPC to gather any necessary information and consider the appropriate treatments and steps. These procedures will allow PGE to conduct its necessary activities and to fulfill its stewardship responsibilities as efficiently as possible. Figure 4 provides a diagram of the PGE historic review process. The bulleted list below provides further detail in the proper review procedures once the project has been referred to the HPC.

- The project proponent, such as PGE Management or Westside Hydro Manager will contact the HPC [Bob Steele at (503) 464-7545] and provide all relevant information regarding the activity, the location and any designs, maps, or construction plans.

- The HPC consults this Guide to confirm that the project will affect a cultural resource. If no cultural resource will be affected, the HPC will notify the project proponent, and the project may proceed through PGE's normal channels of review.

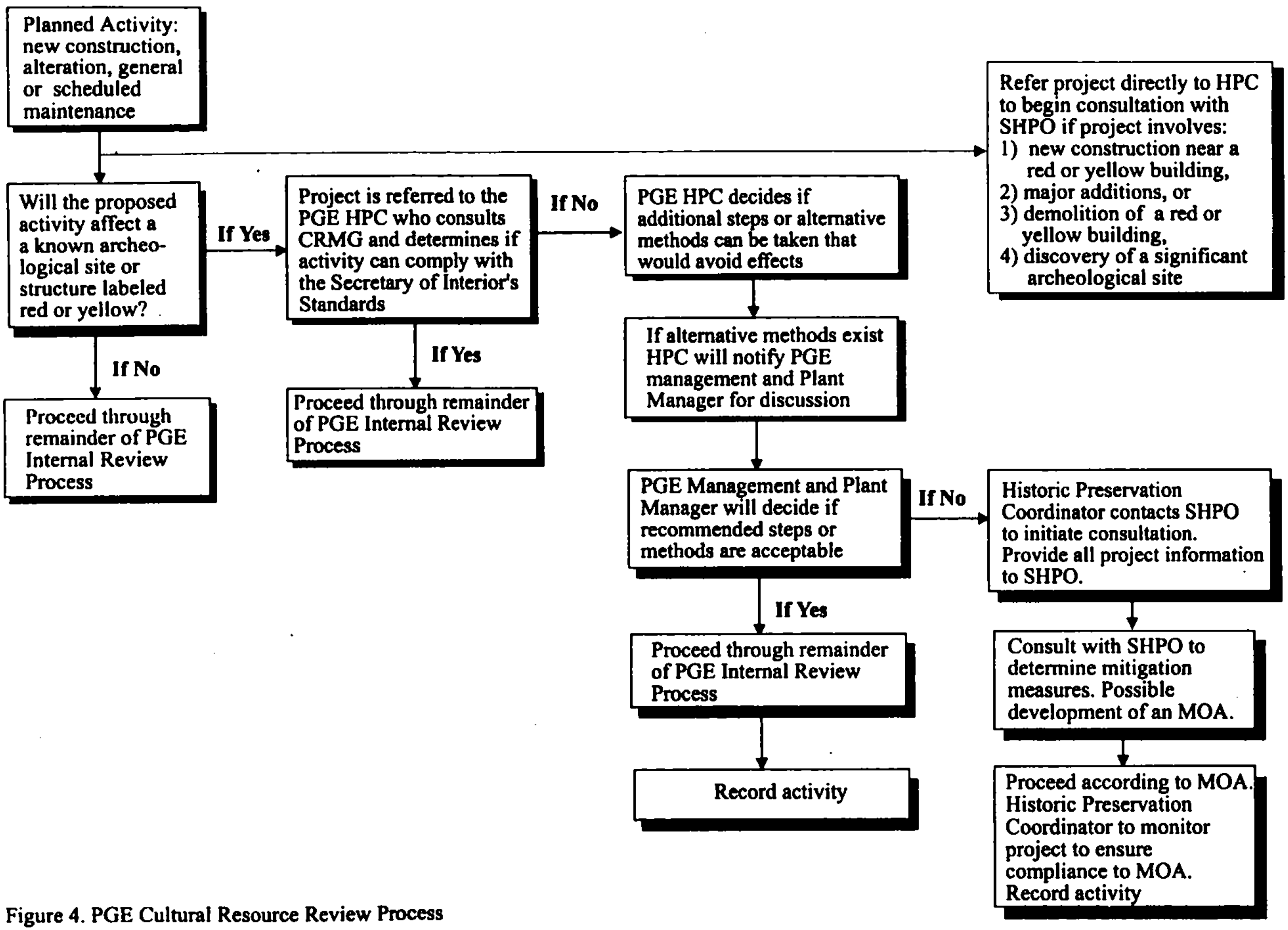


Figure 4. PGE Cultural Resource Review Process

- If, however, a cultural resource will be affected, the HPC determines if the project can be completed according to the Secretary of Interior's Standards outlined in Section 2.3 of this Guide. If so, the project may proceed through PGE's normal channels of review. If the HPC is uncertain whether a project can or cannot be completed according to the Standards, the HPC may consult with other qualified professionals in the fields of historic preservation and/or archeology.

- **If the HPC determines that the proposal cannot meet the Standards, the HPC will identify any alternative treatments or design modifications that could be taken to avoid effects on cultural resources.** Some methods that may avoid adverse effects would include choosing a different maintenance technique. For example, instead of sand blasting concrete surfaces to clean them, first determine what is causing the building to appear dirty (oil, rust, smoke, graffiti, etc.) and then use the most appropriate and gentlest possible means to remove it. For archaeological sites, the staff may be able to relocate the activity to avoid the site. An option may be to use a helicopter to transport materials, such as the replacement of a damaged transmission pole, instead of transporting the material over ground by truck.

- If an alternative method exists, the HPC will notify PGE Management and the Westside Hydro Manager for discussion.

- PGE Management and the Westside Hydro Manager will determine if the proposed alternative method is acceptable and appropriate, or may identify additional alternative methods at this point.

- If PGE Management and the Westside Hydro Manager agree with the alternative treatment or design modification, the project will proceed through PGE's normal review process with the stipulation that the alternative methods be implemented.

- The HPC maintains a record of the activity as well as any correspondence or other proceedings, and monitors the project for implementation of the additional methods.

- **If PGE Management decides that the alternative method is unacceptable for any reason or the Westside Hydro Manager is unwilling to modify the project as recommended, the project must undergo consultation with the Oregon SHPO.**

- The HPC contacts the Oregon SHPO to initiate consultation. As part of consultation process, the HPC shall ask SHPO for a Determination of Effect (DOE) and provide all pertinent information including the affected resource, the nature of the activity, the status of the activity, the nature of potential effects, and any suggestions regarding avoidance or mitigation for the SHPO's consideration. Photographs, maps, and drawings should be submitted as necessary. All pertinent information and other documentation shall be provided to the HPC by PGE Management.

- The Oregon SHPO will determine if the effects are adverse. If the effects are adverse, the HPC, PGE Management, and the SHPO shall seek to identify alternatives, mitigation measures, and/or enhancements to the proposed project that will avoid or mitigate the adverse effects. This consultation may result in the development of a Memorandum of Agreement (MOA) between the SHPO and PGE.

- The proposed project, complete with alterations and/or enhancements determined during consultation, proceeds through PGE's normal project review process.

- The Westside Hydro Manager completes the activity according to the outcome of the consultation, incorporating the measures specified in the MOA. The HPC should monitor the completion of the activity to ensure that the stipulations of the MOA or other agreements are followed.

- The HPC records the activity and the results of consultation and will maintain copies of any correspondence, MOAs, or other proceedings.

Consultation proceeding with the SHPO will vary according to the project proposals and will be reviewed on a case-by-case basis. Actual impact mitigations may include, but are not limited to, the following:

- Recommended design alterations or enhancements to the proposed project that will avoid, reduce, or mitigate the adverse effects, such as the reduction in the height or bulk of an addition or the application of certain building materials. For example, the SHPO may request that instead of using metal seam roofs for some of its re-roofing projects, PGE should use a roofing material more compatible with the original fabric of an historic building.

- Historic American Building Survey (HABS) documentation, which includes both written context statements and descriptions of physical appearance, as well as photographic documentation to National Park Service standards, of an historic building proposed for demolition or alteration that would adversely affect the building's historical integrity.

- The design and implementation of an on-site interpretive display or other commemorative work which depicts the historic significance of a building or site lost to demolition.

- The donation of historic hydroelectric equipment, such as turbine blades, control equipment, or other historic hydroelectric memorabilia to an historical museum or society for the interpretation and enjoyment by the public. These items could be used to augment the existing permanent exhibit at the Clackamas County Historical Society and Museum, or other appropriate repository, which interprets the importance of hydropower in Oregon's development.

It should be noted that certain activities are of such significant scale that they will automatically require consultation with the SHPO. For these types of activities, it is not necessary to follow each individual step of the process. Types of major activities which automatically require consultation include:

- Proposed demolition or decommissioning of a building or component listed as Primary Historic or Secondary Historic - Compatible in Table 2
- New construction directly adjacent to a Primary Historic or Secondary Historic -Compatible building or component
- Major addition to a Primary Historic building (any addition that increased the overall floor area of a building by 25% or more would constitute a major addition)
- Substantial alteration of a Primary Historic building or component with incompatible materials (i.e. replacement of a wood box flume with steel).
- Discovery of an archeological site and subsequent determination of eligibility (see Section 3.5)

2.6 Identified Project Modifications

During the information gathering portion of the Cultural Resource Studies of the PGE Westside Projects, several proposed modifications involving potentially significant resources were identified. The purpose of this section is to review these anticipated modifications and provide specific information on required review procedures and offer design options that will have minimal or no adverse impact on historic character defining features and integrity.

2.6.1 Removal of Surge Tanks, Bull Run Hydroelectric Project

DATE OF FEATURE:

1911-12, element of original construction

CONSTRUCTION DESCRIPTION:

Located to the west of the Bull Run Powerhouse, near the top of the penstock line from Lake Roslyn, these two steel surge tanks each consist of a large welded steel tank atop an X-braced steel framework that rises from a poured concrete base. The tanks are located in a small clearing and are visible from the side of the Bull Run-Sandy Road as it rims Lake Roslyn.

HISTORIC ASSESSMENT:

Red, Primary Historic, contributing element in potential National Register (NR) area

AT ISSUE:

According to Bull Run Project staff, the surge tanks have been superseded by improved technology and are no longer a necessary element in the power-generation facilities. On-going concerns about the seismic resistance of the surge tanks require that they be either strengthened or removed, possibly prior to the year 2000.

COMMENTS:

The twin steel surge tanks at Bull Run have identified significance as an element of the original Bull Run Project and retain very high integrity to their original character and construction. Prior to any modification the PGE HPC should initiate consultation with Oregon SHPO as detailed in Section 2.5.1 of this Guide.

As PGE reviews the potential modification of the Bull Run surge tanks, options that permit the tanks to remain a visible element in the project should be given preference. Bypassing the tanks functionally (if this is not already done) and the installation of additional bracing as required to meet seismic concerns are highly preferred over removal. Any additional bracing should be undertaken with similar materials, retaining consistency with the open latticework tower design to the highest degree feasible.

If no repair alternative is determined feasible, the surge tanks should be accurately documented for future interpretation and, *at minimum*, the concrete tower bases should remain in place following the removal of the steel superstructure. Options that include retaining some larger portion of the steel framework on site, even if "abandoned" and left lying in close proximity to the original location might also be considered. Complete removal of all surge tank elements and the elimination of all evidence of their presence is not a preferred alternative.

2.6.2 Minor System Modification as the Result of Automation & Remote Control, All Sites

DATE OF FEATURE:

Variable from project to project.

CONSTRUCTION DESCRIPTION:

Variable from project to project.

HISTORIC ASSESSMENT:

Potentially historic control and system features at each project are intrinsically contributing elements in the various potential National Register areas.

AT ISSUE:

As a part of on going system enhancement, project automation, and the centralization of project control, various original or early historic period system elements have either become superfluous or will be replaced with modern computer-compatible parts. Mentioned elements scheduled or already upgraded include synchronizers, exciters, switches, valves, monitoring systems and similar industrial-type controls.

COMMENTS:

The upgrade and periodic replacement of minor systemic elements with improved technologies is not considered to be inherently at odds with maintaining the overall integrity of historically significant industrial resources, such as those of the Westside Projects. Where such modifications are determined necessary for continued utility, PGE's previous actions such as the relocation of the control panel at Oak Grove while still retaining it as an element of the powerhouse floor and the bypass and retention of the "Bakelite" control panel with original knife switches, etc., are recommended as appropriate models for similar situations in the future.

Newly installed system elements should, to the fullest extent possible, be located in positions that reflect the historic interior arrangement of the generation facilities and the orderly relationship between those elements. New features should be painted or appropriately treated to retain the traditional visual character of the interior space.

Large elements of the generation system that are no longer required should, where possible, remain at or as close to their original location as is practical. Entirely replaced or upgraded system elements, such as the large cast iron housing and valve stem now located in the Bull Run yard, should be retained on site for use in future interpretation.

Where the situation or other constraints preclude the retention of early features no longer needed for power generation or control, and where PGE is unable to retain the feature on site for interpretation, such elements should be offered to historic or technological museums, such as the Clackamas County Historical Museum or other appropriate repository, for continued display wherever possible.

2.6.3 Removal of Cabin No. 37 at Three Lynx, Oak Grove Hydroelectric Project

DATE OF FEATURE:

February 1929

CONSTRUCTION DESCRIPTION:

A single-story wood frame cottage, this cabin is one of the many Aladdin "Victory" catalog houses that were erected at Three Lynx as part of its original development as a worker housing area.

HISTORIC ASSESSMENT:

Red, Primary Historic. Cabin No. 37 is a contributing historic feature within the Oregon SHPO Determination of Eligibility of Three Lynx Housing and as a result will constitute a contributing feature within the proposed Clackamas Project Multiple Property Submission.

AT ISSUE:

Due to poor drainage and water, Cabin No. 37 is suffering from severe moisture problems and foundation settlement. It is reported as "sinking" and is no longer occupied. Determined unnecessary as part of PGE's current Oak Grove management and utilization plan, it is expected that Cabin No. 37 will eventually be scheduled for demolition.

COMMENTS:

As part of a formally determined eligible housing complex, prior to any action concerning the future of Cabin No. 37 the PGE HPC should initiate consultation with Oregon SHPO as detailed in Section 2.5.1 of this Guide.

Much of the character of the Three Lynx Housing stems from the compound placement of its similarly designed structures around the informal circular street system of the complex. While removal of any individual structure may not be prohibited, to the extent that demolition affects the character of the area, such actions should be avoided whenever possible.

As part of consultation proceedings, the SHPO will require an analysis of all alternatives before agreeing to the demolition of a contributing historic feature, such as Cabin No. 37. Prior to any potential demolition, PGE should explore the feasibility of other options for the cabin, including raising the building on blocks to allow increased ventilation and drainage, re-grading or the installation of drainage systems to better manage groundwater, or relocation to another site within the Three Lynx Housing area (preferably to the site of a previously demolished one-story cabin). The SHPO will only allow demolition after all options have been exhausted and it has been determined that removal is the only feasible alternative.

If, following consultation, demolition is determined the appropriate course, accurate documentation of Cabin No. 37 should be prepared as per the direction of the Oregon SHPO

2.6.4 Seismic Retrofit of the River Mill Dam, River Mill Hydroelectric Development, North Fork Hydroelectric Project

DATE OF FEATURE:

1911

CONSTRUCTION DESCRIPTION:

The River Mill Dam is located in the channel of the Clackamas River and consists of the spillway and powerhouse sections. The structure was built by the Puget Sound Bridge and Dredging Company from designs by the Ambursen Hydraulic Construction Company, the patent holder of the Ambursen, or hollow "slab and buttress" dam.

HISTORIC ASSESSMENT:

Red, Primary Historic, contributing element in the potential Clackamas River Projects Multiple Property Submission

AT ISSUE:

PGE and its engineering consultants are currently exploring various options for increasing the seismic resistance of the hollow River Mill Dam. Any change has the potential to adversely impact the historic integrity of the dam.

COMMENTS:

The River Mill Dam is an integral part of the potential Clackamas River Projects Multiple Property Submission (MPS). Prior to any major seismic modification, the HPC should initiate consultation Review with Oregon SHPO as detailed in

Section 2.5.1 of this Guide.

The 1911 River Mill Dam represents a key contributing feature at the River Mill site in the potential Clackamas River Projects MPS. Additionally, the dam is considered significant not only under Criterion A for its role within the project as a whole, but also has potential significance under Criterion C for its design and association with the Ambursen Company. A key defining feature of this slab and buttress dam is the intrinsic design character and accessibility of its hollow interior.

Among the several alternatives to seismic retrofit now under consideration, options that include "filling" the interior to any degree with material that would preclude the full longitudinal access now present are strongly discouraged. Options that add additional lateral strength, either through the addition of new concrete or steel bracing should be undertaken in a manner that least impacts the present open characteristics of the inter-buttress bays.

Any added support elements, such as lateral ribs, additional buttress work, or other elements should be designed and installed in a manner that is as compatible with the existing interior character as is possible. Exposed surfaces of raw concrete, treated to match existing are preferable over any other potential treatment. Installation of new bracing should, to the extent possible, retain the open interior character and maintain the visual primacy of the existing buttresses over any newly installed elements. New elements, to the extent feasible, should be slightly smaller in section where they join the buttresses, so that they are visually secondary to the original structural buttresses.

2.6.5 Install New Roof Over the Thrust Block, Oak Grove Hydroelectric Project

DATE OF FEATURE:

1923

CONSTRUCTION DESCRIPTION:

The thrust block is located at the top of the bluff above the Oak Grove powerhouse just west of the surge tank. The thrust block is made of concrete and is roughly square in plan. The penstocks run through the block and connect with the surge tank nearby.

HISTORIC ASSESSMENT:

Red, Primary Historic. An original element of the Oak Grove project, the thrust block is considered a contributing feature within the potential Clackamas River Projects MPS.

AT ISSUE:

PGE Staff report that the existing concrete is exposed to the elements and is spalling off in sections. A new roof is required to protect the block from further deterioration.

COMMENTS:

The character defining features of the thrust block at Oak Grove are the functional, raw concrete, character of its visible elements. Strategies to stabilize the concrete that have minimal visual impact are preferred. Although a corrugated metal roof may be appropriate for long-term protection purposes, a wood roof structure with composite shingles installed over the thrust block is preferred for visual appearances.

2.6.6 Repair of Lake Roslyn Park Buildings, Bull Run Hydroelectric Project

DATE OF FEATURE:

1960s

CONSTRUCTION DESCRIPTION:

The multiple structures at Lake Roslyn Park are of wood-frame construction in the "rustic" tradition. Original exterior surfaces include painted board and batten, with wood shingle roofs. More recent alterations include standing seam metal roofing and plywood panel siding.

HISTORIC ASSESSMENT:

Green, Non-Historic

AT ISSUE:

While non-historic by virtue of construction date, the campground buildings at Lake Roslyn Park represent a well designed and substantially intact recreation-based setting that is compatible with the general Bull Run development. Certain of the features, such as the group kitchen, may well merit individual designation in the future as they approach 50 years of age. While not formally constrained by the findings of the Cultural Resource Study, recent replacement and change at Lake Roslyn have potentially adverse impacts on the character of the campground and should be avoided where possible in the future.

COMMENTS:

Since the buildings at Lake Roslyn Park are not historic resources, the following treatment recommendations are advisory and should not be considered a requirement. To the degree possible, however, repair or replacement of materials at Lake Roslyn should be undertaken to remain visually compatible with the original design and rustic character of the site.

"Architectural Grade" asphalt in natural tones (brown, green or gray) is generally considered an acceptable compromise as a replacement where maintenance and cost issues do not allow a continuation of the original wood shingle or shake roof. If standing seam metal roofing is to be used, muted, darker, colors that are as inconspicuous as possible are preferred over light colors of whatever shade. Siding, stone, and other materials should be replaced in-kind and painted or stained in appropriate tones wherever possible.

3.0 MANAGEMENT OF ARCHAEOLOGICAL RESOURCES

This section of the Guide discusses what steps should be taken to assess the National Register eligibility of known archaeological resources and how to safeguard these resources until their significance can be determined. These steps are also applicable to other archaeological resources that may be discovered in the course of future studies. This section also provides general management guidelines and review procedures for PGE projects that may affect archaeological cultural resources.

3.1 Eligibility for Listing in the National Register

The limited archaeological surveys conducted as part of the Cultural Resources Study for the PGE Westside Projects located and recorded two prehistoric archaeological sites and one location with two prehistoric artifacts (isolates). The PGE Cultural Resources Study recommended that the two prehistoric sites be considered potentially significant sites and that subsurface testing be conducted at both sites to determine site size, structure, and content. These data are needed to assess National Register eligibility and to effectively manage the site if deemed eligible. The Oregon SHPO generally recommends subsurface testing of prehistoric archaeological sites for National Register eligibility evaluations.

The criterion generally used for assessing the National Register eligibility of archaeological resources is Criterion D of federal regulations 36 CFR 60.4, which states that, in addition to having integrity (of location, setting, etc.), significant properties are those "that have yielded, or may be likely to yield, information important in prehistory or history." In general, this means that the significance of a site lies in its proven or potential ability to make substantial contributions to "the theoretical and substantive knowledge of the discipline" (Butler 1987:821), either to regional cultural history or to broader questions of human behavior and endeavor. Thus, evaluation of subsurface cultural deposits at an archaeological site is generally necessary to adequately assess its potential for contributing important scientific information.

Both of the prehistoric sites recorded in the vicinity of the Clackamas River Hydroelectric Projects may be potentially significant sites, based on the observed surface artifacts, apparent site size, and location. The two obsidian flakes found in disturbed soil near Roslyn Lake in the Bull Run Hydroelectric Project may indicate a larger archaeological site with buried cultural deposits. Until full evaluations of these archaeological resources can be accomplished, these locations should be considered properties that are *potentially eligible* for listing in the NRHP, and should be treated accordingly until otherwise demonstrated. Given that both recorded sites are located in established recreation areas and are affected by continued use of these facilities, it is recommended that these resources be evaluated soon as feasible.

3.2 Management Guidelines Pending Site Evaluations

Pending the implementation of archaeological resource assessment studies, a basic policy of avoiding additional disturbance to the recorded sites and isolate locations should be followed. This basic policy should be applied whenever archaeological resources have been identified but not yet evaluated. Both sites identified during the limited surveys are located in established recreation areas, so both are being affected by continued use of these facilities. One approach to protecting these sites would be to close the areas completely until site evaluations can be conducted. While closure might provide some additional protection to the sites, it might also draw undesirable attention to these archaeological site areas. This could result in vandalism and lead to costly site protection measures such as fencing or electronic surveillance. Both sites have been subjected to impacts from recreational use for years, so it is doubtful that allowing continued use of the sites for a short time will dramatically alter their current integrity. This approach, however, is only feasible if the site evaluation tests can be conducted in the near future, preferably before the 1999 recreation season.

The following guidelines should be implemented to manage the known sites until site evaluations can be accomplished. The general principles in these guidelines should be used to manage any archaeological resource until it can be evaluated.

- Current recreational day use of the park areas can continue until the sites have been evaluated for National Register eligibility, provided that the evaluation tests be conducted within a reasonable time. Both affected recreation areas appear to be day use picnic areas. This use can continue, but no overnight camping should be allowed in either area.

- No projects that involve ground-disturbing activities should be undertaken in these recreation areas until the sites have been evaluated. Specifically, no scraping, cutting, or digging should be done in these recreation areas for vegetation clearing, landscaping, park improvements, camping, or any other purpose.

- If ground disturbance cannot be avoided prior to full evaluation, archaeological testing to assess at least that portion of the site to be affected by the ground disturbance should be undertaken before the disturbance is incurred.

- These recreation areas should be monitored on a regular basis to determine if vandalism or inadvertent site disturbance is occurring. At present, no overt evidence of vandalism (such as open holes or presence of excavation equipment) has been seen at either site, but the areas should be patrolled to ensure that disturbance does not occur before the sites can be evaluated.

In sum, site evaluation tests to assess National Register eligibility should be conducted as soon as feasible. Until the sites are evaluated, current use of the areas by casual day visitors can continue, but any ground disturbing activities beyond normal recreational foot traffic should be avoided.

3.3 Archaeological Resource Assessment

This section describes the rationale for evaluating National Register eligibility and the field techniques that should be employed. This discussion applies to both the currently recorded sites (and isolated find) and to sites/isolates that may be found in anticipation of, or during, PGE projects in the future. Evaluation investigations at individual sites will serve two purposes: (1) to provide information for assessing site significance in terms of NRHP eligibility, and (2) to obtain sufficient data at sites considered to be NRHP-eligible to assess ongoing or potential project effects/impacts so that treatment plans addressing mitigation avenues can be developed.

Essential elements in assessing site eligibility are to: (1) determine the horizontal and vertical structure of the site, (2) gain information on the general contents of the site to aid in estimating age and function, and (3) assess research potential by examining whether the site can contribute significant scientific information in specific research domains. The data obtained from the first two elements are basic for any significance evaluation and impact assessment, to determine what research interests *can* be addressed at a site. These data are also important for assessing ongoing and proposed impacts to the site and developing site management options.

The quantity and quality of the data recovered (and the data inferred to be present in the remaining site deposits) should be assessed in terms of defined archaeological and anthropological research domains to evaluate the third element of site eligibility. Prehistoric archaeological research in the Western Cascades of Oregon has generally focused on cultural chronology and various aspects of regional hunter-gatherer land use, as discussed in the Cultural Resource Studies. Burtchard (1990) and Burtchard and Keeler (1991) have proposed a chronological model that focuses on changes and developments in land use strategies. The research themes and questions generated by this model can be used to guide assessment of each site's research potential.

Subsurface test excavations are necessary to fully determine the size, depth, structure, and content of archaeological sites Even if a site is obviously NRHP-eligible, some testing to learn about the subsurface structure of the site is necessary if the site is likely to be subjected to project-related adverse impacts. At NRHP-eligible sites these data will be obtained to assess potential project impacts on the overall site and on specific site areas (as needed, given specific project impacts). At non-eligible sites these data *should still be obtained* - to demonstrate that the site size and structure are well-enough known to reliably evaluate site eligibility. In this way, it is unlikely that some untested portion of the site would contain material sufficient to find the site eligible.

Subsurface investigations should also be conducted at any isolated find locations where ground visibility is poor and/or where surface evidence suggests that subsurface cultural materials may be present (e.g., artifacts in backdirt from rodent burrows, in disturbed soil, etc.). Vegetation and organic duff often obscures artifacts on the ground surface in the Western Cascades. These same factors also contribute to soil development which can bury cultural materials, leaving few artifacts on the surface. Subsurface tests using probes (described below) should be excavated in the immediate vicinity of the isolated find location to determine if additional artifacts are present. If a site is identified through these tests, then excavations should continue for eligibility evaluation. If insufficient materials are found, the location can be determined non-eligible and investigations can be halted.

All site/isolate evaluation investigations should be conducted according to standard professional practice as outlined in the Secretary of the Interior's Standards and Guidelines (Department of Interior 1983). All work should be accomplished by qualified professional archaeologists, and consulting specialists should be retained as appropriate. As discussed below, general testing methods would include surface collections, round/square small test probes with controlled volumes, and excavation units 1x1 m in size or larger, if needed. Other testing techniques, such as remote sensing or mechanical trenching could be employed depending on site conditions, as deemed appropriate in consultation with PGE and relevant agencies.

The number and type of units used for evaluation tests will be unique to each site examined, given differences in site size, depth, and cultural features. However, most sites can be approached in a similar manner. Surface artifacts should be identified to delineate the surface distribution of the site, and surface collections may be made. Small round auger probes and/or square shovel probes should be excavated to delineate the subsurface structure of the site and site boundaries. Auger probes are generally 25 cm in diameter and are excavated using a shovel and a bucket auger. The auger can be extended to examine subsurface deposits up to 2.5 meters (8 feet) in depth. This type of probe is useful in examining a large area relatively quickly and in exploring for deeply buried cultural materials. Shovel probes are square units, 50x50 cm in size, and can generally be excavated 70-80 cm (2.2-2.6 feet) deep. This type of probe can also explore a large area relatively quickly, but its depth is somewhat limited. These units provide a larger sample of excavated material per unit and a much clearer exposure of the stratigraphic structure of the soil and the site.

These probes would be dug systematically to document densities and extent of cultural deposits across the site area, define the site boundaries, and compare the subsurface extent with the visible surface artifact distribution. Auger and/or shovel probes will generally be adequate to obtain needed information on site size, depth, structure, and content at most sites. If probes reveal the presence of subsurface cultural deposits or cultural features, larger units (excavated in 1x1 m provenience units) could be excavated to better examine these deposits, should this be necessary as part of establishing the NRHP-eligibility of the site or determining how project impacts may affect the site. All probes and any larger units should be excavated and screened by hand, using standard excavation techniques. All of the recovered artifacts, samples, and other data should be appropriately processed, catalogued, and prepared for subsequent analyses as needed. Finally, a full report describing the excavations, recovered materials, any laboratory analyses, and recommendations for National Register eligibility should be prepared.

3.4 Guidelines for Protecting Eligible Archaeological Resources

Archaeological resources that are determined to eligible for the National Register of Historic Places are protected under a variety of federal and state regulations. Treatment plans to protect and manage individual resources should be developed soon after the resources are evaluated. In general, the method of management preferred by the Secretary of the Interior and the NRHP is avoidance and conservation of significant resources. However, several management options can be developed in cultural resources treatment/management plans. The primary methods of site management include:

- **Avoidance.** Protect and preserve the eligible archaeological property in place by avoiding any activities that might adversely affect the property. This might entail redesigning portions of a project to avoid significant resources.

- **Protection.** Protect and preserve the eligible archaeological property from adverse project impacts by placing protective coverings at the site or implementing other protective measures. Protective measures will vary according to site structure, proposed impacts, and project requirements, and cannot be fully enumerated here. Appropriate measures should be determined in consultation with qualified professional archaeologists. Examples include measures such as allowing only vehicles with rubber tires on designated site surfaces, using filter fabrics to protect site areas subject to flooding or burial, using rip rap materials to control erosion, or undertaking surface activities when ground is dry or frozen.

- **Data Recovery.** If eligible archaeological resources cannot be avoided or protected in place, data recovery excavations should be conducted to obtain and preserve the scientific information that will be destroyed or adversely affected by the project. Data recovery excavations generally entail intensive fieldwork to carefully remove and record all or a representative sample of the site area to be disturbed. A qualified professional archaeologist should develop the research design, prepare a detailed field excavation strategy, direct the fieldwork, analyze the collected data and materials, and prepare a full report of the research. It will be necessary to consult with the appropriate Indian Tribes prior to the fieldwork and to obtain the appropriate state or federal excavation permits (see below).

3.5 Management Review Procedures for Archaeological Resources

Section 2.4 advocates the need for PGE to create a role for an Historic Preservation Coordinator (HPC) and establishes review procedures needed to facilitate ongoing operation of the PGE Westside Projects while protecting significant historic resources. It should be remembered that the HPC's role and these review procedures apply to archaeological cultural resources as well historic structures. The responsibilities and historic preservation review procedures outlined in Section 2.4 should be followed whenever operational, maintenance, or new construction projects will involve ground-disturbing activities in areas that may potentially affect archaeological cultural resources.

Any PGE project involving ground disturbance (e.g., facility construction, pole replacements, vegetation clearing, etc.) should be reviewed by the HPC. The HPC should maintain records and maps of previous cultural resources investigations on PGE project lands and consult these to determine whether a project area has been previously surveyed and whether National Register-eligible archaeological resources are present in the area. The Oregon SHPO maintains such records and should be consulted as needed. If the area has been surveyed and no eligible properties are present, the HPC may allow the project to proceed through the normal PGE internal review process.

The HPC may decide that the previous work was inadequate or not detailed enough for the proposed project. If this is the case, or if the area was not surveyed, the HPC will determine whether a cultural resources survey is required for the proposed project. This determination may be made in consultation with a qualified professional archaeologist and the Oregon SHPO, as needed. **This review and needs assessment should be conducted as early in the project timeline as possible**, since the survey may conclude that additional field studies and/or site evaluation tests are required prior to approval of the project.

In the heavily vegetated areas of the Oregon Western Cascades, surface survey alone may not be sufficient to identify archaeological resources. In areas where there is a high probability for archaeological sites and ground-disturbing activities are part of the proposed project, subsurface probing should be conducted in an effort to discover buried or otherwise obscured archaeological resources (please refer to the PGE Westside Cultural Resources Studies for discussions of the Mt. Hood National Forest Site Location Model and the potential for presence of archaeological sites in relation to slope, water, and landforms).

To be most cost-effective, it is recommended that any cultural resources study conducted in advance of a construction/ground disturbance project routinely include both a survey phase (surface and subsurface as needed) and a site evaluation test phase. Incorporating both phases ensures that decisions regarding the National Register eligibility of sites found in a proposed project area can be made in a timely fashion. As discussed above in Section 3.1, until a site can be evaluated, it should be considered potentially eligible to the National Register and avoided or otherwise protected.

However, it should also be remembered that subsurface test excavations at locations identified as archaeological sites in Oregon generally require a permit. For non-federal Oregon public lands a permit is required for *any* subsurface investigations (such as site discovery probing), even when a site has not been identified. For private lands in Oregon, a permit is required for excavations at an archaeological site, but is not required for site discovery probing before a site has been identified. If the site is on private land or non-federal public land, a state permit issued by SHPO is required under Oregon state law ORS 358.920. This permit must be obtained by an archaeologist meeting the qualifications set forth in

ORS 390.235. If the site is on federal public land (e.g., land administered by Mt. Hood National Forest), a federal Archaeological Resources Protection Act (ARPA) permit is required. Again, the permit must be issued to a qualified archaeologist. The permitting processes are somewhat different, but both require notification and consultation with appropriate Indian Tribes, and a period for review and comment on the proposed excavation strategies and procedures.

Once the area has been surveyed and any archaeological resources that may be affected have been evaluated for National Register eligibility, the HPC will review the findings and determine subsequent courses of action. If no eligible resources are present the HPC can allow the project to continue. If eligible resources are present and will be affected by the proposed project, the HPC may recommend that the project be reassessed to find alternatives that will avoid the eligible resources or mitigate any adverse project-related impacts.. Some of these mitigation methods, including protective measures or data recovery excavations, discussed in Section 3.4.

Native American human burials are protected under state and federal laws, on both public and private property. If a burial is discovered in the course of archaeological investigations or other PGE projects, all work in the vicinity of the find should be halted and the HPC notified. The HPC should consult with a qualified professional archaeologist and notify the appropriate parties (depending the land jurisdiction--state or federal), for consultation and determination of subsequent actions. Generally, the HPC should notify and consult with the Oregon SHPO, the appropriate Indian Tribes, the Oregon State Police, and the land manager(s) having direct responsibility for the property.

While adherence to the review procedures presented above should be sufficient to identify and evaluate the archaeological resources in a project area, there always remains the possibility that buried prehistoric or historic cultural resources may be present in untested portions of a project area. If cultural resources are encountered during the course of a project, earth-disturbing activities in the vicinity of the find should be suspended in accordance with state and federal laws, and a qualified professional archaeologist should evaluate the discovery and recommend subsequent courses of action.

3.6 Confidentiality Procedures

Archaeological site locations should be considered sensitive information and should not be readily available to the general public. Site record forms held in repositories such as the Oregon SHPO are conditionally exempt from public records requests (such as requests through the Freedom of Information Act), and can be withheld from individuals who do not have professional or legal reasons for needing these data. PGE should follow this same principle. Information on site locations and contents should be on a "need to know" basis. The HPC should use discretion and judgment in providing site information.

Of course, some individuals must know where sites are located to accomplish their management responsibilities with PGE and to protect these sites. PGE managers, engineers, and selected field supervisors and personnel should receive training on cultural resources laws and protection, stressing why cultural resources are important and how they can be protected. Project personnel should have training to recognize cultural resources in the field.

4.0 CULTURAL RESOURCE MANAGEMENT SYSTEM (CRMS)

The CRMS is a PC-based application with an interactive graphic interface enabling users to access cultural resources information from multiple sources and software platforms. It was developed to manage PGE's cultural resources and facilitate implementation of this management plan. As a management and decision-making tool, the CRMS makes it possible to actively manage and track the various cultural resources located throughout the PGE Westside Projects system. It combines various forms of electronic media, including database information, documents, photographs, and maps, into a user-friendly system. Hypertext links and searching capabilities enable users to access and copy relevant sections of cultural resources studies and management documents. The CRMS has the look and feel of a web page browsing by taking advantage of access via any web browsing software (e.g., Netscape, Explorer). The CRMS will serve as a local area network application and will reside on the internal computer network at PGE's main office in Portland, Oregon. It could be easily accessed by any number of the company's departments that are connected to PGE's network, and can be updated and expanded to accommodate the needs of the company.

This section describes the types of data available in the CRMS, its intended users, and description of how to use this management and informational tool.

4.1 Data Available

There are four types of electronic data available on the CRMS. They are:

1) Documents related to cultural resource studies, management guides, and references for further information related to historic preservation.

2) Color maps of all the PGE Westside buildings and structures, identifying which are historic resources. The maps range from large vicinity maps to site specific maps of the individual buildings and components.

3) Historic photographs of the individual hydroelectric projects and their associated features.

4) Historic information for each hydroelectric project provided in two forms - the Oregon Inventory of Historic Properties Survey Form, which includes descriptive text, photographs, and site maps, and a Microsoft Access database in which contains all information on the inventory forms.

Under normal circumstances, documents, maps, photographs, and databases would be located in different places within PGE and would not be immediately accessible to everyone in the company. The CRMS integrates these disparate sources of information in a user-friendly manner and makes them available to everyone with access to a computer network. Further detail on the contents of the CRMS and how to access it is provided in section 4.3.

4.2 CRMS Users

Intended users of the CRMS are primarily PGE Management who have been charged with the protection of cultural resources within the PGE hydroelectric system. Plant modifications and alterations, as well as maintenance and ground-disturbing activities, all have the potential to affect cultural resources. Quick and accurate retrieval of cultural resource information will help PGE Management make informed decisions, determine the effects of their decisions on cultural resources, and give them the tools to effectively manage these resources. Both read and write capabilities will be available to PGE Management to make changes to the contents of the CRMS. In addition, sensitive, confidential information regarding the location of site-specific archeological resource can made available to users with password rights.

The CRMS can also be used to produce quick and effective reports regarding issues which may affect cultural resources. These users could produce reports which combine text, maps, and photographs. Read-only capability would be available to these users allowing them to review and copy the information, but not change its contents. Password rights could block these users from viewing confidential material. Finally, the read-only CRMS can be used by anyone at PGE interested in their company's history or to research the history of a specific hydroelectric project or component. Eventually, the CRMS could be made available to the general public by incorporating it entirely, or portions of it, into the existing PGE website on the World Wide Web.

4.3 How to Use the CRMS

To use the CRMS, open the PGE CRMS Home Page file on the company network using any internet browser (e.g., Netscape, Internet Explorer). Once in the Home Page, the user will notice a tool bar at the top of the page, and three color photos in the middle of the page; one of each hydroelectric project (Bull Run, Willamette Falls, or the Clackamas River Hydroelectric Projects - the last of which leads the user to information on River Mill, Faraday, North Fork Hydroelectric

Developments, as well as the Oak Grove Hydroelectric Project). Below the photos are the names of each project. The user can navigate through the system via the blue tool bar at the top of the page, or by clicking on any name that is in color and underlined. These are called "hot links," and lead to detailed information about each building or component within the various hydroelectric projects. Most of the information contained in the CRMS can be accessed through multiple paths.

Within the Home Page, the user can select the colored and underlined names of one of the six hydroelectric projects. After selecting the desired project, a color photo of the project is displayed along with a list of six items. The following is a brief description of each item:

1) Cultural Resource Studies: Selecting this item launches Acrobat Reader allowing the user to view, print, select, and copy all three PGE Westside Cultural Resources Studies without making unauthorized changes to the original file. The user can read about the historic context of a project, as well as an evaluation of its historic and archeological significance. Bookmarks on the left hand column allow the user to go directly to key subsections in the text.

2) Maps: Selecting this item launches a color vicinity map of the project area. This map is linked to more detailed site maps for each resource. By clicking on the words that are colored and underlined, the user can go a map of that specific area. For example, within the Bull Run Vicinity Map, the user can select the word "Bull Run Powerhouse" to reach the individual site maps of this feature. The individual site maps are color coded red, yellow, or green denoting different levels of historic significance. The user can click on the colors in the legend at the bottom of the map to launch a description of each significance level, as well as the treatment procedures for each category. The user can also click on the individual building or component to bring up the Oregon Historic Inventory Survey Forms to view data related to the specific resource (see next).

3) Survey Forms: Selecting this item launches thumbnail images and descriptions of all four pages of the Oregon Historic Inventory Survey Forms. Below the images and description is a matrix of all the historic resources surveyed, categorized by resource type and project location. Clicking on the various X's in the matrix will lead the user to the form for the individual building or component. This brings up the four pages of the form, each one

5.0 Literature Cited

Burtchard, Greg C.

1990 *The Posy Archaeological Project; Upland Use of the Central Cascades; Mt. Hood National Forest, Oregon.* Report by the Laboratory of Archaeology and Anthropology, Department of Anthropology, Portland State University to USDA Forest Service, Mt. Hood National Forest, Gresham.

1991 *Cultural Resource Evaluation of the Ruby Site, 35CL42; Mt. Hood National Forest, Oregon.* Report of the Laboratory of Archaeology and Anthropology, Department of Anthropology, Portland State University to USDA Forest Service, Mt. Hood National Forest, Gresham.

Burtchard, Greg C., and Robert W. Keeler

1991 *Mt. Hood Cultural Resource Reevaluation Project; A Consideration of Prehistoric and Historic Land-Use and Cultural Resource Survey Design Reevaluation.* Report of the Laboratory of Archaeology and Anthropology, Department of Anthropology, Portland State University to USDA Forest Service, Mt. Hood National Forest, Gresham.

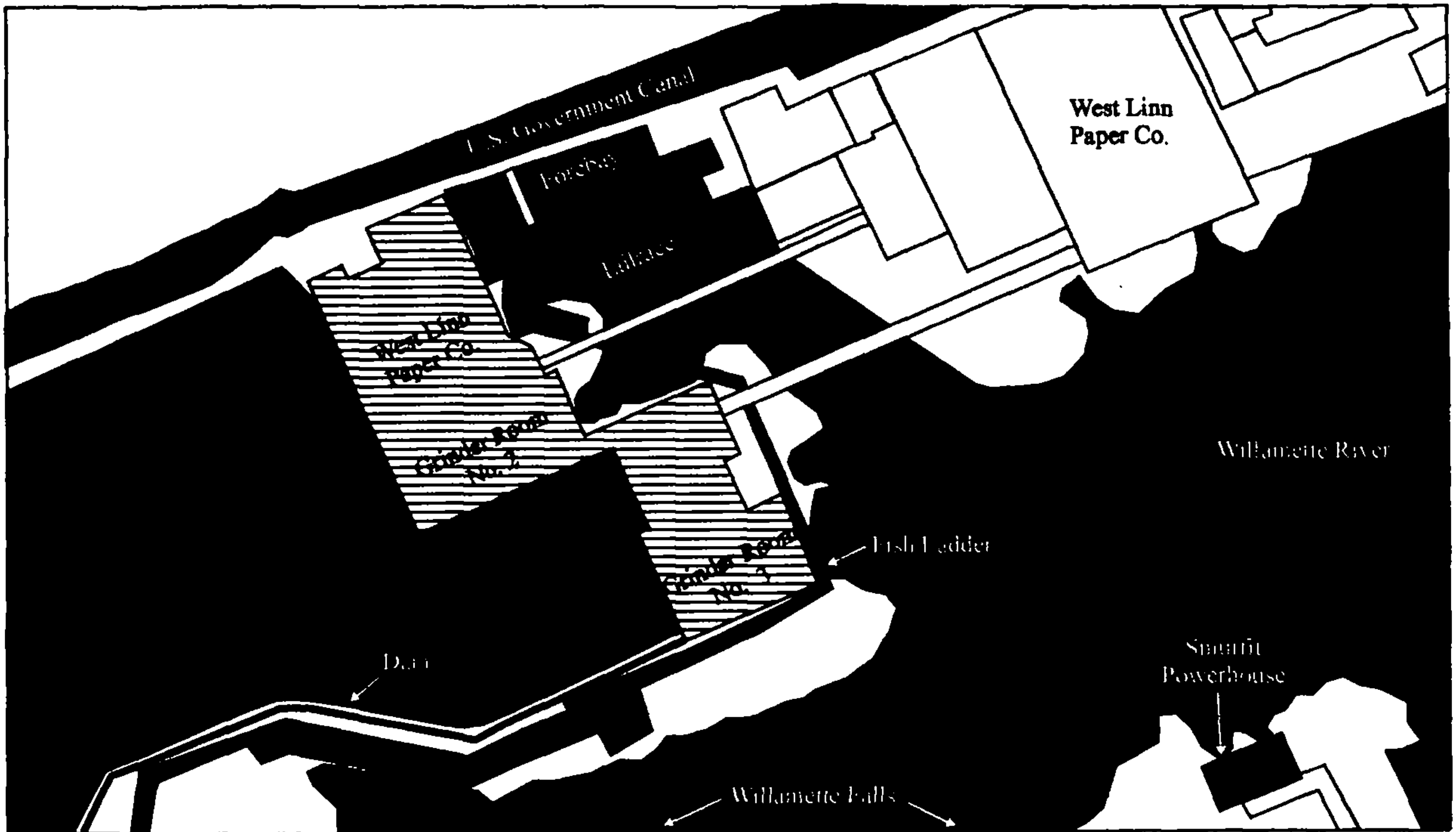
Butler, William B.

1987 Significance and Other Frustrations in the CRM Process. *American Antiquity* 52(4):820-829.

U.S. Department of the Interior

1983 Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines. *Federal Register* 48 FR 44716-42.

Appendix A:
Constraints on Alterations to PGE Westside Hydroelectric Project Structures and Components



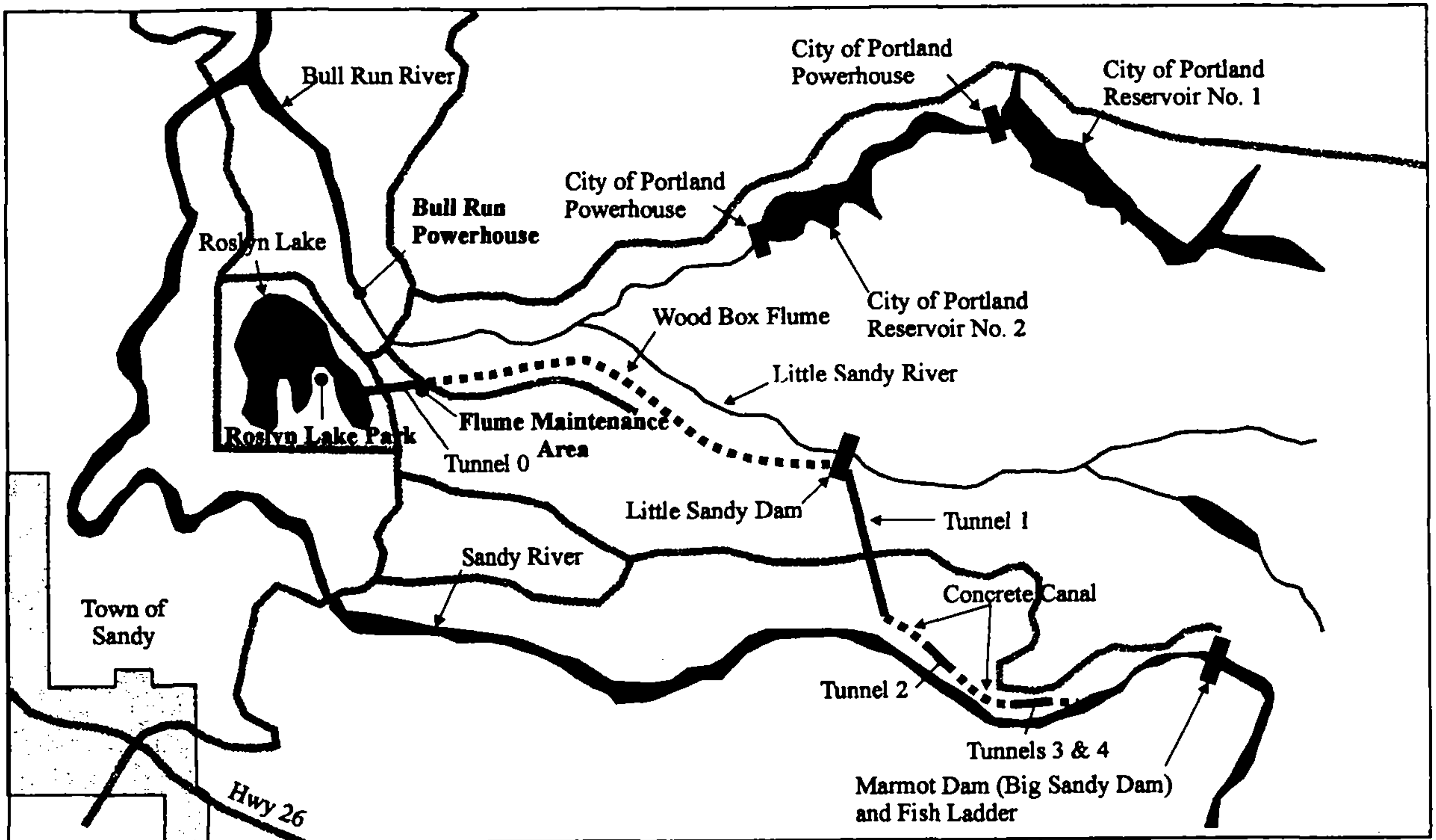
Legend

- Primary Historic Building - Highly Constrained
- Determined Eligible by SHPO - to be included in a later survey
- Secondary Historic Building or Comptible Building - Constrained
- Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to the Willamette Falls Hydroelectric Project



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Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

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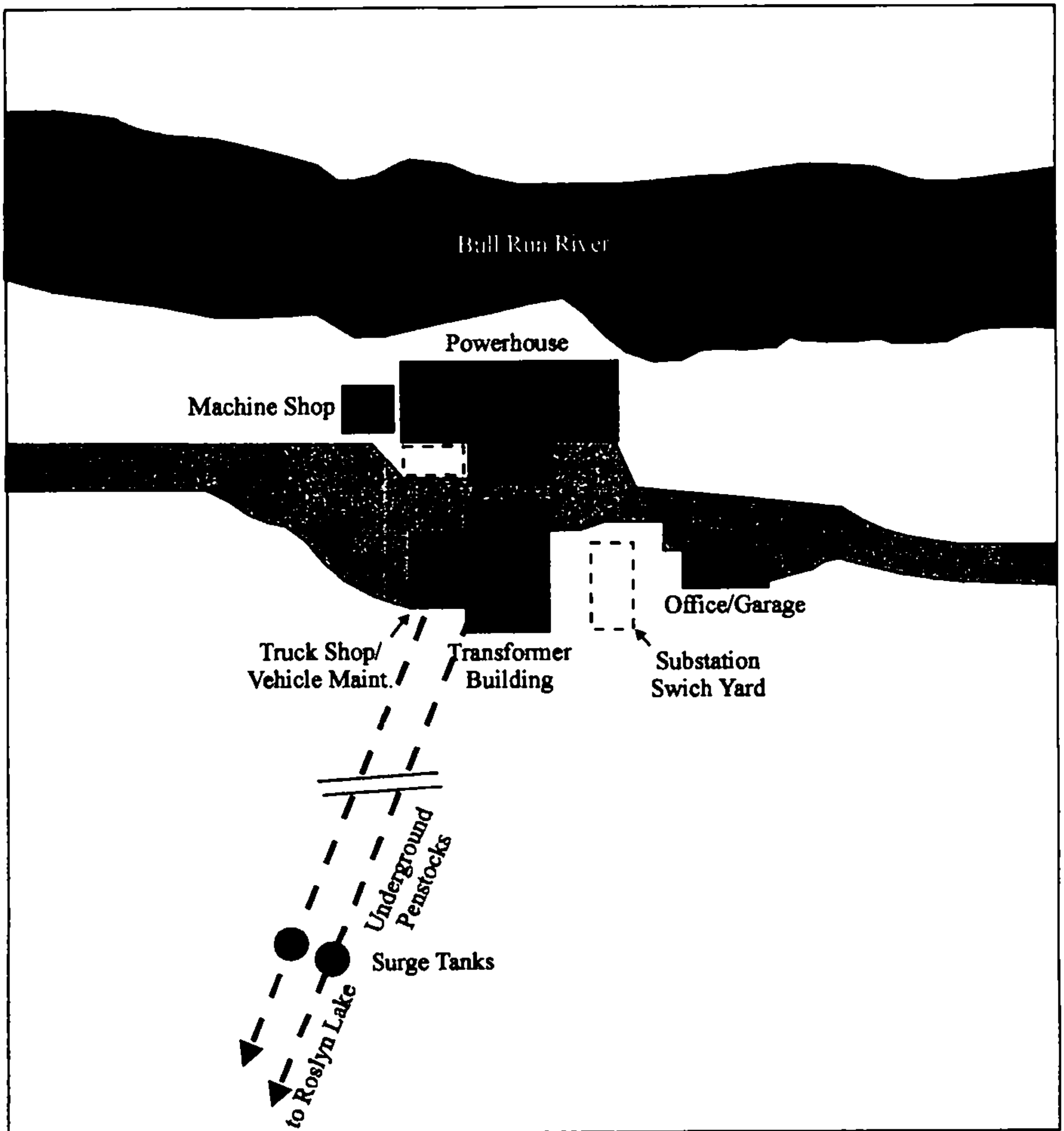
Not to Scale

Constraints on Alterations to Bull Run Hydroelectric Project



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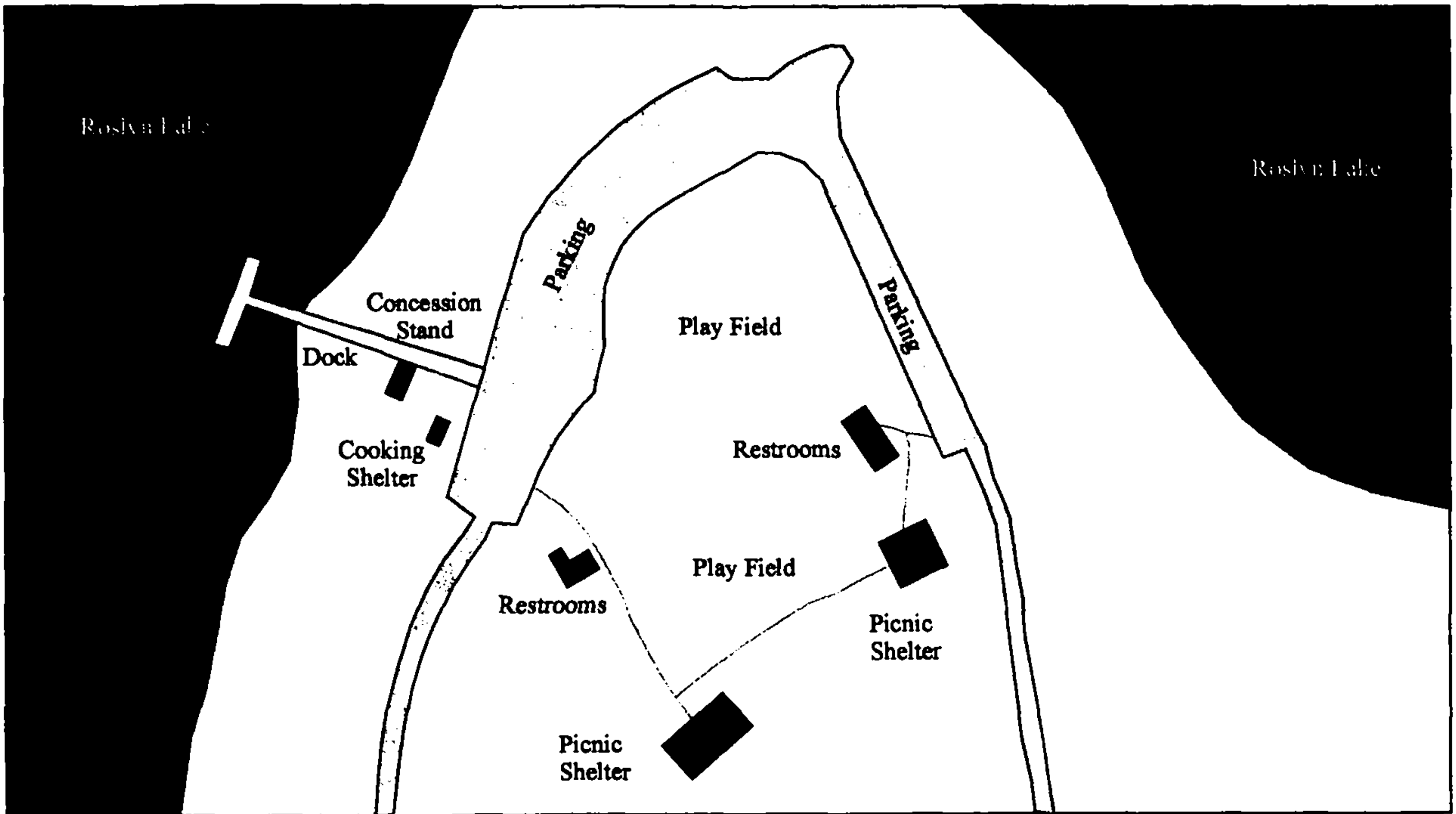
Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

Not to Scale

Constraints on Alterations to Bull Run Hydroelectric Project



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Legend

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Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

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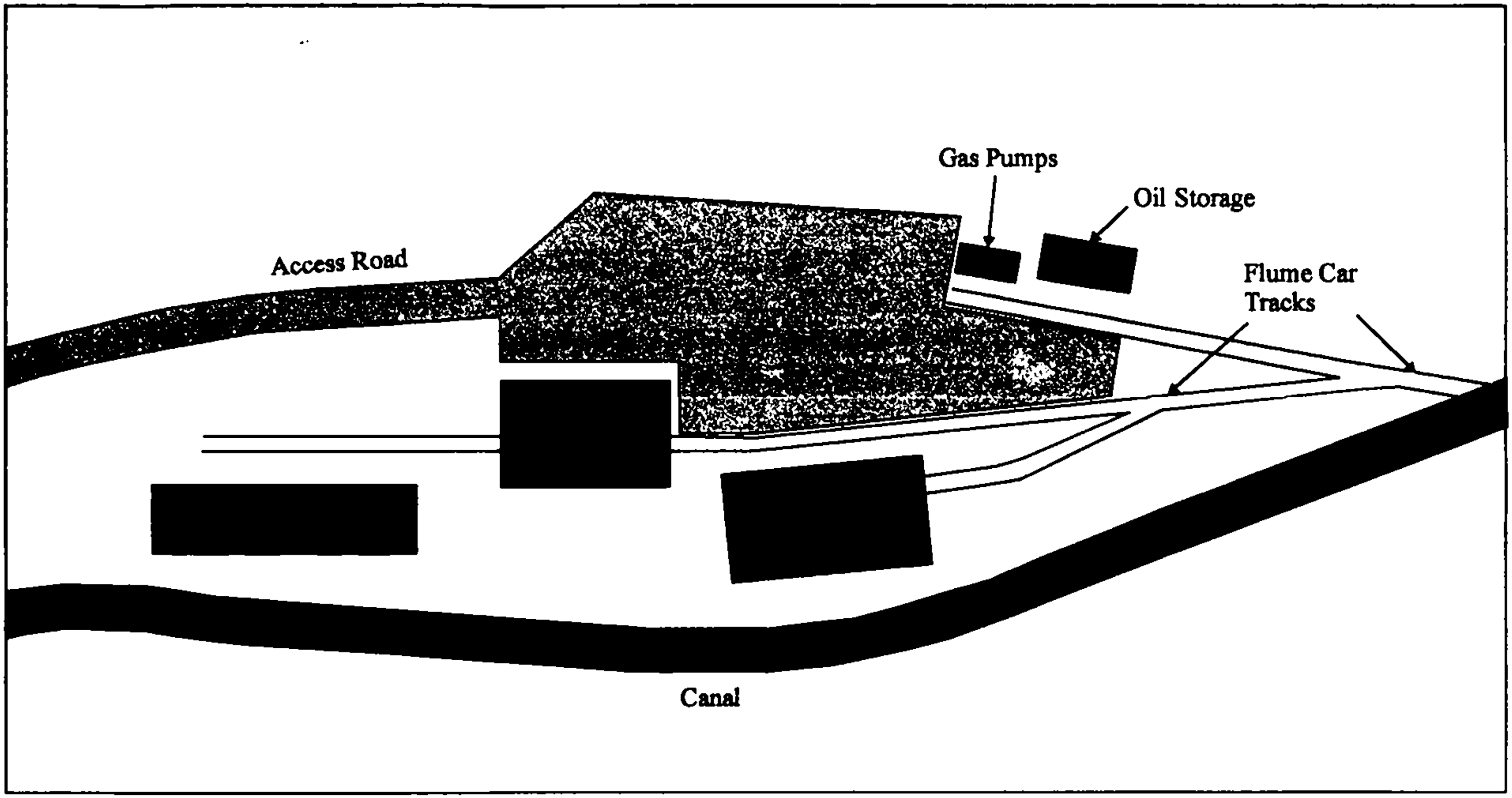
Not to Scale

Constraints on Alterations to Bull Run Hydroelectric Project - Roslyn Lake Park Buildings



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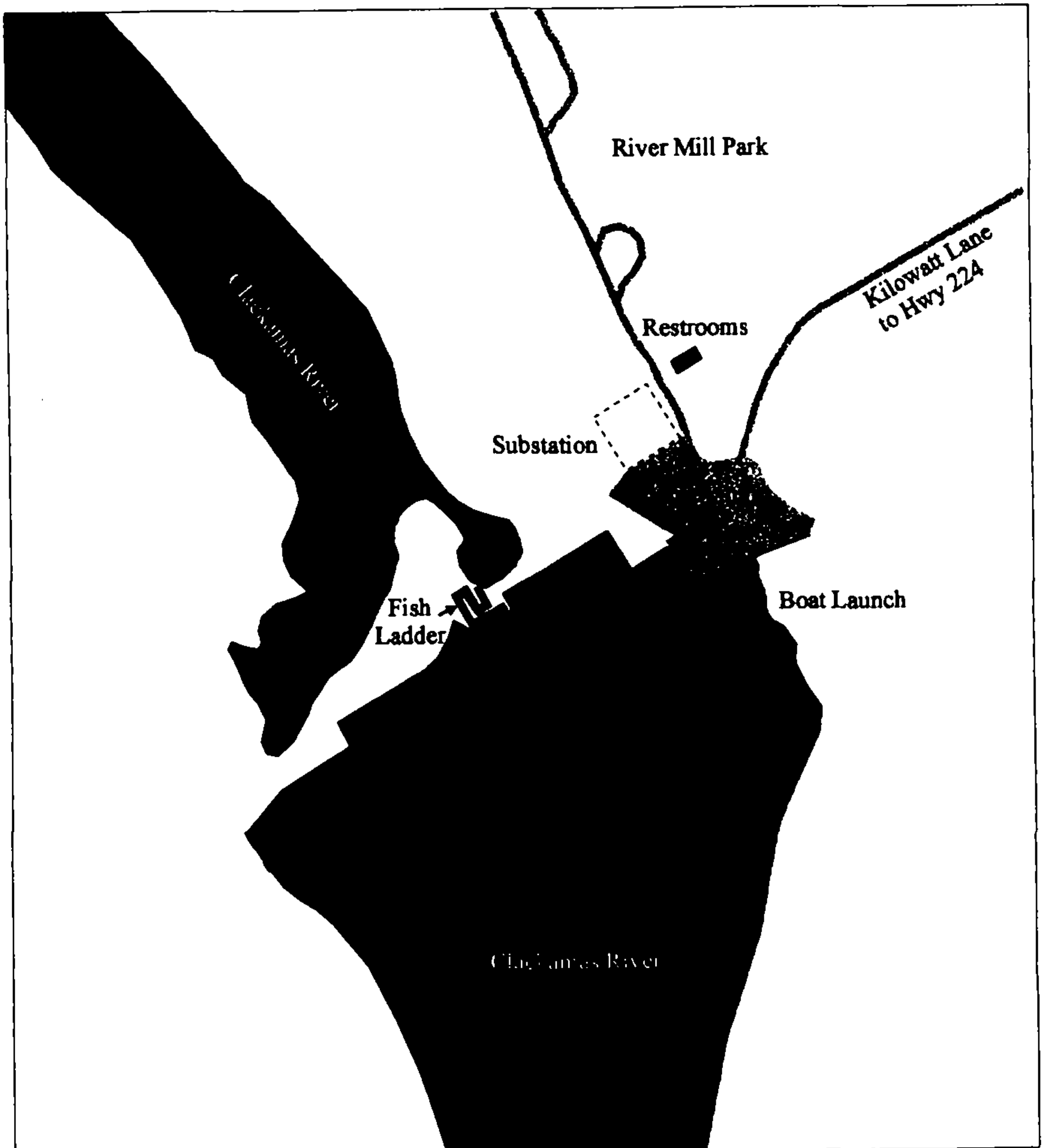
Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

Not to Scale

Constraints on Alterations to Bull Run Hydroelectric Project - Flume Maintenance Area



P/7e224.01/document/ormg/graphics/River Mill.cdr

Legend

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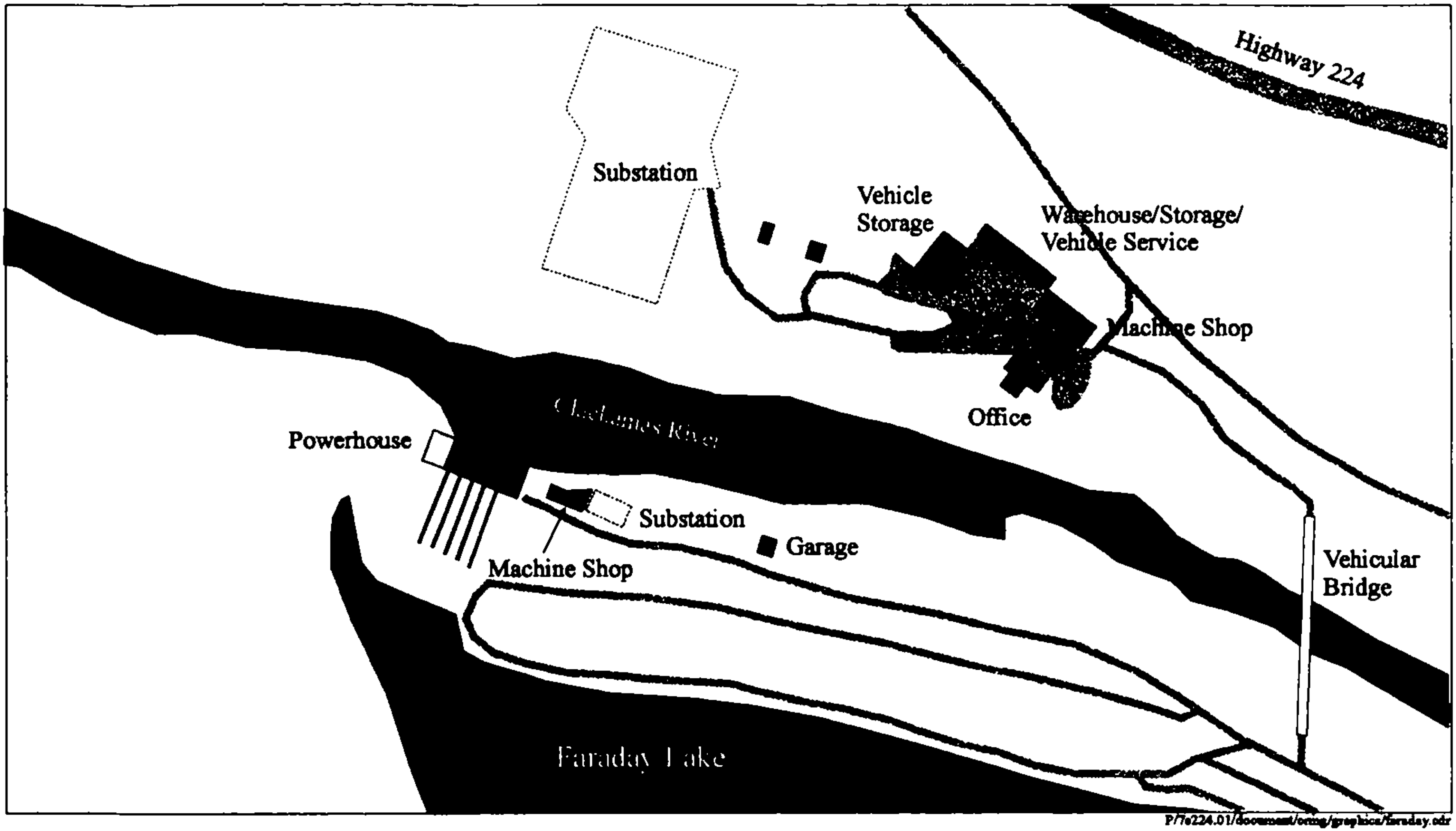
Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to River Mill Hydroelectric Project



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Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

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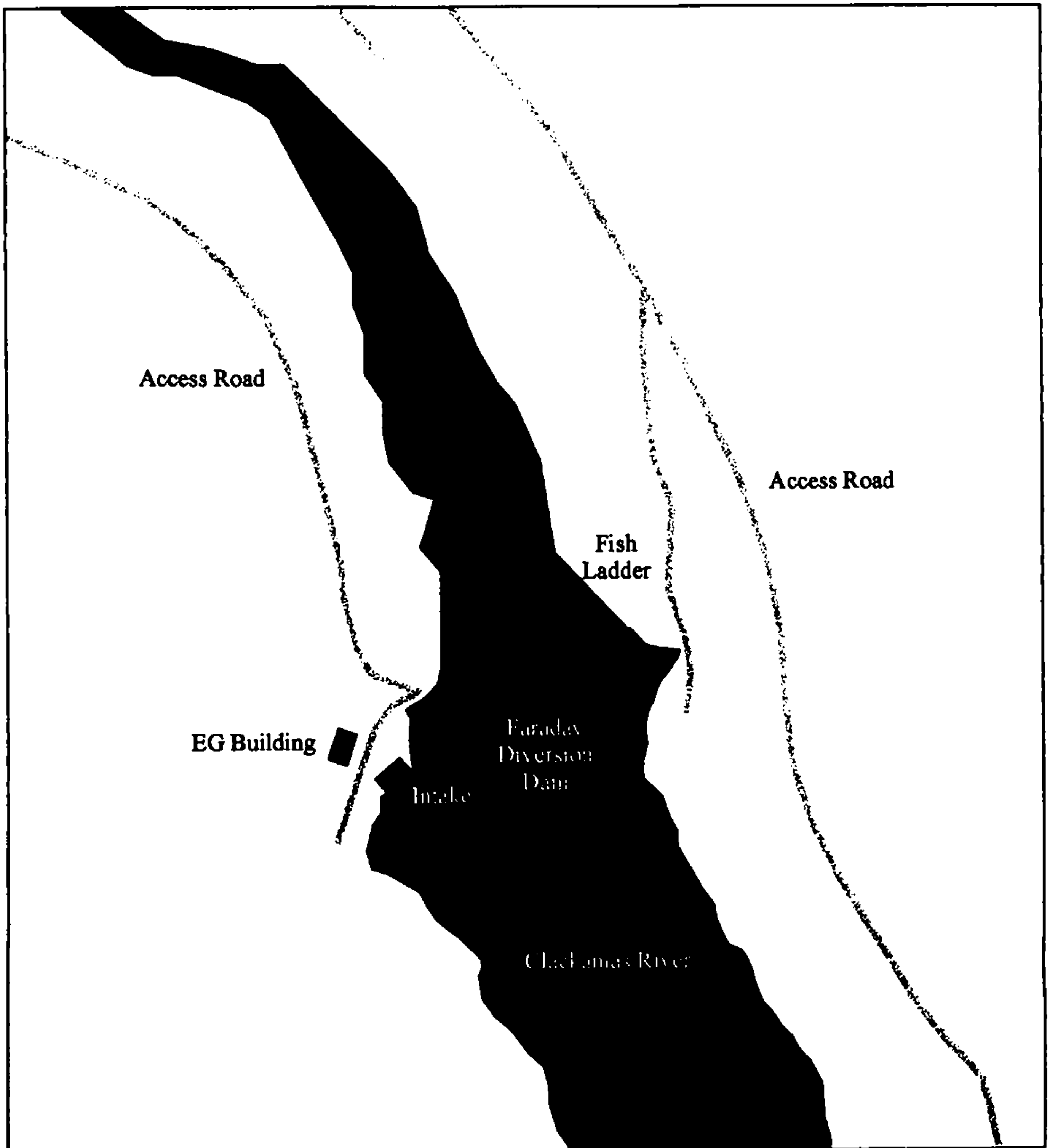
Not to Scale

Constraints on Alterations to Faraday Hydroelectric Project



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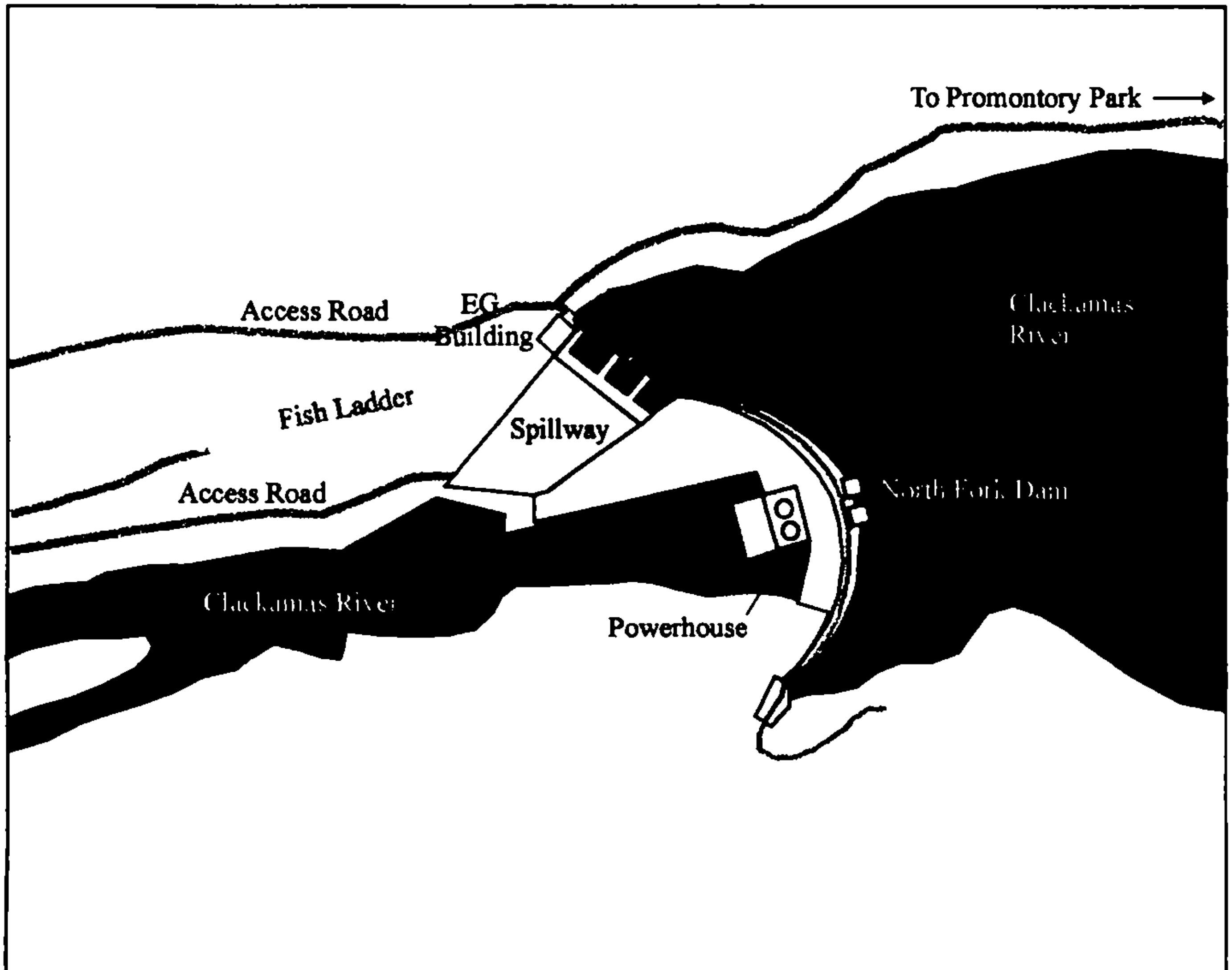
Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

Not to Scale

Constraints on Alterations to Faraday Hydroelectric Project



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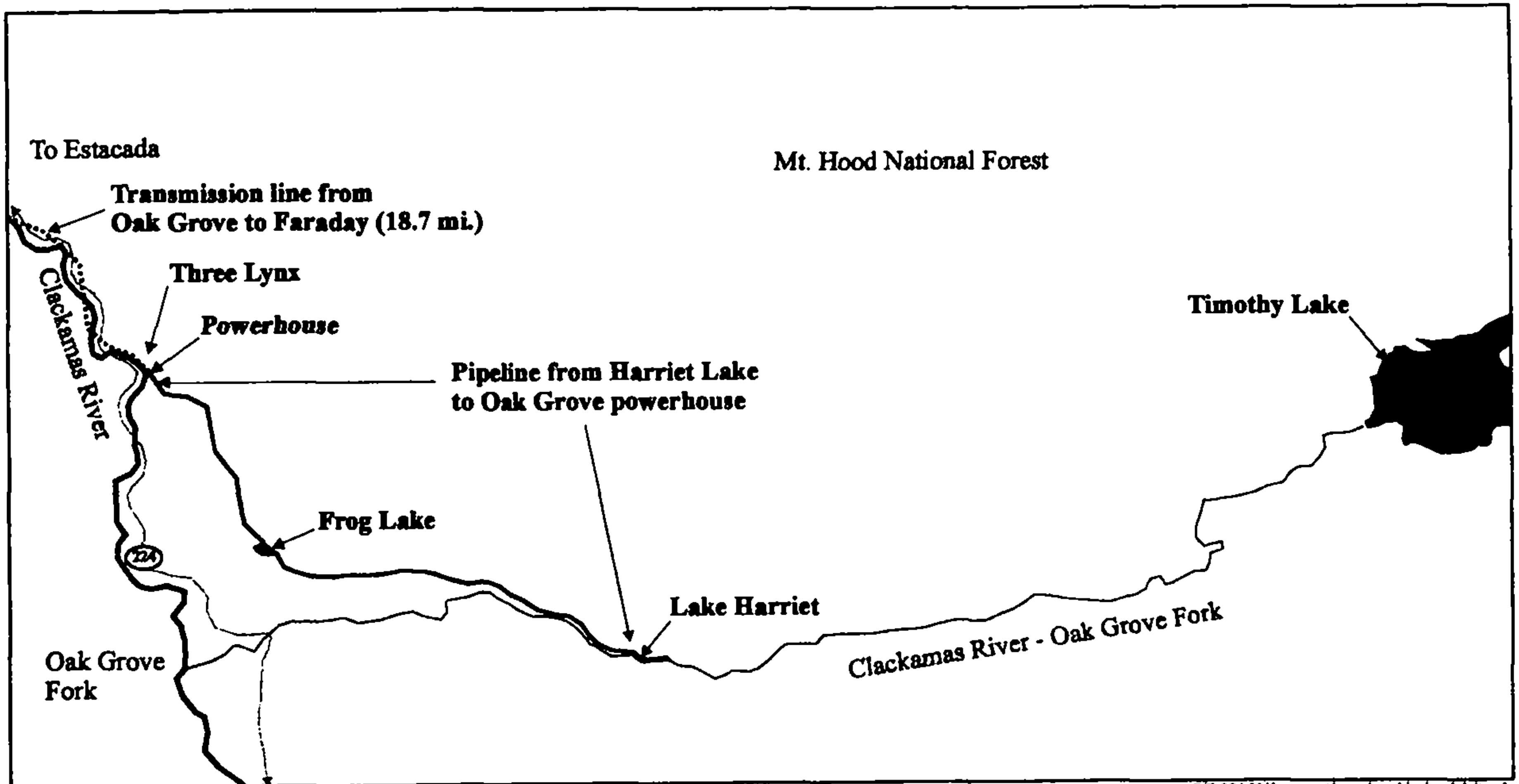
Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to North Fork Hydroelectric Project



Legend

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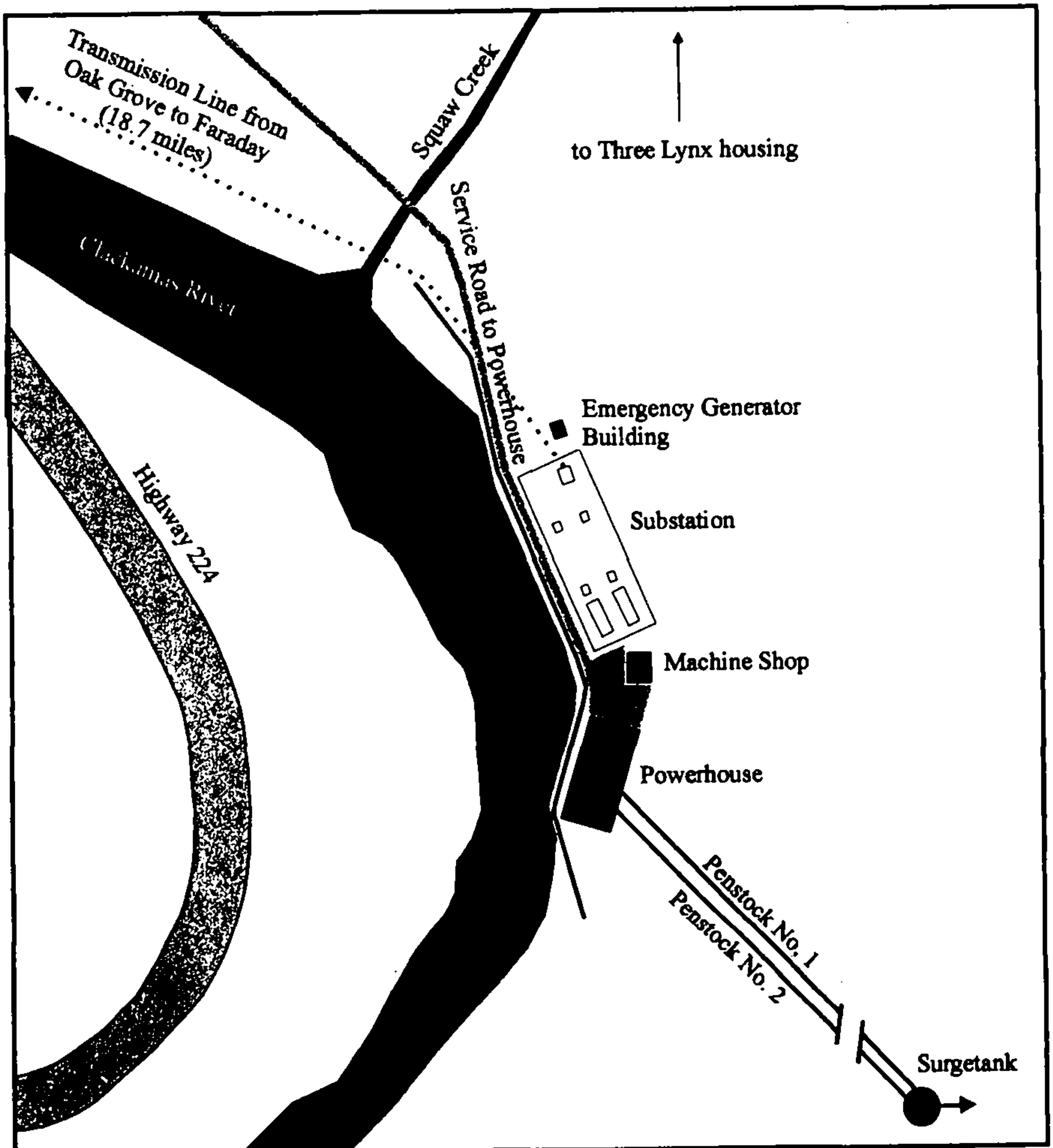
- Secondary Historic Building or Compatible Building - Constrained
- Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to the Oak Grove Hydroelectric Project



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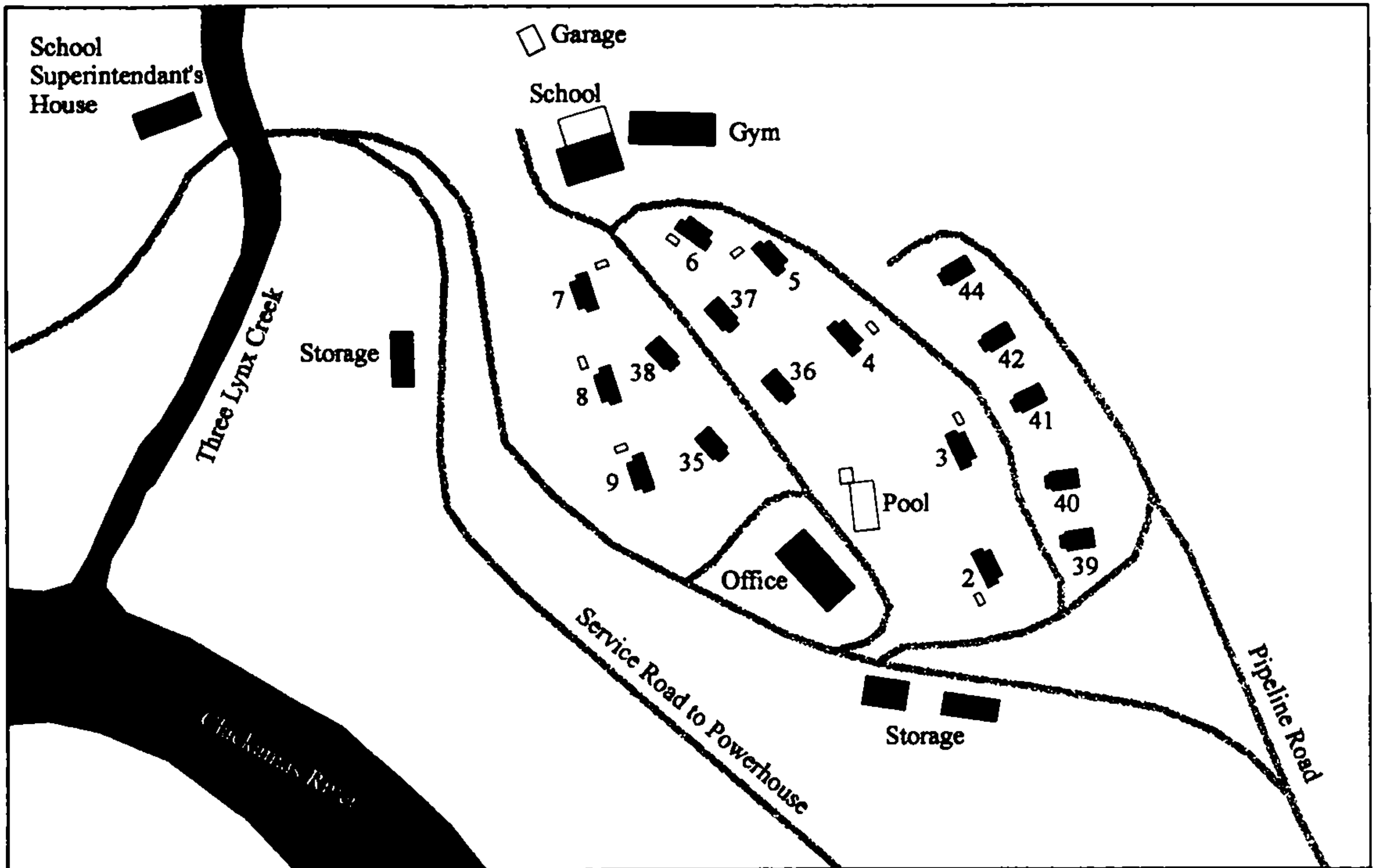
- Secondary Historic Building or Comptible Building - Constrained
- Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to Oak Grove Powerhouse



7e224.01/document/crmg/graphics/three lynx.cdr

Legend

Primary Historic Building - Highly Constrained

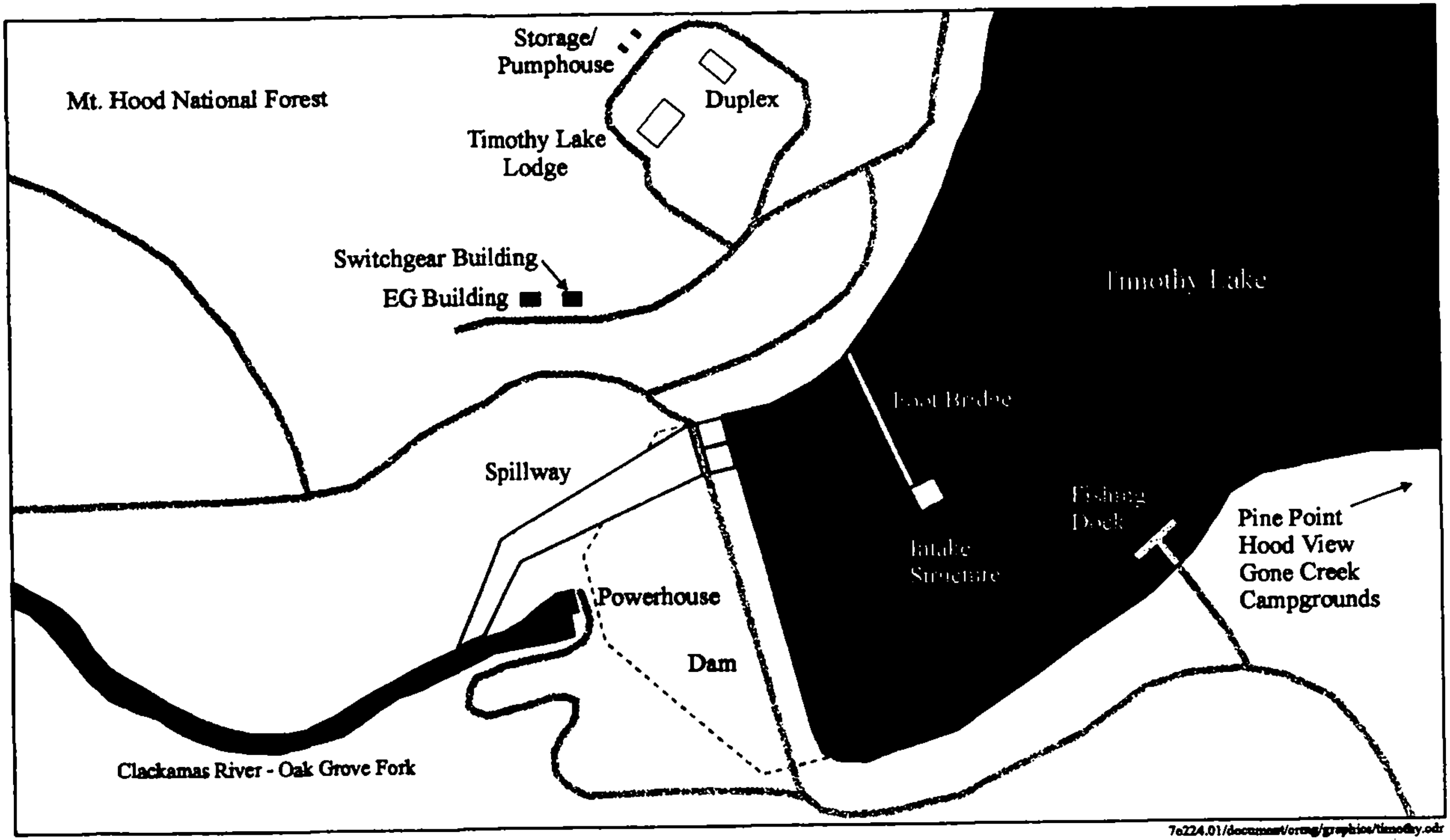
Secondary Historic Building or Comptible Building - Constrained

Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to Three Lynx Housing



Legend

Primary Historic Building - Highly Constrained

Secondary Historic Building or Compatible Building - Constrained

Non-Historic Building - No Constraints

N

Not to Scale

Constraints on Alterations to the Timothy Lake Complex