

## **APPENDIX 5C**

### **RMA2 HYDROLOGIC MODELING GRAPHICS**



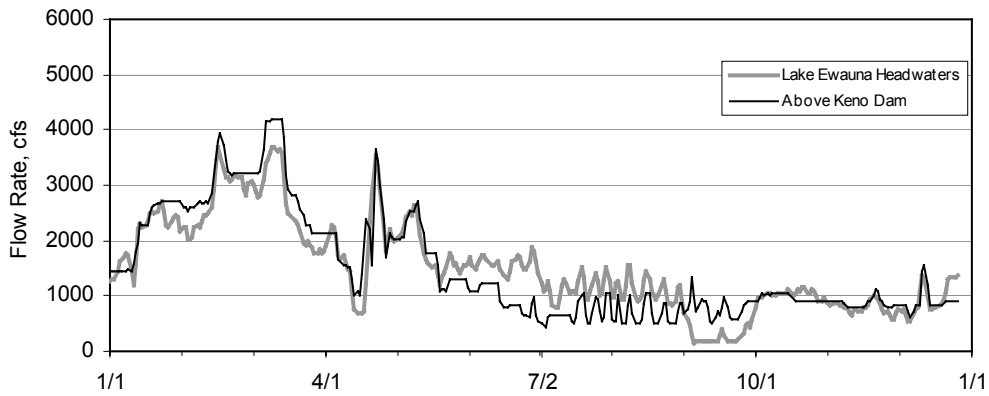
This appendix contains graphs depicting the results of modeling of hourly flow in the Klamath River at several sites within and downstream of the Project area using the hydrodynamic and flow routing models in RMA-2<sup>1</sup> and CE-QUAL-W2.<sup>2</sup> For riverine reaches, RMA-2 was used. RMA-2 is a model specifically designed to assess flow response in complex river systems. For Project reservoirs, CE-QUAL-W2 was used. CE-QUAL-W2 effectively simulates the routing of flow through reservoir geometry and predict reservoir water surface elevations. These models were used to examine the short-term hydrology and hydrodynamics effects of Project operations scenarios, together with examination of water quality effects based on 2000 and 2001 conditions.

The graphs include model output from four basic operations scenarios: (1) existing conditions, (2) steady flow condition, (3) a hypothetical without-Project (WOP I) condition, and (4) a second hypothetical without-Project (WOP II) condition. These scenarios and their associated modeling assumptions are described in detail in Appendix 4A of this FTR titled Development of Water Quality Analysis Modeling Framework. A summary description of the four basic scenarios is provided in subsection 5.4.2.1: Effects on the Short-Term (Daily and Hourly) Hydrologic Regime of Section 5 of this FTR.

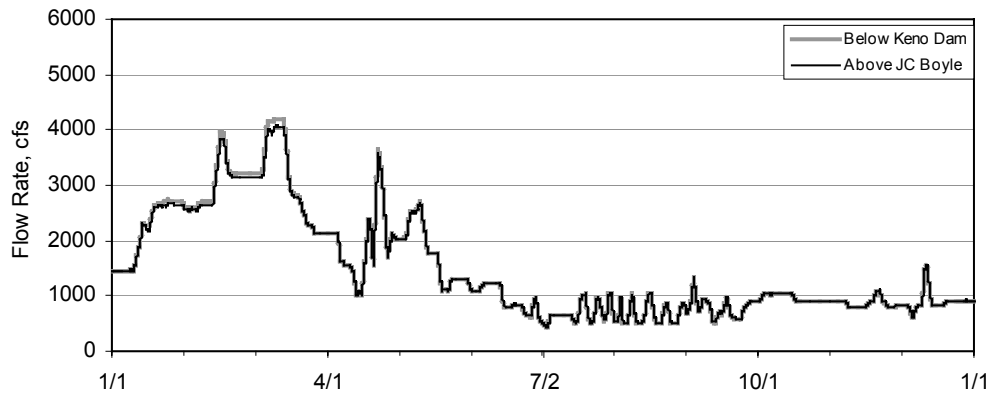
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<sup>1</sup> RMA-2 was used in combination with RMA-11 to provide a complete and comprehensive water quality model. RMA-11 uses the geometry and output of RMA-2, and solves the advection-diffusion equation to determine the fate and transport of up to 16 water quality constituents.

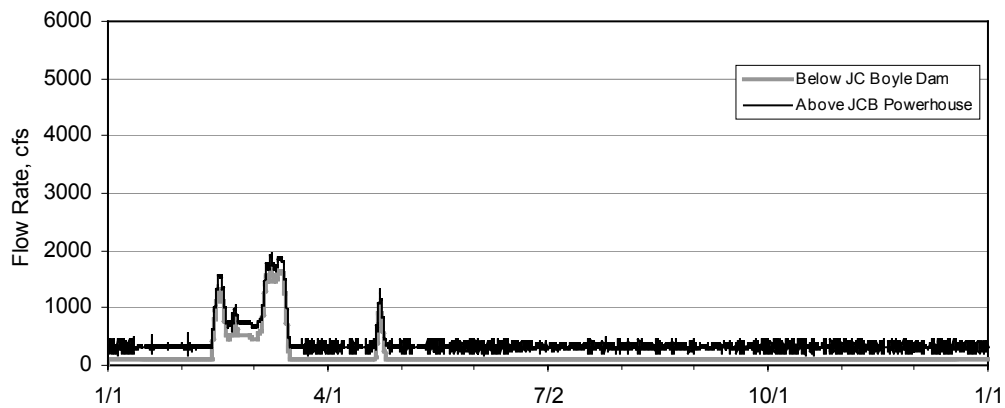
<sup>2</sup> Different models were selected for riverine reaches and reservoirs because of fundamental differences in their geometric, hydraulic, and water quality characteristics. See Appendix 4A of this FTR for further discussion on model purpose and selection.



Daily Flow in Klamath River 2000

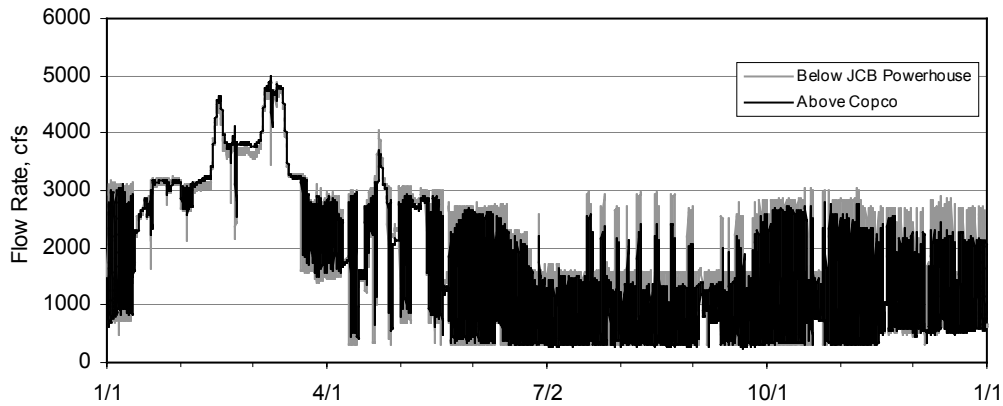


Flow in Klamath River 2000

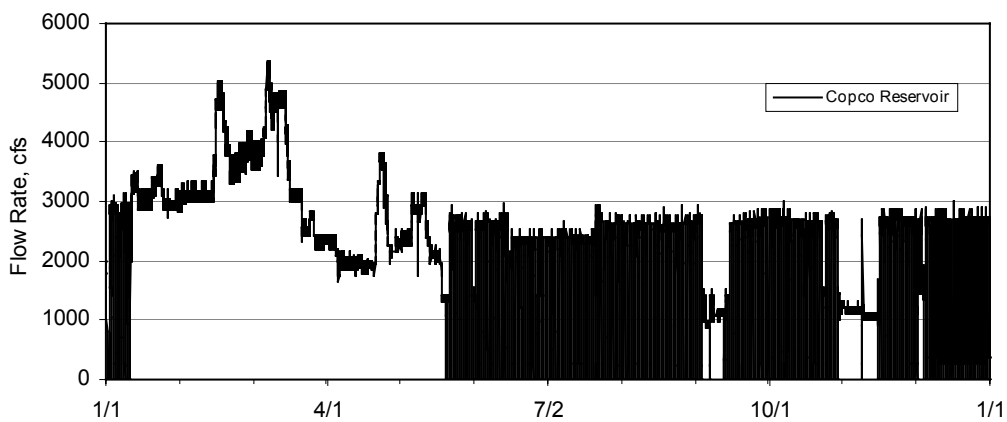


Flow in Klamath River 2000

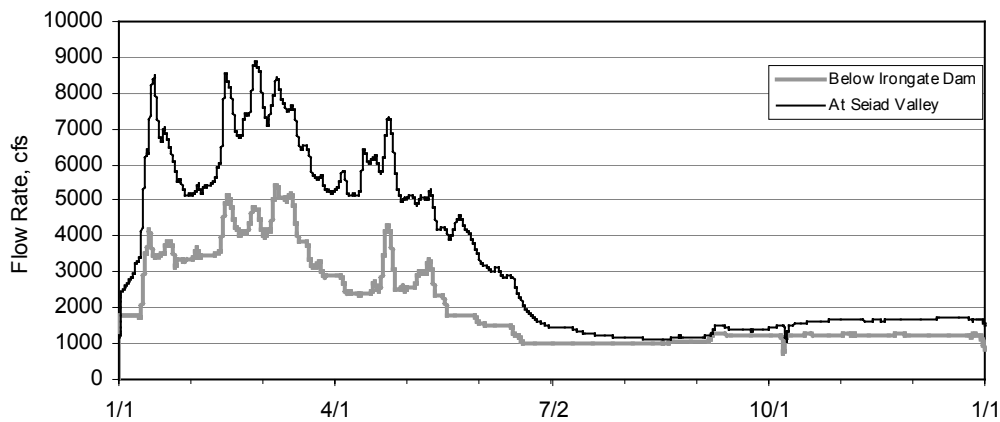
Figure 5C-1. Existing conditions model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).



Flow in Klamath River 2000

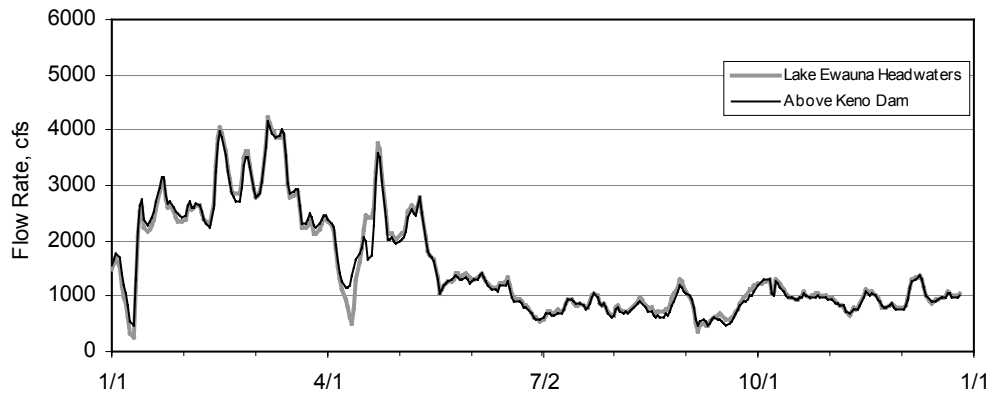


Flow in Klamath River 2000

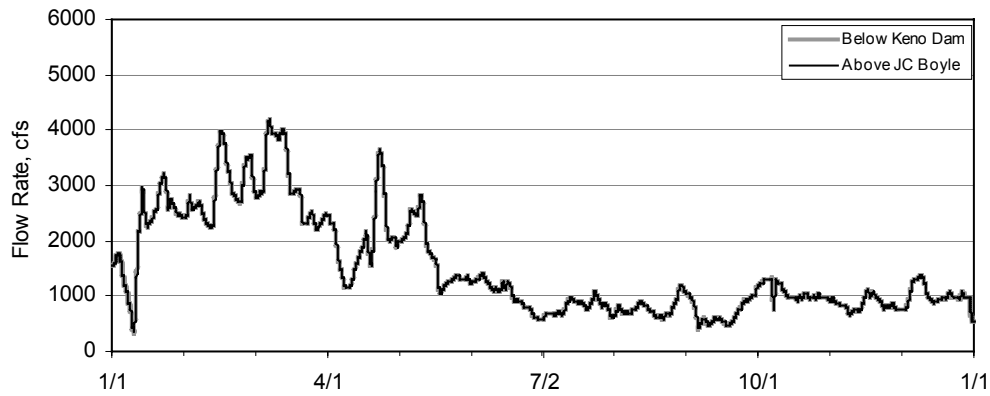


Flow in Klamath River 2000

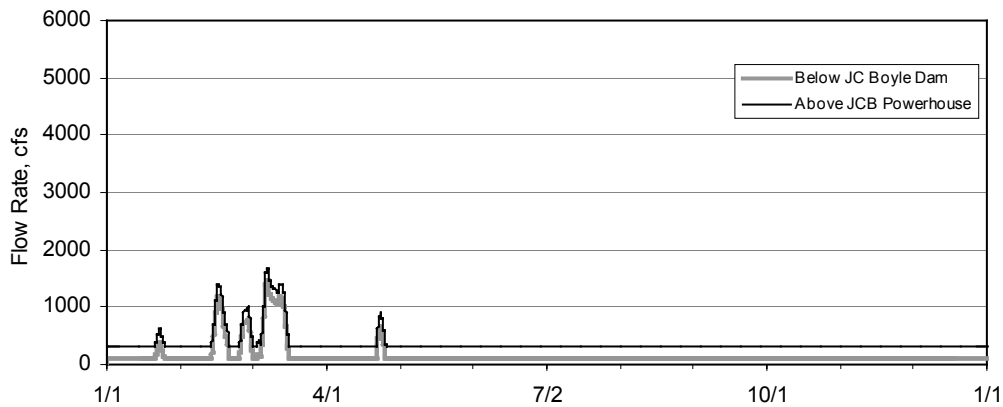
Figure 5C-2. Existing conditions model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).



Daily Flow in Klamath River 2000

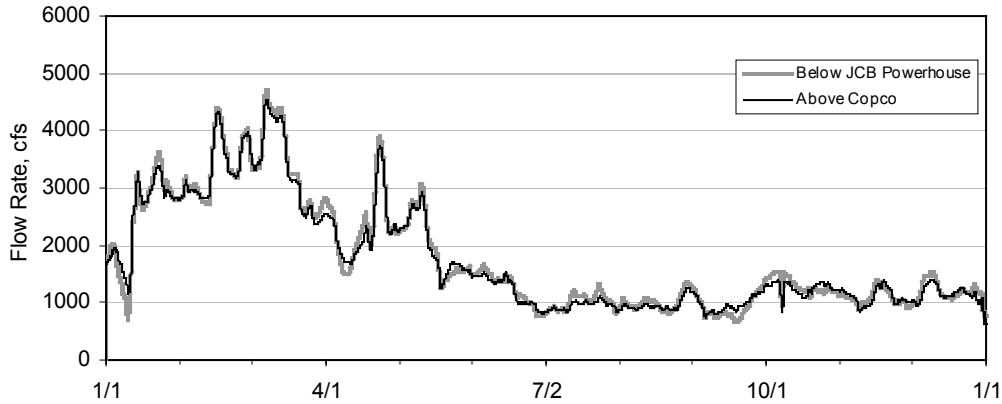


Flow in Klamath River 2000

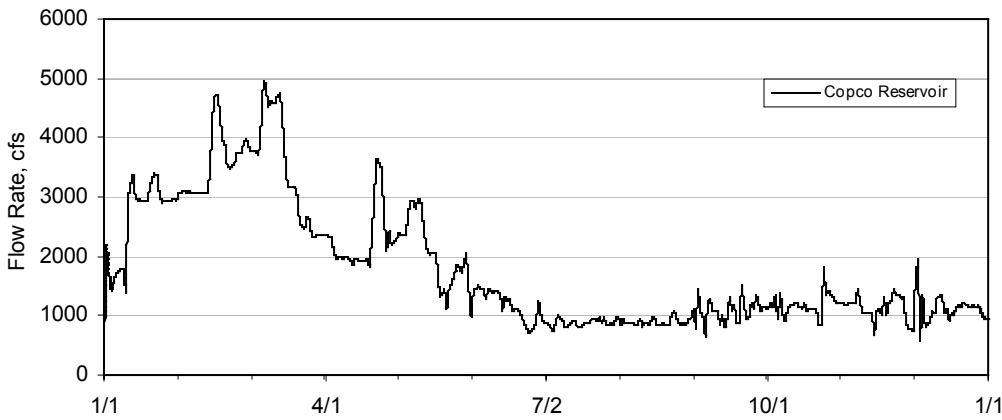


Flow in Klamath River 2000

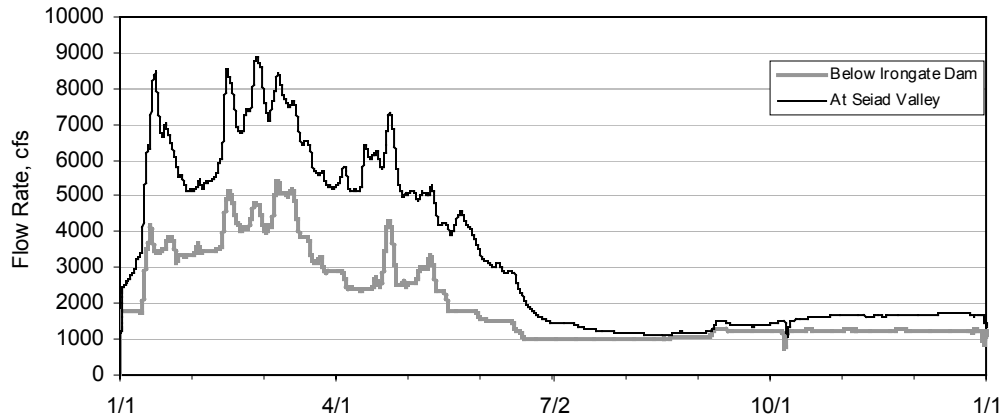
Figure 5C-3. Steady flow model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).



Flow in Klamath River 2000

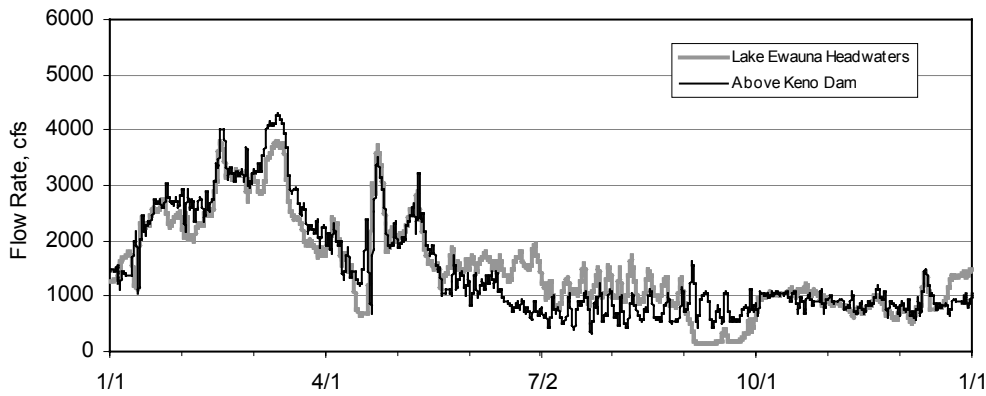


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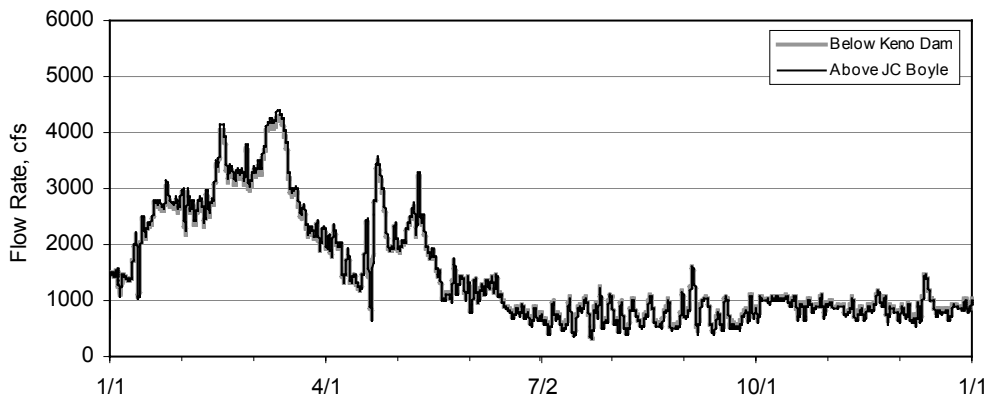


Flow in Klamath River 2000

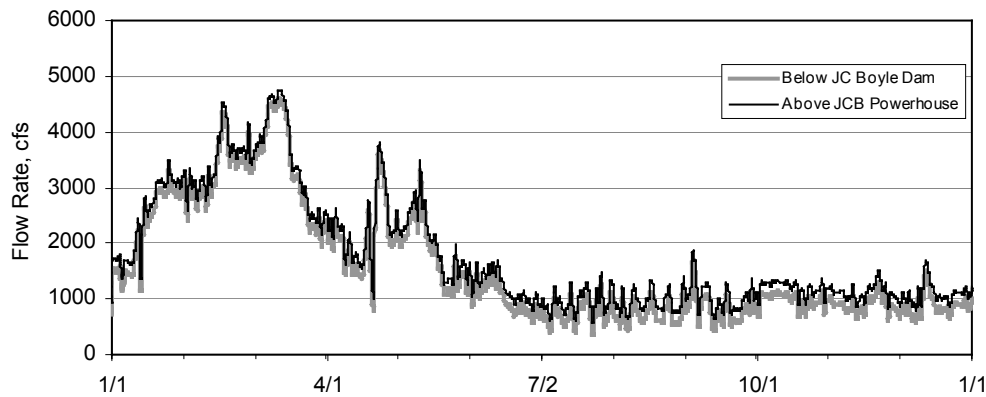
Figure 5C-4. Steady flow model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).



Flow in Klamath River 2000 Without Project

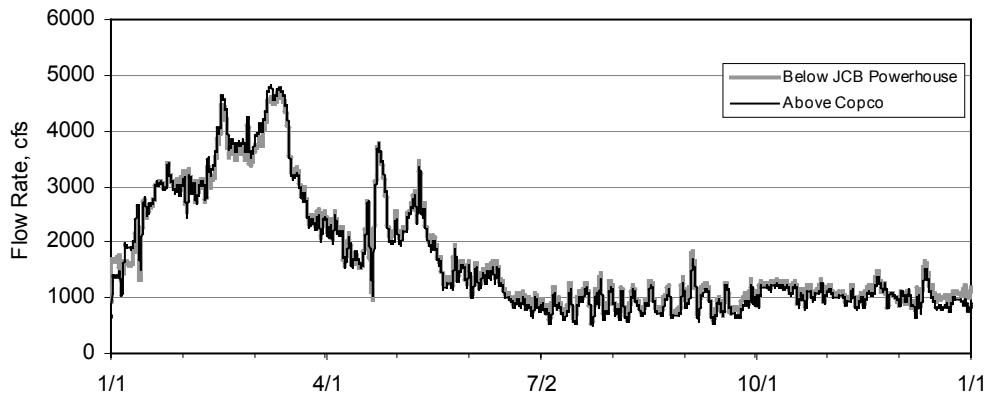


Flow in Klamath River 2000 Without Project

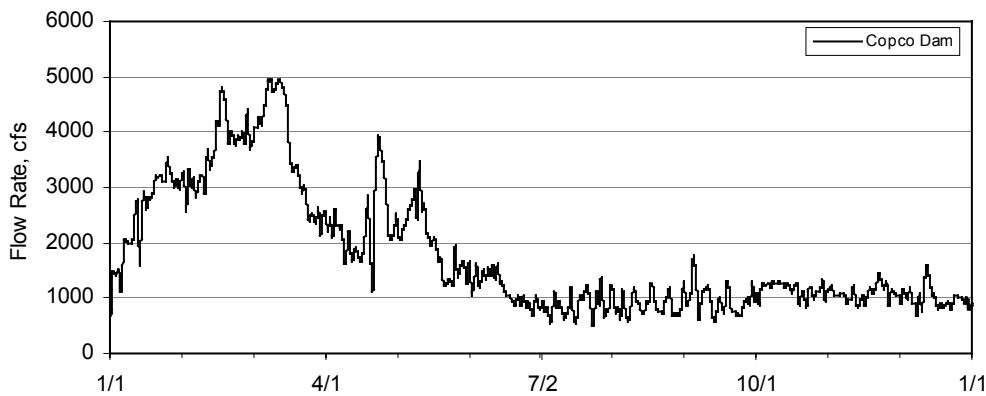


Flow in Klamath River 2000 Without Project

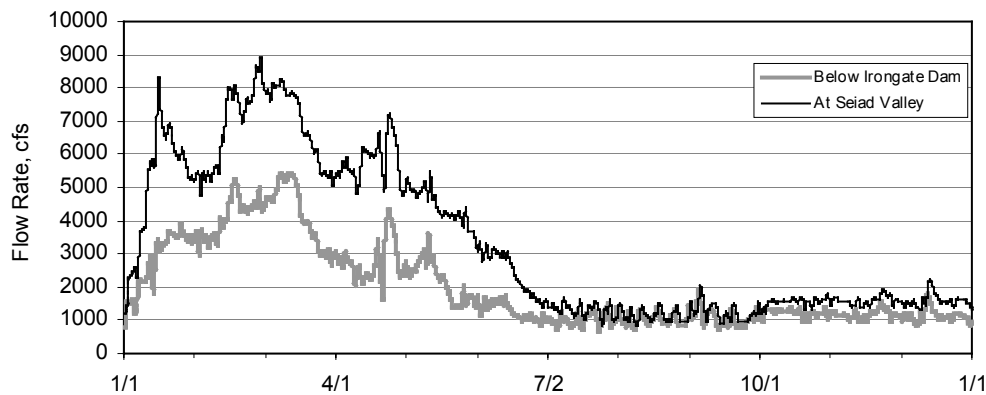
Figure 5C-5. Without-Project I (WOP I) model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).



Flow in Klamath River 2000 Without Project

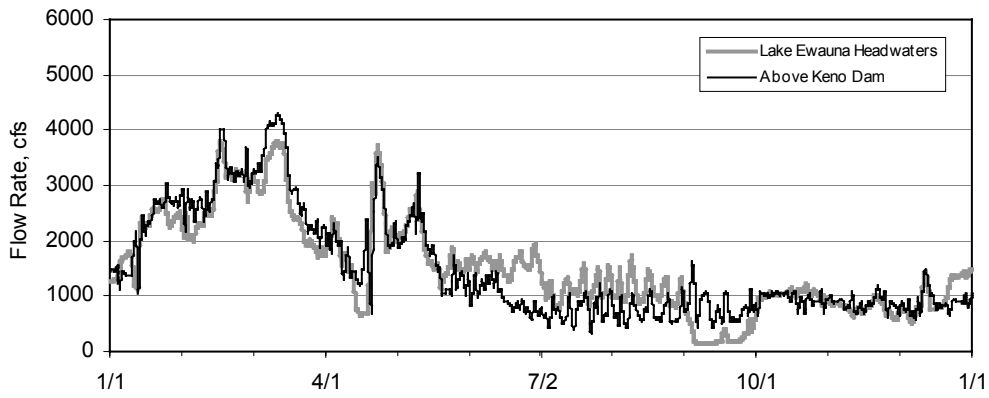


Flow in Klamath River 2000 Without Project

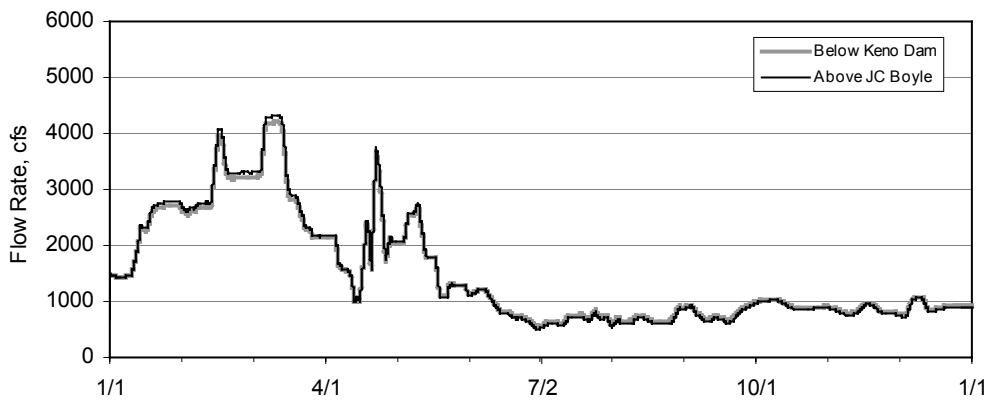


Flow in Klamath River 2000 Without Project

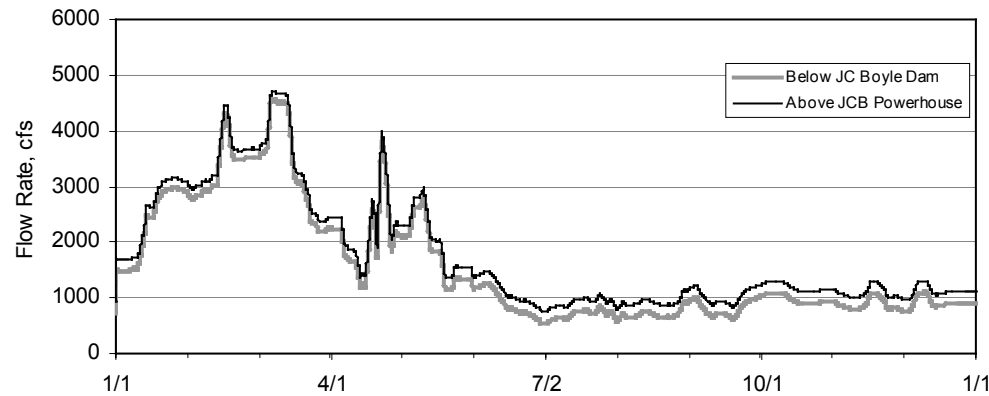
Figure 5C-6. Without-Project I (WOP I) model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).



Flow in Klamath River 2000 Without Project

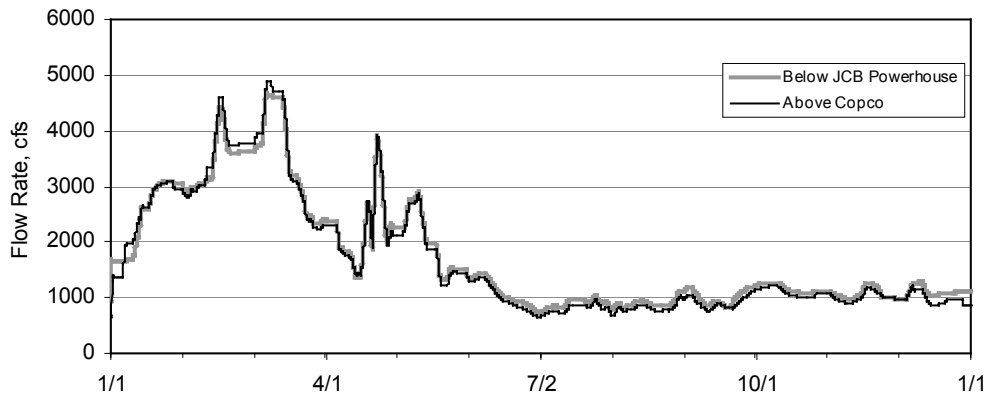


Flow in Klamath River 2000 Without Project

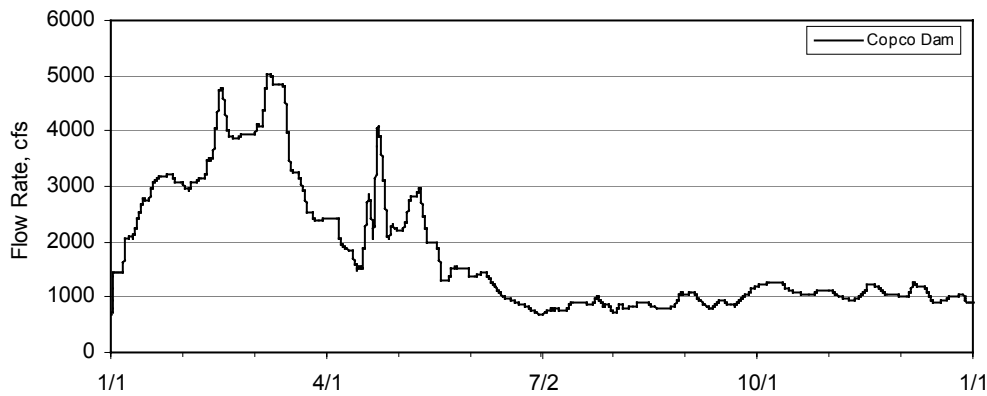


Flow in Klamath River 2000 Without Project

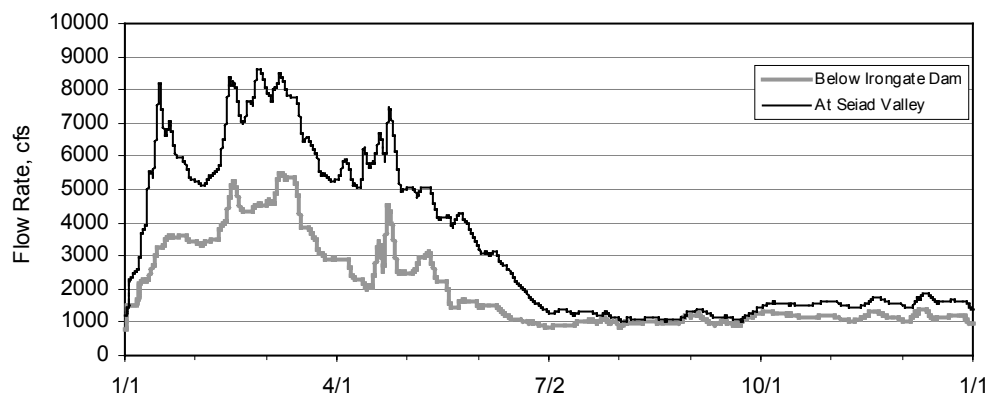
Figure 5C-7. Without-Project II (WOP II) model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).



Flow in Klamath River 2000 Without Project



Flow in Klamath River 2000 Without Project



Flow in Klamath River 2000 Without Project

Figure 5C-8. Without-Project II (WOP II) model simulation for hourly flow rate (cfs) for year 2000 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).

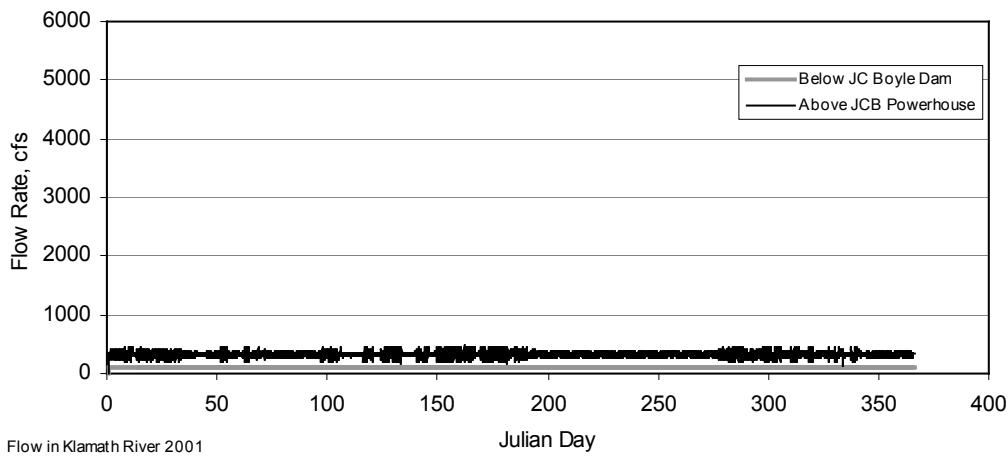
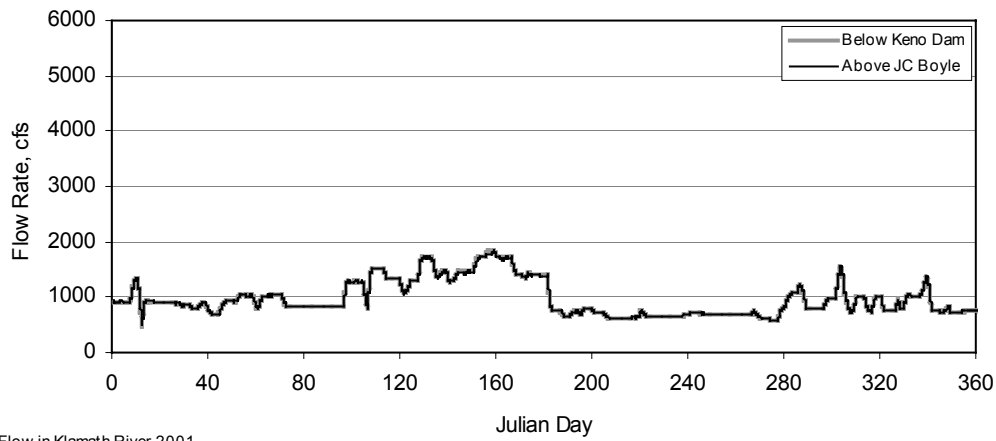
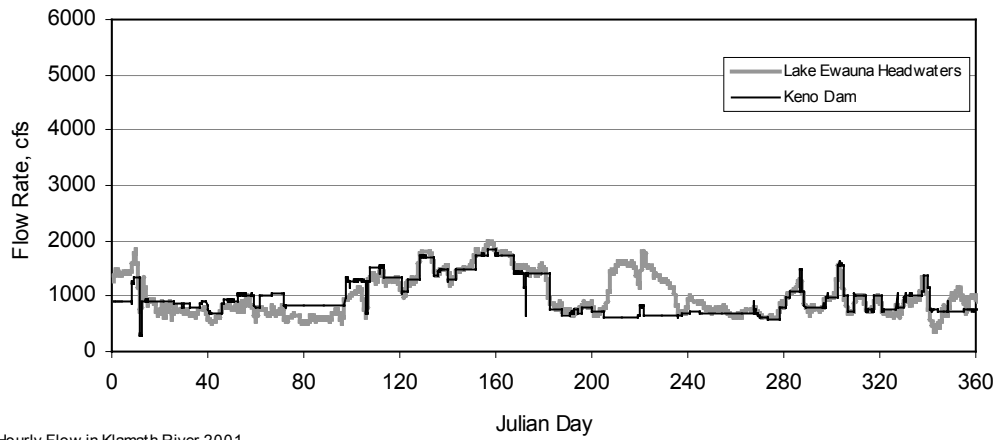


Figure 5C-9. Existing conditions model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).

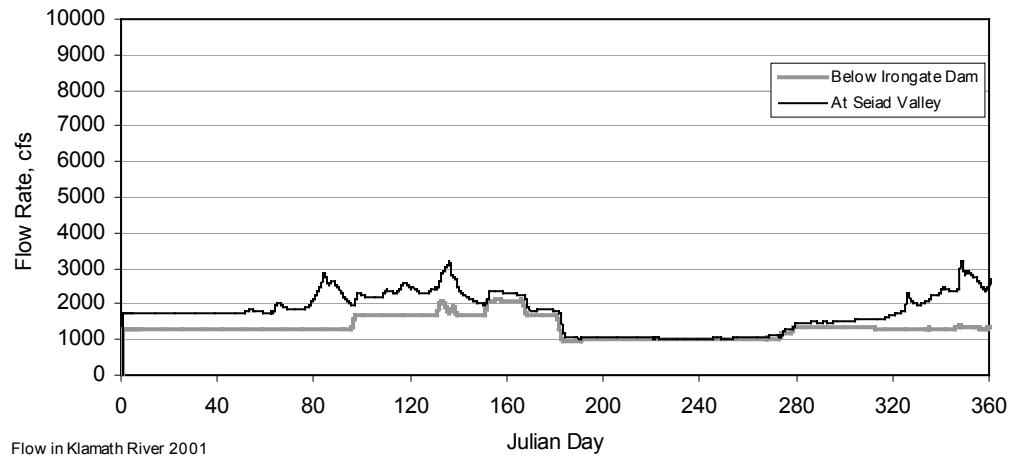
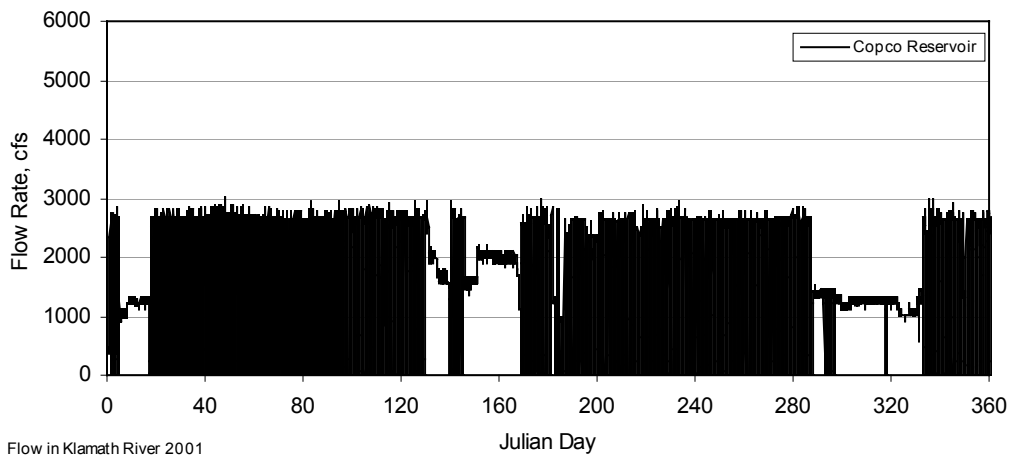
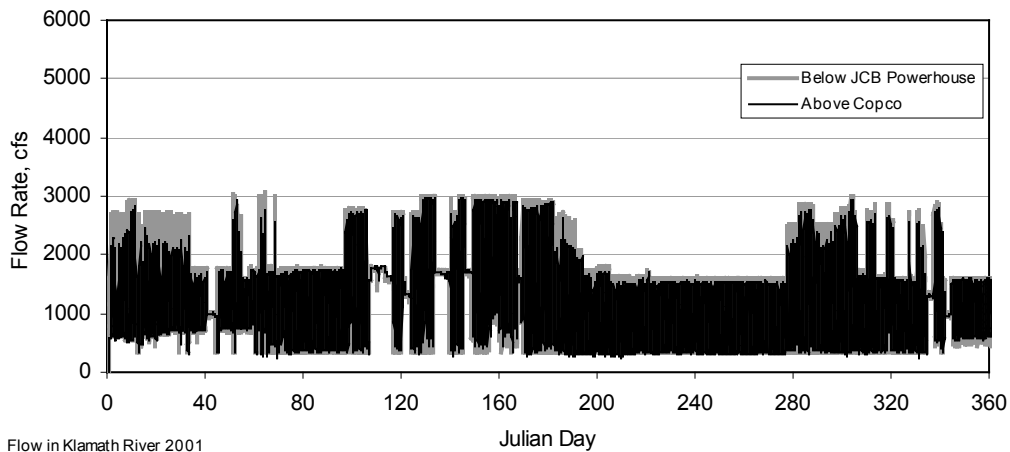


Figure 5C-10. Existing conditions model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).

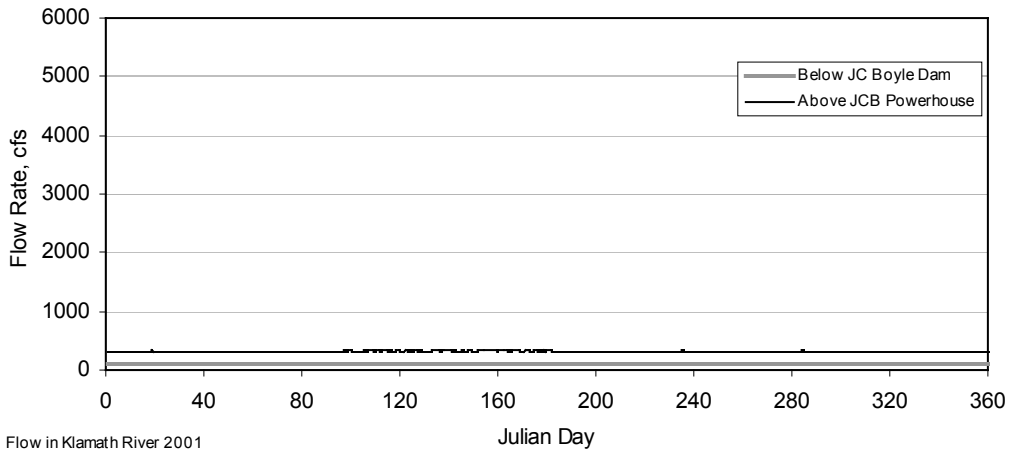
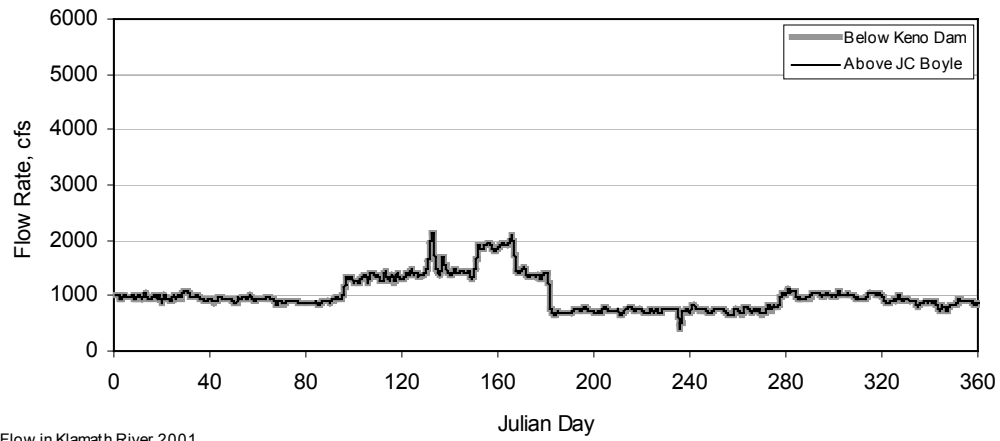
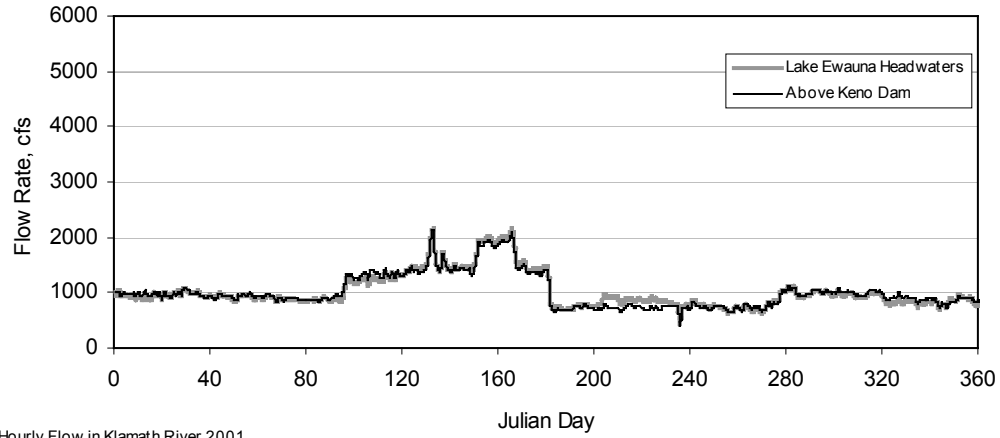


Figure 5C-11. Steady flow model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).

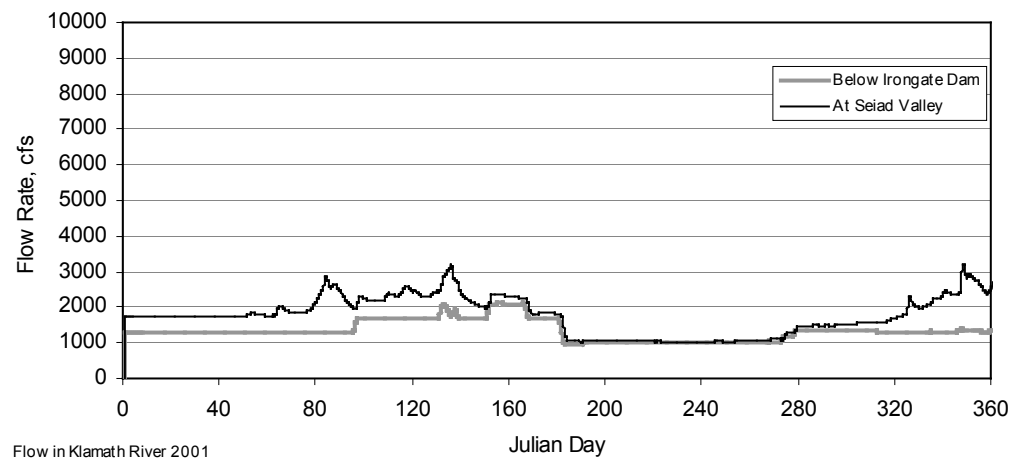
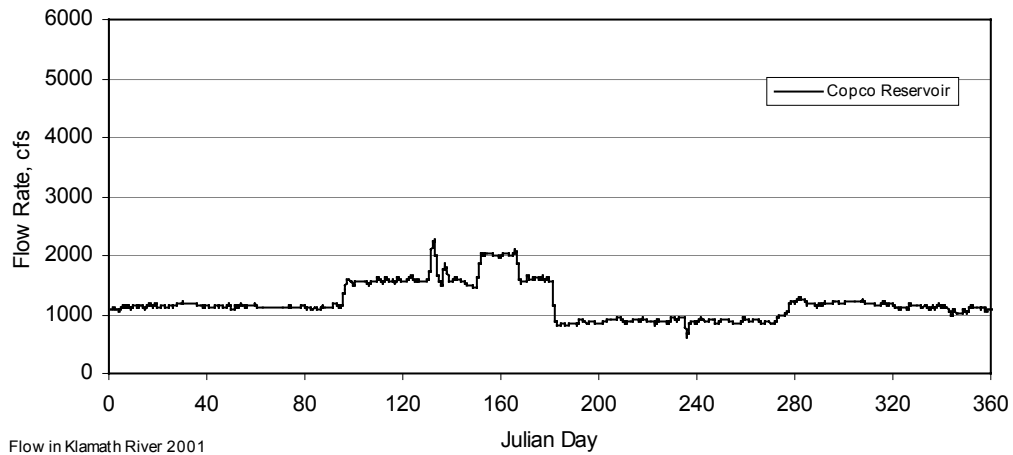
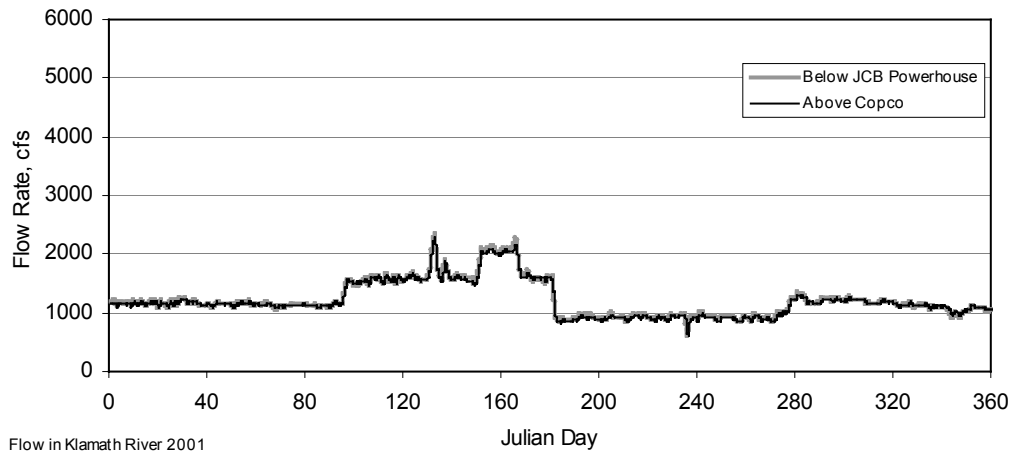
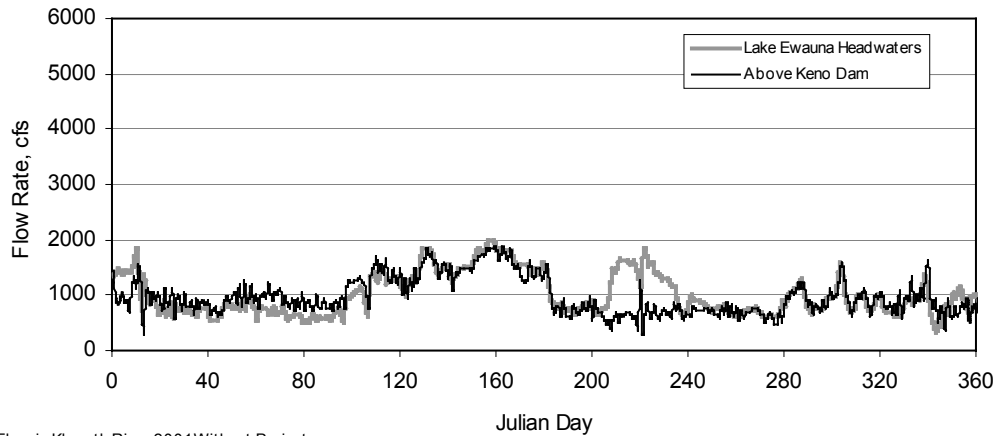
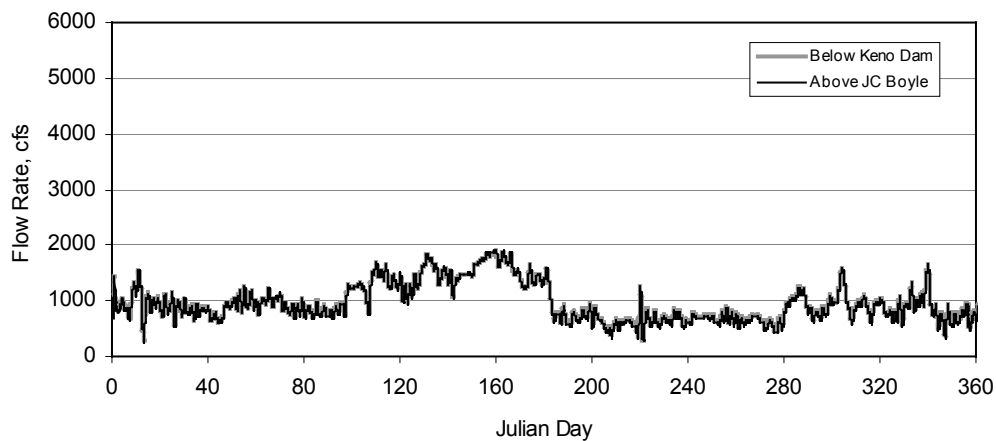


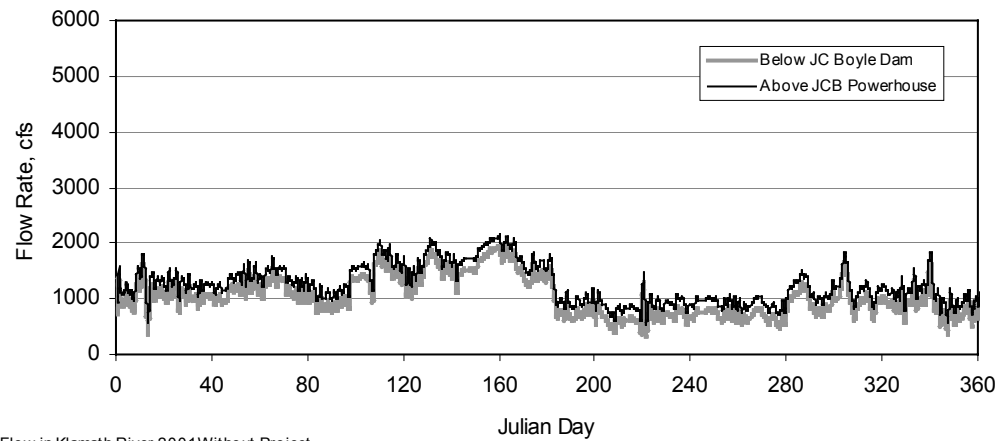
Figure 5C-12. Steady flow model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).



Flow in Klamath River 2001 Without Project

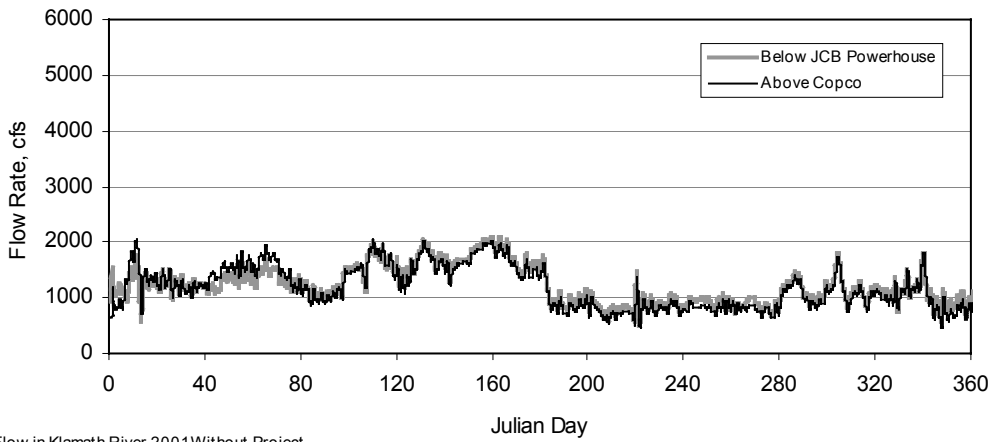


Flow in Klamath River 2001 Without Project

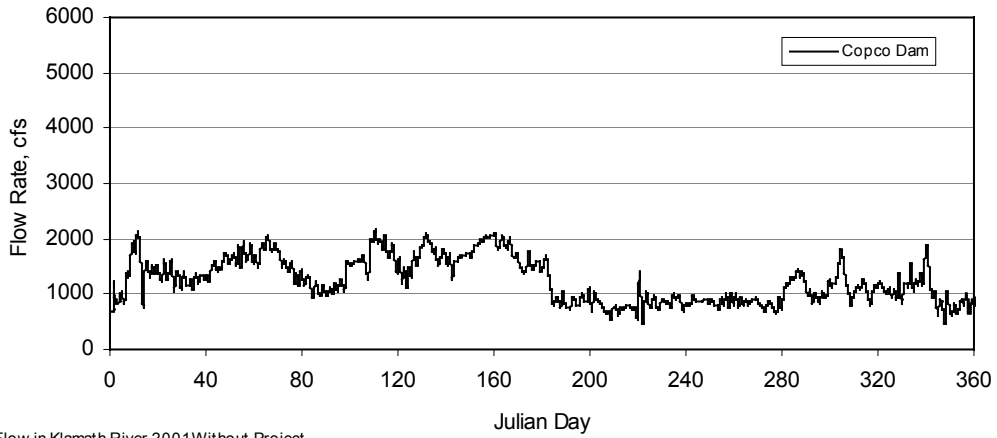


Flow in Klamath River 2001 Without Project

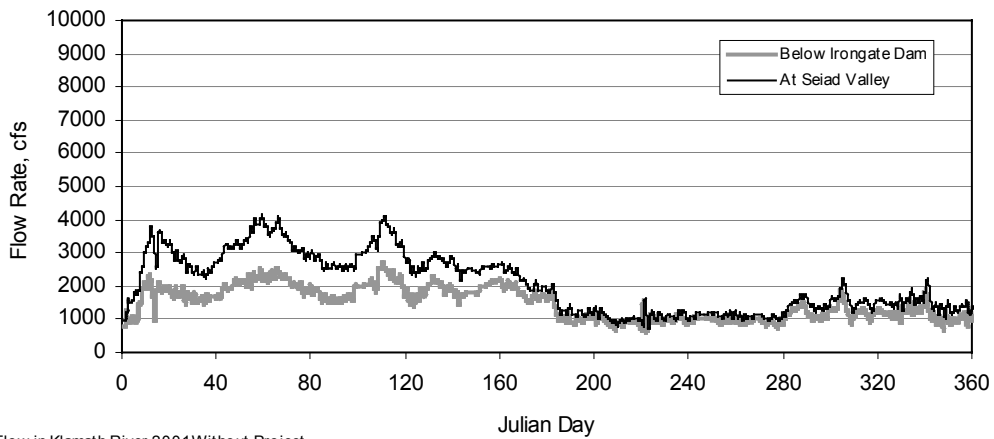
Figure 5C-13. Without-Project I (WOP I) model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).



Flow in Klamath River 2001 Without Project



Flow in Klamath River 2001 Without Project



Flow in Klamath River 2001 Without Project

Figure 5C-14. Without-Project I (WOP I) model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).

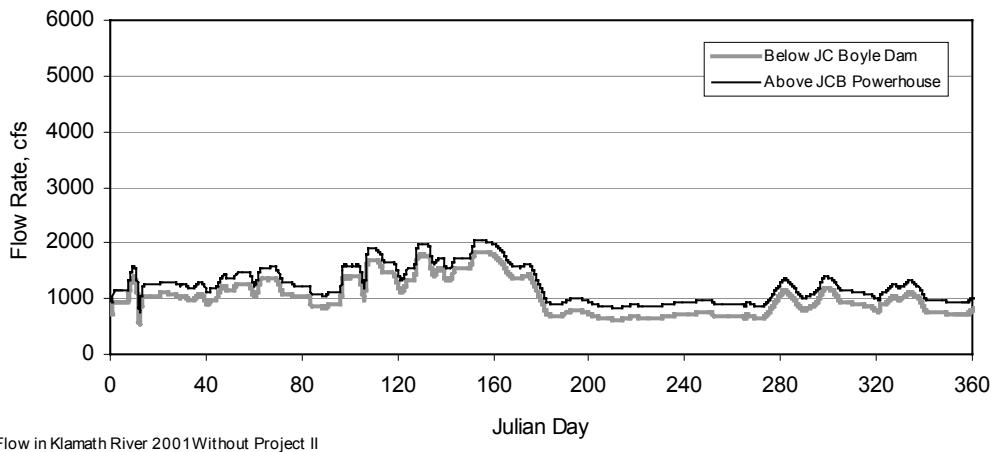
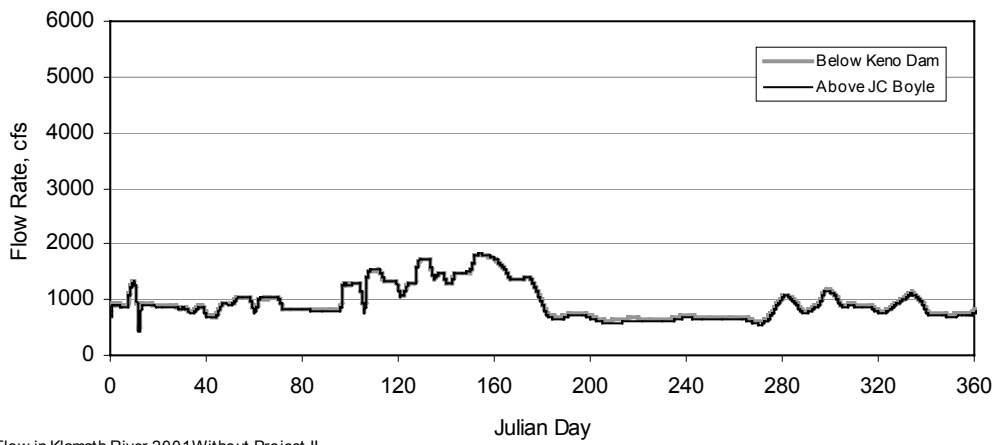
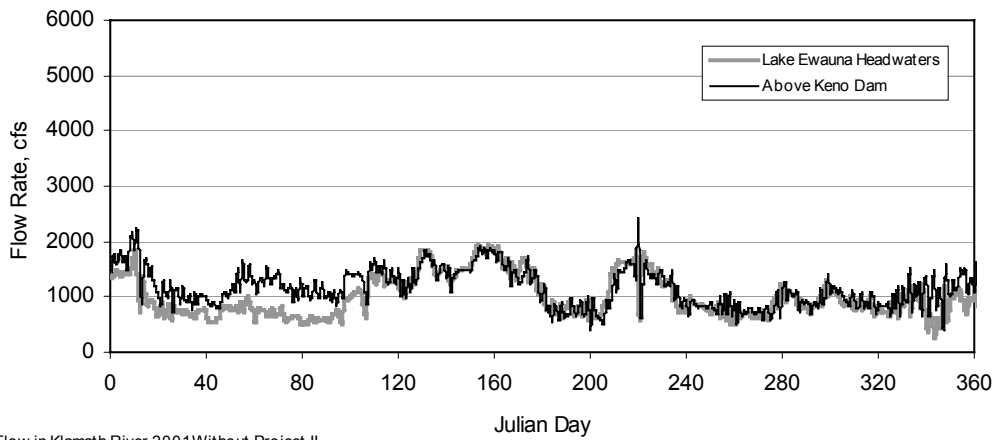
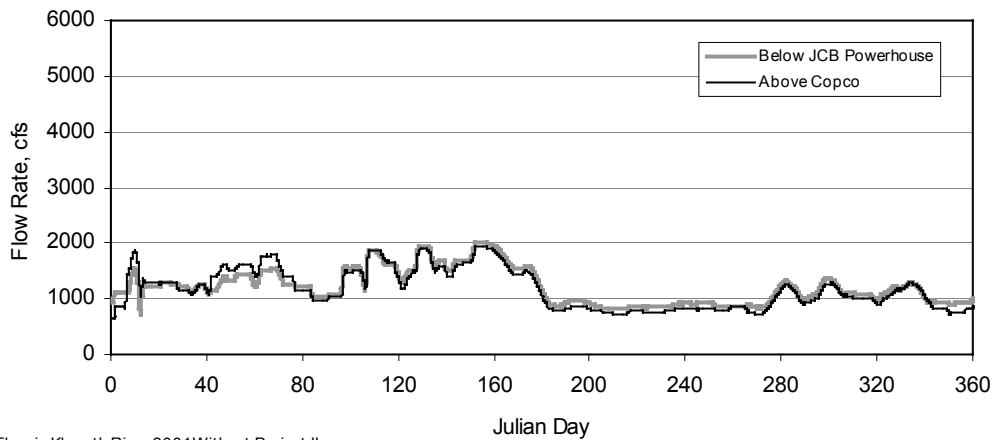
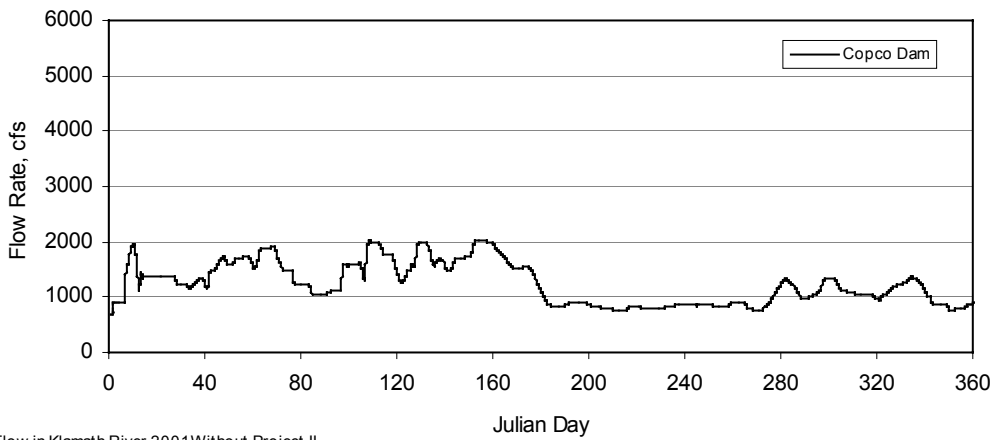


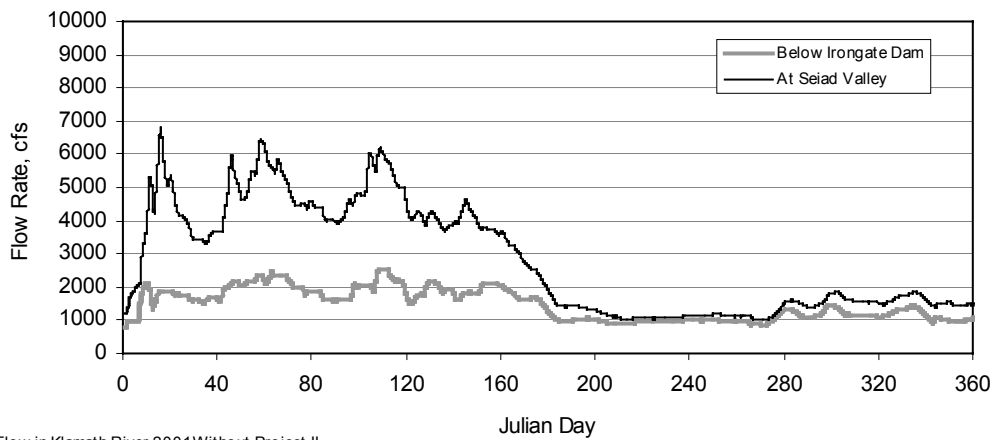
Figure 5C-15. Without-Project II (WOP II) model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River at Lake Ewauna headwaters (RM 253.9) and above Keno dam (RM 243). Middle plot shows Klamath River below Keno dam (RM 232.9) and above J.C. Boyle reservoir (RM 227.6). Bottom plot shows Klamath River at J.C. Boyle dam (RM 224.3) and above J.C. Boyle powerhouse (RM 221).



Flow in Klamath River 2001 Without Project II



Flow in Klamath River 2001 Without Project II



Flow in Klamath River 2001 Without Project II

Figure 5C-16. Without-Project II (WOP II) model simulation for hourly flow rate (cfs) for year 2001 conditions. Top plot shows Klamath River below J.C. Boyle powerhouse (RM 220) and above Copco reservoir (RM 203.6). Middle plot shows Klamath River at Copco No. 2 dam (RM 198.6). Bottom plot shows Klamath River below Iron Gate dam (RM 190.5) and at Seiad Valley (RM 129).