# 7 STRATEGY 3: RIPARIAN-ORIENTED MANAGEMENT STRATEGY

The riparian-oriented management strategy focuses on the riparian resources of the San Joaquin River corridor. River valleys serve as important movement corridors for both fish and wildlife species. This strategy focuses on balancing efforts to improve aquatic and floodplain habitat for chinook salmon with efforts to enhance riparian and wetland vegetation on floodplains and terraces for wildlife species, native fish communities, and overall biodiversity. Although each of the three restoration strategies includes riparian restoration measures, the riparian-oriented management strategy features the riparian zone more prominently, tailoring actions to enhance their potential for recruiting and establishing riparian vegetation along the San Joaquin River. The emphasis on the riparian corridor means that this strategy more broadly covers the river channel, floodplain, and floodplain terraces, and uplands as potentially suitable habitats for preservation and restoration. The selected approaches for this strategy to the four key issues described in Section 2 are summarized in Table 7-1.

**Table 7-1. Selected approaches to key issues under Strategy 3.**

| Key Issue | Selected Approach |
|---|---|
| Conveyance Capacity | Expanded floodway capacity |
| Juvenile Salmonid Rearing | Focus rearing in Reach 1 |
| Mendota Pool/Dam Routing | Route fish through a bypass channel at Mendota Pool |
| Reach 4B routing | Route fish through the Reach 4B mainstem channel |

## 7.1 Actions Based on Key Issues

### 7.1.1 Flood conveyance capacity and operational rules for flow routing

The assumed flood conveyance capacities described below represent modifications necessary to enhance the riparian vegetation corridor within the project area. Under this strategy, we assume expansion of the existing flood conveyance capacity in Reaches 1 through 4B1, and retention of existing flood conveyance capacity in Reaches 4B2 and 5. These expanded capacities will help achieve riparian vegetation restoration targets, and will provide adequate flows and surfaces for establishment of various plant species. The rated and assumed conveyance capacities under Strategy 3 are summarized in Table 7-2 by reach and Figure 7-1.

**Table 7-2. Rated and assumed conveyance capacities by reach under Strategy 3.**

| Reach | Current conveyance capacity (cfs) | Assumed conveyance capacity (cfs) under Strategy 3 | Comments |
|---|---|---|---|
| 1 | 8,000 | 16,400 | Expanded conveyance capacity in this reach, based on infrastructural constraints in Reaches 3 and 4A, maximum possible managed release from Friant Dam, and expansion of Chowchilla Bypass capacity |
| 2A | 8,000 | 16,400 | Expanded conveyance capacity in this reach, based on infrastructural constraints in Reaches 3 and 4A, maximum possible managed release from Friant Dam, and expansion of Chowchilla Bypass capacity |

| Reach | Current conveyance capacity (cfs) | Assumed conveyance capacity (cfs) under Strategy 3 | Comments |
|---|---|---|---|
| 2B | 2,500 | 8,000 | Expanded conveyance capacity in this reach, based on infrastructure constraints in Reaches 3 and 4A |
| Mendota Pool Bypass | N/A | 8,000 | Conveyance capacity based on upstream and downstream conveyance capacity |
| 3 | 4,500 | 8,000 | Expanded conveyance capacity in this reach, based on conveyance capacity of upstream Reaches 1 and 2 and under the constraint of existing infrastructure (elevated canals) |
| 4A | 4,500 | 8,000 | Expanded conveyance capacity in this reach, based on conveyance capacity of upstream Reaches 1, 2, and 3 and under the constraint of existing infrastructure (elevated canals) |
| 4B1* | 1,500 | 8,000 | Expanded conveyance capacity in this reach, based on conveyance capacity of upstream Reaches 1, 2, 3 and 4A |
| 4B2* | 10,000 | 10,000 | Conveyance capacity remains unchanged |
| 5 | 26,000 | 26,000 | Conveyance capacity remains unchanged |

*For Strategy 3, Reach 4B was further split into Reaches 4B1 [RM 168.5 to 147.2] and 4B2 [RM 147.2 to 135.8] to develop restoration targets oriented towards riparian vegetation.

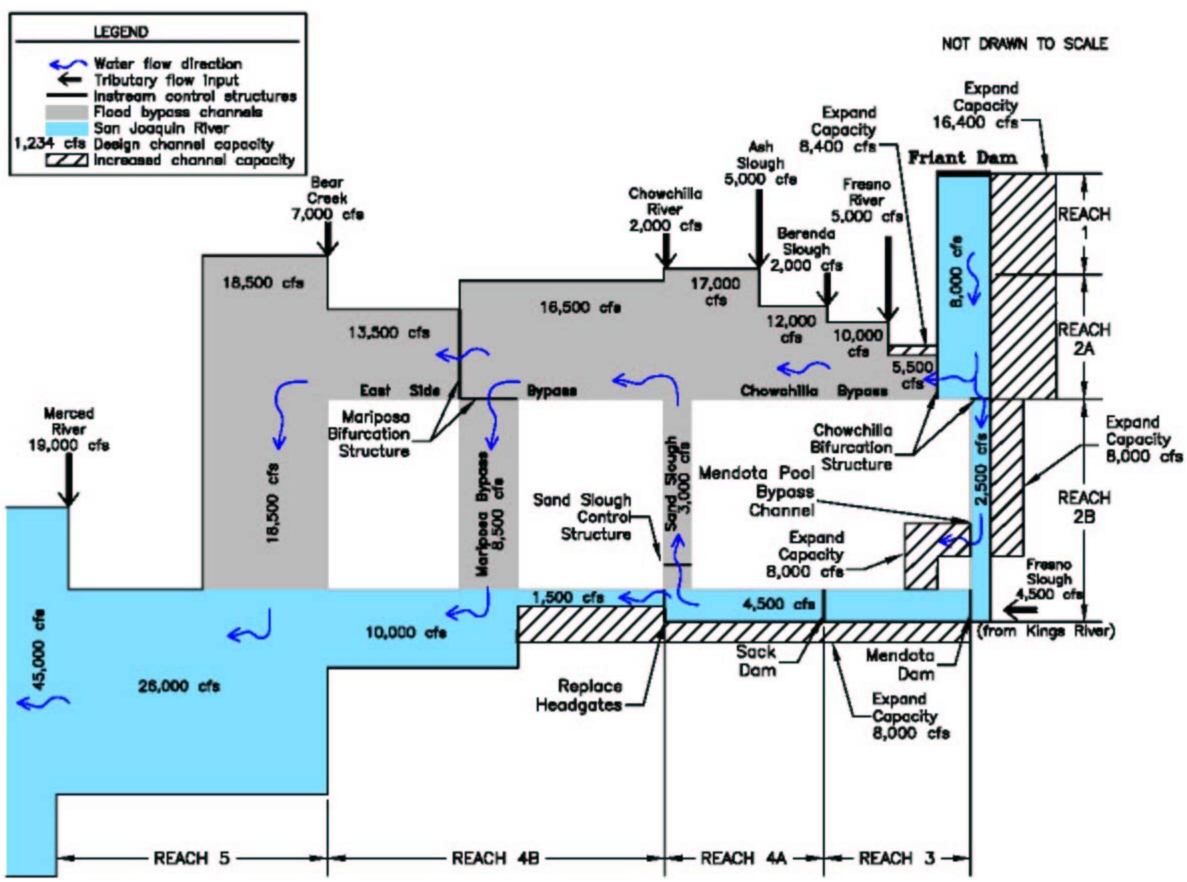

**Figure 7-1. Strategy 3: Riparian-Oriented Strategy.** Published flood control project conveyance under existing conditions, and additional flood control conveyance needs for maximum release of 16,400 cfs from Friant Dam.

### Reach 1

The current advertised conveyance capacity for Reach 1 is 8,000 cfs. Under Strategy 3, we assume expanded flood conveyance capacity for this reach to 16,400 cfs. This expanded capacity is the same as to assumed conveyance capacity under Strategy 2, and is based on (1) the maximum possible conveyance (based on infrastructural constraints presumed to be inflexible) in Reaches 3 and 4A (assumed to be 8,000 cfs), (2) the maximum possible managed release from Friant Dam of 16,400 cfs, and (3) the expansion of the capacity of Chowchilla Bypass downstream of Reach 1 from 5,500 cfs to 8,400 cfs. Both choices for flood conveyance capacity in this reach will require modifications to infrastructure, including levee setbacks, reinforcements, and possibly levee raising, as well as culvert and road crossing upgrades.

### Reach 2A

The current advertised conveyance capacity for Reach 2A is 8,000 cfs. Under Strategy 3, we assume expanded flood conveyance capacity for this reach to 16,400 cfs, achieved by levee setbacks from RM 216 to 229. The expanded flood conveyance capacity of 16,400 cfs is based on the same downstream constraints, expansion of the capacity of the Chowchilla Bypass, and maximum release at Friant Dam described above for Reach 1.

### Reach 2B

The current advertised capacity for this reach is 2,500 cfs. Under Strategy 3, we assume an expanded conveyance capacity of 8,000 cfs for this reach, achieved by a left bank levee setback. The expanded flood conveyance capacity the same as assumed conveyance capacity under Strategy 2 and is based on downstream infrastructural constraints in Reaches 3 and 4A which limit conveyance to 8,000 cfs. Levee setbacks for this reach are similar to Strategy 2.

As with both Strategies 1 and 2, expanding the conveyance capacity of Reach 2B will also restore sediment supply to this reach.

Also like Strategy 2, operational rules at the Bifurcation Structure are assumed to be altered to route flows through Reach 2B up to its expanded capacity, before routing flows through the Chowchilla Bypass. Thus, we assume the first 8,000 cfs will be routed into the re-constructed mainstem San Joaquin River channel when managed releases from Friant Dam are under 16,400 cfs, with surplus flows being redirected into the Chowchilla Bypass. As discussed under Strategy 1, we also assume operational rules at the Bifurcation Structure will be balanced with inflow from Fresno Slough.

### Mendota Pool Bypass

Under Strategy 3, we assume flows in Reach 2B will not empty into Mendota Pool, but will instead be routed through the Mendota Pool bypass channel with a conveyance capacity of 8,000 cfs. The flood conveyance capacity of this bypass channel is based on conveyance capacities of upstream and downstream reaches.

### Reach 3

The current advertised conveyance capacity for Reach 3 is 4,500 cfs. Under Strategy 3, we assume an expanded conveyance capacity of 8,000 cfs for Reach 3. This assumes that local levees and berms will be removed in Reach 3. The expanded flood conveyance capacity is the same as assumed conveyance capacity under Strategy 2. Our analysis suggests that a capacity of 8,000 cfs can be accommodated between the elevated canals in Reaches 3 and 4A, with some modifications.

**Reach 4A**

The current advertised conveyance capacity for Reach 4A is 4,500 cfs. Under Strategy 3, we assume an expanded conveyance capacity of 8,000 cfs for Reach 4A. This assumes that local levees and berms will be removed in Reach 4A. Our analysis suggests that a capacity of 8,000 cfs can be accommodated between the elevated canals in Reaches 3 and 4A, with some modifications.

**Reach 4B1 (RM 168.5 to 147.2)**

The current advertised conveyance capacity for Reach 4B1 is 1,500 cfs. The actual conveyance capacity of this reach is estimated to be considerably less than the rated capacity (McBain and Trush 2002). Under Strategy 3, we assume an expanded flood conveyance capacity of 8,000 cfs for Reach 4B1. This expanded flood conveyance capacity assumes significant earth work and reconstruction of the channel, since the reduced capacity of the channel compared with upstream and downstream reaches prevents natural geomorphic processes (such as scour) to maintain channel geometry within this reach. As a result, anthropogenic land use extends into the historical floodway. Also, because of irrigation return flows being routed through this confined channel, a thick bed of vegetation has established. The assumed expanded conveyance capacity of Reach 4B1 is based on the advertised flood conveyance capacity of upstream Reaches 3 and 4A. Expanding the capacity of Reach 4B1, in conjunction with expanding the capacity of other reaches, will improve flood management flexibility.

Expanding the capacity of Reach 4B1 will require building levees from approximately RM 151. to 168.4, as described under Strategy 1. Levees are required to contain floods in this reach because the land lateral to the channel is generally flat for miles, and there are no natural features to contain high flows. Reconstructing the channel in this reach provides an opportunity to tailor channel surfaces to optimize ecological benefit.

Operational rules for this reach are assumed to allow the first 8,000 cfs to be conveyed through the reconstructed mainstem channel in Reach 4B1. In the event that flood management releases exceed 8,000 cfs, surplus flows are assumed to be routed into the Eastside Bypass.

**Reach 4B2 (RM 147.2 to 135.8)**

The current advertised conveyance capacity for Reach 4B2 is 10,000 cfs. Under Strategy 3, we assume managed releases will be limited to 10,000 cfs in this reach.

**Reach 5**

The current advertised conveyance capacity for Reach 5 is 26,000 cfs. Under Strategy 3, we assume managed releases will be limited to 26,000 cfs in this reach.

### 7.1.2 Juvenile chinook salmon rearing

Under Strategy 3, like Strategy 1, flow releases are intended to provide suitable habitat for rearing juvenile chinook salmon in Reach 1, but not necessarily throughout the planning area. As described in Section 5.1.2, invertebrate sampling in Reach 1 indicates comparable prey availability to similar reaches of the Tuolumne River, suggesting adequate conditions to support juvenile chinook salmon in Reach 1.

### 7.1.3 Mendota Pool flow routing

Under Strategy 3, flows (including fish and sediment) would be routed around Mendota Pool and Dam, through a newly constructed Mendota Pool bypass channel, as in Strategy 2. The configuration of the bypass channel and the operation of Mendota Pool and Dam would be the same as in Strategy 2 (see Section 6.1.3.1).

### 7.1.4 Reach 4B flow routing

The published flood conveyance in Reach 4B1 (between Sand Slough and Mariposa) is 1,500 cfs, but riparian encroachment has reduced the actual flood conveyance to approximately 300 cfs. Under Strategy 3, flood conveyance in Reach 4B1 would be increased to 8,000 cfs in the existing main channel alignment.

Reconstructing the channel in Reach 4B1 would provide opportunities to create seasonal or perennial wetlands to benefit aquatic and terrestrial species (see Sections 3.4.6.3 and 3.4.6.4 for discussion of potential benefits to native fish, and Section 3.5.4.3 for discussion of benefits to wildlife). A three-stage channel, as shown in Figure 7-2, would be constructed, consisting of:

- a baseflow channel 110 ft wide and 3.2 ft deep, designed to facilitate migration by adult and juvenile anadromous salmonids;
- a bankfull channel 350 ft wide and 9.2 ft deep, to contain a discharge of approximately 4,500 and provide opportunities to recharge wetland habitats; and
- levees on both banks to confine a maximum flow of 8,000 cfs.

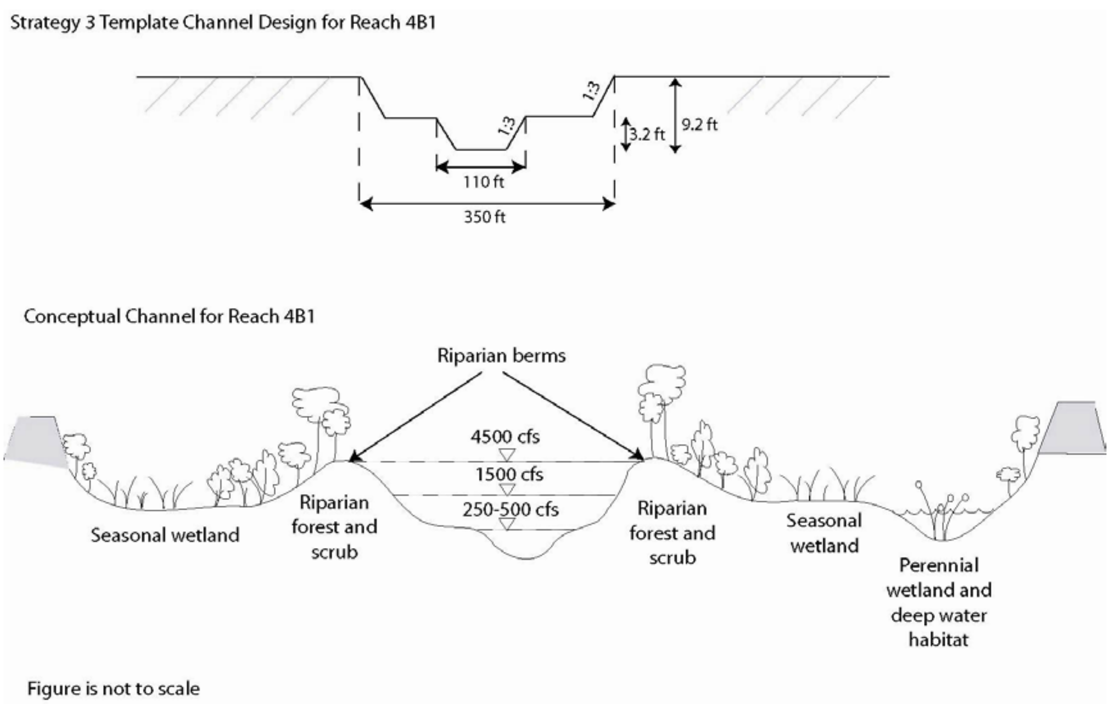


**Figure 7-2. Conceptual channel design for Reach 4B1.**

As described above for Strategy 1 (Section 5.1.4), the bankfull width was chosen based on estimation of the historical bankfull width-to-depth ratio in this reach. The proposed Reach 4B1 channel is 38, which is very close to the estimated historical bankfull channel width in Reach 3.

As envisioned in Strategy 1, the primary focus of the reconstructed channel is to create low benches (inundated at flows <2000 cfs) for juvenile chinook salmon floodplain rearing. Vegetation establishment on the higher floodplain surfaces will likely occur through natural recruitment of riparian forest and scrub (based on results from the SJR Riparian Recruitment Model), and seasonal wetlands will likely develop on existing lower elevation surfaces. Some strategic horticultural restoration of both wetland and riparian species on the low bench and floodplain is proposed in Section 5.2. Increasing and enhancing floodplain habitats in the project area may benefit native resident fish species that spawn on floodplains, such as Sacramento splittail, and Sacramento blackfish. Shallow, vegetated floodplains would also provide high-quality rearing habitat for other native resident fish, including Sacramento blackfish, hitch, Sacramento pikeminnow, hardhead, and Sacramento sucker.

## 7.2 Additional Vegetation- and Wildlife-oriented Actions

The following proposed restoration activities are specific to Strategy 3. This discussion focuses on those restoration elements that distinguish Strategy 3 from Strategies 1 and 2. There are many reach-specific strategy elements and approaches that are common to all three strategies. Restoration measures and approaches common to all three strategies are described in Chapter 4.

### 7.2.1 Horticultural restoration

#### 7.2.1.1 Wetland restoration within existing or proposed levees and canals

Strategy 3 proposes the greatest extent of horticultural wetland restoration to improve the quantity, quality, and diversity of wildlife and aquatic habitats and improve wetland vegetation recruitment to the greatest extent feasible. Under Strategy 3, we propose horticultural wetland restoration of low elevation areas (0–2 feet above the summer baseflow water surface) along constructed channels and bypasses in Reaches 1, 2B (around Mendota Pool), and 4B1, as well as strategic low-elevation patches within the floodplain of other reaches.

Table 7-3 summarizes the areas that we propose for horticultural wetland restoration inside of existing or proposed levees and canals under Strategy 3. The preliminary acreage targets identified in Table 7-3 were developed using the methods outlined in Section 3.5.4 and designating each site, or a portion of the site, as appropriate for wetland/mesic riparian vegetation. Designation of individual parcels was based on the suitability of site conditions for each type of restoration and the objectives and conditions under Strategy 3 (e.g., increased flow capacity and the need to maximize floodplain rearing for salmonids in Reach 1).

**Table 7-3. Proposed horticultural wetland restoration actions for inside of existing or proposed levees and canals under Strategy 3.**

| Reach | Description of Restoration Action | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|
| 1[1] | Revegetate low bench of reconstructed channel[2] | 100 | N/A | |
| 2A | Revegetate lower elevations on floodplain between setback levees | 20 – 200 | N/A | DEM analysis of existing ground surface elevation relative to planned baseflow (see Restoration Objectives Report) suggests that approximately 200 acres would be suitable for seasonal wetlands. A minimum of 10% would provide some benefits for initial seed source and habitat value |
| 2B | Grade and revegetate to mimic oxbow slough topography for wetland creation between setback levees | 120 | 2 | |
| | Revegetate strategic patches to provide seed/propagule sources and wildlife habitat[3] | 70 – 120 | 4 to 5 | |

| Reach | Description of Restoration Action | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|
| | Revegetate strategic habitat patches on left bank of Mendota Pool | 150 | 3 | Proposed to enhance wetland habitat and benefit documented wildlife species around Mendota Pool (e.g, giant garter snake) |
| | Revegetate low bench of Mendota Pool bypass channel to provide seed source and habitat | 4 – 40 | N/A | While horticultural restoration on 100% of the lower bench of the reconstructed channel (~40 acres total) might be most desirable to achieve target restoration conditions, a minimum of 10% would provide some benefits for initial seed source and habitat value |
| 3 | Revegetate strategic patches for seed/propagule source[2] | 30–80 | 3–4 | |
| 4B1 | Revegetate low bench of reconstructed channel | 15 – 150 | N/A | While horticultural restoration on 100% of the lower bench of the reconstructed channel (~150 acres total) might be most desirable to achieve target restoration conditions, a minimum of 10% would provide some benefits for initial seed source and habitat value |
| | Excavate/grade and revegetate strategic habitat patches on floodplain surface of levee setback area | 270 – 650 | N/A | DEM analysis of existing ground surface elevation relative to planned baseflow (see Restoration Objectives Report) suggests that approximately 10 – 15% of the floodplain in Reach 4B1 would be suitable for seasonal/perennial wetlands. Consider additional pilot-scale excavation to promote deeper open water and perennial wetland habitat for native fish (see discussion in Section 3.4.6.2). Target acreage will depend on final width of reconstructed channel/levee setbacks for Reach 4B1. |

[1] Also see discussion of restoration of key sites in Reach 1 (Section 7.2.1.4).

[2] These actions are common restoration elements described in further detail in Section 4.1.

[3] A minimum of acreage is a common restoration elements (discussed in further detail in Section 4.1). Under Strategy 3, this minimum acreage is expanded to provide additional benefits.

**Constraints and Uncertainties**

Constraints and uncertainties regarding horticultural restoration of wetlands are discussed in detail in Section 5.2.1.1.

#### 7.2.1.2 Riparian forest and scrub restoration within existing or proposed levees and canals

While more of the floodway will experience natural recruitment of native riparian plant species under the expanded flow regime proposed for Strategy 3 (Section 7.3.6), horticultural restoration of riparian forest in mid- to higher elevation areas will increase the width and benefits of the riparian corridor, provide initial seed and propagule sources, hasten the establishment of riparian habitat patches along the river corridor, and provide a minimum area of riparian habitat for wildlife needs. Horticultural restoration is proposed to optimize riparian conditions in reaches that will maintain existing levee configurations under this strategy (Reaches 3, 4A, 4B2, and 5), and expand and enhance riparian conditions in reaches where channel reconstruction or levee setbacks are planned (Reaches 1, 2A, 2B, and 4B1). See section 5.2.1.2 for a discussion of sites potentially suitable for horticultural restoration.

Strategy 3 proposes the greatest extent of horticultural riparian forest and scrub restoration to improve the quantity, quality, and diversity of wildlife habitats and improve riparian vegetation recruitment and succession to the greatest extent feasible. Table 7-4 summarizes the areas along the river that we propose for horticultural riparian forest and scrub restoration inside of existing or proposed levees and canals under Strategy 3. These areas were identified using the methods described in Section 3.5.4.

**Table 7-4. Proposed horticultural riparian forest and scrub restoration actions for inside of existing or proposed levees and canals under Strategy 3.**

| Reach | Description of Restoration Action | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|
| 1[1] | Revegetate upper bench of reconstructed or diked channel or on elevations 2 – 6 feet above baseflow of other constructed/re-graded sites to provide seed/propagule source and habitat | 560 | N/A | |
| 2A | Revegetate strategic patches to provide seed/propagule source and habitat | 60 | 3 | Focused on agricultural, herbaceous, and disturbed areas between proposed setback levees |
| | Excavate depressional areas on the floodplain to serve as cottonwood recruitment sites | target acreage not defined[2] | N/A | Excavation should occur during levee setback construction |
| 2B | Excavate depressional areas on the floodplain to serve as cottonwood recruitment sites | target acreage not defined[2] | N/A | Excavation should occur during levee setback construction |
| | Revegetate upper bench of Mendota Pool bypass channel to provide initial seed and propagule source | 20–60 | 2–3 | |
| | Revegetate strategic habitat patches on right bank of Mendota Pool between Columbia Canal | 170 | 4 | Would connect Mendota Pool habitat with bypass channel, expanding existing riparian habitat and benefiting documented wildlife species around Mendota Pool |

| Reach | Description of Restoration Action | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|
| | Revegetate strategic habitat patch on left bank of Mendota Pool area | 30 | 1 | Would expand existing riparian habitat and benefit documented wildlife species around Mendota Pool |
| | Revegetate strategic patches to enhance initial seed/propagule source and start to improve habitat prior to levee setbacks | 30–80 | 3–4 | Potential to plant 10% of the acreage in the 1st five years to jumpstart the natural revegetation process and provide stands every mile or so along the reach |
| 3 | Revegetate strategic patches to provide seed/propagule source and habitat | 320 | 9 | Focused on agricultural, herbaceous, and disturbed areas between levees |
| 4A | Revegetate strategic patches to provide seed/propagule source and habitat | 125 | 3 | Focused on agricultural, herbaceous, and disturbed areas between levees |
| 4B1 | Revegetate strategic patches to provide seed/propagule source and habitat | 15 | 1 | Focused on agricultural, herbaceous, and disturbed areas between levees |
| | Revegetate strategic cottonwood source patches along floodplain of reconstructed channel and levee setback area | 100 – 300 | 10 – 15 | Currently, the only remaining cottonwood stand in Reach 4B1 occurs at RM 164 (adjacent to Pick Anderson Bypass). Shallow year-round groundwater levels in Reach 4B1 suggest that horticultural restoration using cuttings would be effective to establish cottonwood in strategic patches throughout the 11 mile reconstructed channel area. Strategic patches would provide mature trees able to serve as initial seed sources by the time the channel reconstruction/levee setbacks were complete |

[1]Also see discussion on restoration of key sites in Reach 1 (Section 7.2.1.5)

[2]Action should occur opportunistically; final acreage will depend on more detailed restoration planning.

**Constraints and Uncertainties**

Constraints and uncertainties regarding horticultural restoration of riparian forest and scrub are discussed in detail in Section 5.2.1.2.

### 7.2.1.3 Restoration of higher-elevation vegetation types

Conserving valley oak woodland in Reach 1 and elderberry savanna in Reach 2B are common elements to all three restoration strategies (see Sections 4.1.8 and 4.2.1). In Strategy 3, however, we also propose expanding and creating valley oak woodland (in Reaches 3, 4B1, and 5) and elderberry savanna (in Reach 2B) to improve the quantity, quality, and diversity of wildlife habitats to the greatest extent feasible and expedite the natural re-establishment of these vegetation types into suitable areas (i.e., by providing seed sources). Other than the large patch found in Reach 1, valley oak woodland occurs as small isolated patches along the San Joaquin River. As discussed in Section 3.5.5.5, elderberry savanna is a rare habitat type along the San Joaquin River that occurs as only two patches (totaling 63 acres) near the Chowchilla Bifurcation Structure. We propose to expand these small patches of higher-elevation habitat types and create new patches were suitable conditions exist. Further, we propose that horticultural restoration of these habitat types include associated plant species, which will promote the appropriate plant community necessary to enhance habitat for wildlife species that forage and nest within these vegetation types (see discussion of habitat value for specific vegetation types in Section 3.5.5).

Conducting a pilot alkali sink habitat restoration project in Reach 5 is proposed as a common restoration element of all three Strategies (see Section 4.4.2). Under Strategy 3, we also propose to conduct experimental restoration of sycamore alluvial woodland in Little Dry Creek to expand the existing stand by an additional 10 acres (see Section 3.5.5.6 for more detail on the existing sycamore alluvial woodland habitat). The restoration experiment would be conducted at a suitable site (i.e., with appropriate soil, elevation, and inundation conditions) somewhere between the existing stand (approximately 5 miles upstream from the confluence) and the mainstem San Joaquin River. The focus of the experiment would be to restore the plant community, not just additional sycamore trees. The restoration effort would be monitored and adaptively managed to improve the success of the initial pilot effort and provide input into future restoration efforts.

Table 7-5 summarizes the sites that we propose for horticultural restoration of higher-elevation plant communities under Strategy 3.

**Table 7-5. Proposed horticultural restoration actions for higher-elevation plant communities under Strategy 3.**

| Reach | Site Description | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|
| 1[1] | Sycamore alluvial woodland near mouth of Little Dry Creek | 10 | pilot-scale | Expand existing sycamore alluvial woodland habitat, a rare vegetation type within the San Joaquin River corridor. |
| 2B | Elderberry savanna patch near Chowchilla Bifurcation Structure | 60 | 1 | Expand elderberry savanna patches to provide seed/propagule sources and habitat for species such as the valley elderberry longhorn beetle |
| 3 | Valley oak woodland habitat patches | 40 – 80 | 2 – 4 | Consider expanding existing patches and creating additional patches of valley oak woodland |
| 4B1 | Existing valley oak woodland patch near RM 154 | 16 | 1 | Consider horticultural restoration of valley oak with acorn planting in selected locations to expand the existing valley oak woodland patch |
| | Valley oak woodland habitat patches | 10 – 20 | pilot-scale | Consider creating new patches of valley oak woodland in reconstructed channel where soil conditions and elevation are suitable. If necessary, the amount of suitable habitat could be increased by using appropriate fill material (from sites without clay soils) to elevate some sites |
| 5 | Valley oak woodland habitat patches | 20 – 40 | 2 – 3 | Consider expanding existing patches and creating additional patches of valley oak woodland |

[1] Also see discussion on restoration of key sites in Reach 1 (Section 7.2.1.5)

### Constraints and Uncertainties

Constraints and uncertainties regarding horticultural restoration of wetlands are discussed in Section 5.2.1.3.

### 7.2.1.4 Horticultural restoration outside of existing or proposed levees and canals

Horticultural restoration of specific parcels outside of levees or canals is proposed for mid- to higher-elevation areas to increase the width and benefits of the riparian corridor and hasten the establishment of riparian habitat patches along the river corridor. See Section 5.2.1.3 for a discussion of issues related to horticultural restoration of parcels outside of levees and canals.

Many of the identified parcels are strategically located at meander bends to provide additional connectivity along the river corridor and establish larger habitat patches. In addition to these strategic parcels, we propose managing the borrow sites in Reach 1 to provide a diversity of plant communities. To fill and isolate the large mining pits in Reach 1, nearby cut sites were identified as potential fill sources. There are approximately 560 acres, on 12 parcels, of potential cut sites located outside of the 700-foot floodway in Reach 1. We propose the following: approximately 80 percent of cut sites outside of the 700-foot floodway should be considered for grading and restoration to valley oak woodland or savanna, and the remaining 20 percent should be considered for grading and horticultural restoration to mixed riparian forest and scrub. This percentage breakdown was developed using the methods in 3.5.4.4 and designating individual parcels for mixed riparian forest or valley oak based on the need to conserve and expand valley oak woodland in Reach 1 as a common restoration element, and provide a diversity of vegetation types (thus the emphasis of valley oak woodland, which is a rare habitat type, over mixed riparian, which is distributed throughout the river corridor) under Strategy 3.

Table 7-6 summarizes the sites outside of existing or proposed levees that are proposed for horticultural restoration under Strategy 3. Parcels outside of levees and canals that have been identified to provide habitat connectivity will also be restored, but are discussed separately in Section 7.2.2.

**Table 7-6. Proposed horticultural restoration actions for areas outside of existing or proposed levees and canals under Strategy 3.**

| Reach | Description of Restoration Action | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|
| 1 | Grade and revegetate cut sites outside of the 700-foot floodway | 560 | 12 | Under Strategy 3, 20 percent of borrow site areas outside of the floodway would be restored to riparian forest and scrub and the 80 percent to valley oak woodland/savanna |
| 3 | Revegetate strategic habitat patches[1] | 80 | 4 | |
| 4A | Revegetate strategic habitat patches primarily at meander bends[1] | 115 | 2 | |

[1]These actions are common restoration elements and are discussed in further detail in Section 4.1.

**Constraints and Uncertainties**

Constraints and uncertainties regarding horticultural restoration outside of existing or proposed levees are discussed in detail in Section 5.3.1.2.

#### 7.2.1.5 Horticultural restoration of key sites within Reach 1

Under Strategy 3, which is focused on enhancement of riparian vegetation and wildlife habitat, we propose that the key sites, Ledger Island, the mouth of Little Dry Creek, and Rank Island, be considered for grading and horticultural restoration to promote a diversity of vegetation and habitat types.  This would provide habitats such as wetlands and open water for wading birds, waterfowl, and native fish species, backchannels for floodplain rearing of salmonids, and mixed riparian forest intergrading into oak woodland and savanna at higher elevations. See Section 5.2.4.3 for more details on the key sites.

Specifically, we propose that 50 percent of the total acreage of the cut and fill areas at Ledger and Rank Islands, which lie within the floodway, be graded and horticulturally restored to provide wetland/mesic riparian habitat, 25 percent to mixed riparian forest and scrub, and 25 percent to valley oak woodland or savanna habitat. This acreage breakdown accounts for the creation of backwater and side-channel floodplain rearing habitats proposed under Strategy 3. In addition, we propose that 80 percent of the confluence of Little Dry Creek, which lies outside of the floodway, be graded and restored to valley oak woodland or savanna, and the remaining 20 percent be cut, graded, and restored to mixed riparian forest and scrub. This recommendation was developed using the methods described in Section 3.5.4. The percentage breakdown was determined by the need to provide floodplain rearing in Reach 1 (thus the higher percentage of wetland/mesic riparian restoration to provide invertebrate habitat) and a diversity of vegetation types (thus the split between mixed riparian and valley oak woodland) under Strategy 3.

Table 7-7 summarizes the area within the key sites in Reach 1 that are potentially suitable for horticultural restoration of wetland/mesic riparian, mixed riparian, or valley oak woodland under Strategy 3.

**Table 7-7. Proposed horticultural restoration actions for key sites in Reach 1 under Strategy 3.**

| RM | Site Description | Vegetation type | Approximate Area (acres) | Approximate No. of Parcels | Comments |
|---|---|---|---|---|---|
| 263 | Ledger Island (approximately 3 cut sites totaling 53 acres and 8 fill sites totaling 37acres) | wetland/mesic riparian | 45 | 5 | Acreages take into account the restoration of backwater rearing habitats created at Ledger Island under Strategy 3. |
| | | mixed riparian | 22 | 3 | |
| | | valley oak woodland | 23 | 3 | |
| 261 | Mouth of Little Dry Creek (2 cut parcels totaling 74 acres) | wetland/mesic riparian | 0 | 0 | Management of this key site requires consideration of current sediment trap function of the site as well as any adaptive management decisions. |
| | | mixed riparian | 15 | 1 | |
| | | valley oak woodland | 59 | 1 | |
| 259 | Rank Island (5 cut sites totaling 70 acres and 6 fill sites totaling 46 acres) | wetland/mesic riparian | 58 | 5 | Acreages take into account the restoration of backwater rearing habitats created at Ledger Island under Strategy 3. |
| | | mixed riparian | 27 | 3 | |
| | | valley oak woodland | 27 | 3 | |

### 7.2.2 Habitat Connectivity

Under Strategy 3, proposed habitat connectivity restoration elements are focused to provide an enhanced corridor that links the mainstem with adjacent habitat patches and waterways. This focus is meant to provide riparian corridors along the San Joaquin River and between adjacent habitats that provide ample opportunity for wildlife movement and habitat patches for cover, nesting, and foraging.

Providing habitat connectivity between the mainstem San Joaquin and adjacent habitats would require purchasing portions of agricultural fields that are currently privately-owned through conservation easements or fee-title purchases prior to horticultural restoration. Table 7-8 summarizes the sites proposed for preservation and horticultural restoration under Strategy 3 to provide habitat connectivity between the mainstem San Joaquin and adjacent habitats and waterways. Under Strategy 3, we have proposed the following acreages and buffers to provide an enhanced riparian buffer width (300–1,800 feet) (see Section 3.3.7 in the Restoration Objectives Report).

**Table 7-8. Sites proposed for preservation and horticultural restoration to provide habitat connectivity under Strategy 3.**

| Reach | Site Description | Approximate Area (acres) | Approximate Area/No. of Parcels | Comments |
|---|---|---|---|---|
| 2A | Between mainstem and Kerman Ecological Reserve | acreage target not defined[1] | N/A | There are many documented special status species in Kerman Ecological Reserve. There are, however, only agricultural fields between the river and Kerman, leaving no opportunities to build off of an existing corridor. Providing connectivity would likely be a very large-scale restoration project. |
| 2B | Along section of Chowchilla Bypass that intersects with Reach 2B | acreage target not defined[1] | N/A | Consider expansion of the currently thin strip of riparian vegetation to encourage wildlife movement |
| | Between mainstem, Lone Willow Slough, and Chowchilla Bypass | acreage target not defined[1] | N/A | Consider improving habitat connectivity for documented special status species that travel along these adjacent waterways, including Fresno kangaroo rat, blunt-nosed leopard lizard, and San Joaquin kit fox. |
| | Between mainstem at RM 216 and Alkali Sink Ecological Reserve/Mendota State Wildlife Refuge | acreage target not defined[1] | N/A | As with the Kerman Ecological Reserve, there are only agricultural fields between the river and refuges to the south, leaving no opportunities to build off of an existing corridor. Providing connectivity would likely be a very large-scale restoration project. |
| | Fresno Slough between Mendota Pool and Alkali Sink Ecological Reserve/Mendota State Wildlife Refuge | acreage target not defined[1] | N/A | Fresno Slough is recognized as a high priority conservation area by TNC and supports special-status species such as the San Joaquin antelope squirrel, giant garter snake, and Sanford's arrowhead. Upstream portion of Fresno Slough is protected within the Alkali Sink Ecological Reserve/Mendota State Wildlife Refuge. |

| Reach | Site Description | Approximate Area (acres) | Approximate Area/No. of Parcels | Comments |
|---|---|---|---|---|
| 3 | Between mainstem and Lone Willow Slough | 100 | 4 | The confluence area is recognized as a high priority conservation area by TNC, and supports such species as blunt-nosed leopard lizard and Fresno kangaroo rat. |
| 4A | Between mainstem and Fresno River | 170 | 5 | |
| 4B1 | Between mainstem and Mariposa and Sand Sloughs to the north | acreage target not defined[1] | N/A | |
| | Between mainstem and San Luis National Wildlife Refuge Complex/Los Banos State Wildlife Refuge to the south | 24 | 1 | |
| 4B2 | Areas adjacent to the San Luis National Wildlife Refuge Complex | acreage target not defined[1] | N/A | Work with existing conservation easement holders and public agency landowners to identify additional parcels for protection and restoration. |
| 5 | Areas adjacent to the San Luis National Wildlife Refuge Complex | acreage target not defined[1] | N/A | Work with existing conservation easement holders and public agency landowners to identify additional parcels for protection and restoration. |

[1]Specific acreage targets will need to be based on the most recent parcel ownership information available and coordinated with local private and public landowners. Under Strategy 3, specific acreage targets should provide an enhanced corridor width (300–1,800 feet) between habitats.

### Constraints and Uncertainties

Constraints and uncertainties regarding restoration to create or improve habitat connectivity are discussed in detail in Section 5.2.2.

## 7.3 Hydrographs

This section describes the hydrographs proposed under Strategy 3 for dry, normal-dry, normal-wet, and wet water year types (Figures 7-3 through 7-6; Tables 7-9 and 7-10). Unlike typical hydrographs which are driven by geomorphic processes and hydrologic periods (summer base flow, winter base flow, etc.), components of the restoration hydrographs developed for this report focus on more ecologically meaningful time periods, such as salmonid spawning and rearing, native resident fish spawning, and riparian vegetation recruitment. Two hydrographs are provided for each water-year type: one representing a restoration scenario that targets both spring-run and fall run chinook salmon, and one restoration scenario that does not include fall-run chinook salmon. The hydrographs depict proposed releases from Friant Dam. "Friant Release" is a calculation of the annual water volume released from the dam, regardless of the application and use of that water. "Friant Release" is the combination of water released both to supply riparian water rights holders in Reach 1 and additional water released specifically for achieving an ecological benefit. "Environmental Water" subtracts the volume of water released to supply riparian diverters from the Friant Dam release, to identify the annual water volume that would be released, in addition to riparian water rights releases, to achieve an ecological target.

Because the theme of this strategy is to provide benefits for riparian vegetation, many components of the hydrograph are driven by riparian recruitment needs, as well as enhancing opportunities for natural recruitment, floodplain inundation, and wetland creation and inundation. In this strategy, improved conditions for riparian vegetation will include expanded floodway capacity, a bypass around the Mendota Pool, and reconstruction of Reach 4B. In addition, this strategy provides benefits for splittail spawning and rearing in the lower Reaches in wet years and also provides inundated shallow habitat for juvenile salmonid rearing in Reach 1 in all but dry years. Dry-year flows will result in compressed time periods with suitable habitat conditions for targeted salmonid life stages. In wetter years flows will be provided to increase the duration of suitable habitat conditions.

The most critical water requirements of native resident fish and of riparian vegetation recruitment do not have to be met on an annual basis and were therefore considered mainly in wet years. For example, no riparian recruitment flows would be released in dry, normal-dry, or normal-wet years. Because large recruitment events are necessary approximately every 5–10 years to maintain riparian tree populations and age structures, recruitment flows for riparian vegetation would only be released in wet water year types. In these years, flows for establishing riparian vegetation consist of a seedbed preparation flow followed immediately by a recruitment flow.

**Table 7-9. Proposed timing and discharge for four water year types under Strategy 3, for restoration of both spring-run and fall-run chinook salmon.**

| | | DRY | | NORMAL-DRY | | NORMAL-WET | | WET | |
|---|---|---|---|---|---|---|---|---|---|
| season | hydrograph component | timing | discharge | timing | discharge | timing | discharge | timing | discharge |
| early fall | spring-run spawning initiation | 9/1 to 9/3 | 1000 | 9/1 to 9/3 | 1000 | 9/1 to 9/3 | 1000 | 9/1 to 9/3 | 1000 |
| | spring-run spawning | 9/4 to 10/4 | 350 | 9/4 to 10/4 | 350 | 9/4 to 10/4 | 350 | 9/4 to 10/4 | 350 |
| late fall | riparian | 10/5 to | 5000 | 10/5 to | 5000 | 10/5 to | 5000 | N/A | N/A |

| | | DRY | | NORMAL-DRY | | NORMAL-WET | | WET | |
|---|---|---|---|---|---|---|---|---|---|
| season | hydrograph component | timing | discharge | timing | discharge | timing | discharge | timing | discharge |
| | encroachment prevention | 10/8 | | 10/8 | | 10/7 | | | |
| | fall-run upstream migration | 10/8 to 10/31 | 3500 [a] | 10/8 to 10/31 | 3500 [a] | 10/8 to 10/31 | 3500 [a] | 10/5 to 10/31 | 3500[a] |
| | fall-run spawning | 11/1 to 11/30 | 350 | 11/1 to 11/30 | 500 | 11/1 to 11/30 | 500 | 11/1 to 11/30 | 500 |
| winter | winter baseflow | 12/1 to 1/31 | 350 | 12/1 to 1/31 | 500 | 12/1 to 1/31 | 500 | 12/1 to 1/31 | 500 |
| early spring | spring-run upstream migration | 2/1 to 3/15 | 750 | 2/1 to 3/31 | 1500 | 2/1 to 3/31 | 1500 | | |
| | spring-run outmigration and adult upstream migration | 3/16 to 4/14 | 1500 | 2/1 to 3/31 | 1500 | 4/1 to 4/21 | 4500 | 2/1 to 3/15 | 1500 |
| | spring-run emigration | 4/15 to 4/30 | 2500 | 4/1 to 4/15 | 2500 | | | | |
| late spring | fall-run outmigration | 5/1 to 5/7 | 4500 | 4/16 to 5/7 | 4500 | 4/22 to 5/24 | 6000 | | |
| | seed bed preparation | N/A | N/A | N/A | N/A | 5/25 to 6/30 | 6000 to 750 [b] | 3/16 to 4/19 | 1500 to 13,500 [c] |
| | cottonwood establishment | N/A | N/A | N/A | N/A | N/A | N/A | 4/19 to 6/3 | 13,500 to 3,000 [c] |
| | Goodding's black willow recruitment | N/A | N/A | N/A | N/A | N/A | N/A | 6/4 to 6/7 | 7000 [e] |
| | Goodding's black willow establishment | N/A | N/A | N/A | N/A | N/A | N/A | 6/8 to 7/16 | 7000 to 750 [f] |
| summer | summer baseflows | 5/16 to 6/30 | 350 | 5/15 to 8/31 | 500 | 7/1 to 8/31 | 750 | 7/16 to 8/31 | 750 |
| | flow continuity | 7/1 to 8/31 | 450 | N/A | N/A | N/A | N/A | N/A | N/A |

a Ramp down of 500 cfs/day beginning October 25, until reaching spawning flows
b Flows ramp up and down in sequence three times before stabilizing at summer baseflows on July 1.
c Ramp up at various rates from 50 cfs/day to 500 cfs/day, up to 13,500 cfs, to mimic natural conditions. Splittail and fall chinook salmon may also benefit.
d Ramp down at various rates to 3,000 cfs
e Ramp up to 7,000 cfs from 3,000 cfs.
f Ramp down at 300 cfs/day to 4000 cfs, 200 cfs/day to 2600 cfs, 100 cfs/day to achieve summer baseflow on July 16.

**Table 7-10. Proposed timing and discharge for four water year types under Strategy 3, for restoration without fall-run chinook salmon.**

| | | DRY | | NORMAL-DRY | | NORMAL-WET | | WET | |
|---|---|---|---|---|---|---|---|---|---|
| season | hydrograph component | timing | discharge | timing | discharge | timing | discharge | timing | discharge |
| early fall | spring-run spawning initiation | 9/1 to 9/3 | 1000 | 9/1 to 9/3 | 1000 | 9/1 to 9/3 | 1000 | 9/1 to 9/3 | 1000 |
| | spring-run spawning | 9/4 to 10/31 | 350 | 9/4 to 10/31 | 500 | 9/4 to 10/31 | 500 | 9/4 to 10/31 | 500 |
| late fall | riparian encroachment prevention | 3 days[a] sometime | 5000 | 3 days[a] sometime | 5000 | 3 days[a] sometime | 5000 | N/A | N/A |

| | | DRY | | NORMAL-DRY | | NORMAL-WET | | WET | |
|---|---|---|---|---|---|---|---|---|---|
| season | hydrograph component | timing | discharge | timing | discharge | timing | discharge | timing | discharge |
| | | during 11/1 to 11/10 | | during 11/1 to 11/10 | | during 11/1 to 11/10 | | | |
| winter | winter baseflow | 11/1 to 1/31 | 350 | 11/1 to 1/31 | 500 | 11/1 to 1/31 | 500 | 11/1 to 1/31 | 500 |
| early spring | spring-run upstream migration | 2/1 to 3/15 | 750 | 2/1 to 3/7 | 1500 | 2/1 to 3/7 | 1500 | 2/1 to 3/7 | 1500 |
| | splittail spawning | N/A | N/A | N/A | N/A | N/A | N/A | 3/8 to 3/28 | 4500 to 7000[b] |
| | spring-run outmigration and adult upstream migration | 3/16 to 4/7 | 1500 | 3/8 to 3/31 | 1500 | 3/8 to 4/7 | 1500 | N/A[c] | N/A[c] |
| | spring-run outmigration | N/A | N/A | 4/1 to 4/19 | 2500[d] | 4/8 to 5/15 | 4500 | N/A[c] | N/A[c] |
| late spring | splittail spawning and rearing | N/A | N/A | N/A | N/A | N/A | N/A | 4/1 to 4/30 | >4500[e] |
| | wetland inundation and recharge | N/A | N/A | N/A | N/A | 5/16 to 6/17 | 4500 to 750[f] | N/A | N/A |
| | seed bed preparation | N/A | N/A | N/A | N/A | N/A | N/A | 3/29 to 4/19 | 4500 to 13,500[c,g] |
| | cottonwood establishment | N/A | N/A | N/A | N/A | N/A | N/A | 4/20 to 6/3 | 13,500 to 3000[h] |
| | Goodding's black willow recruitment | N/A | N/A | N/A | N/A | N/A | N/A | 6/4 to 6/8 | 3000 to 7000 [i] |
| | Goodding's black willow seedling establishment | N/A | N/A | N/A | N/A | N/A | N/A | 6/9 to 7/14 | 7000 to 750 [j] |
| summer | summer baseflows | 4/8 to 6/30 | 350 | 4/19 to 8/31 | 500 | 6/18 to 8/31 | 750 | 7/15 to 8/31 | 750 |
| | flow continuity | 7/1 to 8/31 | 450 | N/A | N/A | N/A | N/A | N/A | N/A |

a 3-day pulse of 5,000 cfs would be scheduled sometime during the first 10 days of November to minimize encroachment by woody riparian vegetation. The timing of this window is driven by the need to minimize adverse impacts on spring-run spawning and fry emergence and rearing.
b Flows increase to 4500 cfs from March 8 to March 15, and then further up to 7000 cfs from March 16 to March 28.
c Although flows during this time period are primarily designed to benefit splittail and/or riparian vegetation, these flows are expected to provide significant benefits for spring-run chinook salmon.
d Flows would be ramped down at a rate of 500 cfs/day down to 500 cfs, beginning April 16, for summer baseflow conditions.
e Flows for this portion of the hydrograph are driven by riparian objectives, although splittail may also benefit.
f Flows ramp up and down in sequence three times before stabilizing at summer baseflows on June 18.
g Ramp up of 500 cfs/day to 1000 cfs/day to achieve 13,500 cfs by April 19.
h Ramp down of 1000 to 50 cfs/day to achieve 3,000 cfs by June 3.
i Ramp up at 1000 cfs/day to achieve 7000 cfs by June 8.
j Ramp down at 300 to 100 cfs/day to achieve summer baseflows by July 14.

### 7.3.1 Early fall flows for spring-run chinook salmon spawning

The magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type. Refer to the description in Section 5.3.1.

#### 7.3.1.1 Benefits and drawbacks for chinook salmon

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for anadromous salmonids are discussed in 5.3.1.1.

#### 7.3.1.2 Benefits and drawbacks for resident fishes

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for resident fishes are discussed in Section 5.3.1.2.

#### 7.3.1.3 Benefits and drawbacks for vegetation and wildlife

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for vegetation and wildlife are discussed in Section 5.3.1.3.

### 7.3.2 Late fall flows for fall-run chinook salmon spawning

The magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type. Refer to the description in Section 5.3.2.

During all water year types except wet years, the management focus would be to scour woody and herbaceous vegetation from the low flow channel edge by releasing encroachment prevention flows in fall. Because during wet years the management focus will be to recruit and maintain new seedlings by means of spring riparian recruitment flows, encroachment prevention flows will not be implemented in the fall.

#### 7.3.2.1 Benefits and drawbacks for chinook salmon

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks discussed for anadromous salmonids are presented in 5.3.2.1.

#### 7.3.2.2 Benefits and drawbacks for resident fishes

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for resident fishes are discussed in Section 5.3.2.2.

#### 7.3.2.3 Benefits and drawbacks for vegetation and wildlife

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for vegetation and wildlife are discussed in Section 5.3.2.3.

### 7.3.3 Winter baseflows

The magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type. Refer to the description in Section 5.3.3.

#### 7.3.3.1 Benefits and drawbacks for chinook salmon

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks discussed for anadromous salmonids are presented in 5.3.3.1.

#### 7.3.3.2 Benefits and drawbacks for resident fishes

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for resident fishes are discussed in Section 5.3.3.2.

#### 7.3.3.3 Benefits and drawbacks for vegetation and wildlife

Because the magnitude and duration of flows proposed for this hydrograph component under Strategy 3 are the same as those in Strategy 1 for each water year type, benefits and drawbacks for vegetation and wildlife are discussed in Section 5.3.3.3.

### 7.3.4 Early spring flows for spring-run chinook salmon adult immigration and juvenile outmigration, and splittail spawning

In dry years, early spring flows designed to target restoration without fall-run chinook are the same as in Strategy 1 (see section 5.3.4). If both spring-run and fall-run chinook are targeted for restoration, flows proposed under Strategy 3 would increase from 750 cfs to 1,500 cfs one week sooner than under Strategy 1. Dry year flows from March 22 through the spring and summer are the same in Strategy 3 as in Strategy 1.

In normal-dry water years, flows increase to 1,500 cfs on February 1 to inundate floodplains and provide potential rearing habitat for juvenile salmonids and spawning habitat for splittail. Under both chinook salmon restoration scenarios, flows then increase to 2,500 cfs on April 1 to provide suitable water temperatures for spring-run chinook salmon upstream migration and for smolt outmigration through April 15. If both spring-run and fall-run chinook are targeted for restoration, flows would increase to 4,500 cfs on April 16, where they would remain through May 7 to maximize suitable conditions during the end of the smolt outmigration period for spring-run chinook salmon. If fall-run chinook are not targeted for restoration, flows would ramp down from 2,500 cfs beginning on April 16 and reach the summer baseflow level of 500 cfs on April 19.

In normal-wet years, as in normal-dry years, flows increase to 1,500 cfs on February 1 to inundate floodplains and provide potential rearing habitat for juvenile salmonids and spawning habitat for splittail. Beginning in March, spring-run juveniles likely begin to migrate downstream. If both spring-run and fall-run chinook are targeted for restoration, flows then increase to 4,500 cfs on April 1, where they remain for three weeks before increasing to 6,000 cfs on April 22. These flow increases are designed to provide suitable temperatures for adult spring-run upstream migration and for outmigration of fall-run and spring-run chinook smolts. If fall-run chinook are not targeted for restoration, flows would remain at 1,500 cfs until April 7, then increase to 4,500 cfs on April 8.

As in normal-dry and normal-wet water years, flows in wet years increase to 1,500 cfs on February 1, immediately following winter baseflow. If both spring-run and fall-run chinook salmon are targeted for restoration, the 1,500 cfs flow continues through March 15. Under this restoration scenario, wet year flows after mid-March are driven by riparian vegetation recruitment flows, which are discussed in Section 7.3.6.

In a wet year restoration scenario without fall-run chinook salmon, flows increase to 4,500 cfs in early March and increase again to 7,000 cfs in mid-March to provide suitable temperatures for splittail spawning. Flows decrease back to 4,500 cfs in early April to avoid unnecessary expenditure of water before beginning a sharp late spring increase for riparian scour and recruitment (discussed in Sections 7.3.5 and 7.3.6).

#### 7.3.4.1 Benefits and drawbacks for chinook salmon

**Spring-run chinook salmon**

Butte Creek spring-run salmon, the suggested parent population for restoring SJR spring-run, migrate upstream between February and April. Increasing flows to 1,500 cfs at the beginning of February is designed to provide a migratory cue for adult spring-run to begin their upstream migration to holding pools and provide inundated rearing habitat for juvenile spring-run chinook salmon.

It is not clear what flow magnitude will be required to stimulate upstream migration for spring-run adults, so this hydrograph component can serve as a focus for early research. Merced River flow will likely be cooler than San Joaquin River water, so it may be important that San Joaquin River discharge be appreciably greater than the magnitude of Merced River flow in these months. Flows of 1,500 cfs are likely sufficient to maintain the target temperature of < 65°F (<18.3°C) through mid-March.

It is important to note that historical populations of spring-run probably migrated upstream later in the spring (April through June) during snowmelt floods. However, achieving the target temperature (< 65°F [<18.3°C]) during these later spring months is difficult to achieve consistently and cannot be achieved within the 4,500 conveyance capacity limitation imposed in several reaches.

In dry years, increasing flows to 1500 cfs in mid-March and 2500 cfs in mid-April will maintain adequate temperatures (< 65°F [<18.3°C]) for both adults and juveniles. In normal-dry and normal-wet years, these increases occur earlier in the season to ensure suitable conditions for adults moving upstream as well as juveniles moving downstream. In wet years, flows sufficient to maintain adequate temperatures are provided through May, when we predict most adults are already at holding grounds and most juveniles are downstream of the planning area.

**Fall-run chinook salmon**

Increasing flows will provide increased habitat throughout the project area for fall-run juvenile rearing. Particularly on constructed surfaces with floodplain inundation, productivity is likely to be high, allowing fall-run chinook juveniles to potentially develop faster than their spring-run counterparts.

#### 7.3.4.2 Benefits and drawbacks for resident fishes

Early spring flow differences between the three strategies involve the timing, magnitude, and duration of flow increases. In normal-dry, normal-wet, and wet water year types under Strategy 3, an increase to 1,500 cfs from the proposed winter baseflow occurs on February 1 for both restoration scenarios. Although designed primarily to provide suitable flows and temperatures for salmonids, this flow increase would also provide ancillary benefits to most native resident fish species. Flows of approximately 1,500 cfs or greater are required to inundate floodplain surfaces in the study area, which provide important spawning and rearing habitat for Sacramento splittail and other native floodplain spawners such as Sacramento blackfish and Sacramento perch.

The rationale for the timing, magnitude, and duration of subsequent early spring flows in all but wet years under Strategy 3 is driven by the needs of anadromous salmonids and is discussed in Section 7.3.4.1. The potential benefits and drawbacks for resident fishes of early spring flows, including the effects of magnitude, duration, and timing, are discussed in detail in Section 5.3.4.2. Uncertainties associated with these potential benefits and drawbacks are also addressed in Section 5.3.4.2.

In wet years under Strategy 3, the proposed hydrograph for the restoration scenario that does not target fall-run chinook salmon includes flow increases designed to enhance the potential for successful floodplain spawning by splittail. As in wet years under Strategies 1 and 2, the proposed increase in Strategy 3 to 4,500 cfs on March 8 and the proposed flow of 7,000 cfs beginning March 16 are designed specifically to maintain water temperatures at or below 59°F (15°C) through March in an attempt to provide optimal floodplain spawning conditions for splittail. Flows of lesser magnitude, as are proposed in wet years when both spring-run and fall-run chinook salmon are targeted for restoration, and in other water year types, would provide floodplain inundation of sufficient duration to allow splittail spawning and rearing, but may not provide suitable floodplain temperatures for spawning. Additional details on the rationale for these flows, as well as potential benefits, drawbacks, and uncertainties, are discussed in Section 5.3.4.2.

If no attempt is made to maintain floodplain water temperatures within the preferred range for splittail spawning, a water savings can be realized in March in wet years under Strategy 3. In this case, the hydrograph for the restoration scenario without fall-run chinook would likely resemble the hydrograph that targets both spring-run and fall-run chinook salmon for restoration.

#### 7.3.4.3 Benefits and drawbacks for vegetation and wildlife

As in Strategy 2, the mid-March flow increase in wet years to 7,000 cfs for splittail spawning habitat (included under the without-fall-run scenario) has the potential to increase natural recruitment of arroyo willow on inundated floodplains. Arroyo willow releases seeds in early spring, prior to Fremont cottonwood and Goodding's black willow, which are expressly targeted for increased recruitment in wet years under this scenario (discussed in more detail in section 6.3.6). However, other characteristics of the wet year, without-fall-run flow scenario are not conducive to establishment of arroyo willow. The 500 cfs/day ramp-down rate at the end of the March pulse is likely too rapid for newly germinated seedlings to survive desiccation; modeling runs indicate that a ramp-down range of 100 to 300 cfs/day falls more within tolerable limits for willow species at most cross sections. Furthermore, the recruitment pulse flow prescribed for April in wet years (described in section 6.3.6) will inundate and likely mobilize sediments at the 7,000 cfs surfaces where arroyo willow seedlings would recruit and probably kill them. If this is the case, then these seedbeds will be available for recruitment by Fremont cottonwood and Goodding's black willow later in spring, a situation that is consistent with the primary riparian management objectives.

As under Strategy 1, inundation of floodplains and wetland habitats will provide nesting opportunities for numerous bird species such as white-faced ibis and tricolored blackbird, as well as waterfowl, such as northern pintail and mallards.

### 7.3.5 Late spring flows for fall-run chinook salmon outmigration

Late spring flows in dry, normal-dry, and normal-wet years focus on providing adequate conditions for downstream migration of juvenile fall-run chinook salmon. In dry years when both chinook salmon runs are targeted for restoration, flows of 4,500 cfs will be provided from May 1 to May 7. The increase from 2,500 cfs will be required to maintain adequate temperatures in the lower reaches. If fall-run chinook are not targeted for restoration, flows would be reduced from 2,500 cfs on April 8 and reach the initial 350 cfs summer baseflow level on April 10.

In normal-dry years, flows designed to support restoration of both chinook salmon runs would increase from 2,500 cfs to 4,500 cfs on April 16, where they would remain through May 7 to facilitate downstream movement of outmigrant fall-run chinook salmon. If fall-run chinook are not targeted for restoration, flows would be reduced from 2,500 cfs on April 16 and reach the 500 cfs summer baseflow level on April 19.

In normal-wet years, flows to support restoration of both chinook salmon runs would increase from 1,500 cfs to 4,500 cfs on April 1, followed by another increase to 6,000 cfs on April 23. Flows would remain at 6,000 cfs through May 24 to ensure that all fall-run chinook smolts have migrated out with adequate temperatures. If fall-run chinook are not targeted for restoration, flows would increase from 1,500 cfs to 4,500 cfs on April 8, where they would remain through May 15 to facilitate downstream movement of outmigrant fall-run chinook salmon.

During wet years, chinook salmon outmigration is not the driver of the late spring hydrograph. Under both chinook salmon restoration scenarios, riparian vegetation recruitment needs drive high flow conditions to scour seed beds and promote seed germination. These flows would include flow peaks of 13,500 cfs on April 19 and 7,000 cfs on June 7–8, both followed by rampdowns designed to facilitate riparian recruitment. These are discussed in further detail in Section 7.3.6. If fall-run chinook salmon are not targeted for restoration, flows in wet years would increase from 1,500 cfs to 4,500 cfs on March 8, then again from 4,500 cfs to 7,000 cfs on March 16, where they would remain until March 28. The timing and magnitude of these flow increases are designed to maintain cool floodplain temperatures for splittail spawning. Flows under this restoration scenario would ramp down to 4,500 cfs from March 29 to April 5 to save water, and would then ramp up to meet the riparian recruitment needs discussed above and in Section 7.3.6. Flows under this scenario would remain at or above 4,500 cfs through May 26.

#### 7.3.5.1 Benefits and drawbacks for chinook salmon

**Spring-run chinook salmon**

Temperatures in late spring would likely exceed the 65°F (18.3°C) target for upstream migration of spring-run chinook salmon. However if spring-run can tolerate slightly higher temperatures, the proposed flows should provide some additional benefits for spring-run chinook salmon that are migrating upstream later than predicted in all water year types. Juvenile spring-run chinook should have outmigrated by late spring, therefore increasing flows will not likely provide any benefits.

**Fall-run chinook salmon**

Young fall-run chinook salmon will begin achieving a size (80 mm) to support successful outmigration in early May. To maintain the target temperature of 68°F (20°C) , it will likely be necessary to increase flows from 2,500 cfs to 4,500 cfs in dry and normal-dry years. If fall-run are not targeted for restoration, then flows can begin dropping 500 cfs/day in this period until achieving the target summer baseflow of 350 cfs, saving approximately 28,000 af of water.

In normal-wet years, flows are provided through May 24 at 6,000 cfs to ensure suitable conditions for fall-run emigration.

Ramp-down rates in late spring to summer baseflows need to consider the potential to strand juvenile salmon and splittail on floodplain habitats. Adaptive management and monitoring should be conducted to address uncertainties in ramping rates.

Because these flows will be needed to maintain temperatures to RM 118, there are no clear opportunities for making part of this water available for water supply.

#### 7.3.5.2 Benefits and drawbacks for resident fishes

As with early spring flows, the potential benefits and drawbacks of late spring flows result primarily from their influence on spawning and rearing life stages. The effects of early spring flow increases and floodplain inundation on resident fishes are described in Section 5.3.4.2. The duration of late spring flows proposed in each water year type can have considerable influence on the availability and suitability of spawning and rearing habitat for many resident fish species. In particular, splittail, whose reproductive success depends heavily on the duration of floodplain inundation and the water temperatures on floodplains during the spawning period, will derive increasing benefits from higher flows and longer floodplain inundation.

In normal-wet water year types under Strategy 3, fall-run chinook outmigration flows of 6,000 cfs during late spring will provide ancillary benefits to spawning and rearing splittail and possibly to other resident fish species that use floodplains and shallow off-channel habitat. By increasing the area and duration of floodplain inundation and maintaining relatively cool water temperatures later into the season, flows of this magnitude and timing may allow splittail sufficient time to successfully spawn and rear on floodplains. Late spring flows of 4,500 cfs, as are proposed under the restoration scenario that does not include fall-run chinook salmon and in other water year types, can be expected to provide lesser benefits. However, even flows of 6,000 cfs appear insufficient to maintain water temperatures below 59°F (15°C) this late in the year. In dry, normal-dry, and normal-wet years, the proposed flows may therefore provide suitable conditions for splittail spawning only through the first week of March, at which time flows greater than 1,500 cfs are needed to maintain water temperatures below 59°F (15°C) throughout the study area.

As discussed in Section 5.3.5.2 for Strategy 1, water temperature modeling indicates that only in wet years, and only if fall-run chinook salmon are not targeted for restoration (i.e., under the "without fall run" hydrograph), would the proposed Strategy 3 flows provide water temperatures suitable for splittail spawning through March. Flows proposed in wet years for restoration of both spring-run and fall-run chinook, and some of the flows proposed in other water year types, would inundate floodplains long enough (60 days or more) but would not provide cool enough water temperatures to ensure successful splittail spawning. In wet years under Strategy 3, flows proposed for restoration of both spring-run and fall-run chinook salmon would also provide sufficiently cool temperatures beginning in early April when flows exceed 5,000 cfs. Flows under this restoration scenario begin a rapid increase in mid-March and surpass 7,000 cfs on April 9, at which point flows are the same as under a restoration scenario that does not include fall-run chinook. Temperature modeling indicates that flows of 7,000 cfs or above are sufficient to maintain water temperatures at or below 59°F (15°C) in Reaches 4B and 5 only until mid-April. It is likely that the increasing flows would maintain this temperature somewhat longer, but there is considerable uncertainty regarding how long this temperature can be maintained on floodplains in Reaches 4B and 5 as ambient air temperatures and incident solar radiation increase through the spring. Reach 4B is believed to be the maximum upstream extent of suitable floodplain habitat for splittail, and would be the site of channel and floodplain reconstruction under Strategy 3.

The late spring flows proposed under Strategy 3 could also result in additional benefits and drawbacks to splittail and other native and non-native resident fish species. With the exception of those already discussed above, these effects, as well as uncertainties associated with these effects, are expected to be similar to those in Strategy 1, and are discussed in Sections 5.3.4.2 and 5.3.5.2.

#### 7.3.5.3 Benefits and drawbacks for vegetation and wildlife

During dry, normal-dry, and normal-wet years, the late spring flows for fall-run outmigration have the potential to increase recruitment of woody and herbaceous vegetation on surfaces inundated at 4,500 cfs or less in dry years and normal-wet years without fall-run, and 6,000 cfs or less in normal-dry and normal-wet years with both salmon runs. Consequences of vegetation encroachment and measures to prevent it are discussed in Section 5.3.5.3. In wet years, recruitment flows are planned for late spring and vegetation encroachment is not the primary management concern. Recruitment flows are described for this strategy in Section 7.3.6.

As under Strategy 1, inundation of floodplains and wetland habitats will provide nesting opportunities for numerous bird species such as white-faced ibis and tricolored blackbird, as well as waterfowl, such as northern pintail and mallards.

### 7.3.6 Riparian recruitment and wetland recharge flows

Recruitment flows for riparian vegetation are only proposed in wet water year types. No recruitment flows would be released in dry, normal-dry, or normal-wet years. In normal-wet years, however, flows proposed for both salmonid restoration scenarios would include a hydrograph component designed to prolong the inundation of seasonal wetlands in early summer before flows drop to summer baseflow level. This hydrograph component appears as several short, successive spikes originating from an average flow of 2,000 cfs. The flow spikes, which are designed to disrupt spawning by non-native resident fish, are described in more detail in Section 7.3.6.2. If both spring-run and fall-run chinook salmon are targeted for restoration, flows proposed for wetland inundation and recharge would begin at the end of the rampdown period in early June and continue through June 30. In restoration scenarios without fall-run chinook, the pattern of flows in normal-wet years is identical to the scenario where both runs are restored, although it is shifted earlier by 2 weeks. In wet years, the seedbed preparation flow spike occurs March 15 through April 24. This short high flow will scour banks of vegetation, mobilize and deposit fine sediment, and recharge water tables and soil moisture levels to prepare banks and floodplain surfaces for riparian recruitment. The flow spike will necessarily be larger than the initial flow of the recruitment release because river stage will need to be higher than the target recruitment surfaces in order to achieve hydraulic shear stresses adequate to clear vegetation and deposit sediment. Beginning at 1,500 cfs on March 15, flow increases 300 cfs/day until April 19, when it peaks at 13,500 cfs, and declines rapidly (500 cfs/day) to 10,000 cfs on April 24. The peak of 13,500 cfs on April 19 is designed to provide a scouring flow for riparian seedbed preparation timed for the cottonwood seed release period.

Flows will be ramped down at a rapid rate initially to prevent riparian recruitment on higher inundated surfaces. Stranding of juvenile salmonids and other fish on floodplains and other inundated off-channel surfaces should not be a problem at these inundation elevations. At 9,000 cfs the ramp-down rate decreases to 100 cfs/day to promote recruitment on the surfaces inundated between 9,000 and 7,500 cfs. After 7,500 cfs is attained on May 12, the ramp-down rate then increases to 200 cfs/day to provide a rate that should prevent desiccation of newly established seedings. A second peak to 7,000 cfs at the beginning of June provides opportunities for riparian plant species that typically recruit later in the season. On June 8 the ramp-down rate decreases again to 100 cfs/ day until summer baseflow is attained on July 14. The slower ramp rates from 9,000 cfs to baseflow should not strand juvenile fish.

Recruitment flow hydrograph components are designed with a roughly reverse-sigmoidal shape with three phases: (1) an initial slow ramp down rate for approximately a week to concentrate floating seeds against the targeted bank elevation zone; (2) a steeper decline that induces river-stage declines at most cross sections that fall within the published experimentally-determined limits of seedling survival; and (3) a final, more gradual decline intended to maintain soil water resources for seedlings and buffer against potential desiccation from the previous rapid declines. The recruitment flow ends when flow returns to summer base flow levels.

The rationale for riparian recruitment flows in this strategy follows those outlined for Strategy 1 (Section 5.3.6). Since Strategy 3 is designed to maximize benefits to riparian vegetation, recruitment hydrograph components in this Strategy involve larger water volumes to reach more floodplain surfaces and have more complex timing to maximize benefits for several native tree species.

#### 7.3.6.1 Benefits and drawbacks for chinook salmon

**Spring-run chinook salmon**
Late spring riparian recruitment flows may provide some benefits to late-migrating adult spring-run chinook salmon. There is a possibility that adults already in holding habitats in Reach 1A may be affected by high flows associated with riparian recruitment.

**Fall-run chinook salmon**
Late spring riparian recruitment flows may provide some benefits for the tail end of the fall-run outmigration, although warm temperatures in late spring could be stressful or potentially lethal.

#### 7.3.6.2 Benefits and drawbacks for resident fishes

As discussed above, the hydrographs proposed for dry and normal-dry water year types under this Strategy do not include riparian recruitment flows or flows for wetland inundation and recharge. Wetland benefits are provided by flows in normal-wet and wet water years, and riparian recruitment flows are proposed only in wet years under this Strategy.

In normal-wet years, flows designed primarily for wetland inundation and recharge also include several short, successive spikes intended to reduce the spawning success of bass and other non-native fishes. These flow spikes would begin in late May or early June, depending on which chinook salmon runs are targeted for restoration. Because bass and other non-native fishes can spawn at higher temperatures and later in the season than do most native resident species, these flow fluctuations may coincide with spawning and early rearing by some non-natives. Evidence indicates that fluctuations in depth, velocity, and temperature may disrupt nesting and reduce reproductive success of bass by displacing eggs and fry, desiccating eggs, and disrupting spawning behavior. Other non-native fishes may be vulnerable to the same effects. Most native fishes spawn earlier in the year and are generally better suited to spring flow variability, making them less susceptible to these types of impacts. Sacramento perch, Sacramento blackfish, and tule perch, however, are known to spawn during this time period and may therefore be susceptible to the same adverse effects. Little is known about the potential effects of rapid flow and temperature changes on reproductive success in these species.

In wet years, the rapid, high-magnitude flow increases proposed for riparian seed bed preparation in mid-April and early June may be effective at reducing the distribution and abundance in the study area of non-native predatory fishes such as bass and centrarchids. The mechanisms for this are described above and in Section 5.3.4.2. Because bass and other non-native fishes tend to spawn later in the season than do native resident species, these large, rapid flow increases may coincide with spawning and early rearing by some non-natives. In addition to the effects of fluctuations in flow, velocity, and temperature described above, high flows and cool water temperatures during spawning may also reduce reproductive success of non-native fishes for similar reasons. Native fishes, which are generally better suited to spring flow variability, would be less susceptible to these types of impacts.

The potential effects of the gradual flow reduction proposed in wet water years, as well as uncertainties associated with these effects, are expected to be very similar to those under Strategy 1. These are discussed in Section 5.3.5.2.

Additional uncertainties associated with the potential benefits and drawbacks discussed above include:

- Uncertainty regarding the frequency, magnitude, and timing of flow pulses required to reduce spawning success of bass and other non-native fishes.
- Incomplete knowledge of the factors that influence reproductive success in some native resident fish species, including Sacramento perch, Sacramento blackfish, and tule perch.

#### 7.3.6.3 Benefits and drawbacks for vegetation and wildlife

This hydrograph component is expressly designed to increase natural recruitment of Fremont cottonwood, Goodding's black willow, which are key dominant trees within the SJR riparian corridor. Recruitment flows in wet years have a double peak to maximize benefits for Fremont cottonwood in early spring and for Goodding's black willow in early summer. Following the seedbed preparation flow, which ends at 10,000 cfs on April 24, the ramping rate declines 50 cfs/day through May 4, then 200 cfs/day through June 3. From June 4–8, flow increases to 7,000 cfs to target Goodding's black willow recruitment, and declines at decreasing rates until July 14, when the 750 cfs baseflow level is achieved. Other ancillary benefits to understory species and fall-dispersing species, as well as potential undesired ramifications for non-native species are outlined in Section 5.3.6.3.

Wet-year recruitment flows under Strategy 3 will inundate much larger acreages of floodplain than any other hydrograph component and strategy with potential positive ancillary benefits for the most diverse series of habitats, including riparian woodlands, marshes, alkali scrub and associated wetlands, and oxbow lakes. Prolonged inundation would help maintain more natural levels of variability of wetland hydrology, recharge groundwater, dilute agricultural return flows and promote a more complex mix of vegetation and habitat structure.

Inundation of floodplains and wetland habitats during spring will benefit many migratory and resident birds. In normal-wet years, an extended period of flow is provided to recharge wetland habitats and provide foraging habitat, particularly for waterfowl. Peaks during this flow period (three altogether) are intended to disrupt largemouth bass spawning, in an effort to minimize potential predation on juvenile salmonids.

As illustrated in Figure 7.7 (see also Appendix E-1), under Strategy 3 the SJR Riparian Recruitment Model (see Chapter 3 in Stillwater Sciences 2003 for detailed discussion of this model) indicates that there is a general threshold around 8,000 cfs in the amount of potential riparian recruitment area achieved per unit flow (similar to Strategy 2). Additional recruitment area is still predicted to occur, however, with even higher recruitment flows. The likely width of the riparian forest and scrub corridor is another ecological consideration in evaluating potential benefits of recruitment flows of various magnitudes. Review of the predicted length of river corridor within various width categories (Figures 7.8 through 7.11) indicates that there is a noticeable increase in the amount of the river corridor that has a potential width of 300 feet or greater, which is the more desirable riparian corridor width target (as described in Section 3.5.4.5), as recruitment flow magnitude increases from 5,000 to 8,000 cfs. The potential gains achieved in increased woody riparian width with flows above 8,000 cfs are less striking, but there are still valuable increases in corridor width predicted by the model as recruitment flows increase from 8,000 to 10,000 cfs and above. This type of modeling analysis, combined with the flow release and routing rules under Strategy 3, suggests that recruitment flows in the range of 8,000 to 10,000 cfs every 5 – 10 years would be appropriate targets under Strategy 3. In addition, the desire to use higher magnitude flows (for example, 13,500 cfs in this case, as shown in hypothetical wet year hydrograph illustrated in Figure 7.6) to increase the chances that flows alone can provide adequate seedbed preparation (see Section 3.5.3) suggests that a recruitment flow target in the range of 8,000 – 10,000 cfs would be appropriate (since surfaces inundated by these magnitude of flows are likely to exhibit at least some seedbed preparation in response to a spiked flow of 13,500 cfs as shown in Figure 7.6). These findings were incorporated into the hypothetical wet year hydrograph developed for Strategy 3 (see Figure 7.6).

The SJR Riparian Recruitment Model was also used to predict the maximum amount of recruitable area that would be expected under the two hypothetical Strategy 3 wet year hydrographs (the base version includes consideration of both chinook salmon runs, and the second scenario is without fall-run). Under Strategy 3 there is no difference in riparian recruitment between the two scenarios (see results presented in Appendix E-2) since the key characteristics of the recruitment flow component of the two hydrographs are identical. The predicted recruitable width along each transect, the average recruitable area per river mile, and the length of river in various recruitable width categories are plotted for each wet year hydrograph scenario in Figures 7.12 through 7.14. Detailed results are presented for each reach in Appendix E-2. It is important to note that much of the predicted potential recruitment area is already occupied by riparian forest and scrub or other desirable native vegetation types, particularly in Reach 1. The higher quality patches of existing vegetation within the floodway would presumably be targeted primarily for maintenance by the managed restoration flow hydrographs. Some of the riparian forest and scrub patches are currently mapped as low density, with much open or bare area between shrubs and trees. These low-density patches would likely be targeted for enhancement through natural recruitment. Other sites in the floodway are currently disturbed, covered by herbaceous vegetation (which is typically dominated by non-native forbs and grasses), or are agricultural fields. These are the areas that might be the primary targets for restoration through natural recruitment processes. Also, a few mapped patches are currently dominated by non-native invasive species. These areas would likely be targeted first for eradication or control, followed by attempts to promote natural revegetation or the use of horticultural restoration.

The predicted total maximum recruitable area by reach is presented in Table 7-11, along with breakdowns of how much of this potential area overlaps with existing higher quality riparian vegetation that should be maintained by the recruitment flows, existing lower quality (i.e., low density) riparian vegetation patches that should be enhanced by the recruitment flows (i.e., seedlings could be recruited to much of the current bare areas between established shrubs and trees), and an estimate of how much area currently classified in the herbaceous, disturbed, or agriculture cover types might be restored to riparian forest and scrub by the recruitment flows. Note that Reach 1 would not be expected to show greatly increased acreages of riparian vegetation through promotion of natural recruitment processes, but it would be expected to experience some enhancement of current low density patches. Reaches 2A, 2B, 4B1 and 5 would be expected to experience substantial increases in riparian forest and scrub if the restoration hydrographs achieve their desired objectives for riparian vegetation, largely due to the amount of area added to the floodway by levee setbacks in the first three reaches and the lack of levees on much of the left bank in Reach 5. The recruitment model results indicate that there would likely be very little difference in total area and width of potential riparian recruitment under the two different hydrograph scenarios.

**Table 7-11. Predicted riparian vegetation benefits of the hypothetical wet year riparian recruitment flow hydrograph developed for Strategy 1, by Reach.**

| Reach | Total Maximum Recruitable Area (acres) | Existing Riparian Forest and Scrub Maintained (acres) | Existing Riparian Forest and Scrub Enhanced (acres) | Area Potentially Restored to Riparian Forest and Scrub (acres) |
|---|---|---|---|---|
| 1 | 2,062 | 1,950 | 323 | --* |
| 2A | 534 | 369 | 171 | --** |
| 2B | 1,861 | 348 | 22 | 1,491*** |
| 3 | 1,400 | 808 | 72 | 520+ |
| 4A | 345 | 186 | 28 | 131 |
| 4B1 | 3,631 | 367 | 90 | 3,174*** |
| 4B2 | 1,115 | 374 | 115 | 726 |
| 5 | 2,824 | 867 | 335 | 1,622 |
| Total | 13,722 | 5,269 | 1,156 | 7,664 |

*very little recruitment of new patches would be likely in this reach through flow management and natural recruitment processes alone.
**potential levee setbacks in Reach 2A were not modeled, but it is likely that a several hundred to thousand acres or more would be potentially restored through natural recruitment processes depending on levee setback configuration
*** the area potentially restored would depend largely on the selected configuration for setting back levees in this reach
+the area potentially restored through natural recruitment processes in Reach 3 could be higher if some internal levees are breeched or removed as part of expanding floodway capacity in this reach

It should be noted that while the SJR Riparian Recruitment Model is a very useful tool for strategic planning and comparing alternative strategies, the specific acreages reported should be treated more as an index of potential restoration benefits rather than a precise estimate of actual acreages that should be expected. Even when the model accurately predicts the potential for recruitment, that potential would only be met if site-specific conditions were favorable. Site-specific variations in soil texture or chemical characteristics, water quality, surface water-groundwater dynamics, competition from already established native or non-native plants, nutrient levels, seed dispersal limitation, and herbivores (including rodents, deer, beaver, and livestock) can all act as factors limiting seedling recruitment and establishment at a particular location.

### 7.3.7 Summer baseflows for spring-run chinook salmon holding

The summer baseflow hydrograph is designed to provide sufficient depths and temperatures for spring-run holding in Reach 1A. Summer baseflows would be released at 350 cfs under dry water year types, 500 cfs under normal-dry, and 750 cfs under normal-wet and wet year types. To provide sufficient flow continuity during dry years, an increase to 450 cfs would be required in mid-summer.

If both chinook salmon runs are targeted for restoration, summer baseflow releases begin as early as May 16 in dry water years, May 15 in normal-dry years, June 30 in normal-wet and July 14 in wet years. If fall-run chinook are not targeted for restoration, summer baseflows begin on April 10 in dry years, April 19 in normal-dry years, June 18 in normal-wet years, and July 14 in wet years. The wetter the year, the more flows for riparian recruitment can contribute to the success of outmigrating chinook salmon, especially fall-run.

#### 7.3.7.1 Benefits and drawbacks for chinook salmon

**Spring-run chinook salmon**

Because water temperatures of Friant releases are relatively constant between 48°F and 52°F (9 and 11°C), flows of 350 cfs are sufficient to maintain the target temperature (< 70°F [<21°C]) for adult spring-run holding in pools during dry years. Assuming current patterns of riparian diversions in Reach 1 are continued during dry years, then flows of 350 cfs may be sufficient to maintain flow continuity to RM 118, though this will be the subject of analysis once flows are restored to the river.

Because water temperatures of Friant releases are relatively constant between 48°F and 52°F (9 and 11°C), flows of 500 cfs are sufficient to maintain the target temperature (< 70°F [<21°C]) for adult spring-run holding in pools for normal-dry and normal-wet water years. Flows of 500 cfs are also likely to maintain flow continuity to Mendota Pool and RM 118. It is possible to reduce summer baseflows to 350 cfs between mid-May and late June, because 350 cfs is sufficient to maintain holding temperatures for spring-run adults, but it may not be sufficient to maintain flow continuity to RM 118. Reducing early summer baseflows to 350 would produce a water savings of approximately 13,400 af.

Higher summer baseflows (750 cfs) are targeted in wet water year types to help recharge and maintain wetlands and the species that depend upon them, including water fowl. Because water temperatures of Friant releases are relatively constant between 48°F and 52°F (9 and 11°C), flows of only 500 cfs are sufficient to maintain the target temperature (< 70°F [<21°C]) for adult spring-run holding in pools and to maintain flow continuity to RM 118. Reducing summer baseflows to 500 cfs for the summer during normal-wet years produces a water savings of approximately 13,400 af.

**Fall-run chinook salmon**

No fall-run chinook are expected to be in the project area during this time.

#### 7.3.7.2 Benefits and drawbacks for resident fishes

The duration and magnitude of summer baseflows in dry and normal-dry water years would be the same under Strategy 3 as under Strategy 1. The potential benefits and drawbacks for resident fishes are therefore expected to be the same under both strategies. These are discussed in Section 5.3.7.2.

Summer baselfows of 750 cfs are proposed in normal-wet and wet water years under Strategy 3. This slight increase over the baseflow level proposed in normal-wet and wet years under other Strategies could result in greater habitat availability for both native and non-native resident fish species and potentially reduce competition and predation. Higher flows may also provide slightly cooler temperatures, which would be expected to favor natives over non-natives. Because the difference in flow magnitude between the two Strategies is small, however, it is highly likely that normal variations in summer climatic conditions would have far greater effects on water temperatures.

Differences in the duration of summer baseflows may additionally influence their effects on fish population dynamics. In normal-wet years, the duration of summer baseflows differs by two weeks depending on which chinook salmon run is targeted for restoration. In wet years, summer baseflows would not begin until mid July. Baseflows of the shortest duration can be expected to result in the least competition for space and resources, and may also reduce the potential for predation.

Uncertainties associated with these effects include the following:
- The amount of habitat available to native and non-native resident fishes at the flows proposed during the summer baseflow period.
- The strength of interactions among resident fish species.

#### 7.3.7.3 Benefits and drawbacks for vegetation and wildlife

In all years, summer baseflows are necessary to recharge floodplain water tables for riparian vegetation. Maintaining summer baseflows are particularly necessary in wet years to sustain young-of-the-year seedling cohorts (which germinated following recruitment flows), since their root systems will be more vulnerable to drought stress throughout the summer. Furthermore, wet water years provide opportunities to recharge wetland habitats throughout the planning area.

Drawbacks of stable summer baseflows is the potential for vegetation establishment at the low-flow channel margin, particularly for vigorously sprouting woody species such as narrow-leaf willow, a native, and for non-natives such as giant reed and tamarisk. Vegetation encroachment and management issues are discusses in Section 5.3.7.3 and elsewhere throughout this document.

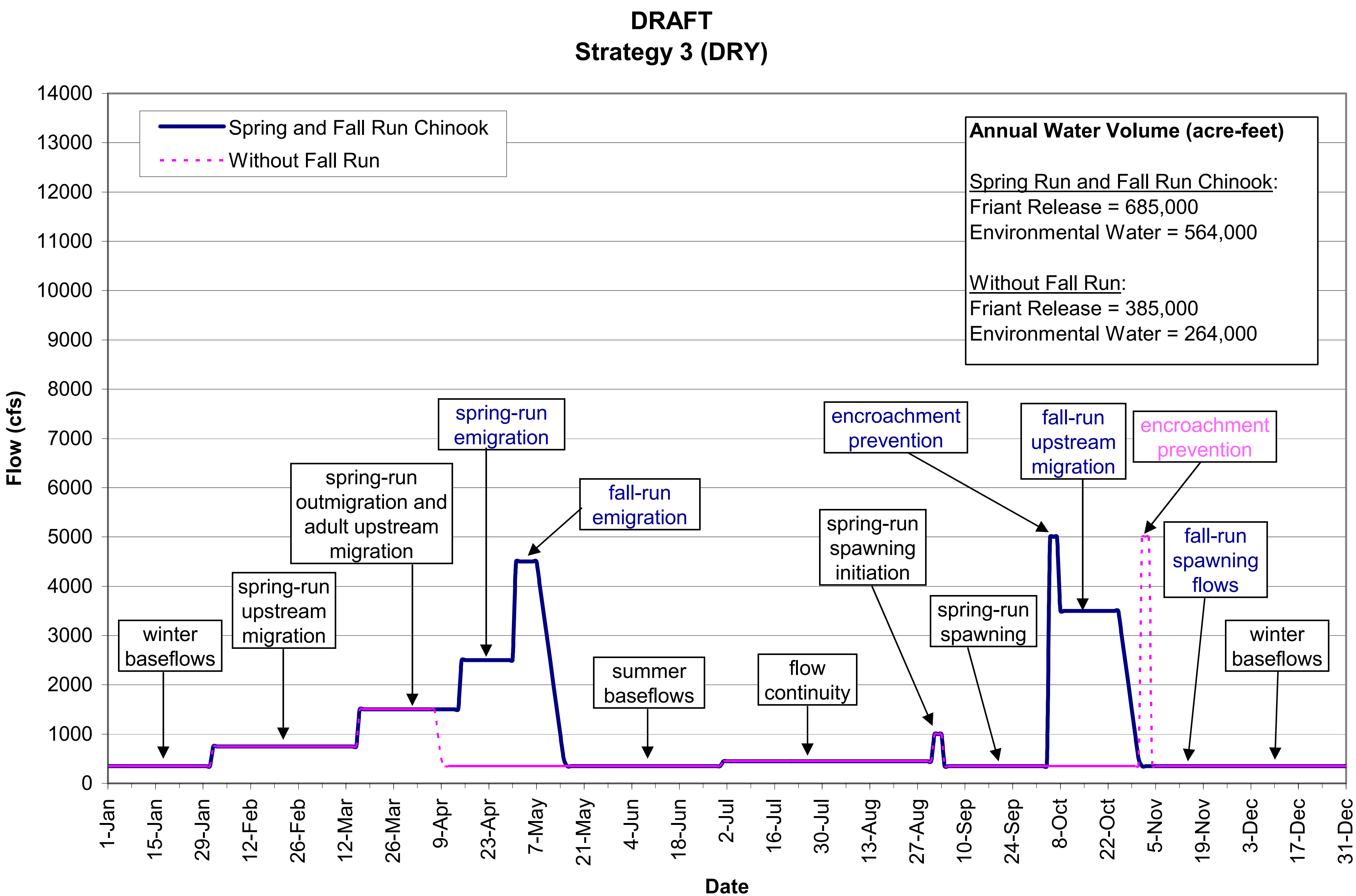


**Figure 7-3.** Potential hydrograph for a dry water year type under Strategy 3.

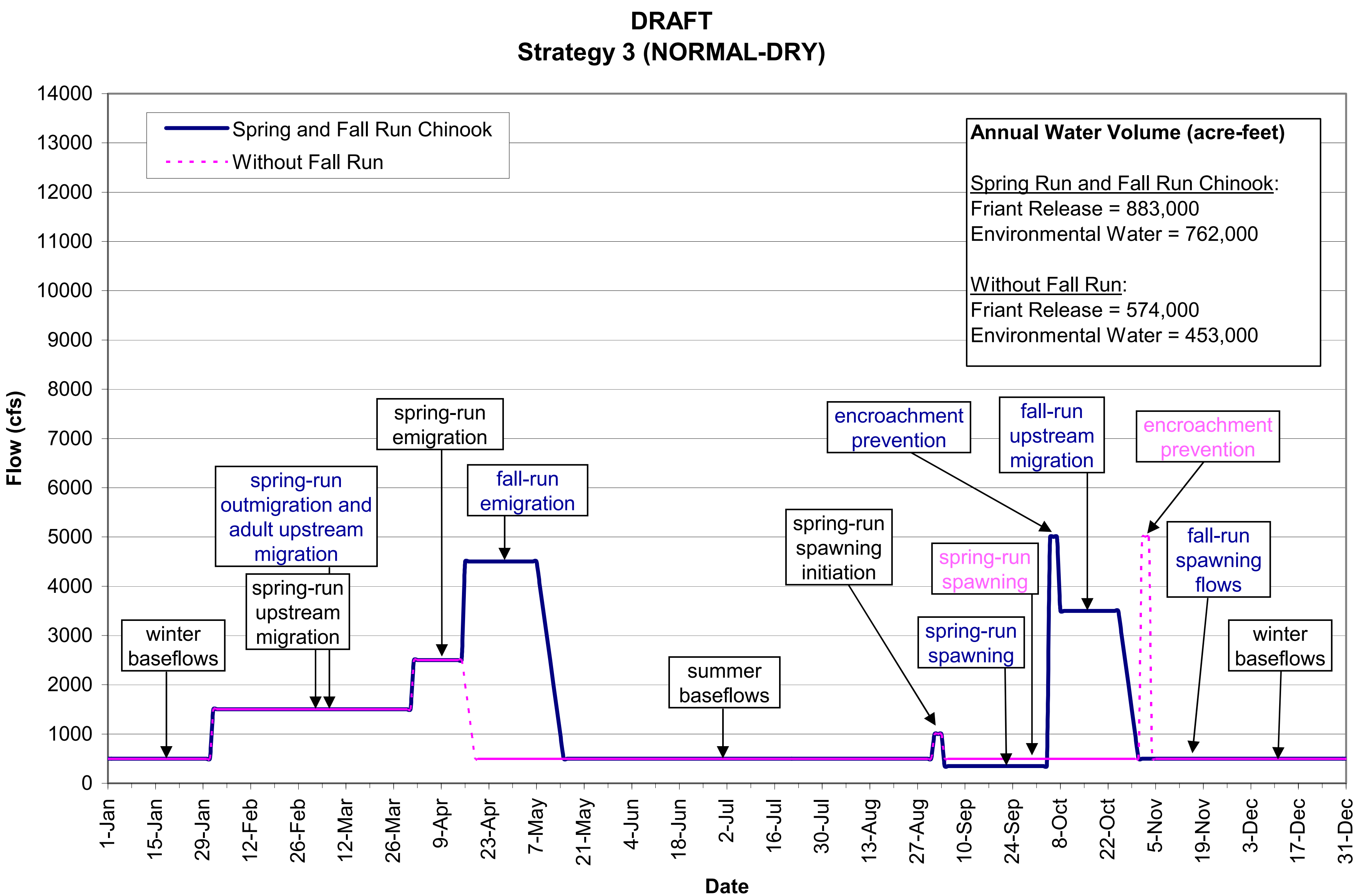


**Figure 7-4.** Potential hydrograph for a normal-dry water year type under Strategy 3.

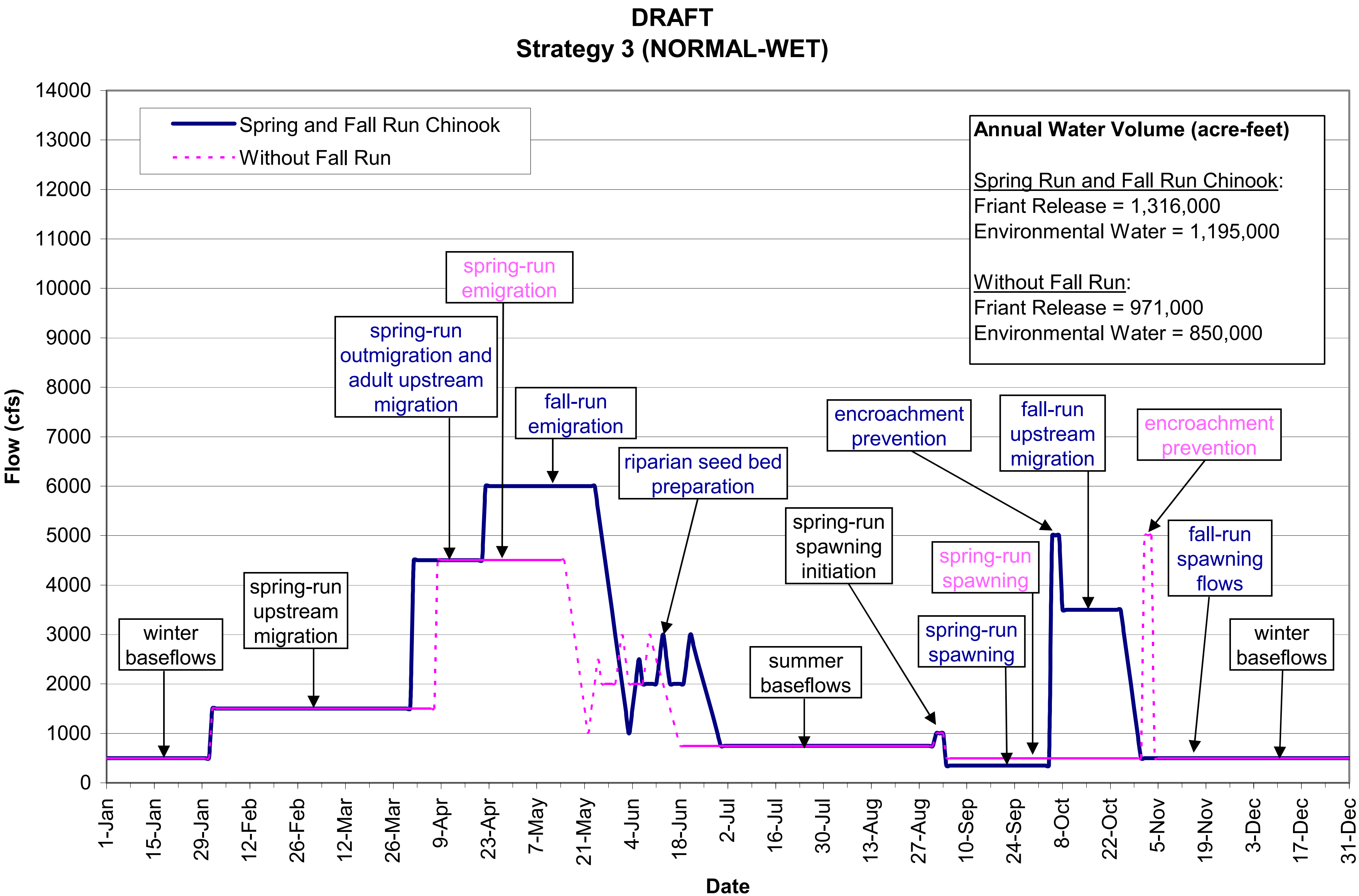


**Figure 7-5.** Potential hydrograph for a normal-wet water year type under Strategy 3.

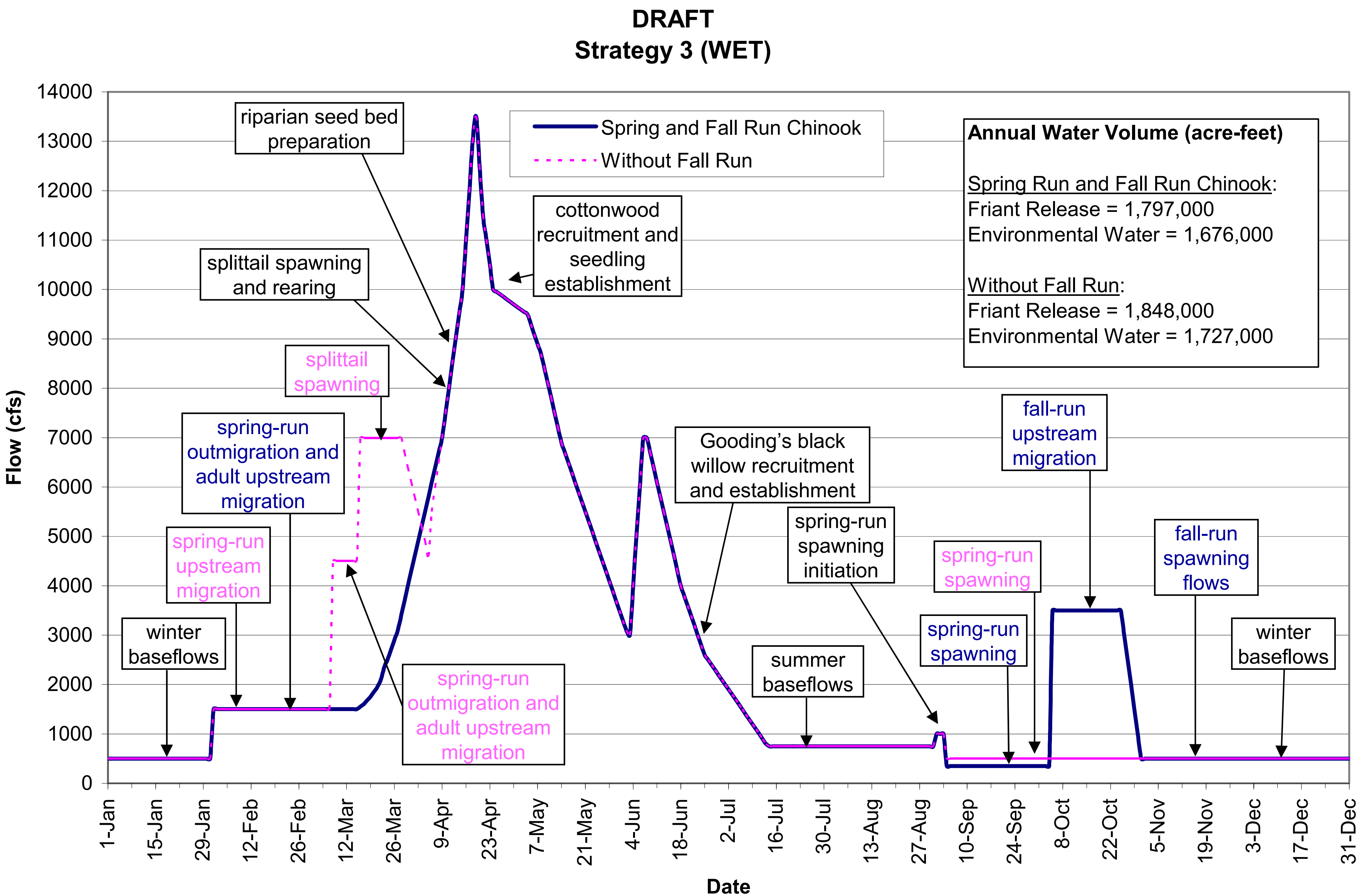


**Figure 7-6.** Potential hydrograph for a wet water year type under Strategy 3.

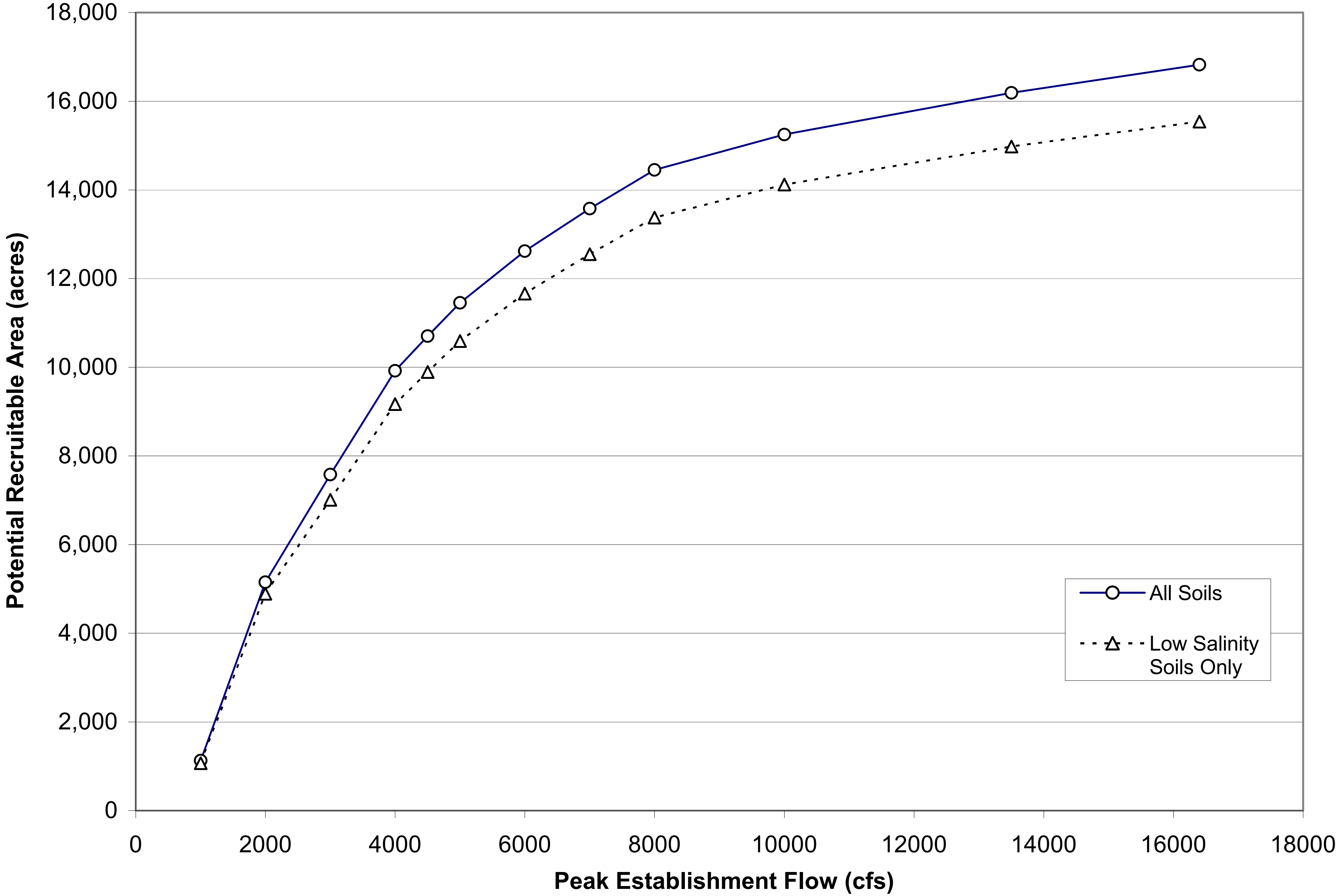


**Figure 7-7. Potential recruitable area versus peak establishment flow (cfs) for all reaches combined under Strategy 3.** The solid line indicates maximum recruitable area if all soils types are considered suitable. The dashed line indicates maximum recruitable area if only the “free” and “low” salinity soil types are considered to be suitable for establishment of cottonwoods and willows.

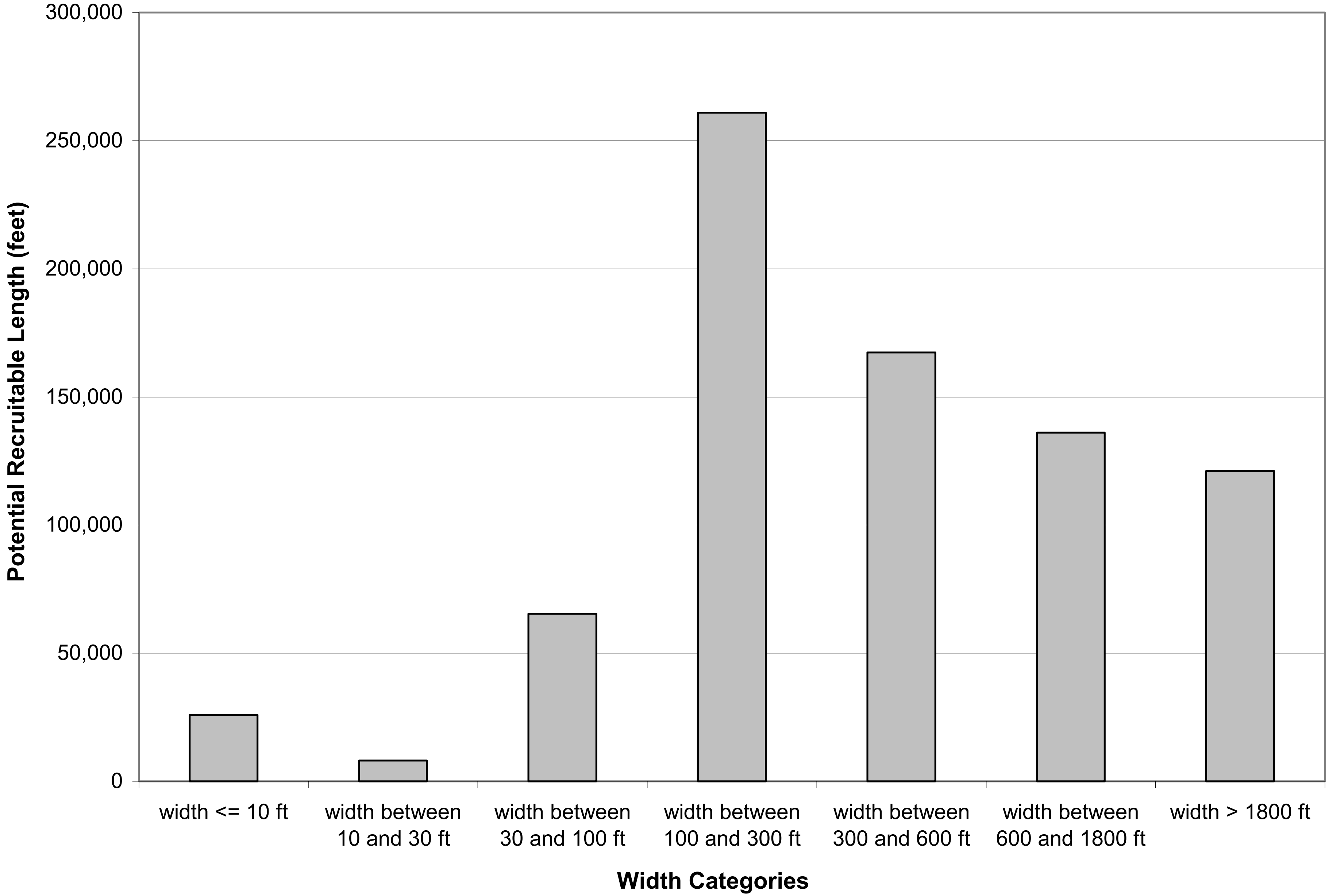


**Figure 7-8. Total length of potential recruitable woody riparian vegetation in different width categories for all reaches combined at 5,000 cfs under Strategy 3.**

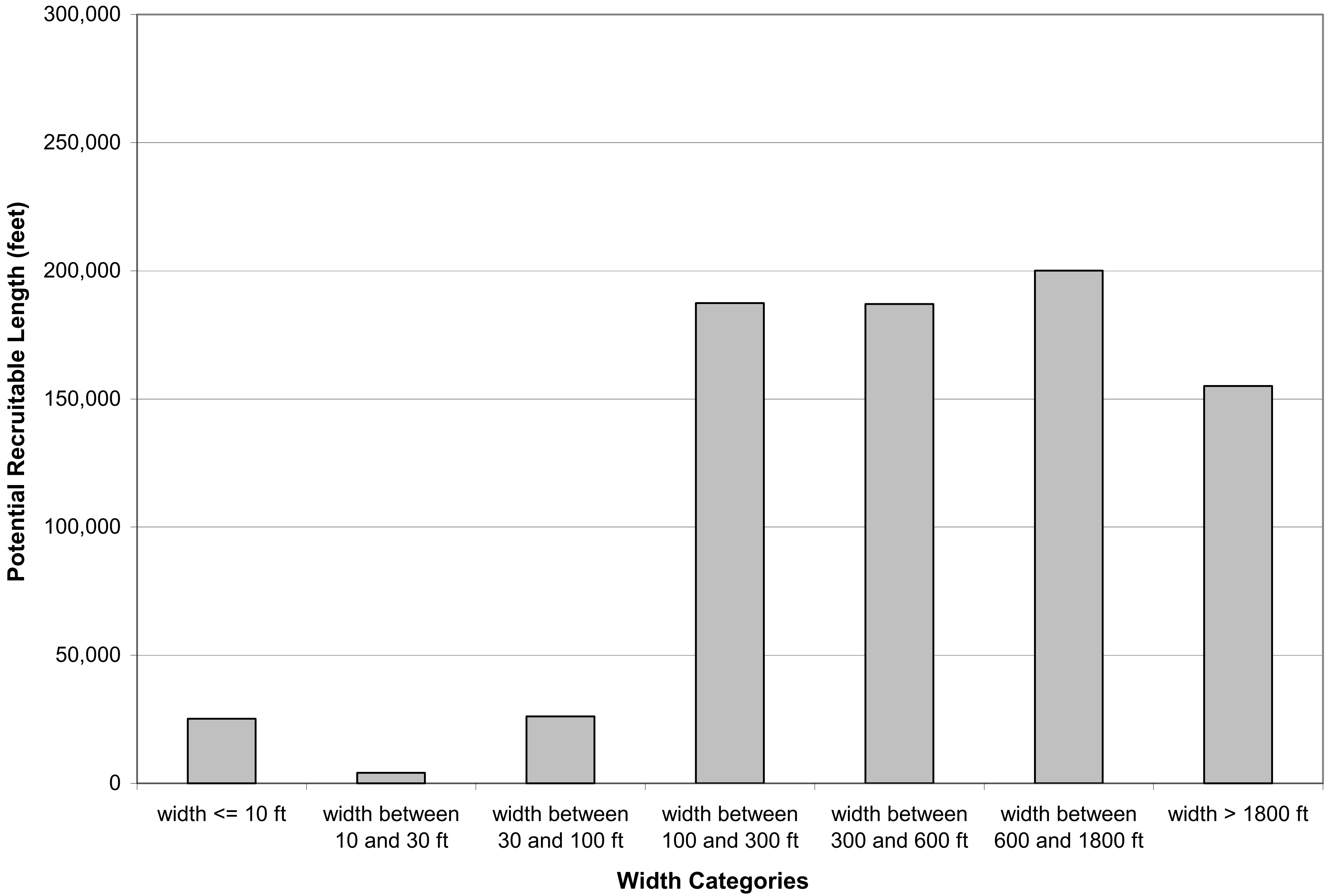


**Figure 7-9. Total length of potential recruitable woody riparian vegetation in different width categories for all reaches combined at 8,000 cfs under Strategy 3.**

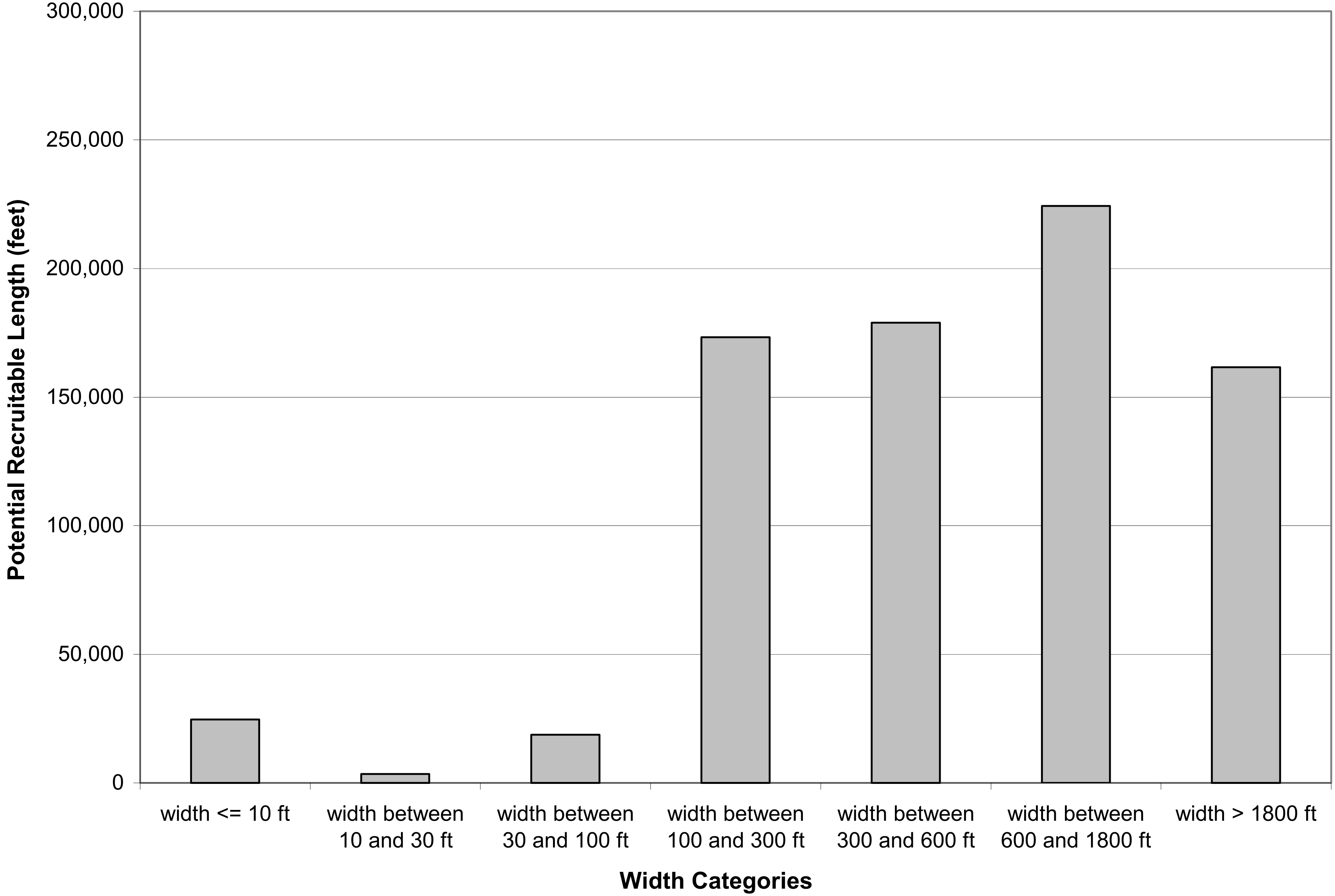


**Figure 7-10. Total length of potential recruitable woody riparian vegetation in different width categories for all reaches combined at 10,000 cfs under Strategy 3.**

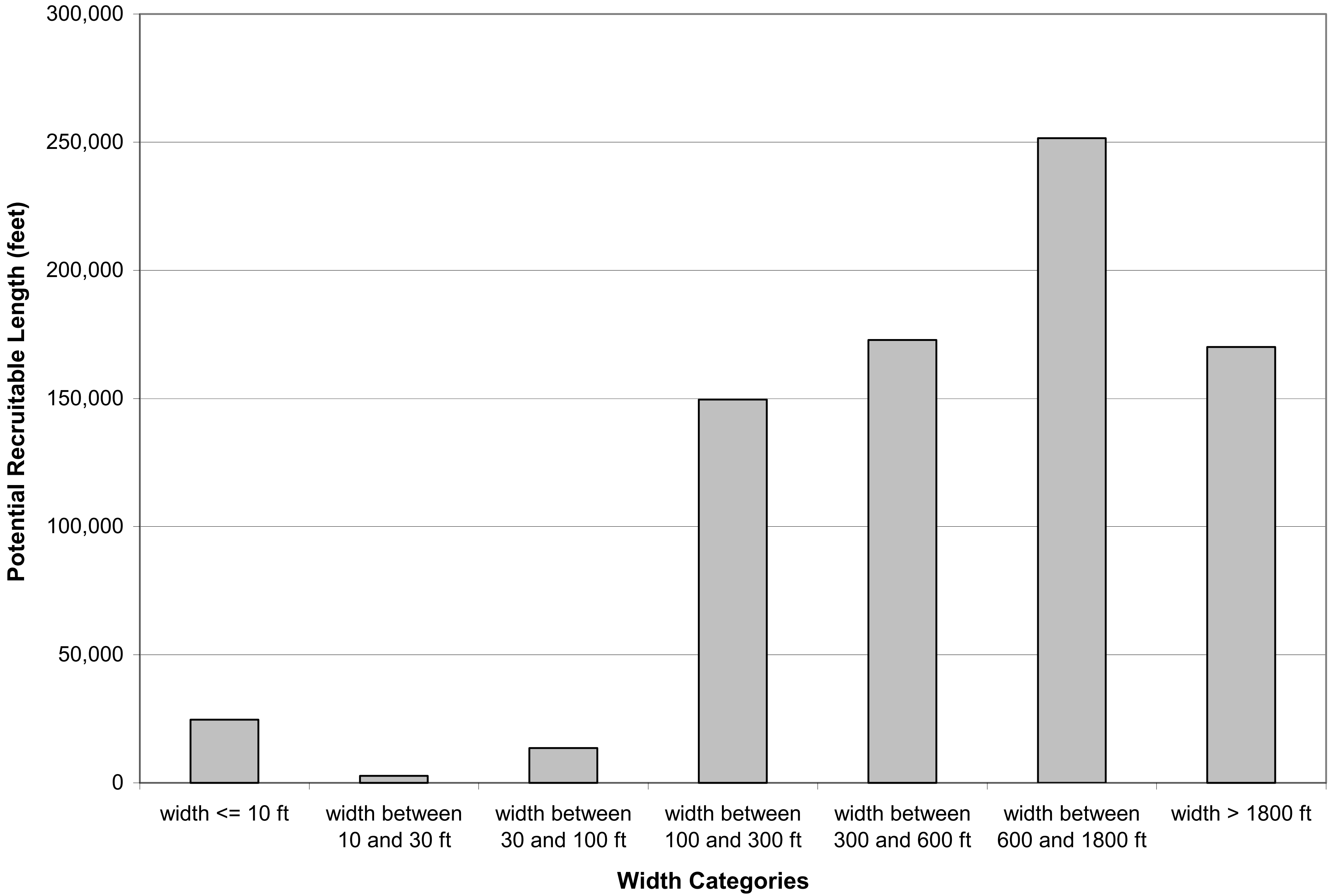


**Figure 7-11. Total length of potential recruitable woody riparian vegetation in different width categories for all reaches combined at 13,500 cfs under Strategy 3.**

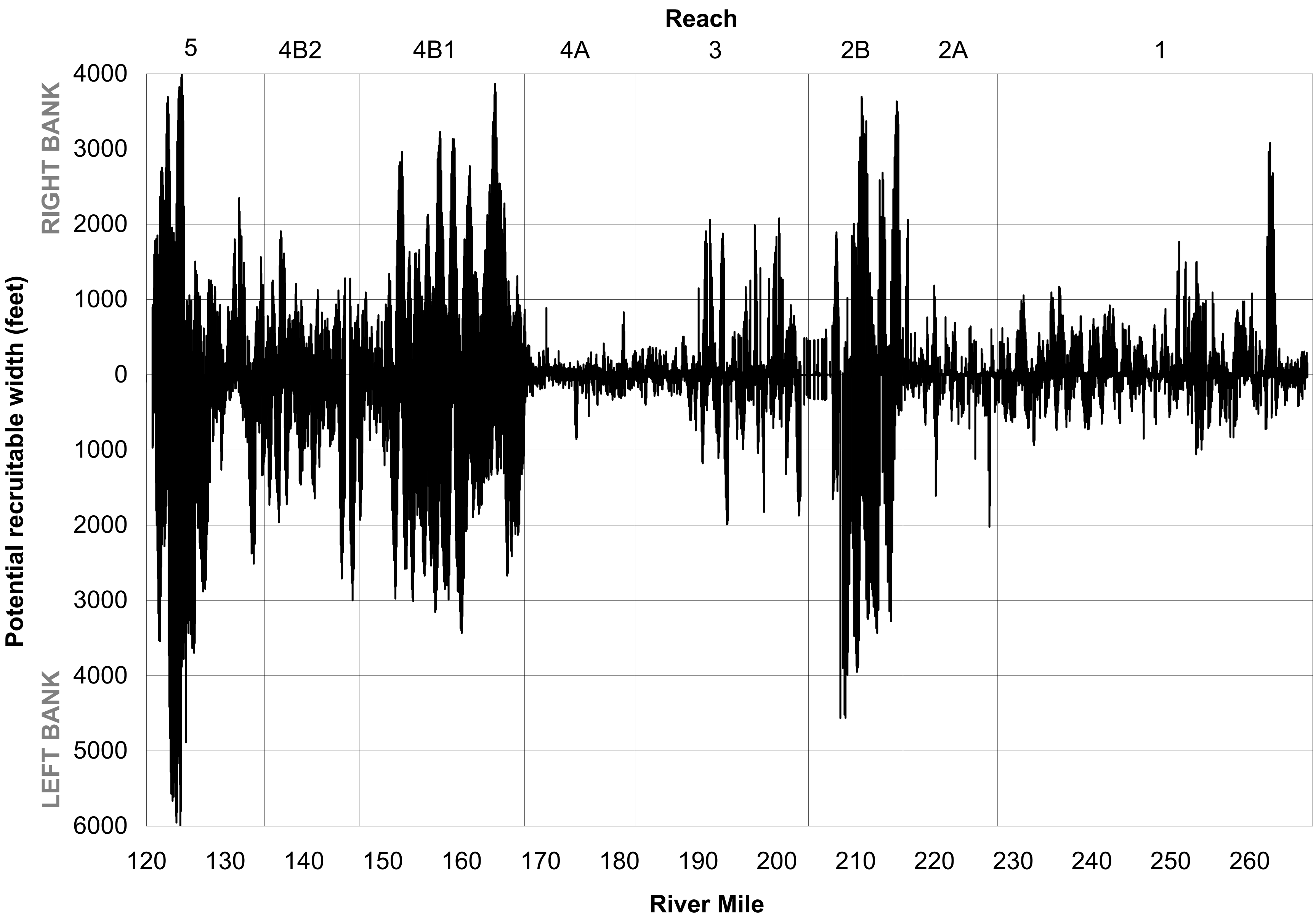


**Figure 7-12. Potential recruitable width of woody riparian vegetation along riparian transects for a hypothetical wet water year hydrograph under Strategy 3.**

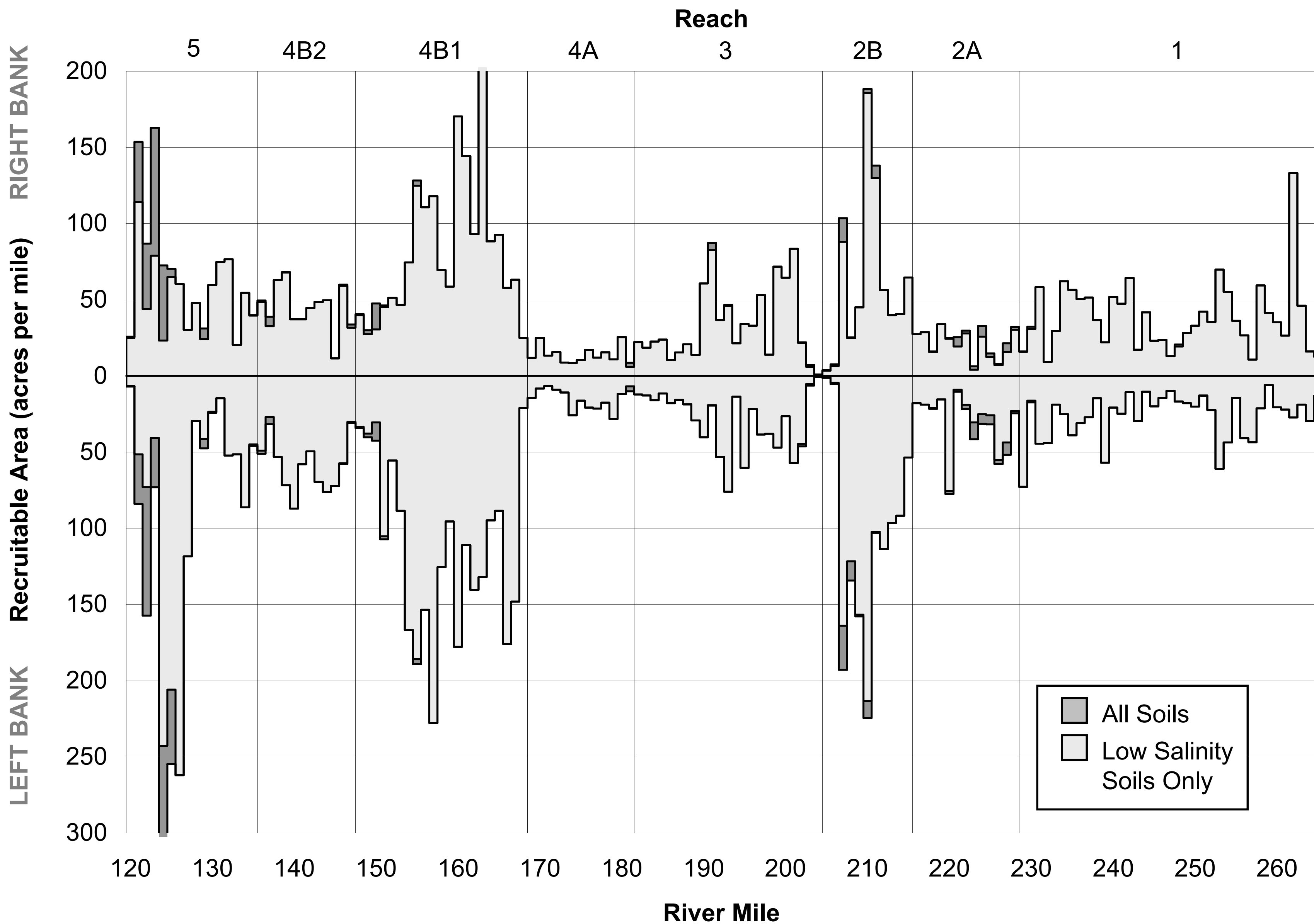


**Figure 7-13. Potential recruitable area of woody riparian vegetation by mile for all soils and low salinity soils only for a hypothetical wet water year hydrograoph under Strategy 3.**

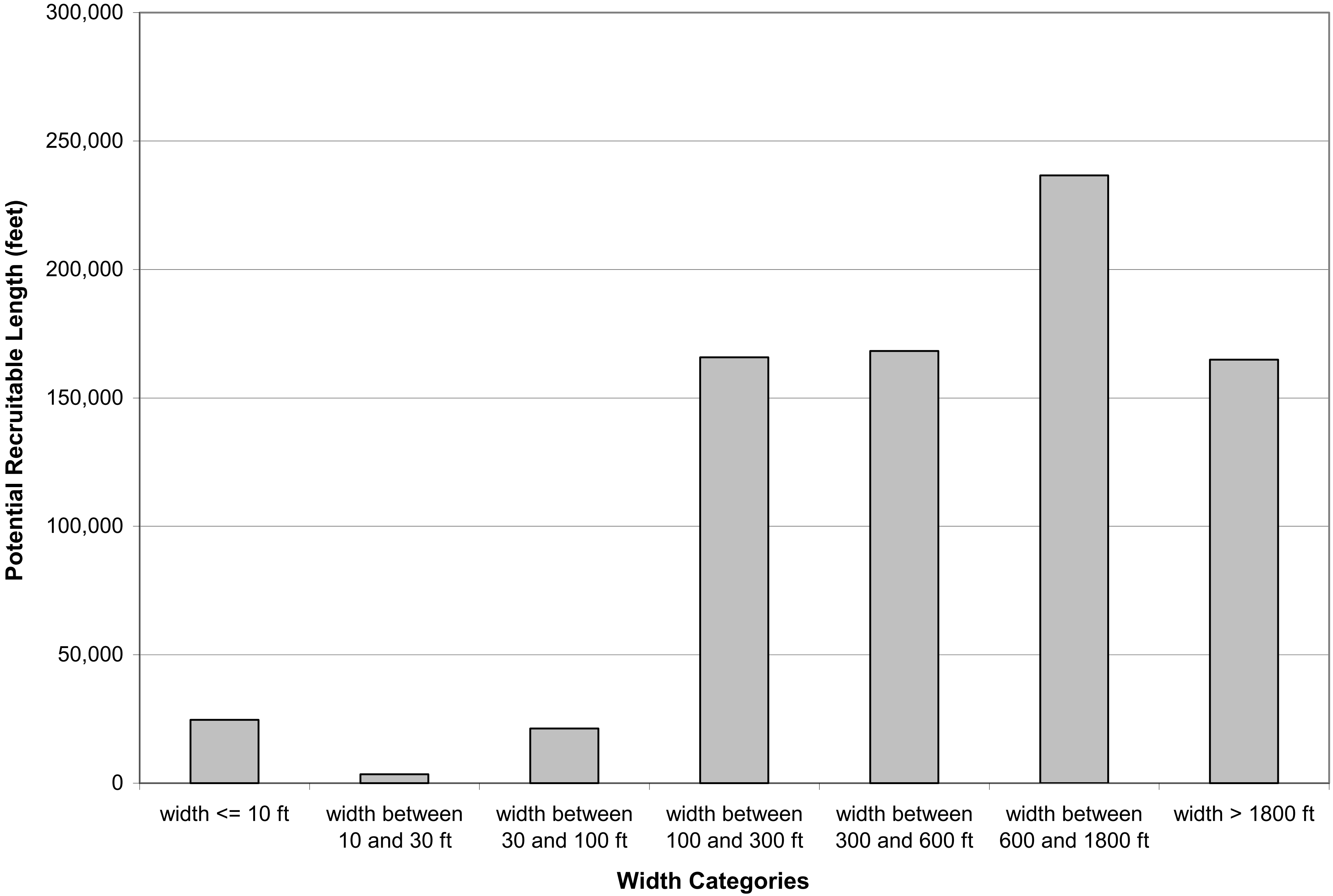


**Figure 7-14. Total length of potential recruitable woody riparian vegetation in different width categories for all reaches combined for a hypothetical wet water year hydrograph under Strategy 3.**