

RECLAMATION

Managing Water in the West

Compact Bypass Channel Design and Revegetation

Presented by: Rebecca Kallio, P.E.
Hydraulic Engineer
Reclamation Sedimentation and River Hydraulic Group
Technical Service Center, Denver, CO
rkallio@usbr.gov

In collaboration with:
Blair Greimann, PhD, P.E. Reclamation: TSC
Scott O'Meara, PhD, Reclamation: TSC



U.S. Department of the Interior
Bureau of Reclamation

SAN JOAQUIN RIVER
RESTORATION PROGRAM



Outline



Compact Bypass Channel Design

- Hydraulic Modeling
- Sediment Transport Modeling
- Bed and Bank Erosion Protection



Revegetation

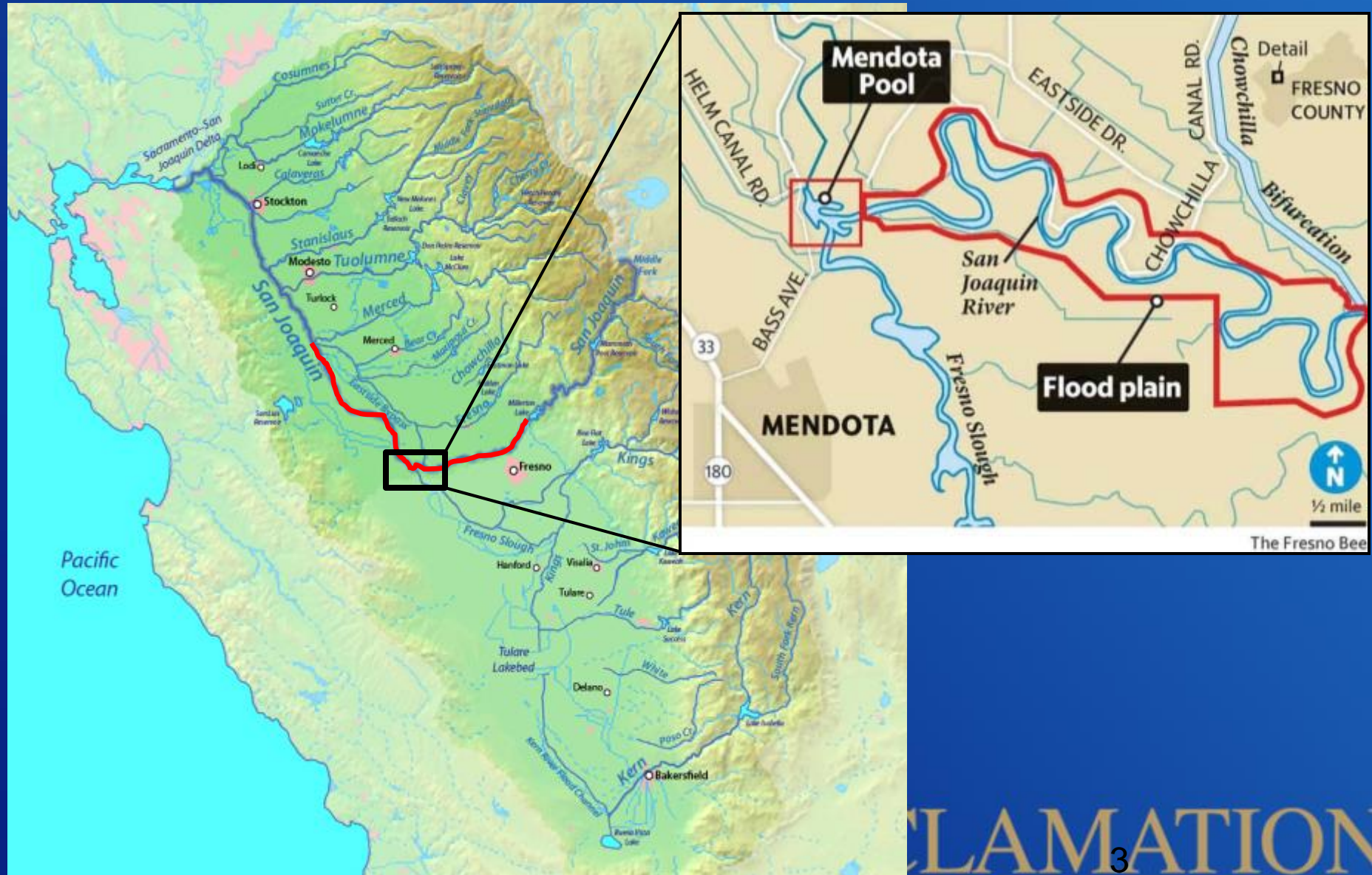
- Site conditions
- Planting Zones
- Species Selection
- Monitoring



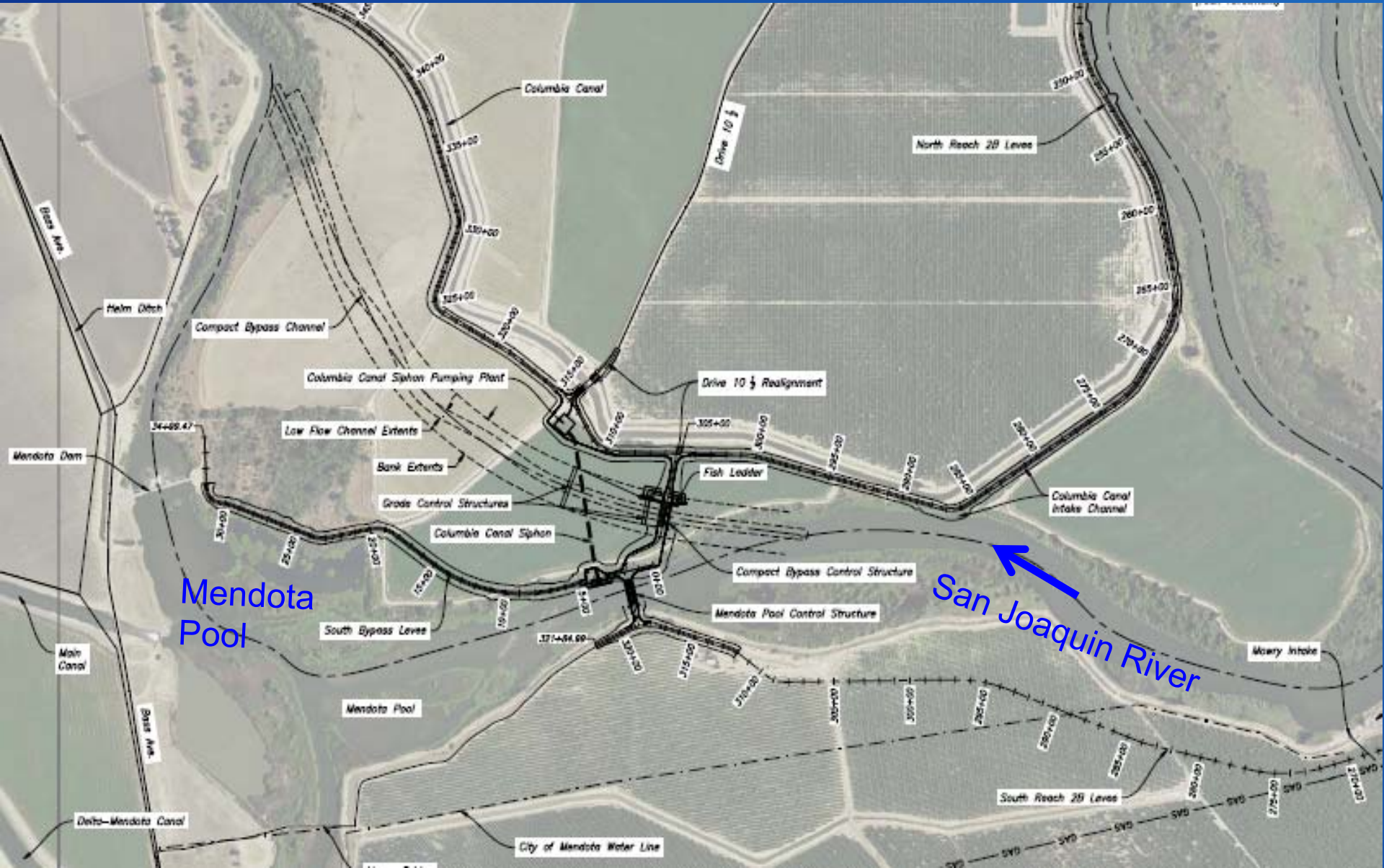
Irrigation

- Water Demand & Schedule
- Design

SJRRP Project Area

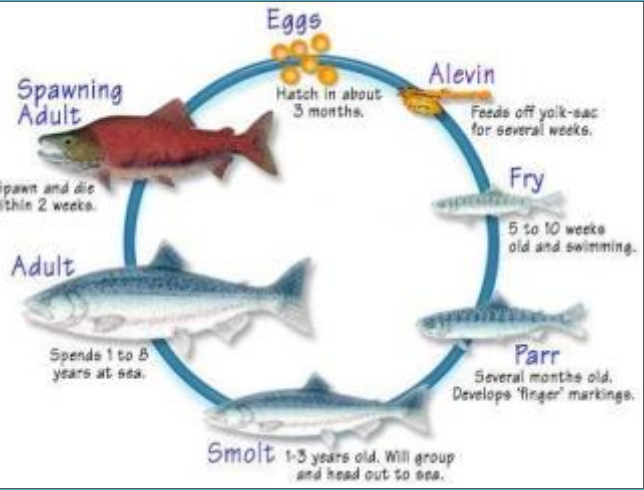


Passage: The Mendota Pool Bypass Project



Design Criteria

2. Promote survival of the species through development of appropriate and sustainable habitat.



1. Pass all life stages of Chinook salmon, pass sturgeon and pass other native species upstream and downstream through the Mendota Bypass project area.
<http://www.wildpacificsalmon.com/>



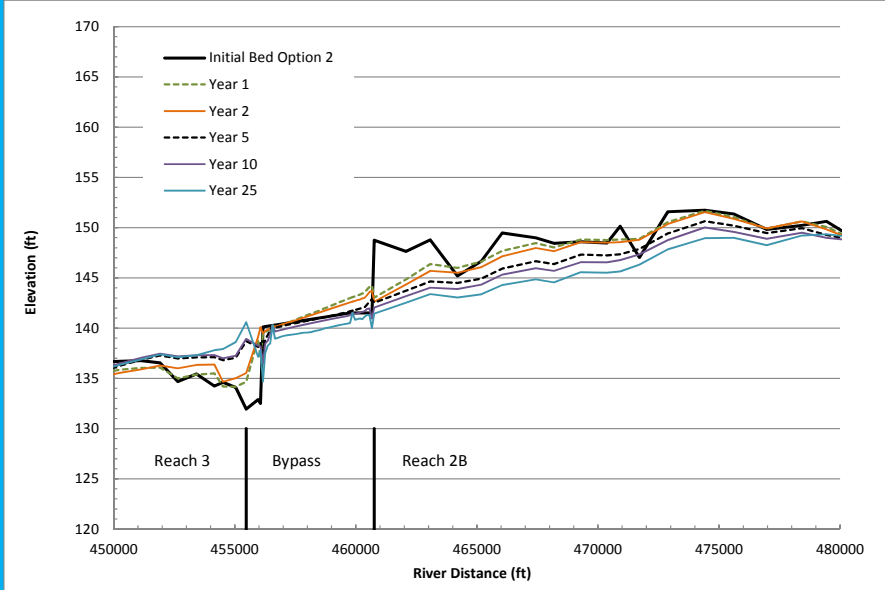
3. Create a bypass channel around Mendota Pool to ensure conveyance 4,500 cfs through Reach 2B to Reach 3. Construction of a structure that directs flow down the bypass. Secretary can make deliveries of San Joaquin River water into Mendota Pool when necessary.

4. Maintain current flood conveyance capacities in Reach 3.

6. Create a sustainable stream profile minimizing long term sediment imbalances within the project area



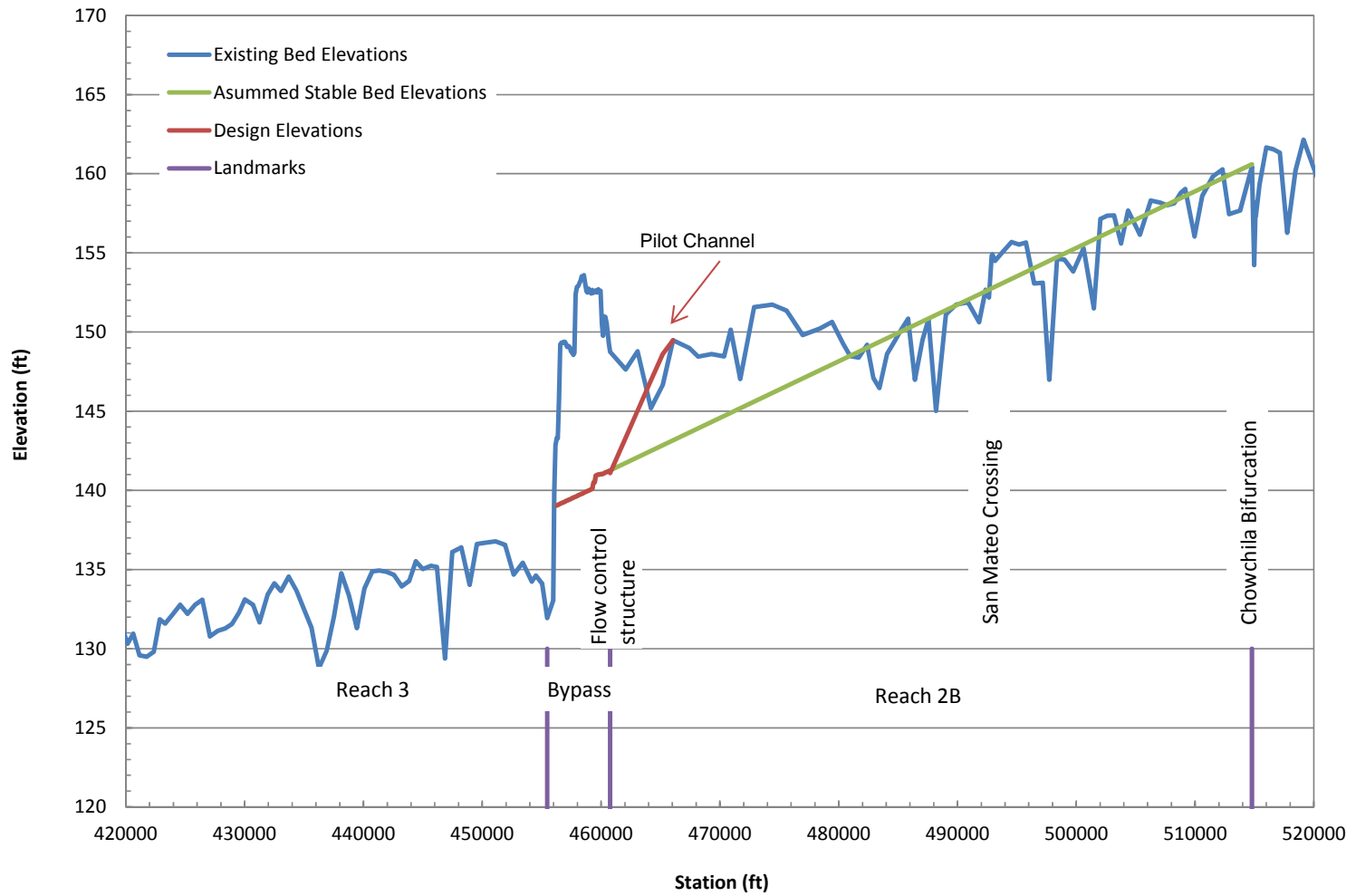
5. Minimize both construction and maintenance cost.



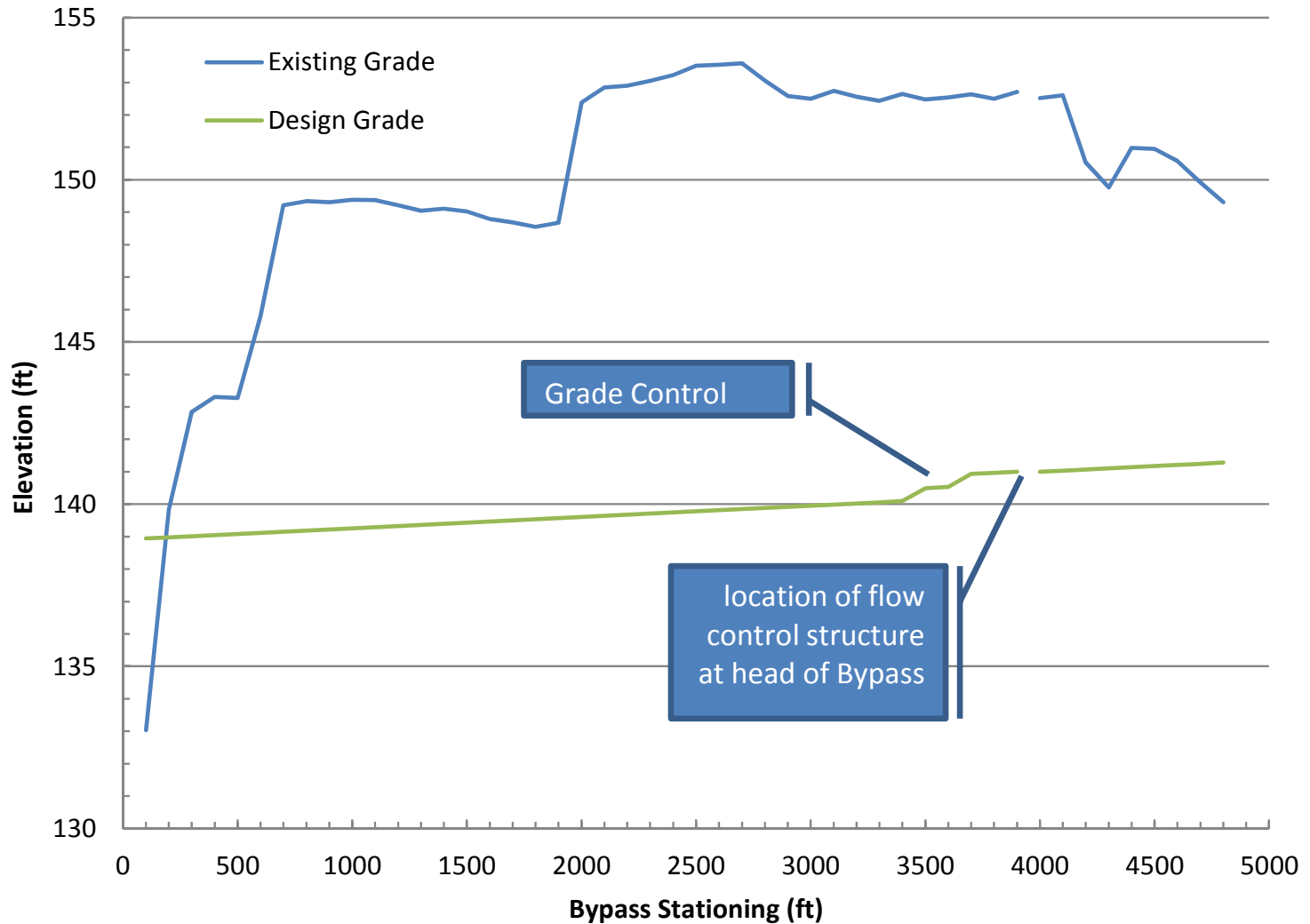
Design Criteria

- 1. Pass all life stages of Chinook salmon, pass sturgeon and pass other native species upstream and downstream through the Mendota Bypass project area.**
- 2. Promote survival of the species through development of appropriate and sustainable habitat.**
- 3. Create a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cfs through Reach 2B to Reach 3. This improvement requires construction of a structure capable of directing flow down the bypass and allowing the Secretary to make deliveries of San Joaquin River water into Mendota Pool when necessary.**
- 4. Maintain current flood conveyance capacities in Reach 3.**
- 5. Minimize both construction and maintenance cost.**
- 6. Create a sustainable stream profile that minimizes long term sediment imbalances within the project area**

Design Profiles

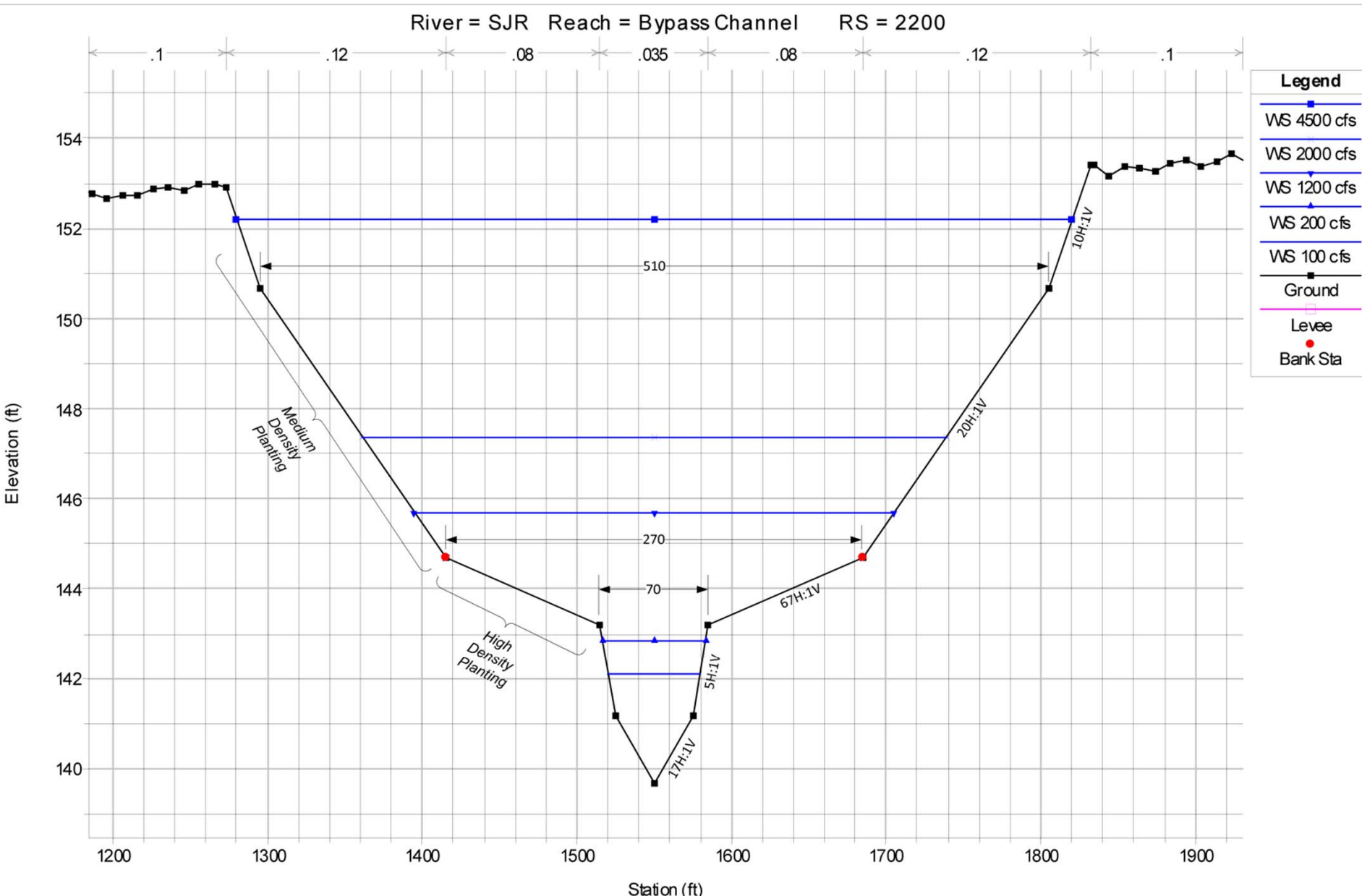


Design Profiles



Cross Section

Example Section

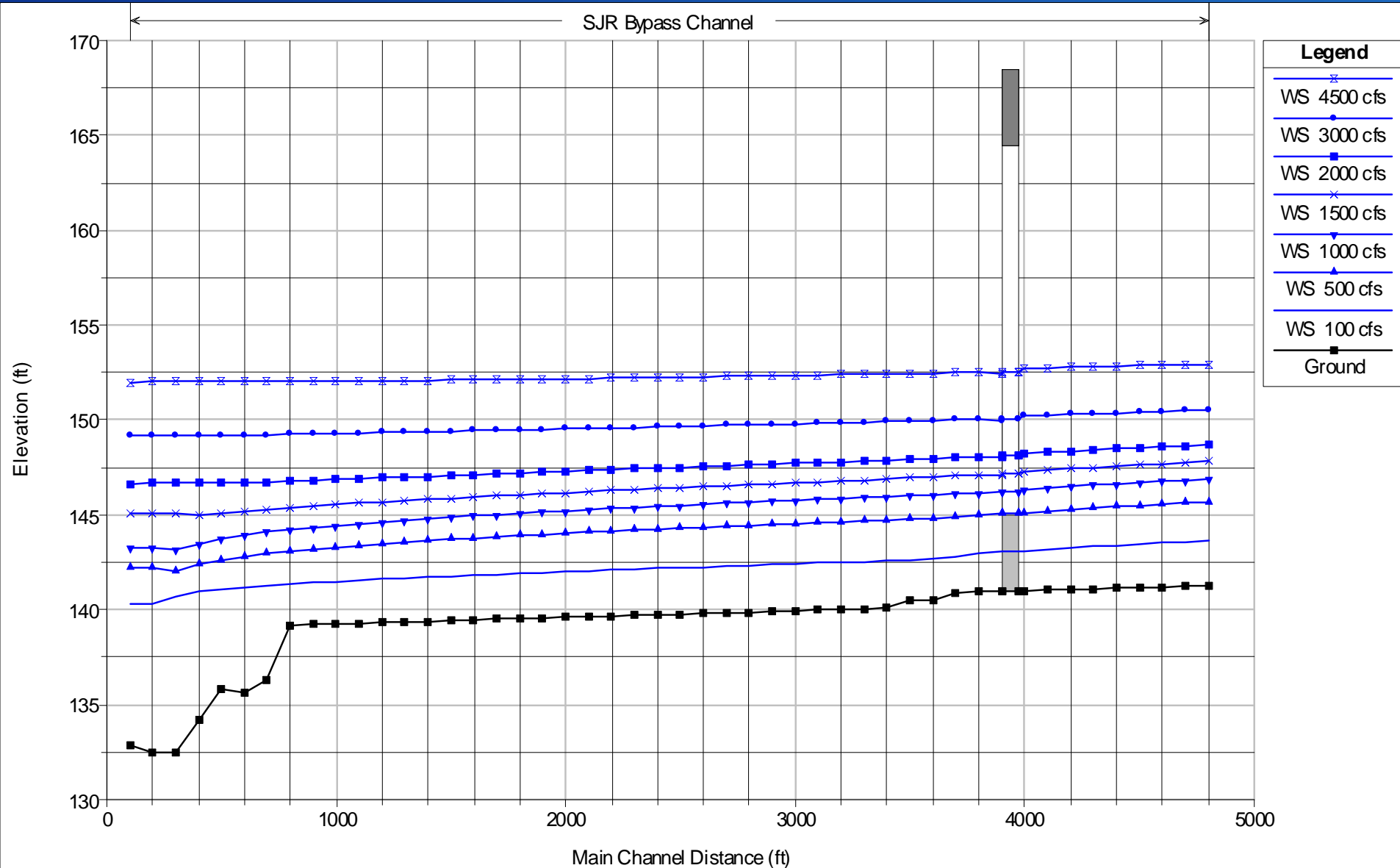


Channel Layout

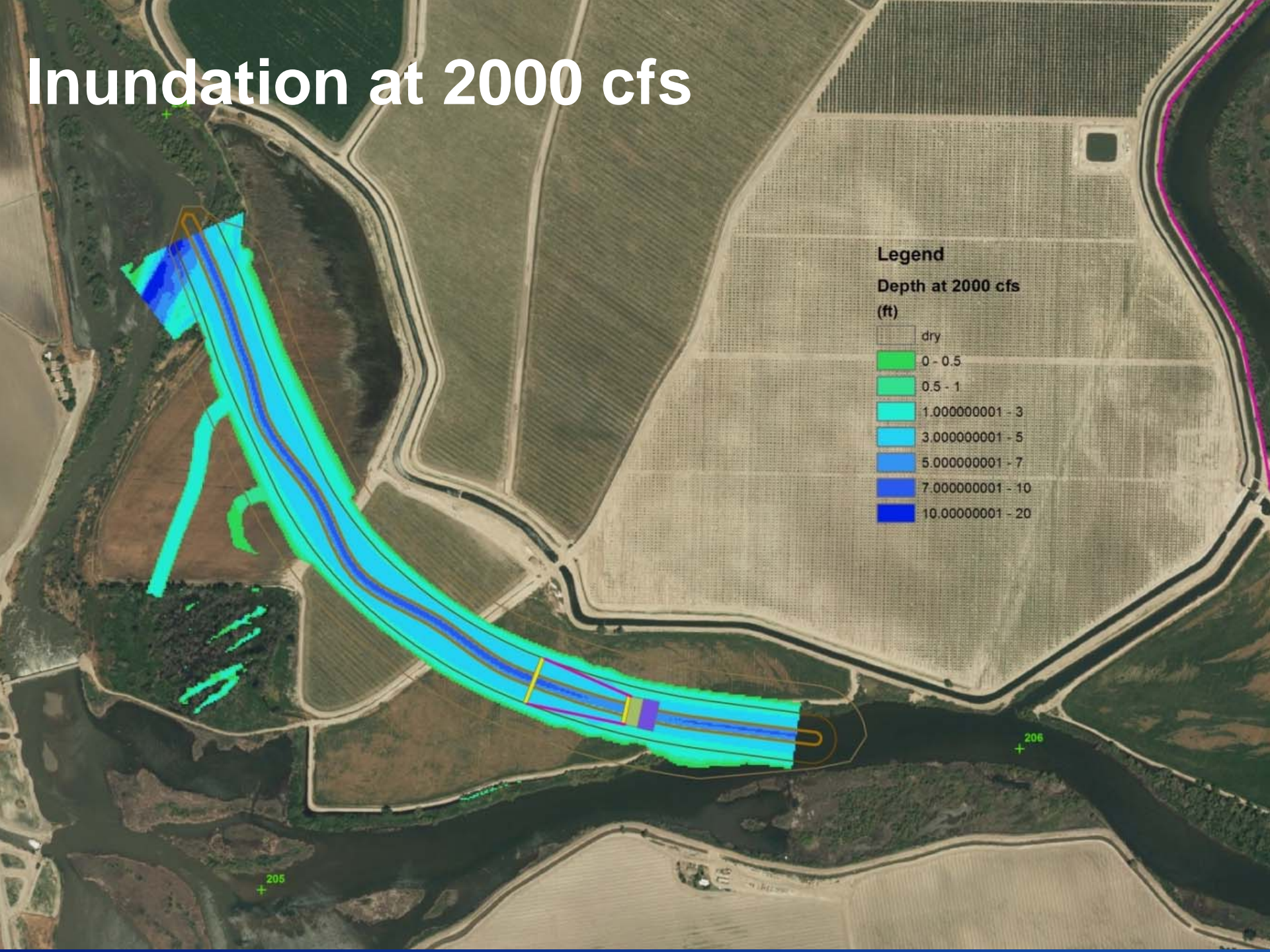


Hydraulic and Sediment Analysis

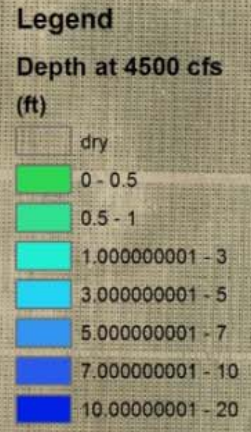
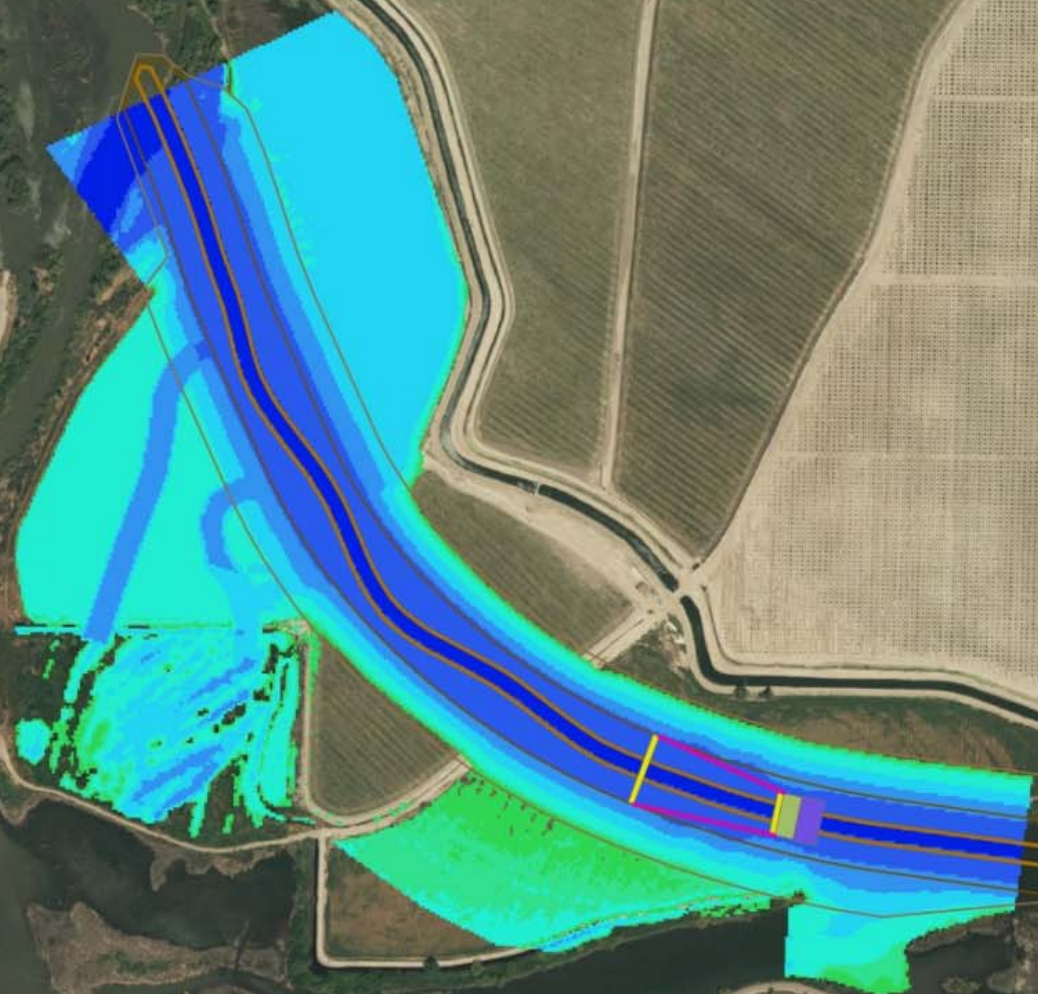
Bypass profile under Restoration Flows



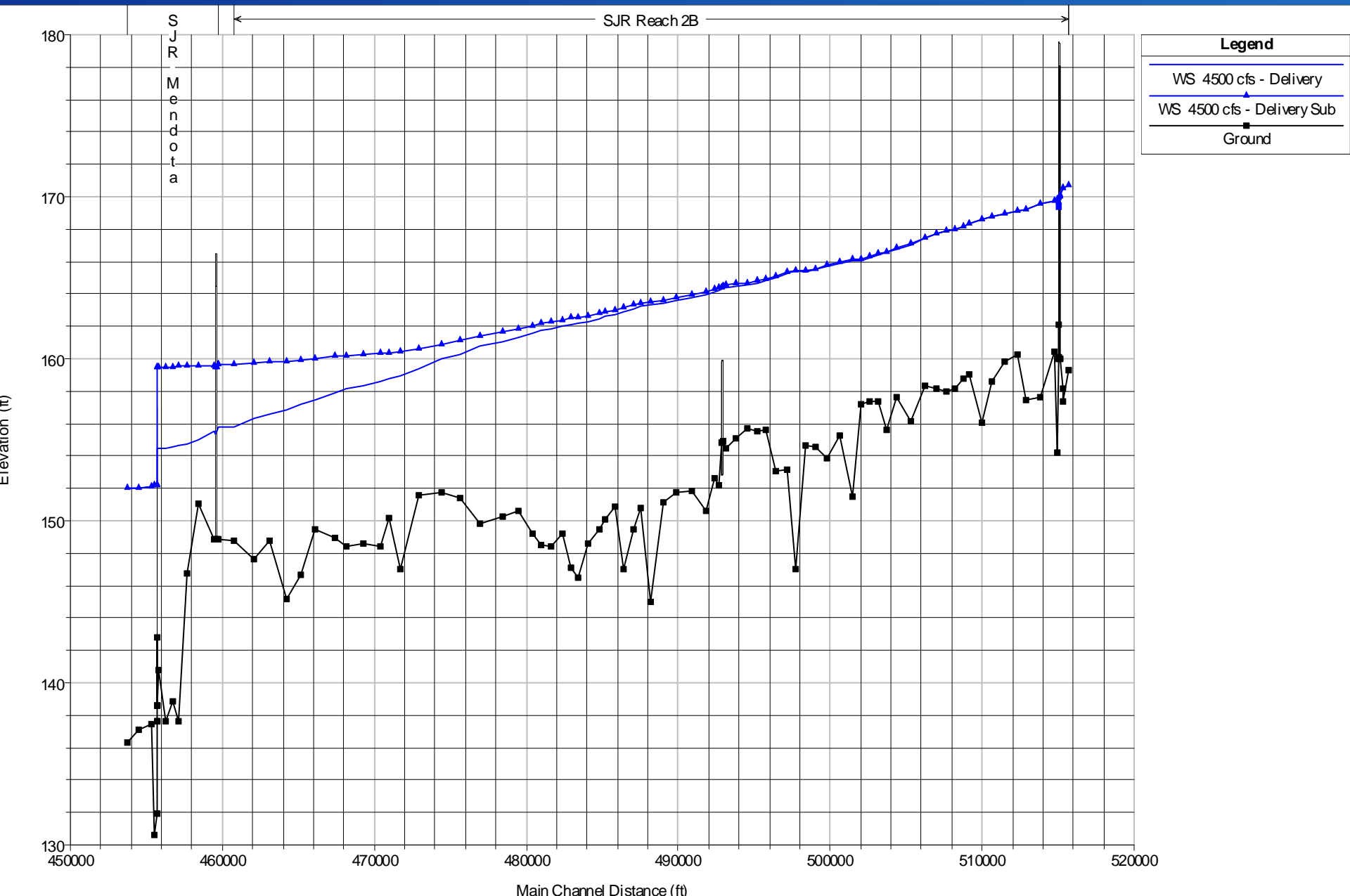
Inundation at 2000 cfs



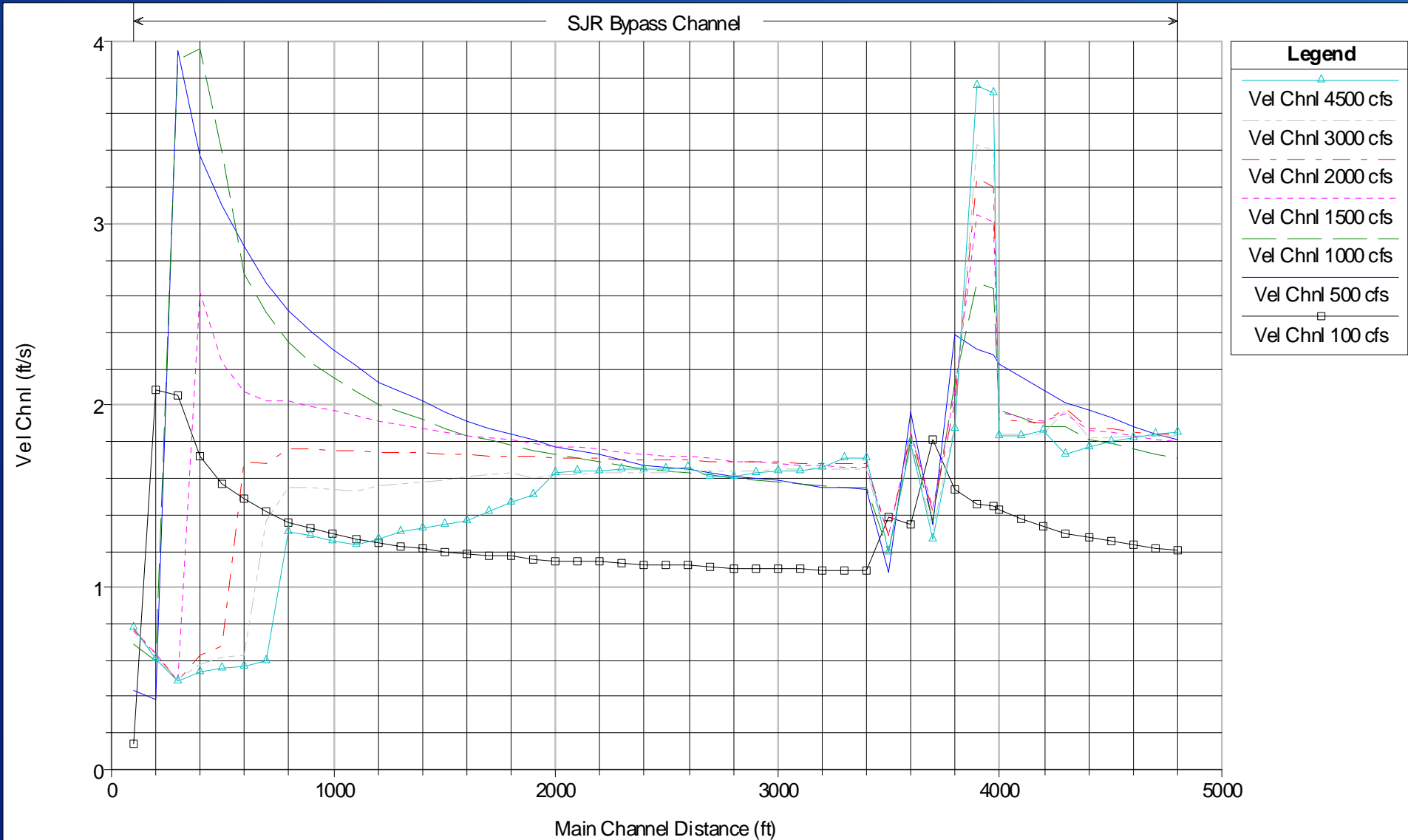
Inundation at 4500 cfs



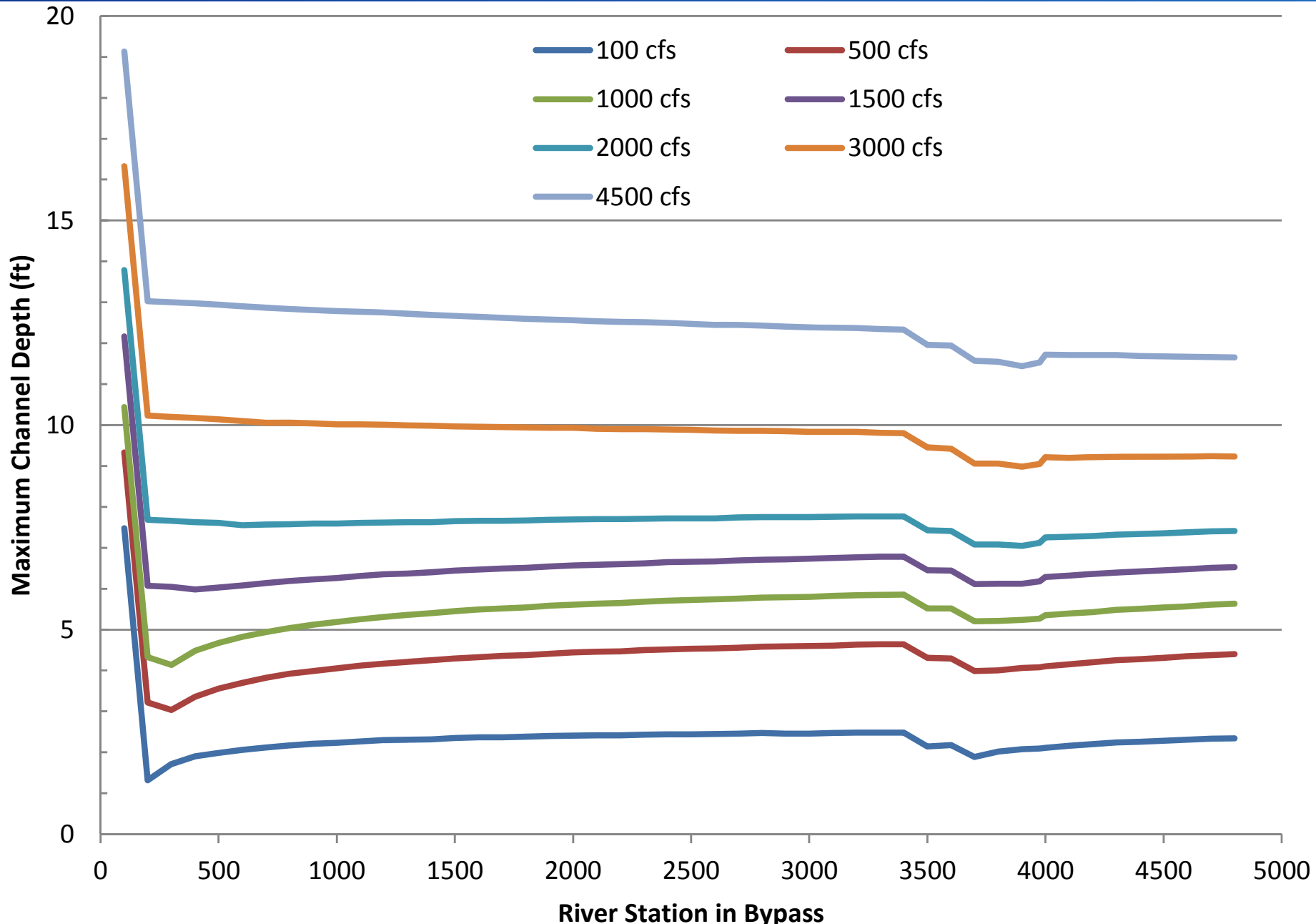
Reach 2B WSE profile under Delivery Conditions (with and with subsidence)



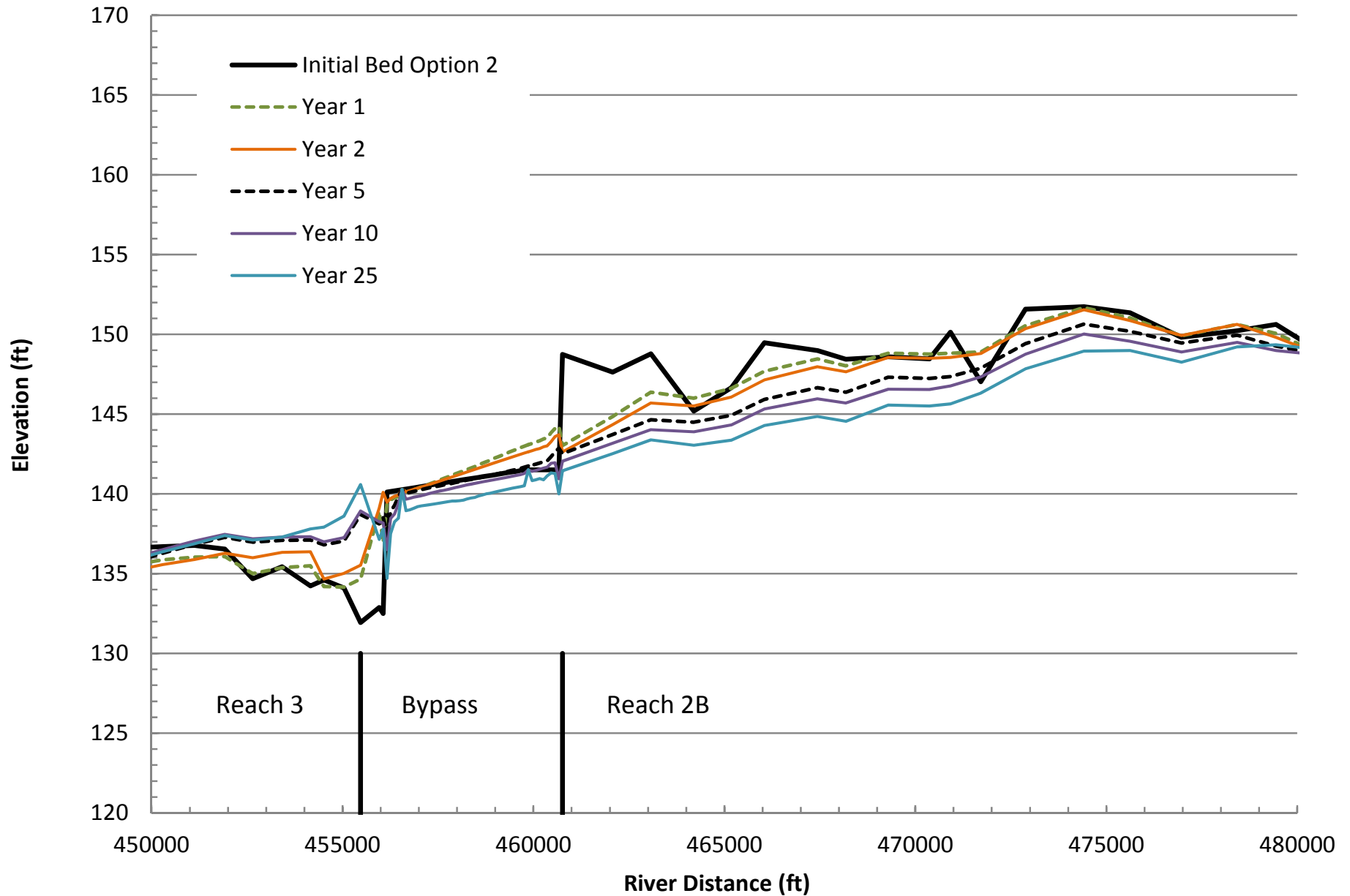
Bypass Velocities



Bypass Depths



Sediment Modeling



Bed and Bank Protection



- + SJRRP River Mile
- Bank Protection
- Control Structure
- Rock Ramp
- Stilling Basin

Description

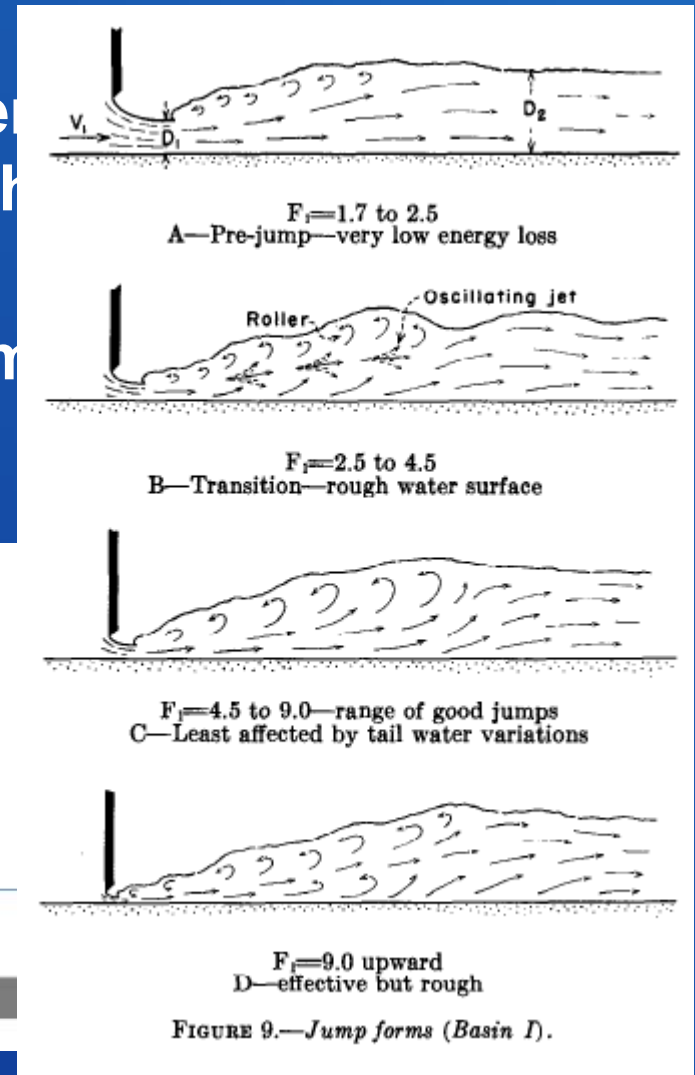
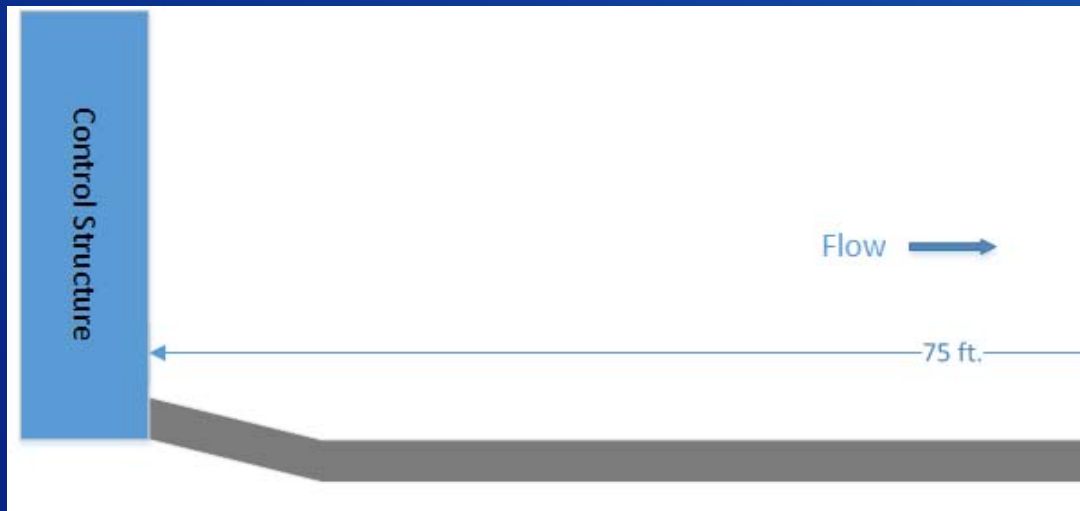
- Bankfull Channel
- Cut Extent
- Low Flow Channel

Sedimentation and River
Hydraulics Group
Technical Service Center
Bureau of Reclamation
Oct 5, 2015

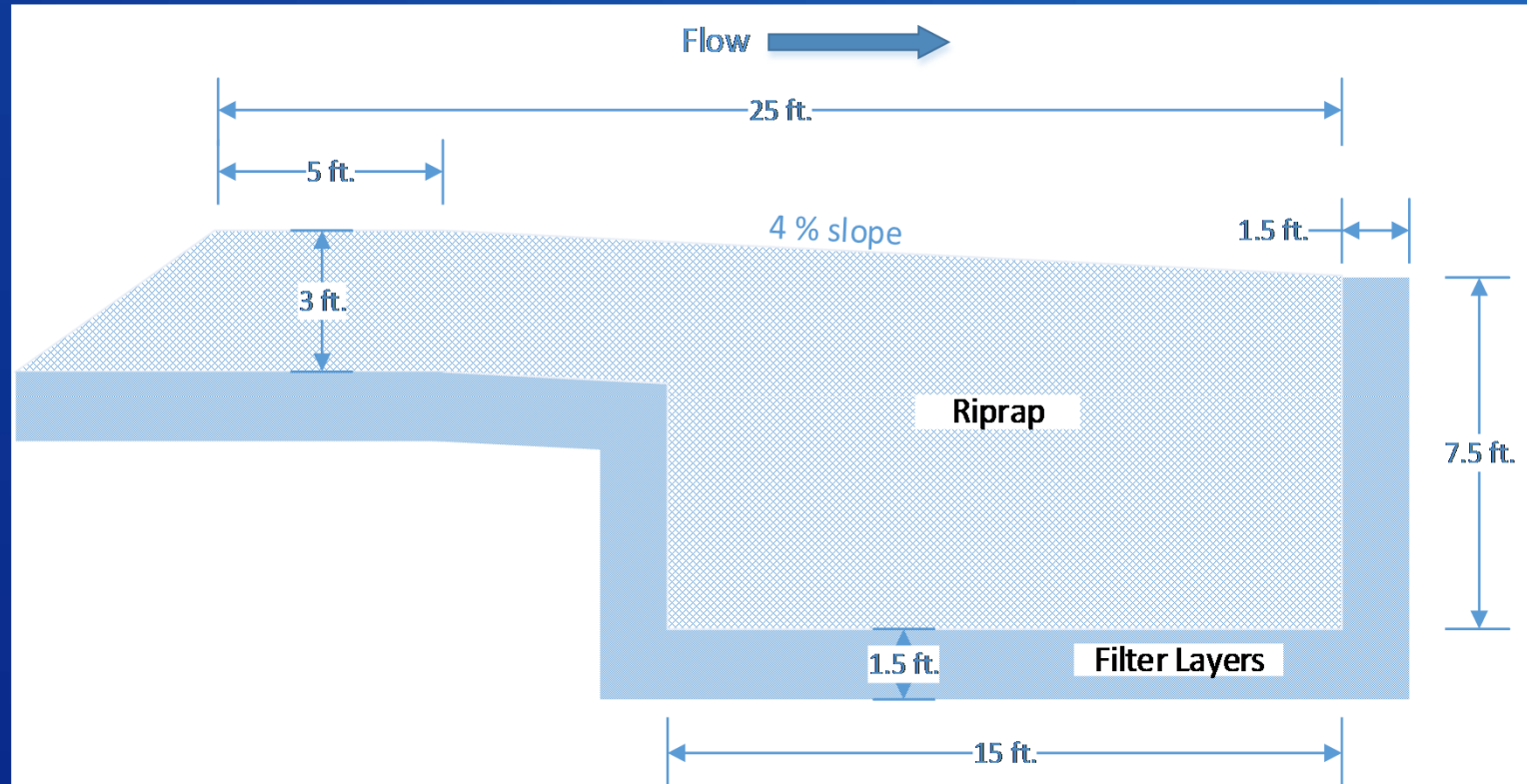
0 500 1,000
Feet

Stilling Basin

- Required to dissipate energy when gates are partially closed and high occurs through gate opening
- Concrete slab extending approximately 75 ft downstream of control structure

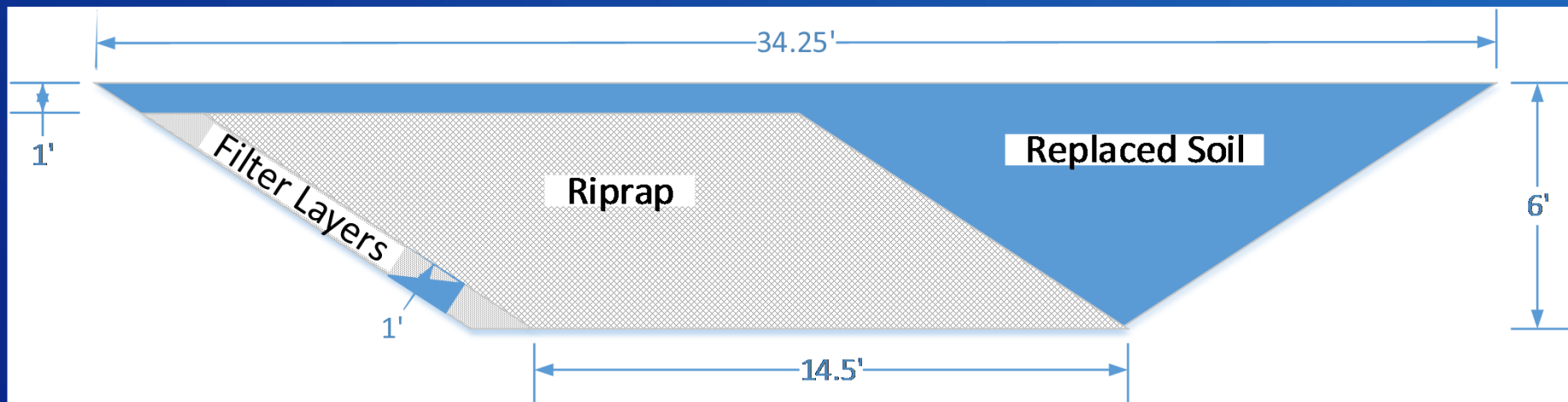


Grade Control



Class III Riprap	Percent Lighter by Weight						
	15		50		85		100
	Min	Max	Min	Max	Min	Max	Min
Weight (lb)	32	93	120	210	310	510	1100
Equivalent Diameter (in)	7.3	10.5	11.5	14	15.5	18.5	24

Bank Protection: rock filled trench



Class III Riprap	Percent Lighter by Weight						
	15		50		85		100
	Min	Max	Min	Max	Min	Max	Min
Weight (lb)	32	93	120	210	310	510	1100
Equivalent Diameter (in)	7.3	10.5	11.5	14	15.5	18.5	24

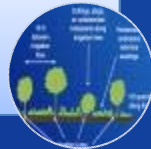
Revegetation



Site
Conditions



Planting
Zones



Monitoring
and
Maintenance

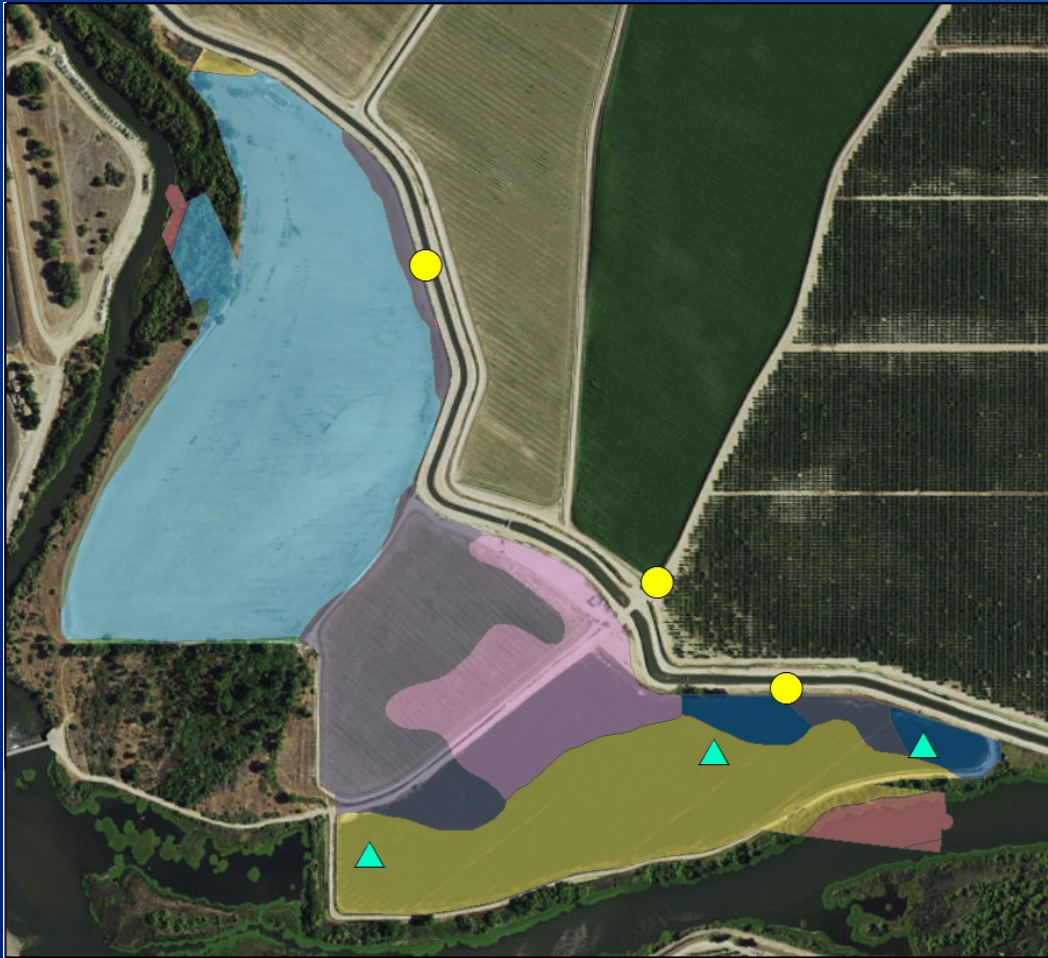


Irrigation



RECLAMATION

Site Conditions: Soils



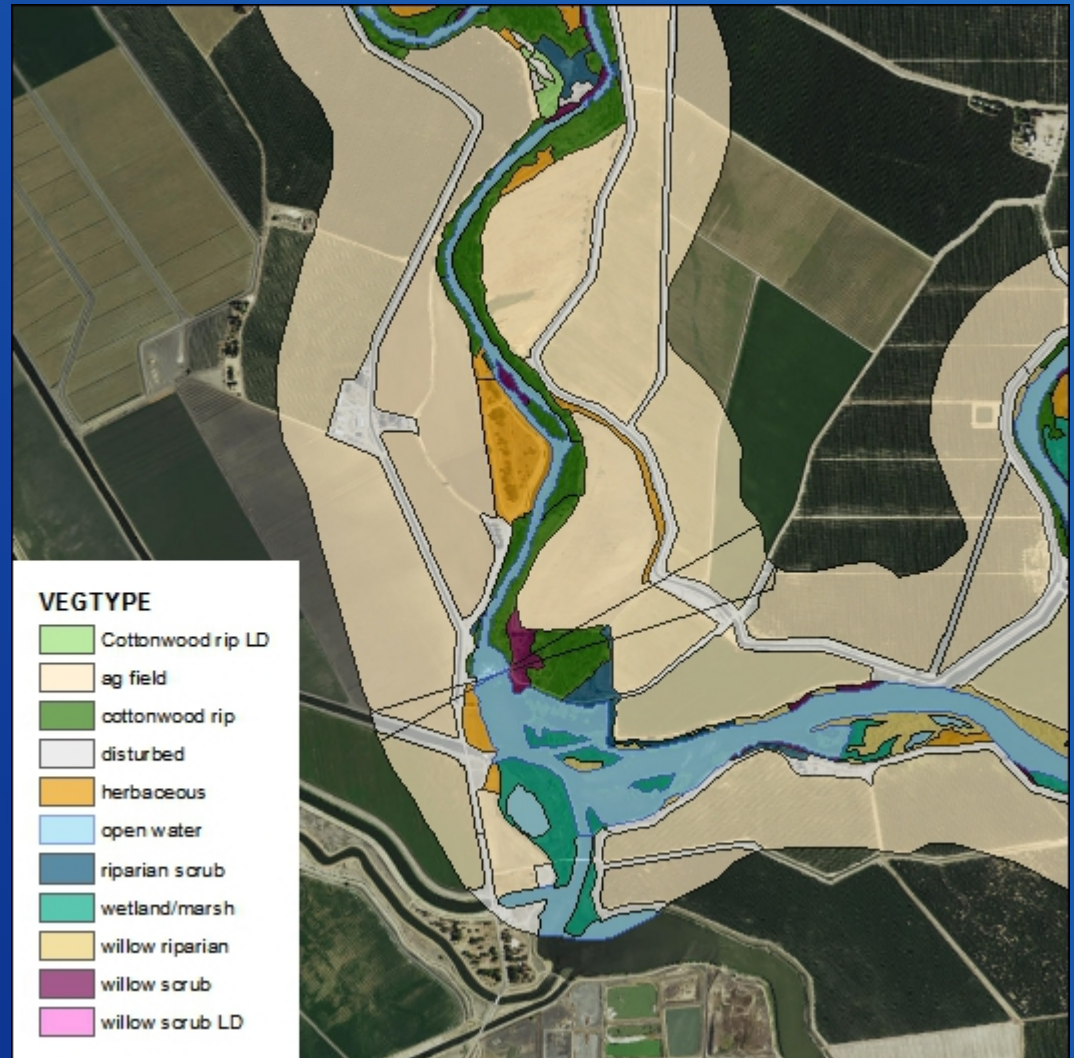
- Chino loam slightly saline (CgaA)
- Chino loam moderately saline (CgbA)
- Columbia loamy sand (CoA)
- Grangeville fine sandy loam slightly saline (GbA)
- Wunje very fine sandy loam strongly saline (WxA)
- ▲ Field sample, 2013 Soil Salinity Monitoring Report
- Geotechnical drill hole

Vegetation

- CA bulrush marsh
- Riparian bank herbs
- Button willow thickets
- Black willow thickets
- Oregon ash groves
- Saltgrass flats
- CA mugwort brush
- Creeping wildrye grassland
- Fremont cottonwood forests

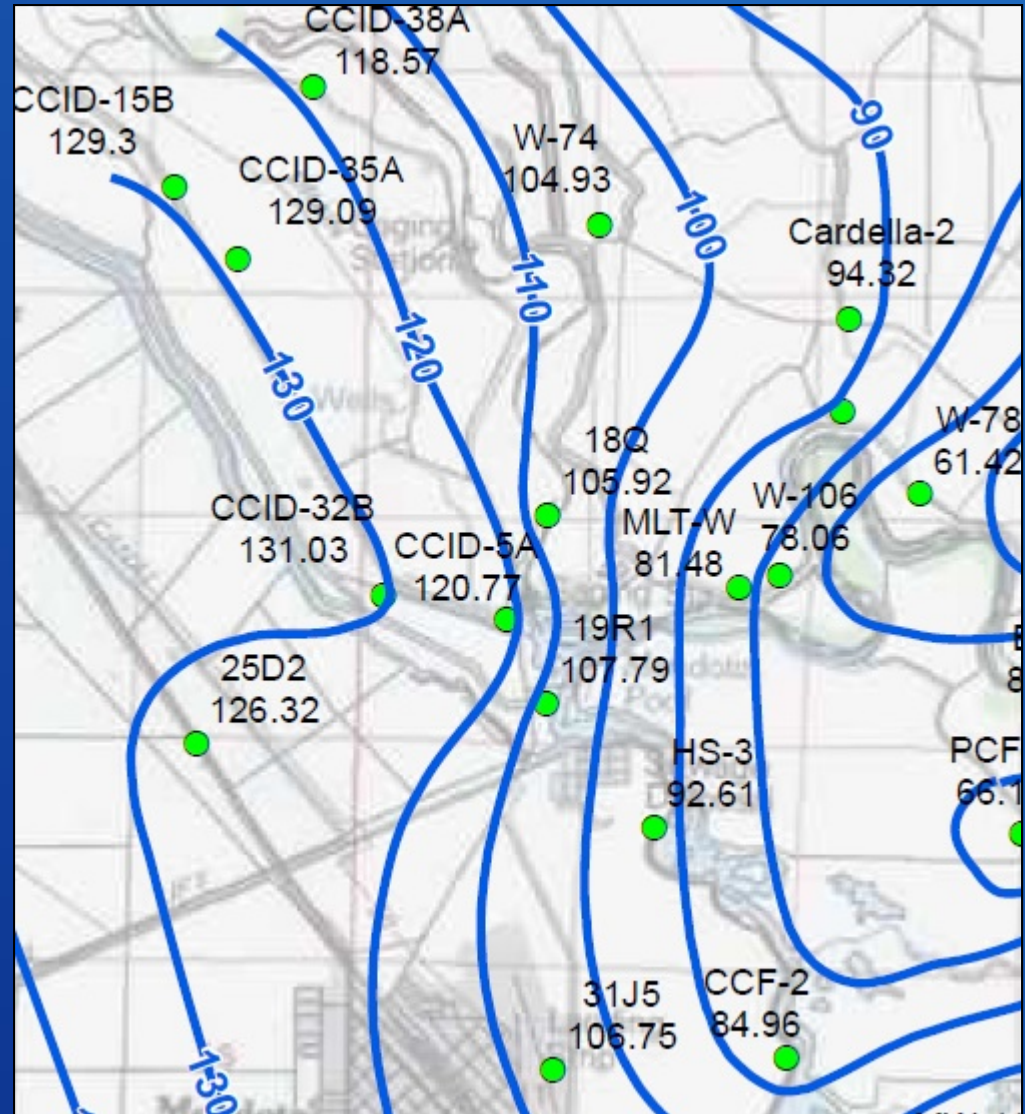
Invasives

- Giant reed
- Red sesbania
- Chinese tallow
- Edible fig
- Tamarisk



Groundwater

- Depth estimates 1 to 50 ft. from excavated Bypass
- Excavation and flows through Bypass will alter groundwater
- Summer baseflow elevation ~ 10-15 ft. from highest riparian zones



Summer 2010 (MPG 2011)

RECLAMATION

Revegetation: Site Preparation

- Top 12-18 inches of topsoil should be scraped and stockpiled, then replaced on the excavated bypass at the completion of the construction phase

Planting Materials

- Two year lead time to obtain sufficient stock
- Local sources generally provide higher establishment rates

Planting Zones

Two year lead time to obtain sufficient stock. Local sources generally provide higher establishment rates

High-Density Riparian (21.9 acres)

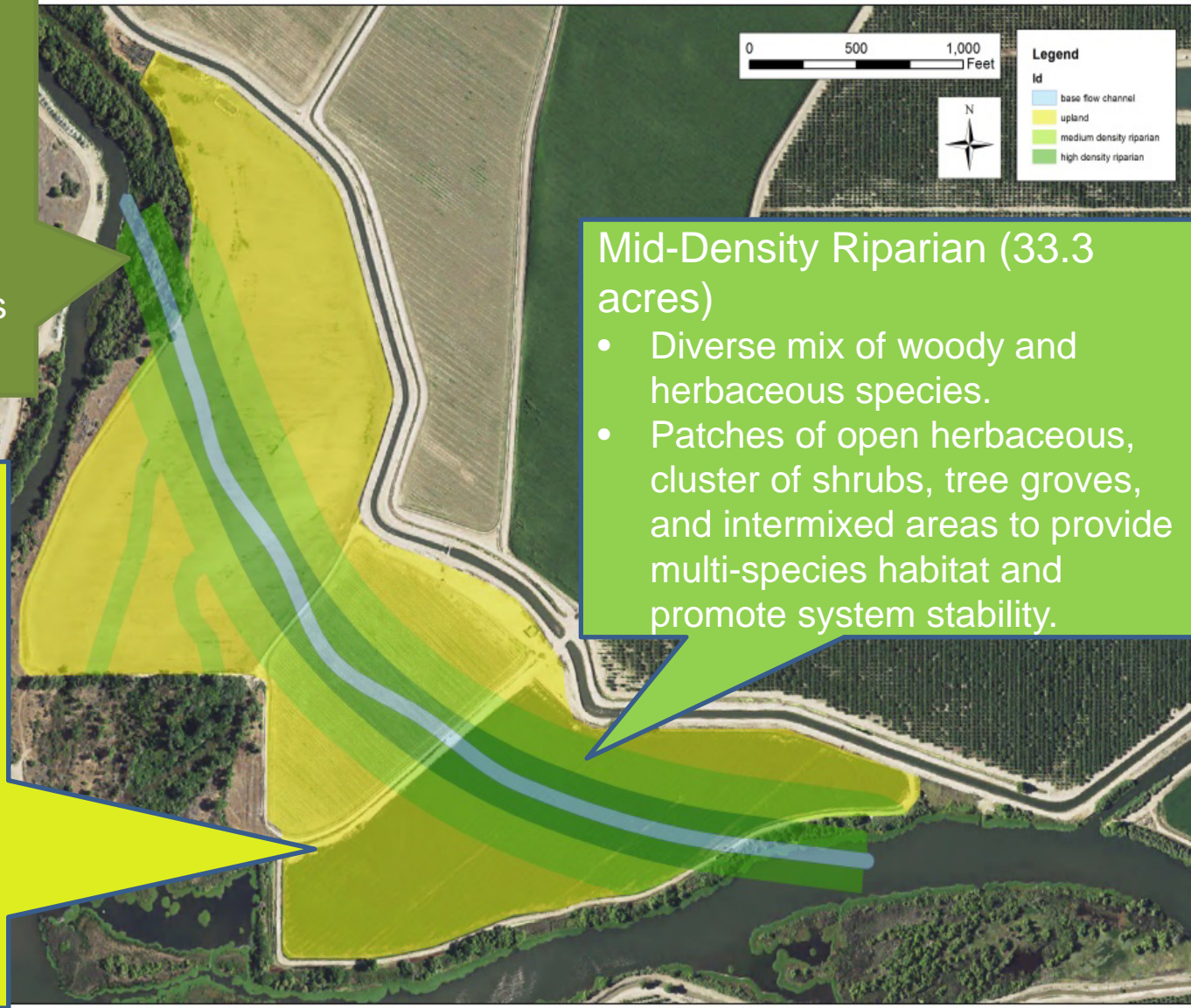
- Heavily planted woody species to max shading & habitat. Competitive understory to facilitate diverse species influx as the community matures.

Upland (72.3 acres)

- Seeded with herbaceous; some woody species. No irrigation.
- Stabilize soils, prohibits weed infestations, and provides some habitat components.
- Further modification of plantings in this zone for secondary species habitat under consideration.

Mid-Density Riparian (33.3 acres)

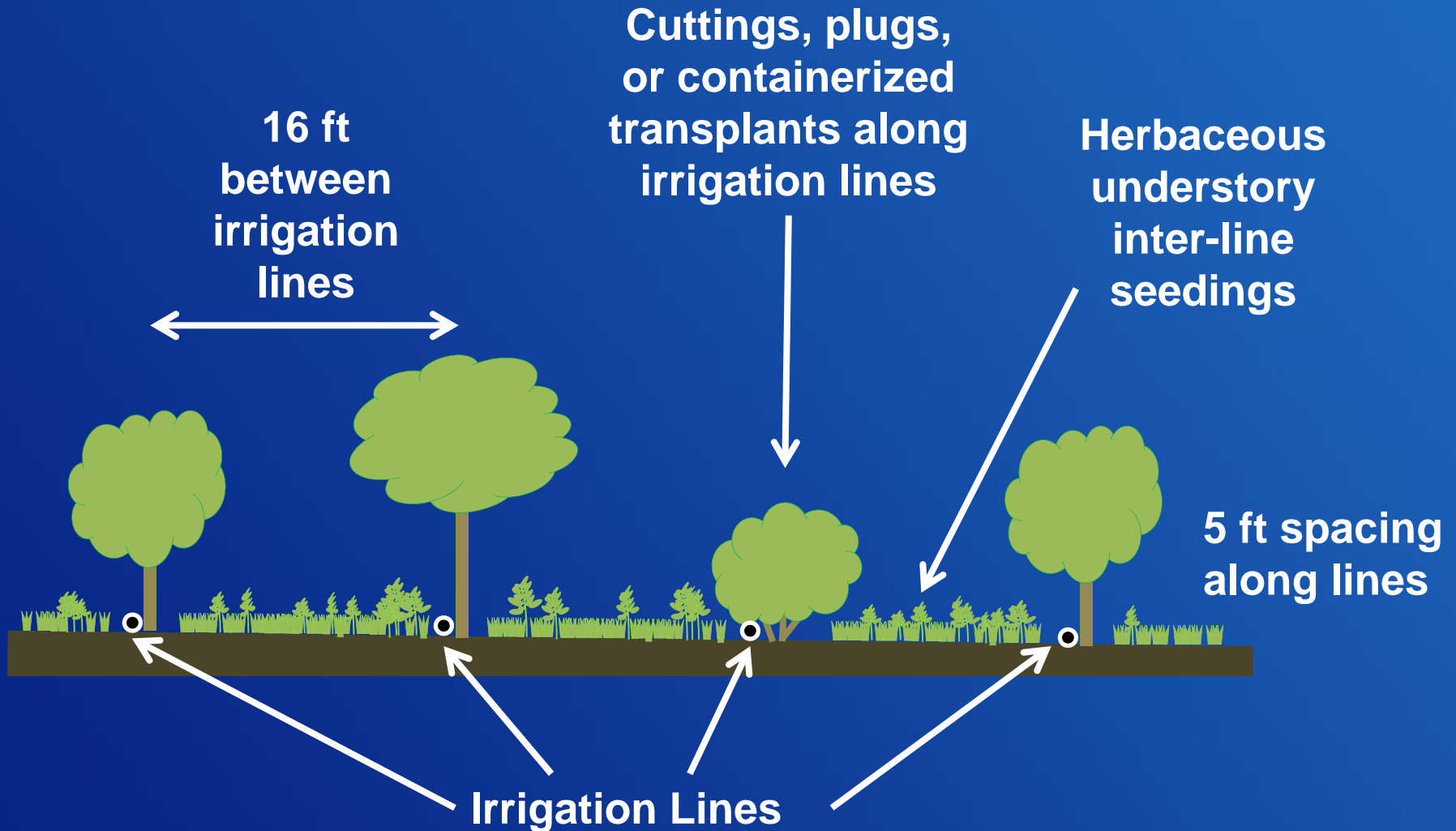
- Diverse mix of woody and herbaceous species.
- Patches of open herbaceous, cluster of shrubs, tree groves, and intermixed areas to provide multi-species habitat and promote system stability.



Planting Zones

- 1 - High-Density Riparian - 0-2 ft above summer baseflow elevations (21.9 acres)
 - Heavily planted with woody species to maximize shading and habitat components.
 - Competitive understory to facilitate diverse species influx as the community matures.
- 2 - Mid-Density Riparian - 2-8 ft above summer baseflow elevations (33.3 acres)
 - Diverse mix of woody and herbaceous species.
 - Various patches of open herbaceous, cluster of shrubs, tree groves, and intermixed areas to provide multi-species habitat and promote system stability.
- 3 - Upland - >8 ft above summer baseflow elevations (72.3 acres)
 - Primarily seeded with herbaceous; minor component of woody species.
 - Will not receive irrigation.
 - Stabilizes soils, prohibits weed infestations, and provides some habitat components.
 - Further modification of plantings in this zone for secondary species habitat under consideration.

Planting Layout: Zones 1 and 2 (irrigated)



Medium Density Riparian

Common Name	Scientific Name	Veg Type	Composition (%)	Density (plants/acre)	Total Plants
creeping wildrye	<i>Elymus triticoides</i>	Grass	15	83	2,764
red willow	<i>Salix laevigata</i>	Tree	10	55	1,832
shining willow	<i>Salix lasiandra</i> var. <i>lasiandra</i>	Tree	10	55	1,832
arroyo willow	<i>Salix lasiolepis</i>	Shrub	10	55	1,832
box elder	<i>Acer negundo</i>	Tree	5	27	899
narrow-leafed milkweed	<i>Asclepias fascicularis</i>	Herb	5	27	899
coyote brush	<i>Baccharis pilularis</i>	Shrub	5	27	899
buttonbush	<i>Cephalanthus occidentalis</i>	Shrub	5	27	899
blue wildrye	<i>Elymus glaucus</i>	Grass	5	27	899
valley oak	<i>Quercus lobata</i>	Tree	5	27	899
golden currant	<i>Ribes aureum</i>	Shrub	5	27	899
California wildrose	<i>Rosa californica</i>	Shrub	5	27	899
California blackberry	<i>Rubus ursinus</i>	Shrub	5	27	899
Gooding's willow	<i>Salix gooddingii</i>	Tree	5	27	899
blue elderberry	<i>Sambucus nigra</i> ssp. <i>caerulea</i>	Shrub	5	27	899

Species Selection: High Density Riparian

Common Name	Scientific Name	Veg Type	Composition (%)	Density (plants/acre)	Total Plants
Fremont cottonwood	<i>Populus fremontii</i>	Tree	15	82	1,796
Gooding's willow	<i>Salix gooddingii</i>	Tree	15	82	1,796
box elder	<i>Acer negundo</i>	Tree	10	55	1,205
Oregon ash	<i>Fraxinus latifolia</i>	Tree	10	55	1,205
red willow	<i>Salix laevigata</i>	Tree	10	55	1,205
yerba mansa	<i>Anemopsis californica</i>	Forb	5	27	591
common buttonbrush	<i>Cephalanthus occidentalis</i>	Shrub	5	27	591
baltic rush	<i>Juncus balticus</i>	Tule	5	27	591
California blackberry	<i>Rubus ursinus</i>	Shrub	5	27	591
sandbar willow	<i>Salix exigua</i>	Shrub	5	27	591
arroyo willow	<i>Salix lasiolepis</i>	Shrub	5	27	591
shining willow	<i>Salix lucida ssp. Lasiandra</i>	Tree	5	27	591
blue elderberry	<i>Sambucus nigra ssp. caerulea</i>	Shrub	5	27	591

Understory in High and Mid Density Riparian

Common Name	Scientific Name	Veg Type	Composition (%)	PLS*/acre (lb.)	Total PLS* (lb.)
meadow barley	<i>Hordeum brachyantherum</i>	Grass	40	25	624.0
creeping wildrye	<i>Elymus triticoides</i>	Grass	30	10	187.2
dwarf barley	<i>Hordeum depressum</i>	Grass	30	25	468.0
Douglas' sagewort	<i>Artemisia douglasiana</i>	Forb	30	2	37.4
Great Valley gumweed	<i>Grindelia camporum</i>	Forb	40	2	49.9
Western goldenrod	<i>Euthamia occidentalis</i>	Forb	30	0.5	9.4

Upland

Planted

Common Name	Scientific Name	Veg Type	Composition (%)	Density (plants/acre)	Total Plants
creeping wildrye	<i>Elymus triticoides</i>	Grass	15	41	2,964
narrow-leaved milkweed	<i>Asclepias fascicularis</i>	Forb	5	14	1,012
valley oak	<i>Quercus lobata</i>	Tree	5	14	1,012
golden currant	<i>Ribes aureum</i>	shrub	5	14	1,012
California wildrose	<i>Rosa californica</i>	shrub	5	14	1,012

Seeded

Common Name	Scientific Name	Veg Type	Composition (%)	PLS*/acre (lb.)	Total PLS* (lb.)
quail bush	<i>Atriplex lentiformis</i>	Forb	10	9	65
western goldenrod	<i>Euthamia occidentalis</i>	Forb	10	0.1	1
small fescue	<i>Festuca microstachys</i>	Grass	10	1	7
purple needlegrass	<i>Stipa pulchra</i>	Grass	10	10	72
yarrow	<i>Achillea millefolium</i>	Forb	5	0.5	2
Spanish lotus	<i>Acemison americanus var. americanus</i>	Forb	5	5	18
Great Valley gumweed	<i>Grindelia camporum</i>	Forb	5	0.5	2
telegraph weed	<i>Heterotheca grandiflora</i>	Forb	5	4	15
tomcat clover	<i>Trifolium willdenovii</i>	Forb	5	0.5	2

Planting implementation

- **Cuttings, plugs, and transplants installed by hand along irrigation lines**
- **Understory and upland broadcast seeded**
- **Follow-up re-plantings may be necessary**

Monitoring

Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Vegetation Monitoring	X	X	X		X		X			X
Final Vegetation Assessment										X

Weed Control & Herbivory

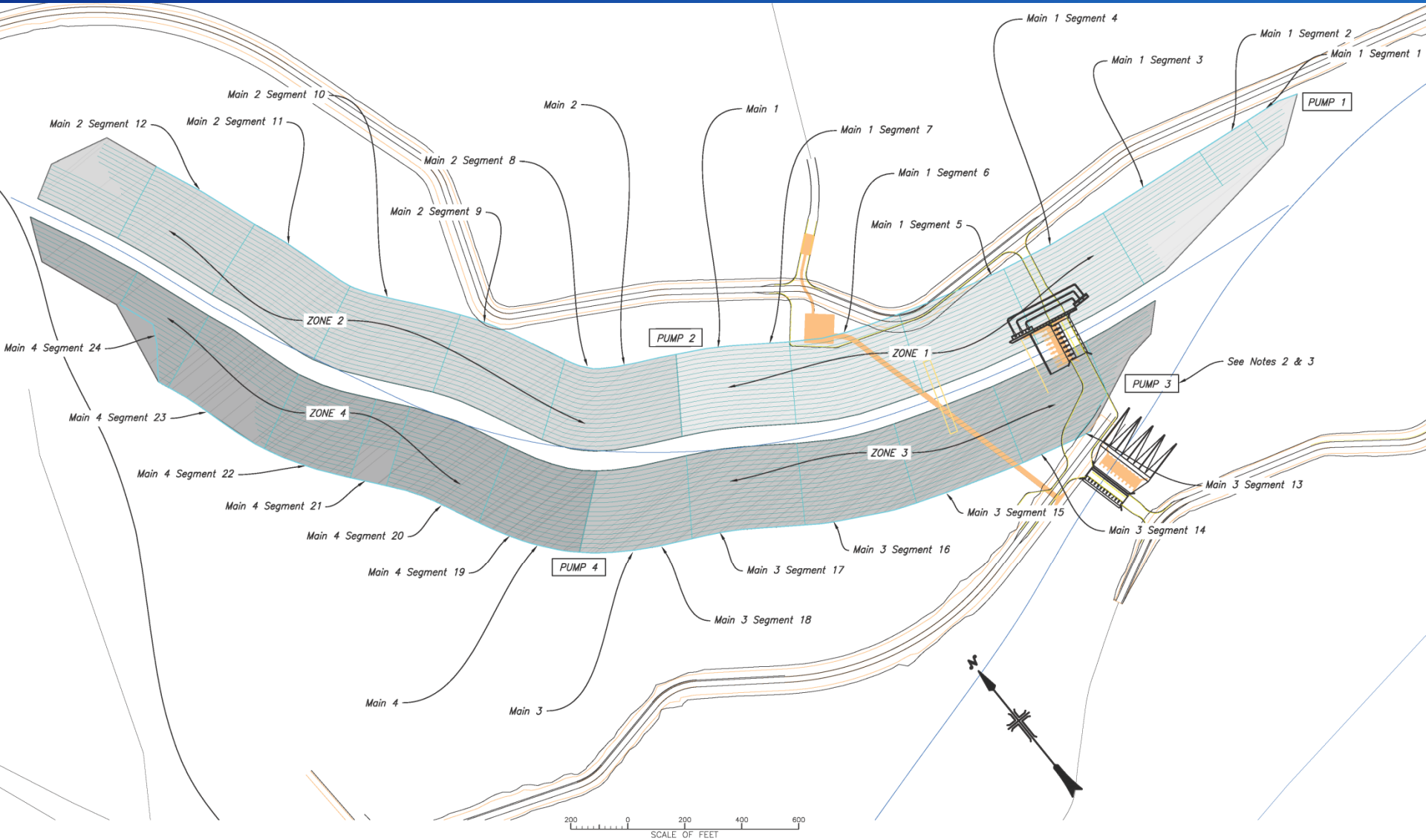
- Chemical and mechanical suppression



wildlifespecialty.com

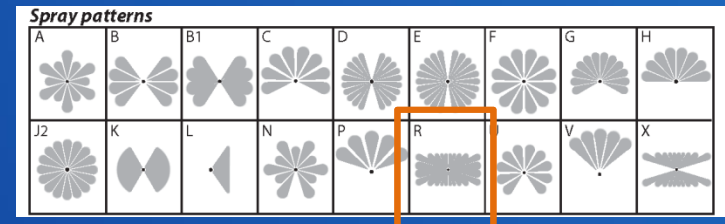
RECLAMATION

Irrigation

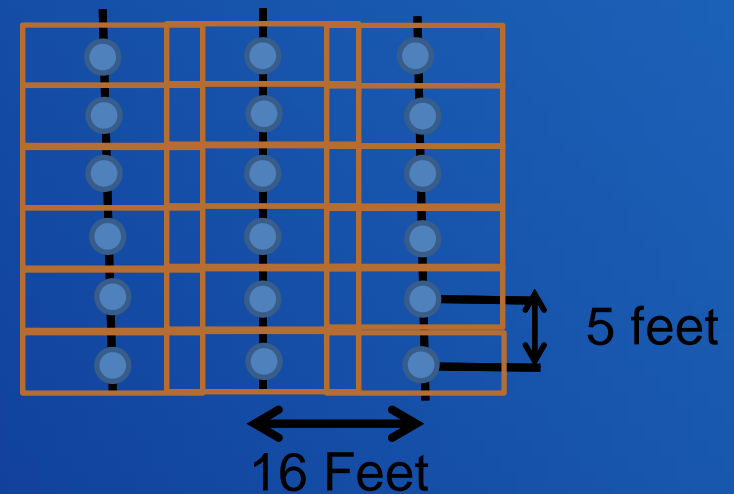


Micro Spray Irrigation System

- Plant Spacing= 16ft by 5ft
 - Understory plantings between rows



- Plant spacing ruled out drip irrigation > micro spray
- Overlap of wetting zone to irrigate the understory

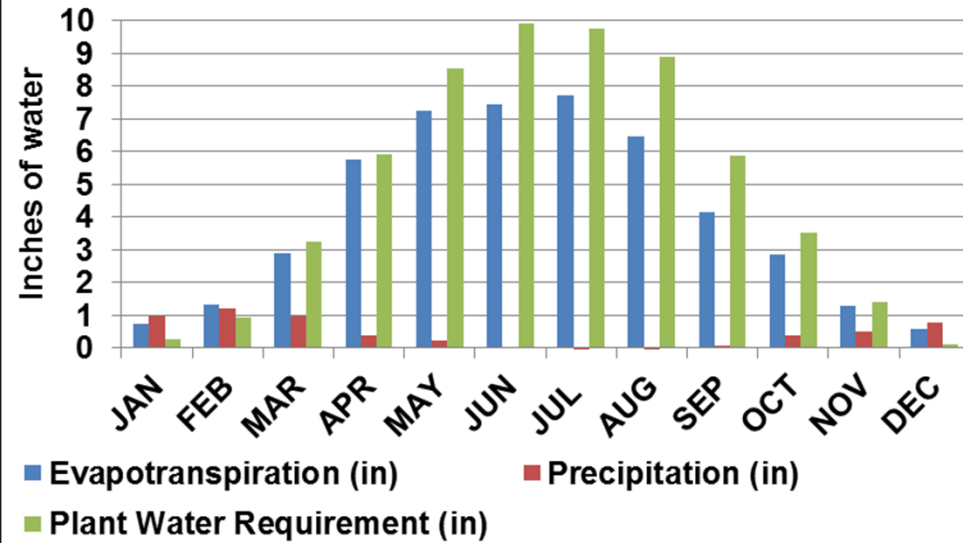


 = wetting radius 5ft X10 ft @ 4.4 gpm

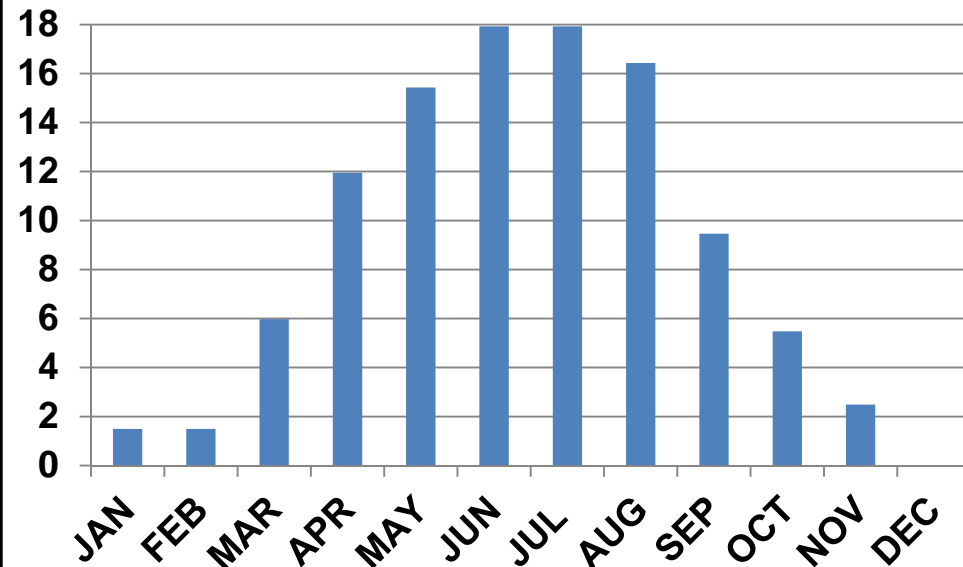
- Micro Sprayers
 - Flow rate 4.4 gph
 - Pressure 10 psi

Irrigation Water Requirements

Environment



Irrigation Volume (ac-ft)



Irrigation Schedule

	Irrigation (hrs/day)	Irrigation (days/mo)	Water supplied (in/mo)	Water supplied (in/day)
JAN	0.8	25	0.9	0.03
FEB	0.8	25	0.9	0.03
MAR	3	25	3.7	0.1
APR	6	25	7.4	0.3
MAY	7.8	25	9.5	0.3
JUN	9	25	11.0	0.4
JUL	9	25	11.0	0.4
AUG	8.3	25	10.1	0.3
SEP	4.8	25	5.3	0.2
OCT	2.8	25	3.4	0.1
NOV	1.3	25	1.5	0.05
DEC	0.0	25	0.0	0.0

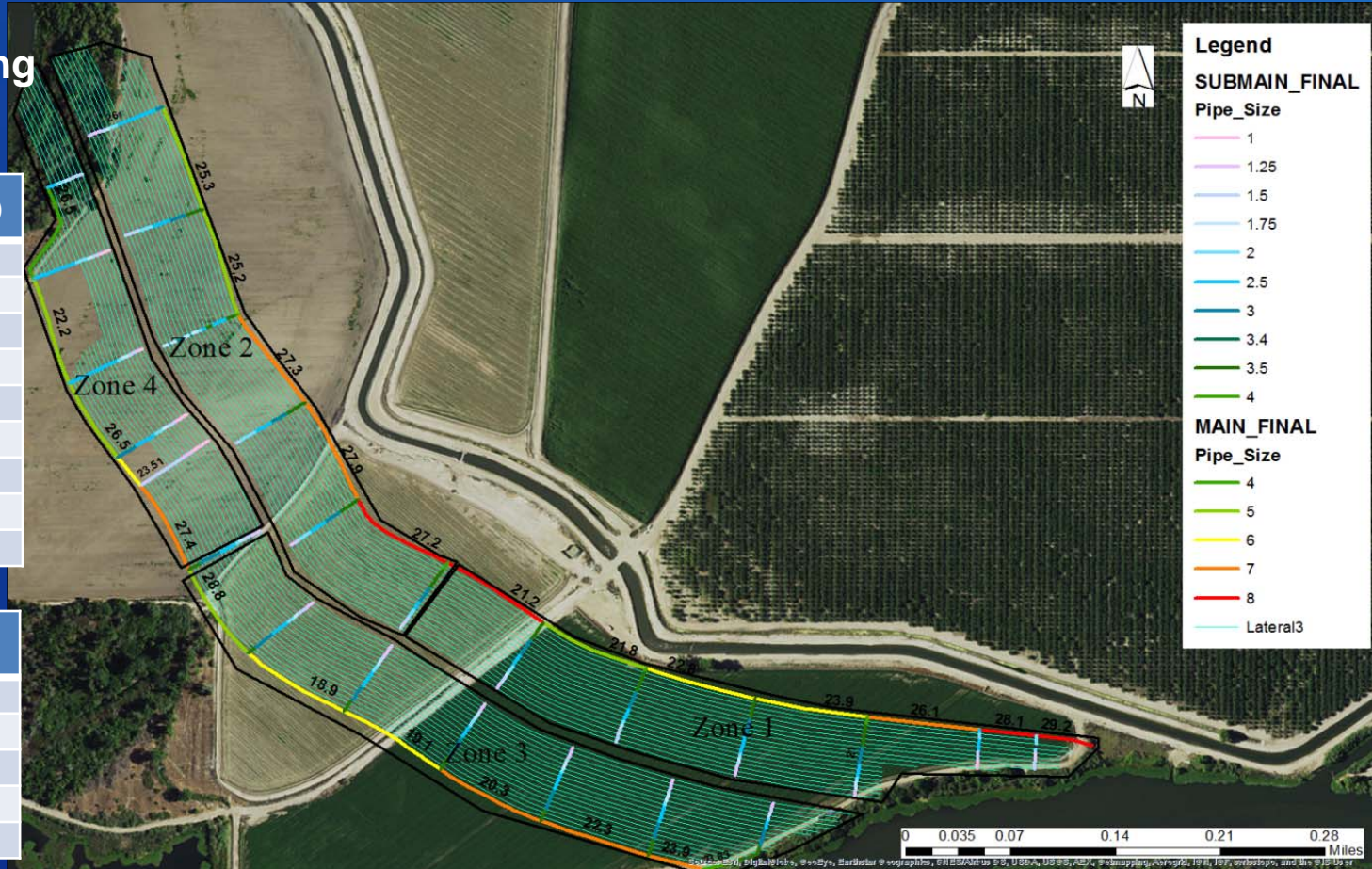
- Assumed an application efficiency of 90%
- Irrigation water will come from surface water rights on part of the bypass property land
- Reach 2B will be irrigated though groundwater

Pipe Quantities

- Maximum operating pressure of 42 psi

Sub-main Pipe Size (in)	Quantity (ft)
1	200
1.25	100
1.5	700
1.75	100
2	1000
2.5	1200
3	1400
3.5	1500
4	700

MAIN Pipe Size (in)	Quantity (ft)
8	1500
7	2000
6	2000
5	2000
4	400



Pump Requirements

Irrigation Zone	Pressure (psi)	Flow rate (gpm)
1	30	725
2	30	822
3	26	816
4	28	459

RECLAMATION

Overall Schedule for Revegetation (Year 0 is beginning of excavation)

Component	Begin	End
Source Plant Materials	Fall -2	Fall 0
Bypass Channel Excavation	Winter 0	Fall 0
Installation of Irrigation system	Summer 0	Fall 0
Initial Planting of Zones 1 – 3	Fall 0	Spring 1
Vegetation Maintenance and Invasive Control	Fall 0	Fall 3
Planting of Understory in Zones 1 and 2	Fall 2	Winter 2
Removal of Irrigation System	Winter 3	Winter 3
Introduction of Base Flows (up to 200 cfs)	Spring 3	-
Construction of Pilot Channel in Reach 2B	Winter 4	Winter 4
Introduction of Bank Full Flows (up to 1200 cfs)	Spring 4	-
Introduction of High Flows (up to 4500 cfs)	Spring 5	-