

*Creating Value ...*



*... Delivering Solutions*

**Mountain State Takes Eco-Friendly High Road  
“Tale of a Sensitive Watershed”  
NHEC Conference, August 2014**

Mohiuddin Shaik P.E., GISP, CFM (Baker) and Brigham S Ash, EIT (WVDOH)



**Baker**

# Presentation Layout

- **Project Background**
- **Hydrologic Modeling**
- **Hydraulic Modeling**
- **Mitigation Strategy**
- **Water Exposure Analysis**
- **Shadow Modeling**
- **Summary and Discussion**

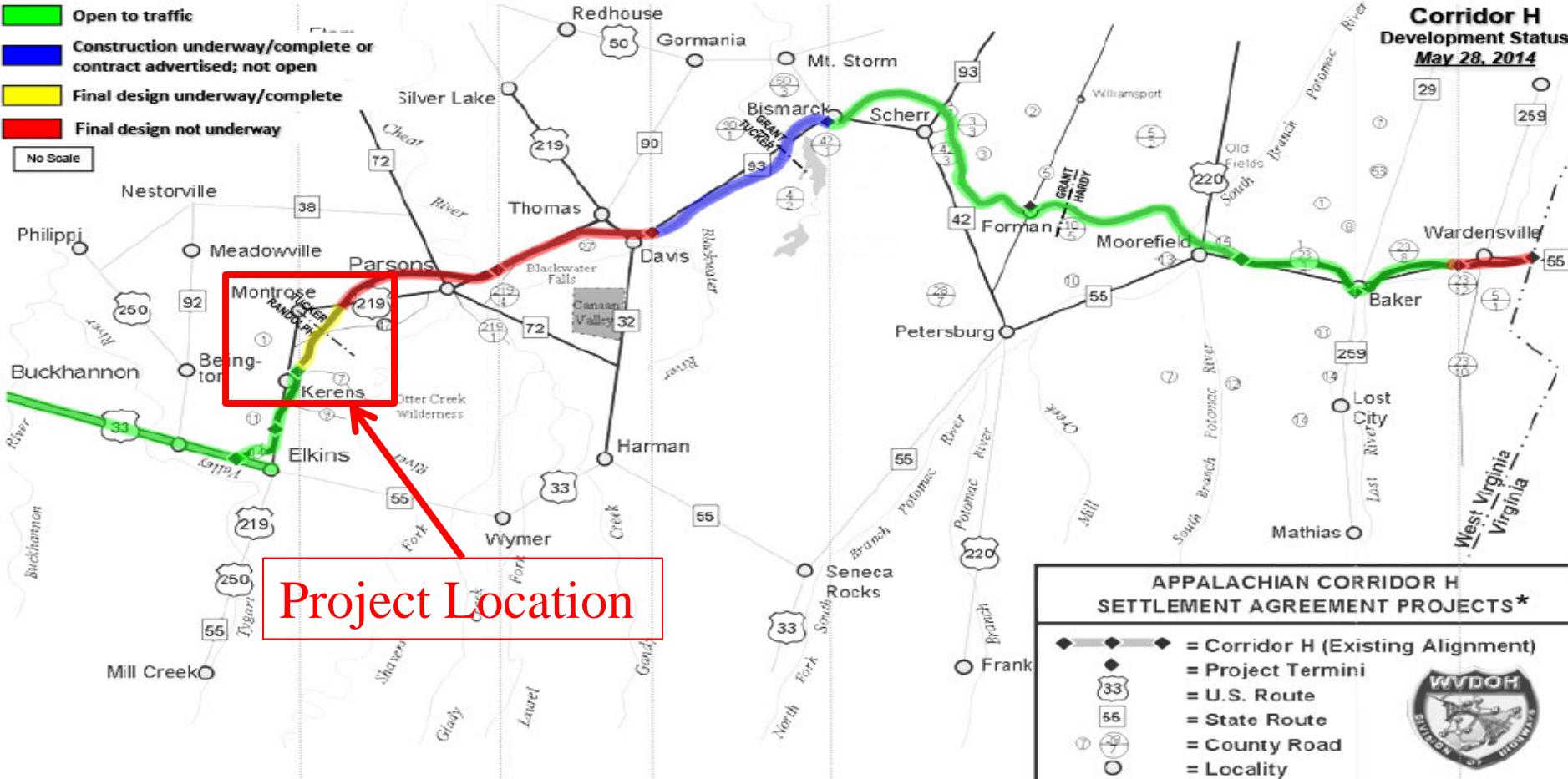
# Project Background

- **Project Route – Kerens to Parsons**
- **7.5-mile Roadway Section**
- **Anticipated Construction Start: Spring 2016**
- **Integral part of Corridor H**
- **Corridors established under the Appalachian Development Highway System (ADHS)**
- **One of six transportation corridors in WV**
- **Last corridor yet to be fully constructed**
- **[www.wvcorridorh.com](http://www.wvcorridorh.com)**



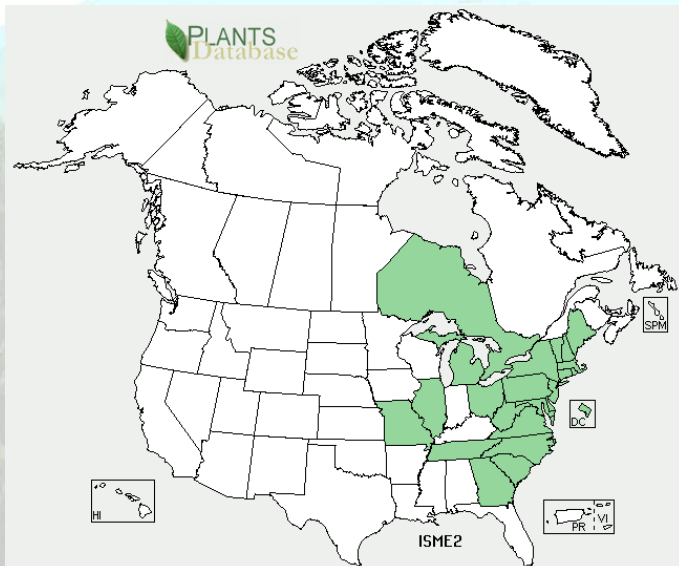
# Current Development Status

**Corridor H  
Development Status  
May 28, 2014**



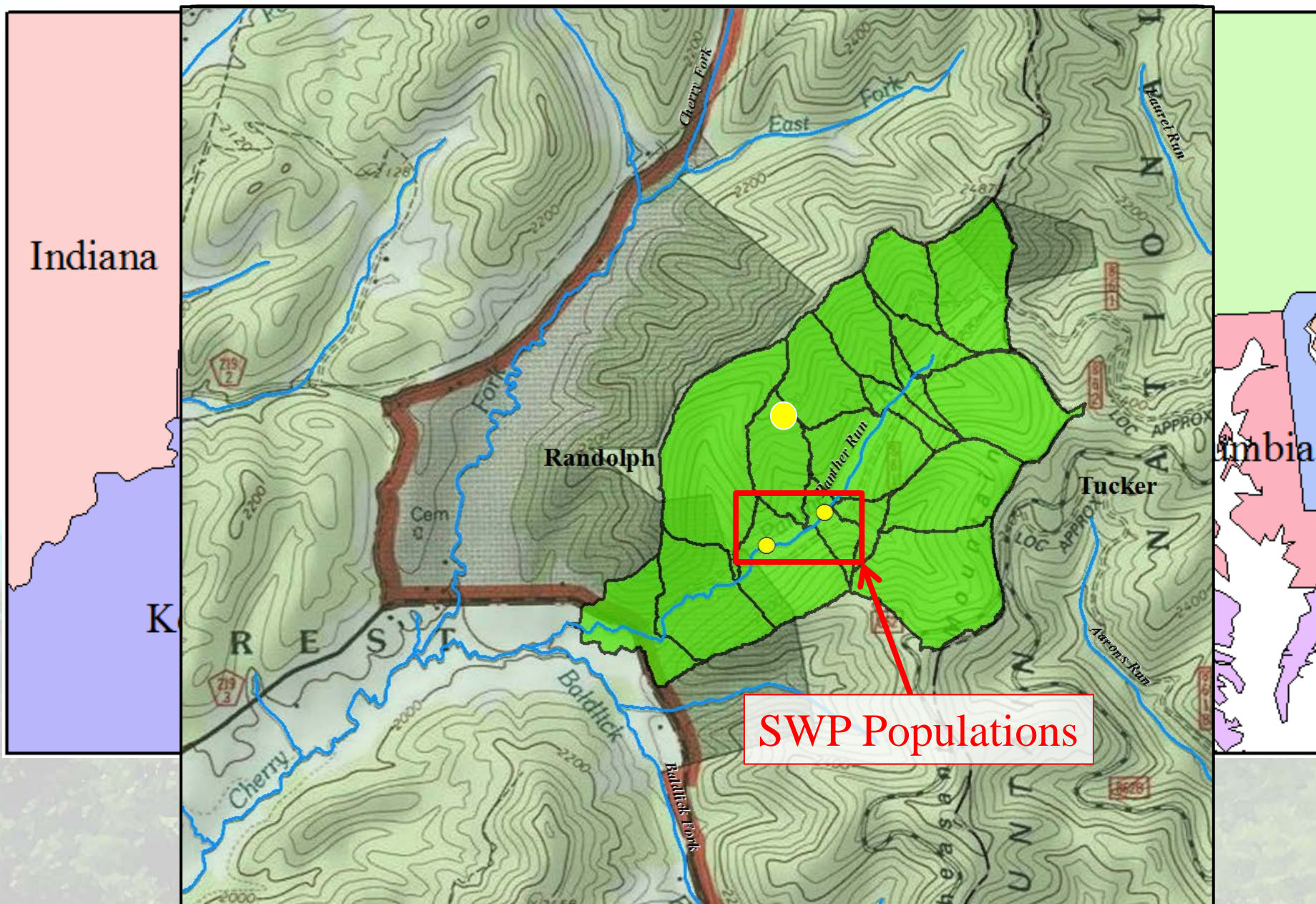
# Sensitive Watershed

- Monongahela National Forest
  - Environmental Studies
  - Small Whorled Pogonia
    - Threatened Species
    - Member of the orchid family
    - Widely distributed, but rare
- successfully cultivated





# Location





# Hydrology and Hydraulics Study

## Small Whorled Pogonia *Isotria medeoloides*



States where the small whorled pogonia, an orchid, is found.

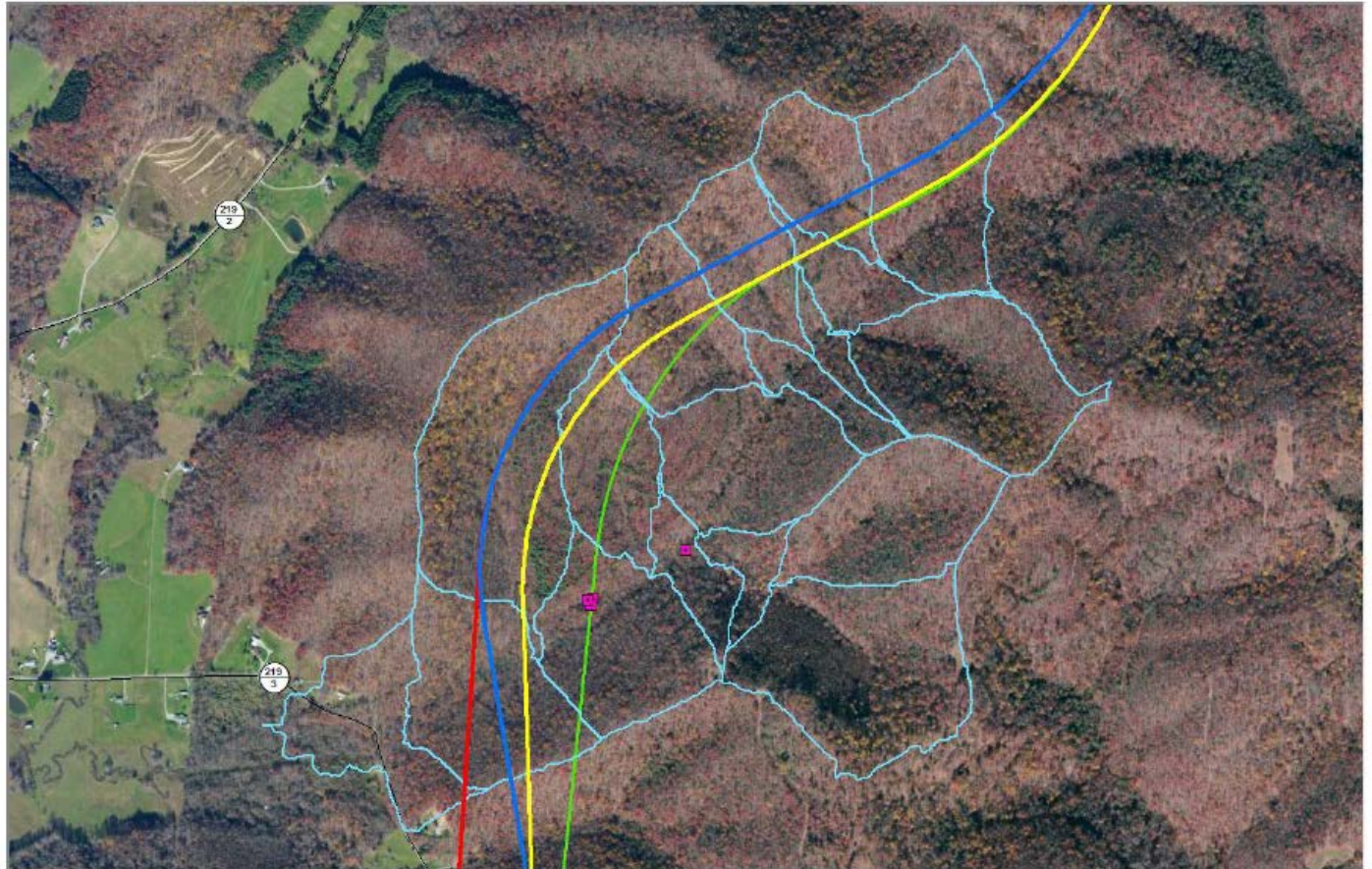


Figure 2: SWP locations relative to proposed highway alignments

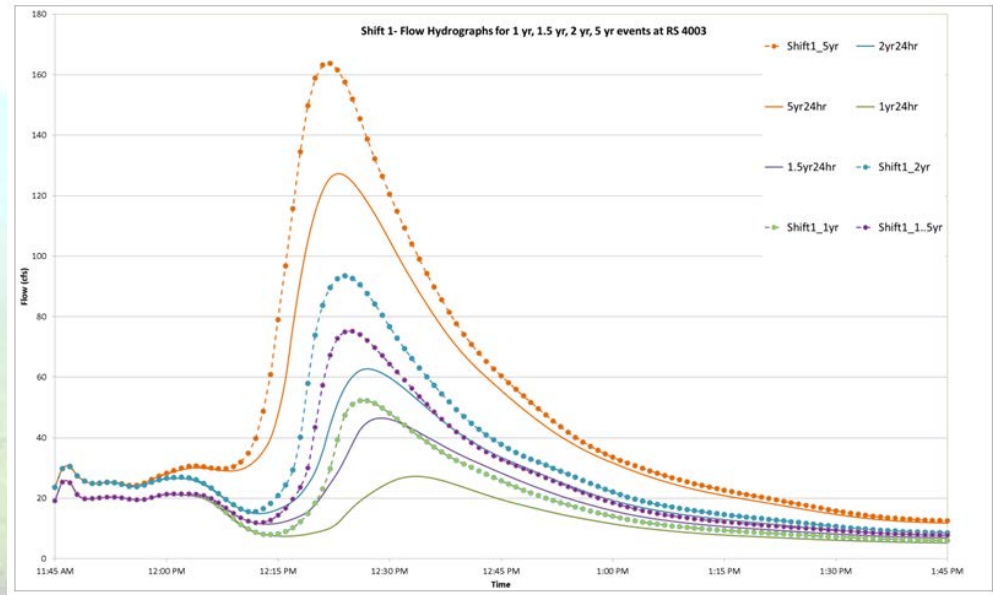
# Purpose

## Panther Run Watershed Hydrologic & Hydraulic analyses performed to:

1. Establish existing (baseline) hydrologic & hydraulic (H&H) conditions at SWP Locations
2. Establish proposed conditions due to roadway construction
3. Predict changes due to the proposed roadway construction
4. Conceptualize mitigation measures and demonstrate their effectiveness

H&H Models developed to predict changes in key H&H variables

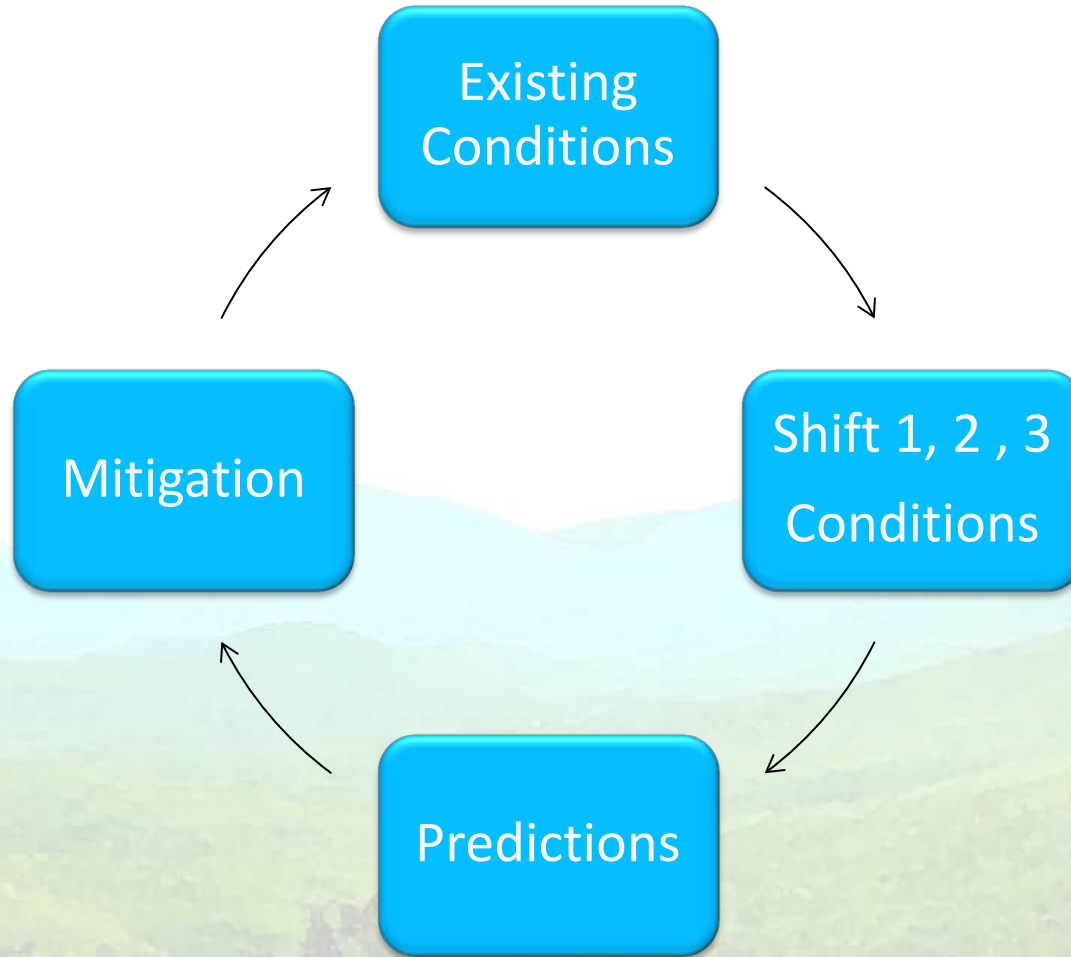
- Peak Discharges
- WSEL or Stage
- Flow Depth
- Velocities
- Shear Stress
- Water Exposure Analysis



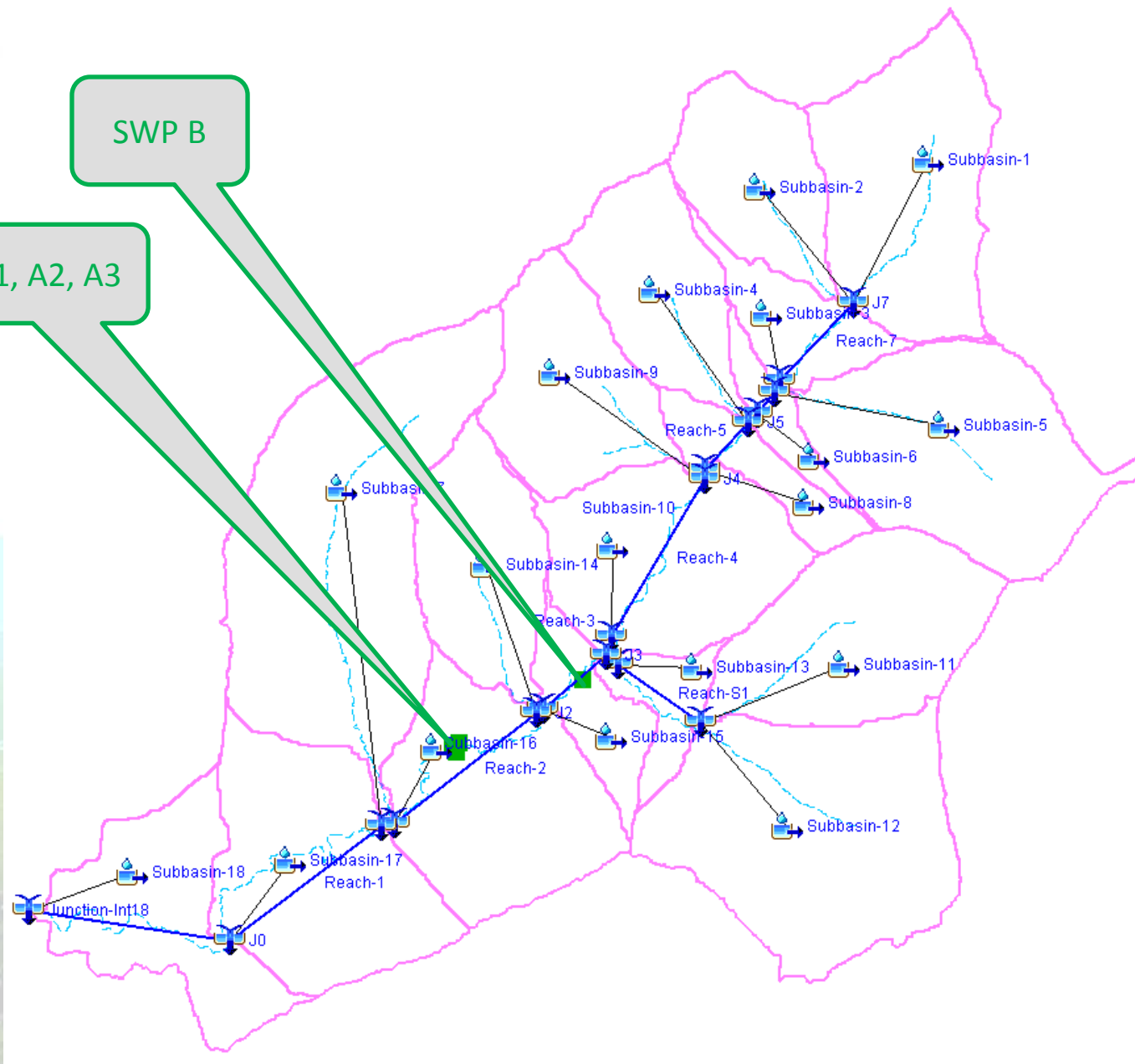
Example Hydrograph (Peak Discharge)



# Panther Run Project



# Hydrology - Existing Conditions





# Hydrology - Shift 1

## Panther Run Drainage Analysis for Impacts to SWP

Figure D5  
SHIFT-1 Drainage Sub-basins



500 0 500  
Feet



WEST VIRGINIA DEPARTMENT  
OF HIGHWAYS  
Appalachian Corridor H  
Elkins to Interstate 81  
Parsons Battlefield Avoidance DF



### Legend

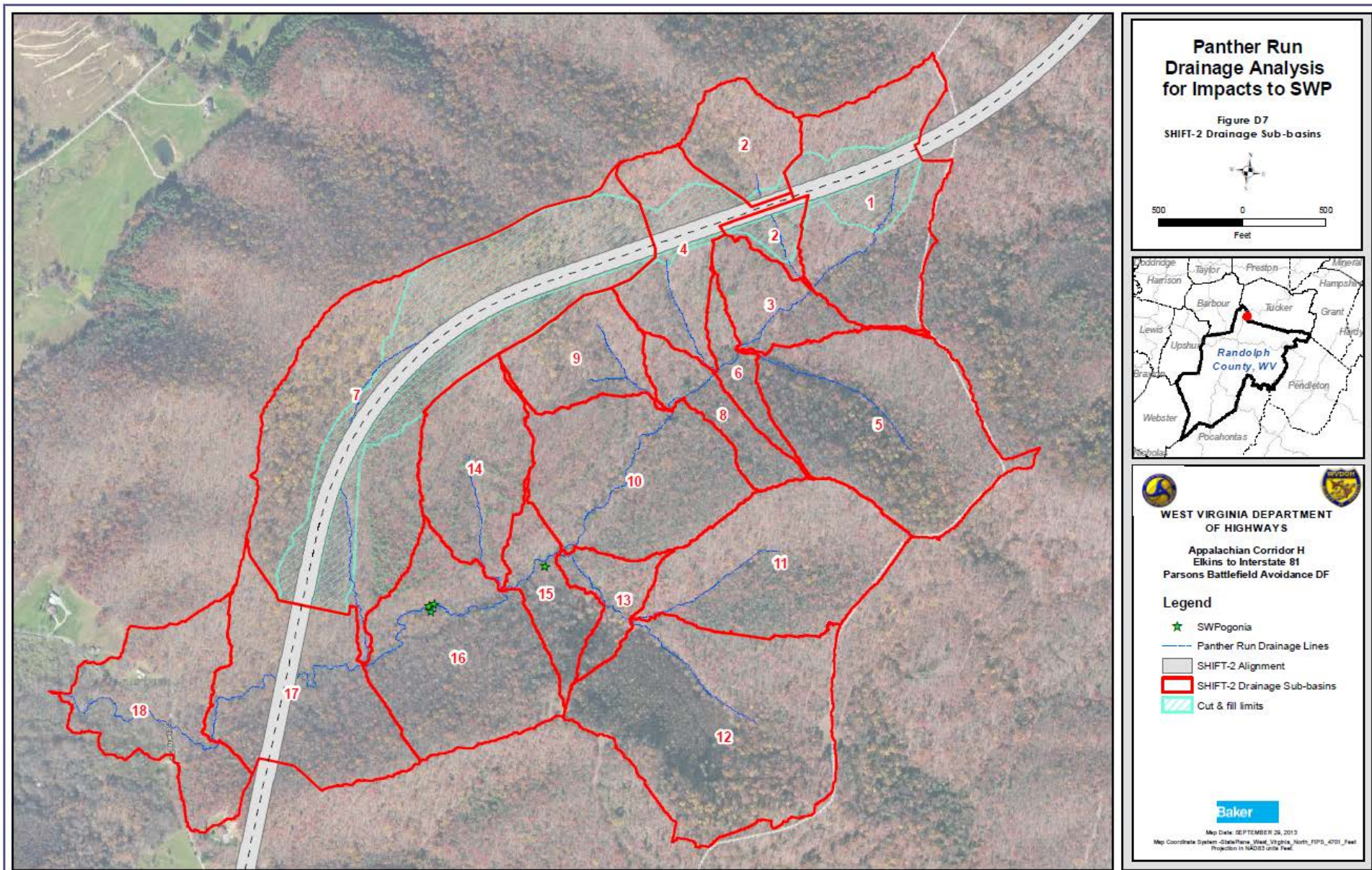
- ★ SWPogonia
- Panther Run Drainage Lines
- SHIFT-1 Alignment
- SHIFT-1 Drainage Sub-basins
- Cut & fill limits

Baker

Map Date: SEPTEMBER 28, 2013  
Map Coordinate System: StatePlane\_West\_Virginia\_North\_FIPS\_4701\_Feet  
Projection: NAD83 units: Feet

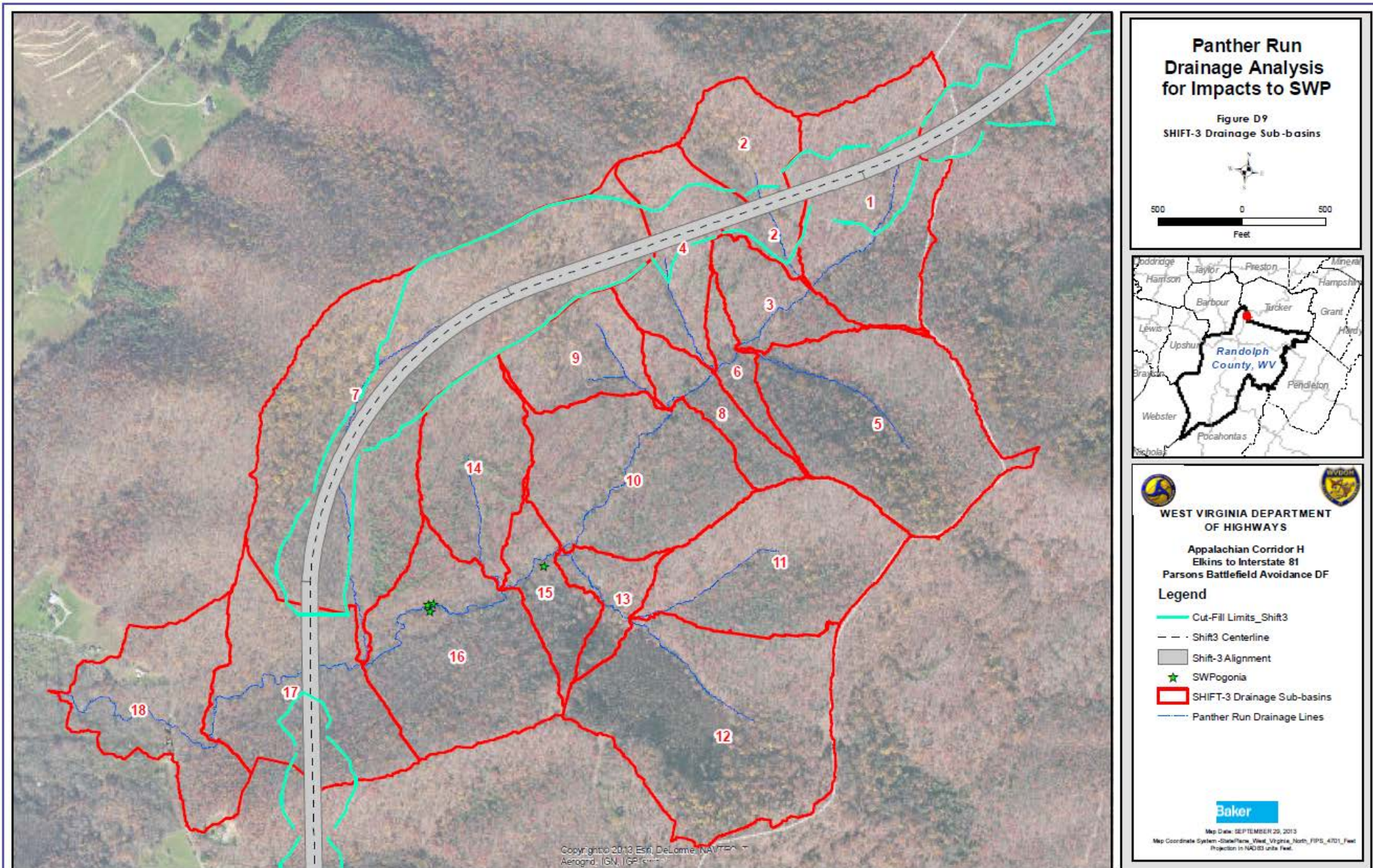


# Hydrology - Shift 2





# Hydrology - Shift 3



# Historical Gage Data

Peak-FQ Bulletin 17B Analysis of Gages in  
Surrounding Areas





# PeakFQ Gage Analysis Summary

## ELKINS TYGART RIVER GAGE BULLETIN 17 B ANALYSIS

Randolph County	ANNUAL	EXPECTED	271 Sq. Miles DA	
	EXCEEDANCE	BULL.17B	Occurrence	
Event	PROBABILITY	ESTIMATE	All Data (60-ysrs)	1994-2004
Year	AEP	cfs	Times	Times
1.005	0.995	3791	60	11
1.010	0.99	3980	60	11
1.053	0.95	4618	57	11
1.111	0.9	5048	55	11
1.250	0.8	5678	46	10
1.500	0.6667	6399	40	9
2.00	0.5	7332	31	8
2.33	0.4292	7783	28	8
5.00	0.2	9882	12	2
10.00	0.1	11760	4	1
25.00	0.04	14350	2	1
50.00	0.02	16450	1	0
100.00	0.01	18690	1	0
200.00	0.005	21110	1	0
500.00	0.002	24610	0	0

## BOWDEN,SHAVERS FORK GAGE BULLETIN 17 B ANALYSIS

Randolph County	ANNUAL	EXPECTED	151 Sq. Miles DA	
	EXCEEDANCE	BULL.17B	Occurrence	
Event	PROBABILITY	ESTIMATE	All Data (22-ysrs)	1998-2011
Year	AEP	cfs	Times	Times
1.005	0.995	4287	22	14
1.010	0.99	4685	22	14
1.053	0.95	6027	21	14
1.111	0.9	6933	19	12
1.250	0.8	8257	16	12
1.50	0.6667	9773	15	12
2.00	0.5	11730	11	9
2.33	0.4292	12670	10	9
5.00	0.2	17030	5	4
10.00	0.1	20880	3	3
25.00	0.04	26130	1	1
50.00	0.02	30320	0	0
100.00	0.01	34740	0	0
200.00	0.005	39450	0	0
500.00	0.002	46130	0	0

## BELINGTON,TYGART RIVER GAGE BULLETIN 17 B ANALYSIS

Barbour County	ANNUAL	EXPECTED	406 Sq. Miles DA	
	EXCEEDANCE	BULL.17B	Occurrence	
Event	PROBABILITY	ESTIMATE	All Data (104-ysrs)	1994-2011
Year	AEP	cfs	Times	Times
1.005	0.995	4995	104	18
1.010	0.99	5310	103	18
1.053	0.95	6327	98	18
1.111	0.9	6981	93	18
1.250	0.8	7902	86	15
1.500	0.6667	8914	73	13
2.00	0.5	10170	55	9
2.33	0.4292	10750	43	9
5.00	0.2	13340	20	4
10.00	0.1	15500	10	2
25.00	0.04	18310	4	2
50.00	0.02	20460	2	1
100.00	0.01	22660	1	0
200.00	0.005	24930	1	0
500.00	0.002	28060	1	0

## PARSONS CHEAT RIVER GAGE BULLETIN 17 B ANALYSIS

Tucker County	ANNUAL	EXPECTED	722 Sq. Miles DA	
	EXCEEDANCE	BULL.17B	Occurrence	
Event	PROBABILITY	ESTIMATE	All Data (99-ysrs)	1994-2012
Year	AEP	cfs	Times	Times
1.005	0.995	11920	97	19
1.010	0.99	12480	97	19
1.053	0.95	14530	96	19
1.111	0.9	16030	91	19
1.250	0.8	18390	81	19
1.50	0.6667	21300	67	18
2.00	0.5	25370	53	13
2.33	0.4292	27440	46	10
5.00	0.2	38040	16	6
10.00	0.1	48730	7	3
25.00	0.04	65260	4	2
50.00	0.02	80090	3	1
100.00	0.01	97340	1	0
200.00	0.005	117400	1	0
500.00	0.002	149200	1	0



# Hydraulic Analysis

HEC-RAS Steady  
and  
Unsteady Models

# Hydraulic – HEC-RAS Models

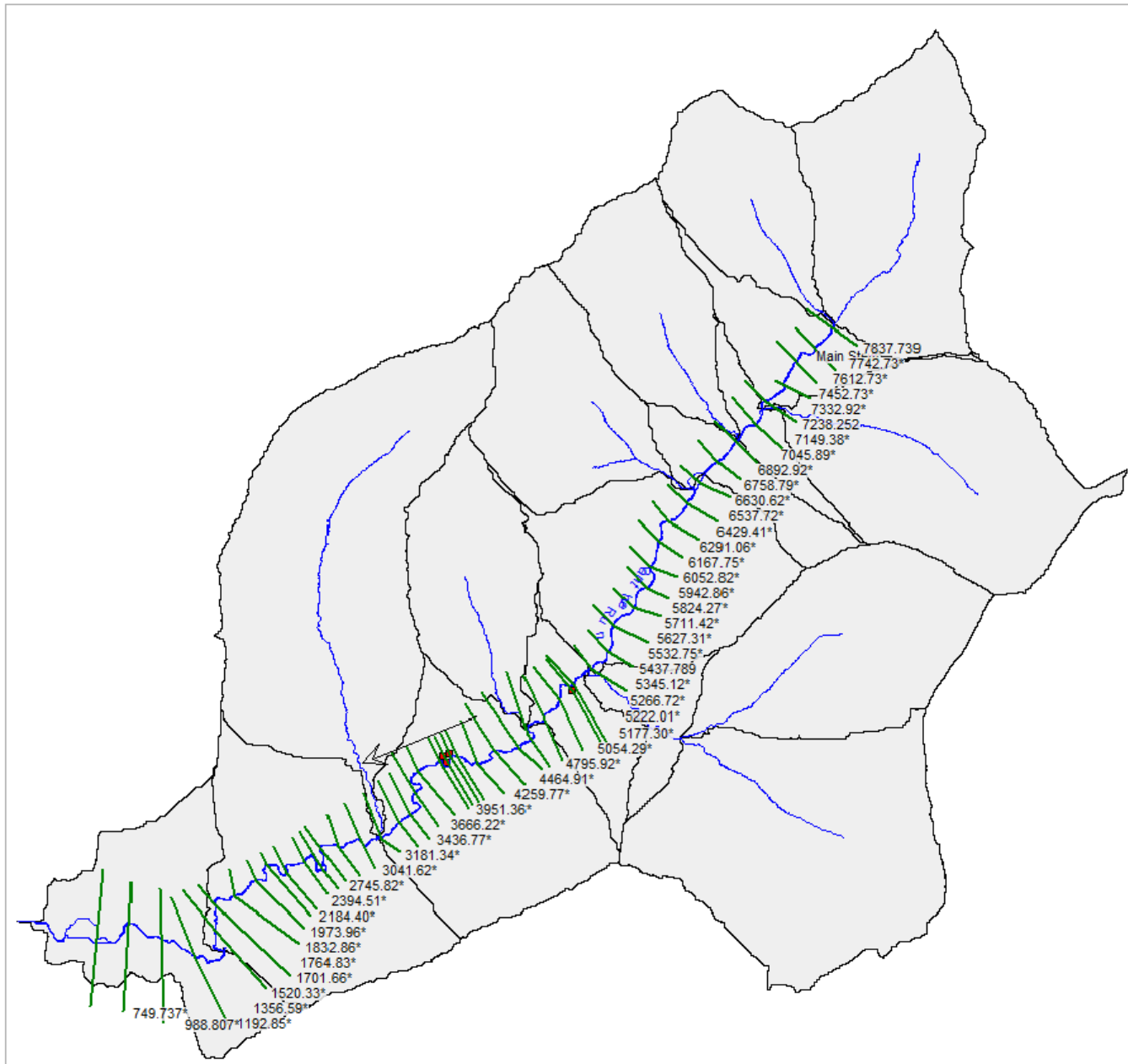


Figure 9: Unsteady Hydraulic Model Geometric Data Schematic

# Hydraulic Analysis

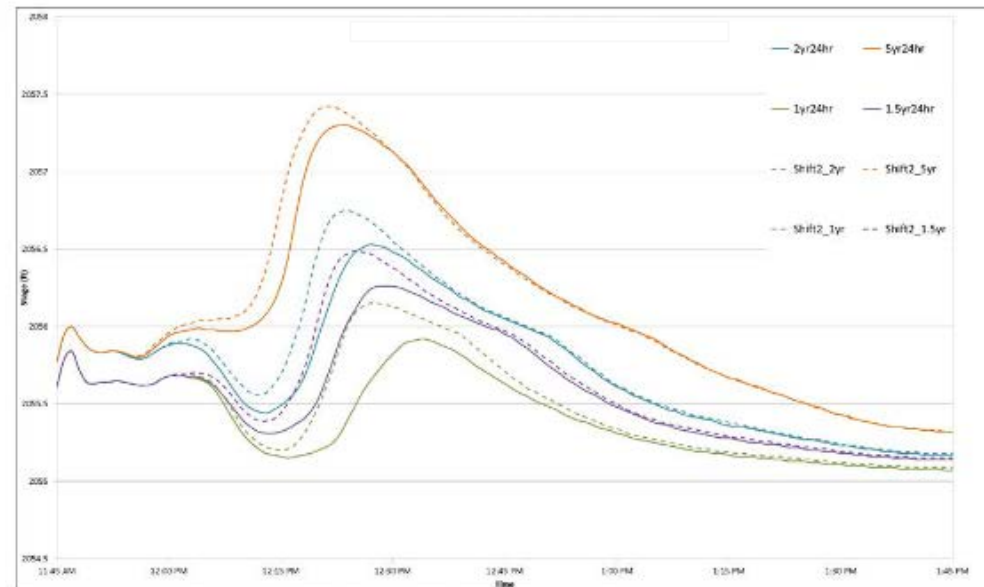
Predicted Changes in Key Hydraulic Variables  
at  
SWP Locations



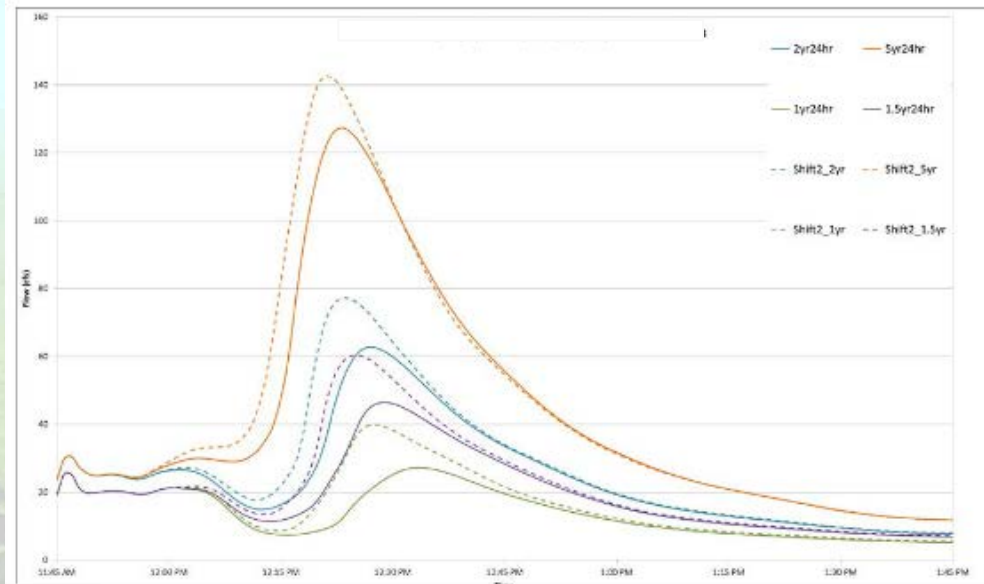
<b>SWP A1</b>	<b>Condition/Event</b>	<b>1-yr</b>	<b>1.5-yr</b>	<b>2-yr</b>	<b>5-yr</b>	<b>10-yr</b>	<b>25-yr</b>	<b>50-yr</b>	<b>100-yr</b>	<b>500-yr</b>
<b>Peak Discharge (cfs)</b>	Ex Cond	27.22	46.45	62.76	127.3	258.28	383.3	483.2	602.98	853.4
	Shift 1	52.35	75.23	93.43	163.9	301.26	427.3	526.4	643.53	891.39
	Shift 2 and 3	39.85	60.41	77.21	142.5	273.81	399.1	496	611.24	855.68
<b>Flow Depth (ft)</b>	Ex Cond	0	0	0.14	0.91	1.85	2.4	2.81	3.11	3.72
	Shift 1	0	0.33	0.6	1.2	2.04	2.6	2.92	3.21	3.8
	Shift 2 and 3	0	0.1	0.36	1.04	1.92	2.47	2.84	3.13	3.72
<b>Velocity (ft/s)</b>	Ex Cond	0	0	0.7	1	1.39	1.68	1.81	2.03	2.36
	Shift 1	0	0.81	0.89	1.14	1.51	1.74	1.9	2.09	2.4
	Shift 2 and 3	0	0.68	0.82	1.07	1.43	1.7	1.84	2.04	2.36
<b>Shear Stress (lb/sq ft)</b>	Ex Cond	0	0	0.26	0.42	0.65	0.88	0.98	1.19	1.51
	Shift 1	0	0.3	0.33	0.5	0.74	0.92	1.06	1.25	1.56
	Shift 2 and 3	0	0.25	0.31	0.45	0.68	0.9	1	1.2	1.52

# SWP A1 and SWP A2 Hydrographs

Comparison of Shift 2/3  
and Existing Hydrographs  
for  
1, 1.5, 2, 5-yr events



Shifts 2 and 3 Stage Hydrographs at RS 4003 (SWP A1 and SWP A2)



Shifts 2 and 3 Flow Hydrographs at RS 4003 (SWP A1 and SWP A2)



# **Mitigation of Predicted Changes**

# Mitigation

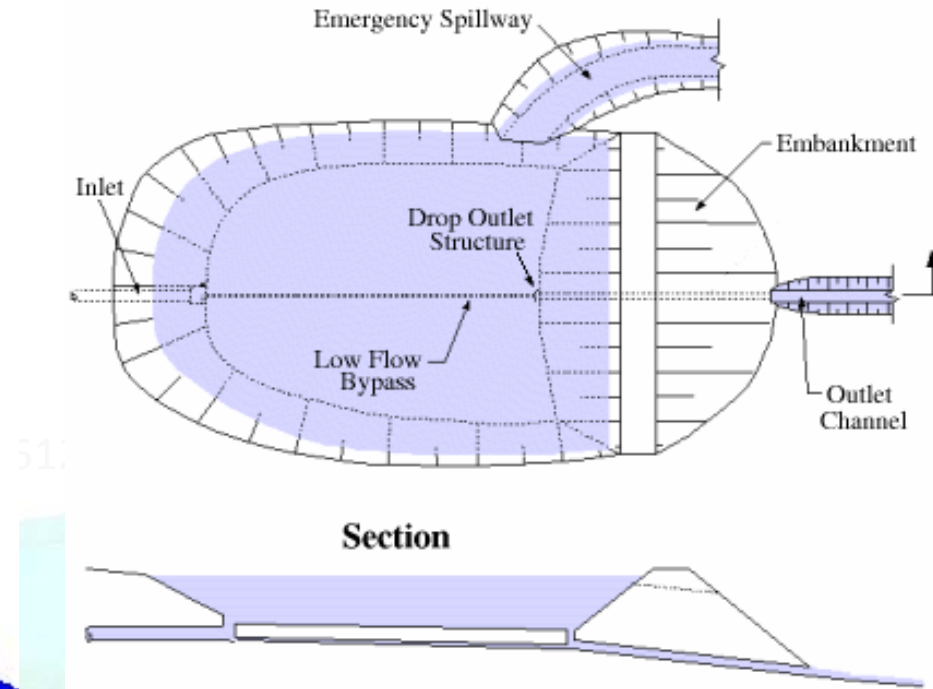
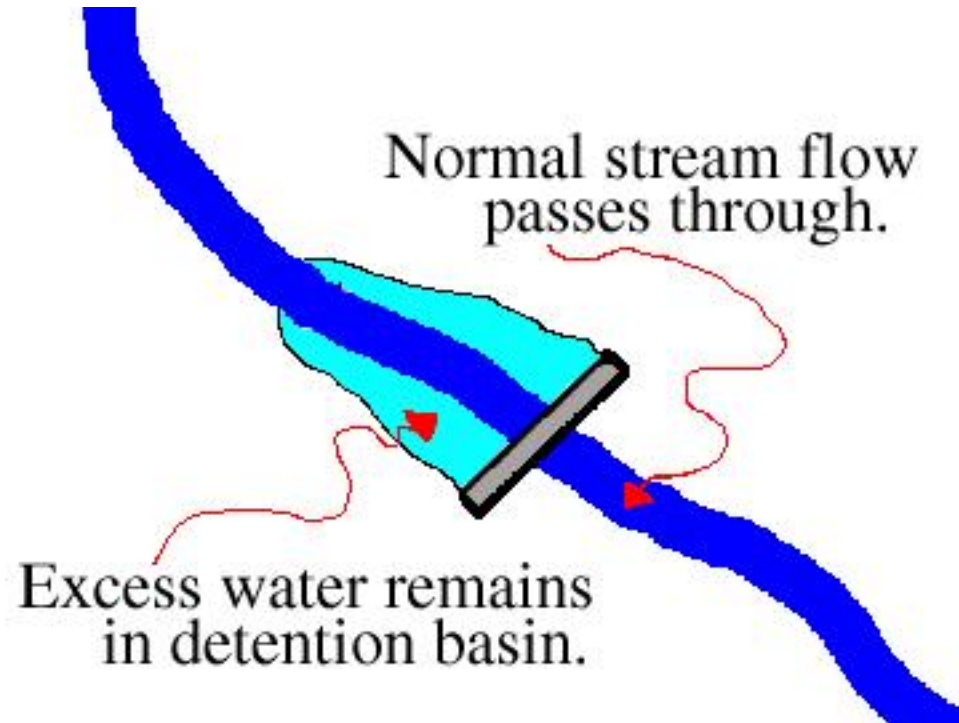
**Shift 3** Selected for Mitigation and **1.5-year event** Identified for Mitigation – Channel forming, Stream Stabilizing flow event

## Mitigation Strategies Considered:

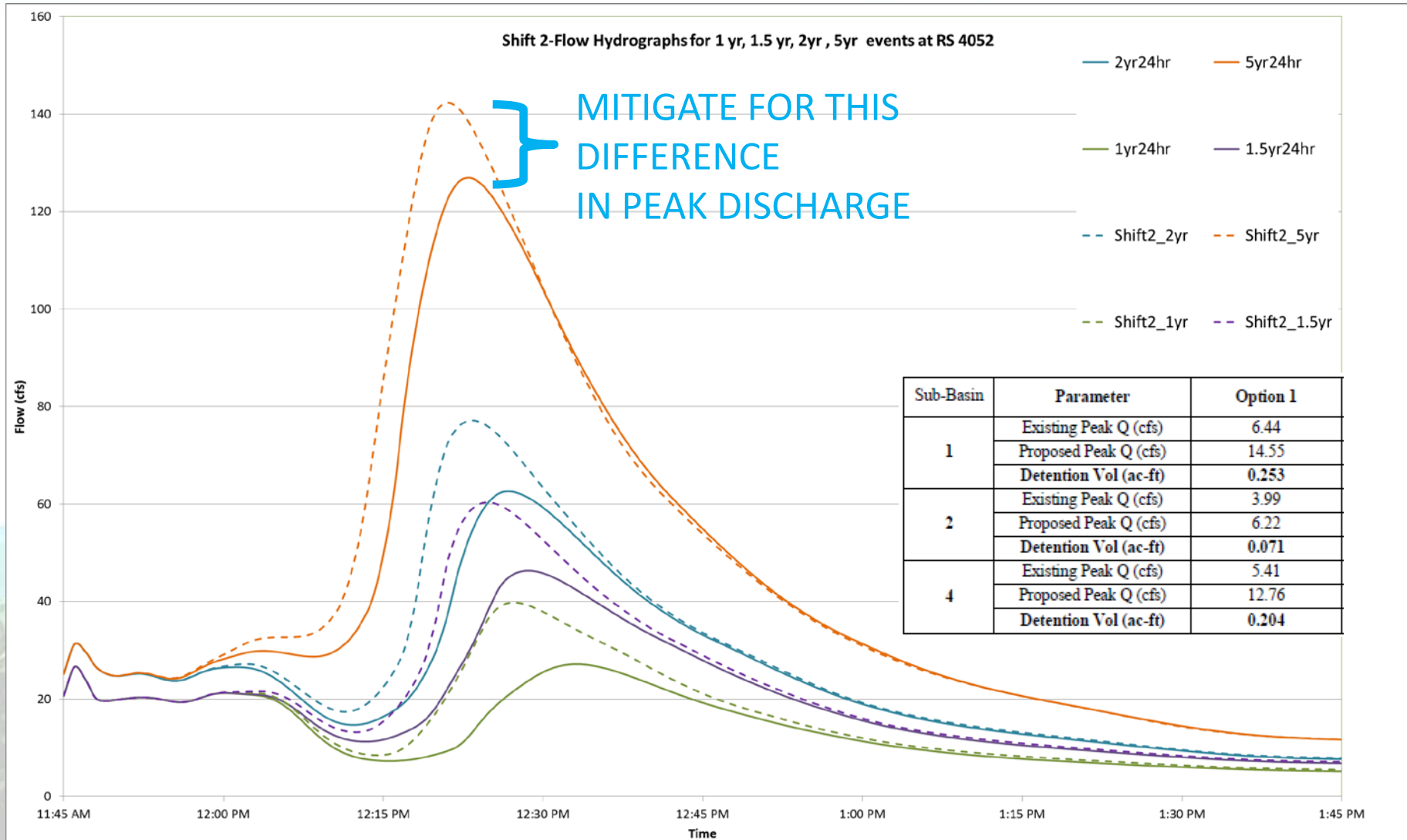
- Offline detention
- **Inline detention**
- **Inlet re-routing to allocate additional roadway drainage areas to trunk lines that discharge further downstream of plant location**
- Retention
- Bio-retention



# Inline Detention – Modeled Option



# Baker Mitigation - Detention Storage





# Predicted Changes (at SWP A1) and Mitigation

<b>SWP A1</b>	<b>Condition/Event</b>	<b>1-yr</b>	<b>1.5-yr</b>	<b>2-yr</b>	<b>5-yr</b>	<b>10-yr</b>	<b>25-yr</b>	<b>50-yr</b>	<b>100-yr</b>	<b>500-yr</b>
<b>Peak Discharge (cfs)</b>	Ex Cond	27.22	46.45	62.76	127.3	258.28	383.3	483.2	602.98	853.4
	Shift 1	52.35	75.23	93.43	163.9	301.26	427.3	526.4	643.53	891.39
	Shift 2 and 3	39.85	60.41	77.21	142.5	273.81	399.1	496	611.24	855.68
	<b>With Mitigation</b>	29.26	46.11	60	125	269.47	398.7	495.9	611.1	855.37
<b>Flow Depth (ft)</b>	Ex Cond	0	0	0.14	0.91	1.85	2.4	2.81	3.11	3.72
	Shift 1	0	0.33	0.6	1.2	2.04	2.6	2.92	3.21	3.8
	Shift 2 and 3	0	0.1	0.36	1.04	1.92	2.47	2.84	3.13	3.72
	<b>With Mitigation</b>	0	0	0.09	0.92	1.9	2.47	2.84	3.13	3.72
<b>Velocity (ft/s)</b>	Ex Cond	0	0	0.7	1	1.39	1.68	1.81	2.03	2.36
	Shift 1	0	0.81	0.89	1.14	1.51	1.74	1.9	2.09	2.4
	Shift 2 and 3	0	0.68	0.82	1.07	1.43	1.7	1.84	2.04	2.36
	<b>With Mitigation</b>	0	0	0.68	0.99	1.42	1.7	1.84	2.04	2.36
<b>Shear Stress (lb/sq ft)</b>	Ex Cond	0	0	0.26	0.42	0.65	0.88	0.98	1.19	1.51
	Shift 1	0	0.3	0.33	0.5	0.74	0.92	1.06	1.25	1.56
	Shift 2 and 3	0	0.25	0.31	0.45	0.68	0.9	1	1.2	1.52
	<b>With Mitigation</b>	0	0	0.25	0.41	0.67	0.9	1	1.2	1.52

Mitigation of Shift 2/3

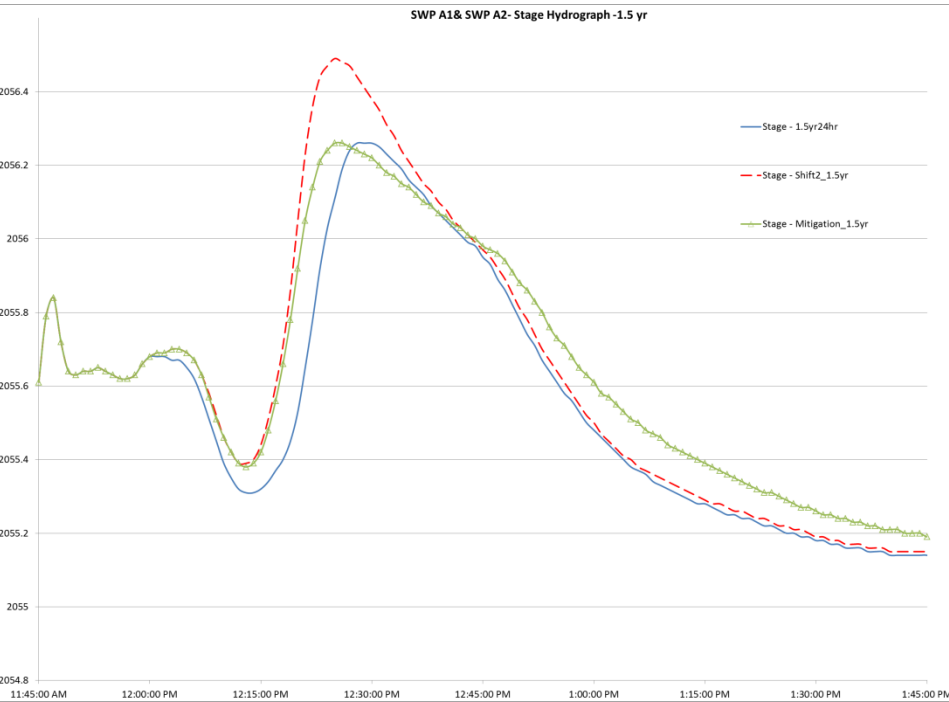
# Predicted Changes (at SWP A1) and Mitigation

<b>SWP A1</b>	<b>Condition/Event</b>	<b>1-yr</b>	<b>1.5-yr</b>	<b>2-yr</b>	<b>5-yr</b>	<b>10-yr</b>	<b>25-yr</b>	<b>50-yr</b>	<b>100-yr</b>	<b>500-yr</b>
<b>Peak Discharge (cfs)</b>	Ex Cond	27.22	46.45	62.76	127.3	258.28	383.3	483.2	602.98	853.4
	Shift 3	37.56	57.53	73.74	136.3	259.77	376.6	468.5	579.35	807.89
	<b>With Mitigation</b>	29.57	46.18	59.87	113.6	237.84	363.9	456	564.32	786.7
<b>Flow Depth (ft)</b>	Ex Cond	0	0	0.14	0.91	1.85	2.4	2.81	3.11	3.72
	Shift 3	0	0.05	0.3	0.99	1.86	2.38	2.77	3.06	3.61
	<b>With Mitigation</b>	0	0	0.09	0.8	1.74	2.32	2.72	3.02	3.56
<b>Velocity (ft/s)</b>	Ex Cond	0	0	0.7	1	1.39	1.68	1.81	2.03	2.36
	Shift 3	-	0.68	0.8	1.04	1.39	1.67	1.79	1.99	2.31
	<b>With Mitigation</b>	0	0	0.68	0.94	1.33	1.65	1.77	1.97	2.28
<b>Shear Stress (lb/sq ft)</b>	Ex Cond	0	0	0.26	0.42	0.65	0.88	0.98	1.19	1.51
	Shift 3		0.25	0.3	0.44	0.65	0.87	0.95	1.15	1.46
	<b>With Mitigation</b>	0	0	0.25	0.38	0.61	0.85	0.94	1.12	1.44

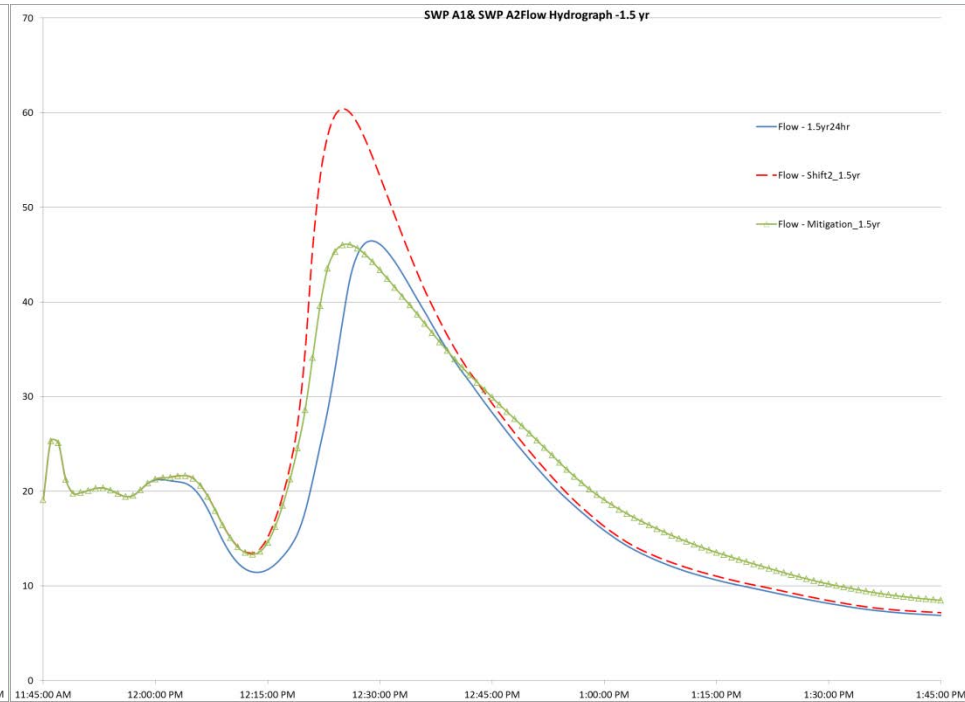


# SWP A1 and SWP A2 - 1.5yr Hydrographs

Existing, Shift 2/3 and Mitigation 1  
Stage Hydrograph 1.5-yr



Existing, Shift 2/3 and Mitigation 1  
Flow Hydrograph 1.5-yr



# **Water Exposure Duration Analysis at SWP**



# Water Exposure Times at SWP in Minutes

**Water Exposure Duration (Minutes) at SWP A1**

Event	Existing	Shift 1	Shift 2	Shift 3	With Mitigation
	(min)	(min)	(min)	(min)	(min)
1-year	0	0	0	0	0
1.5-year	0	11	4	0	0
2-year	7	17	13	12	5
5-year	29	33	30	29	29
10-year	50	52	52	49	49
100-year	74	73	72	72	72

**Water Exposure Duration (Minutes) at SWP A2**

Event	Existing	Shift 1	Shift 2	Shift 3	With Mitigation
	(min)	(min)	(min)	(min)	(min)
1-year	0	0	0	0	0
1.5-year	0	0	0	0	0
2-year	0	7	0	0	0
5-year	18	22	19	18	17
10-year	38	41	39	38	37
100-year	63	62	61	61	61

# Water Exposure Times at SWP in Minutes

**Water Exposure Duration (Minutes) at SWP A3**

Event	Existing	Shift 1	Shift 2	Shift 3	With Mitigation
	(min)	(min)	(min)	(min)	(min)
1-year	0	0	0	0	0
1.5-year	0	2	0	0	0
2-year	0	11	5	0	0
5-year	21	25	23	21	22
10-year	42	44	43	41	41
100-year	66	66	64	64	64

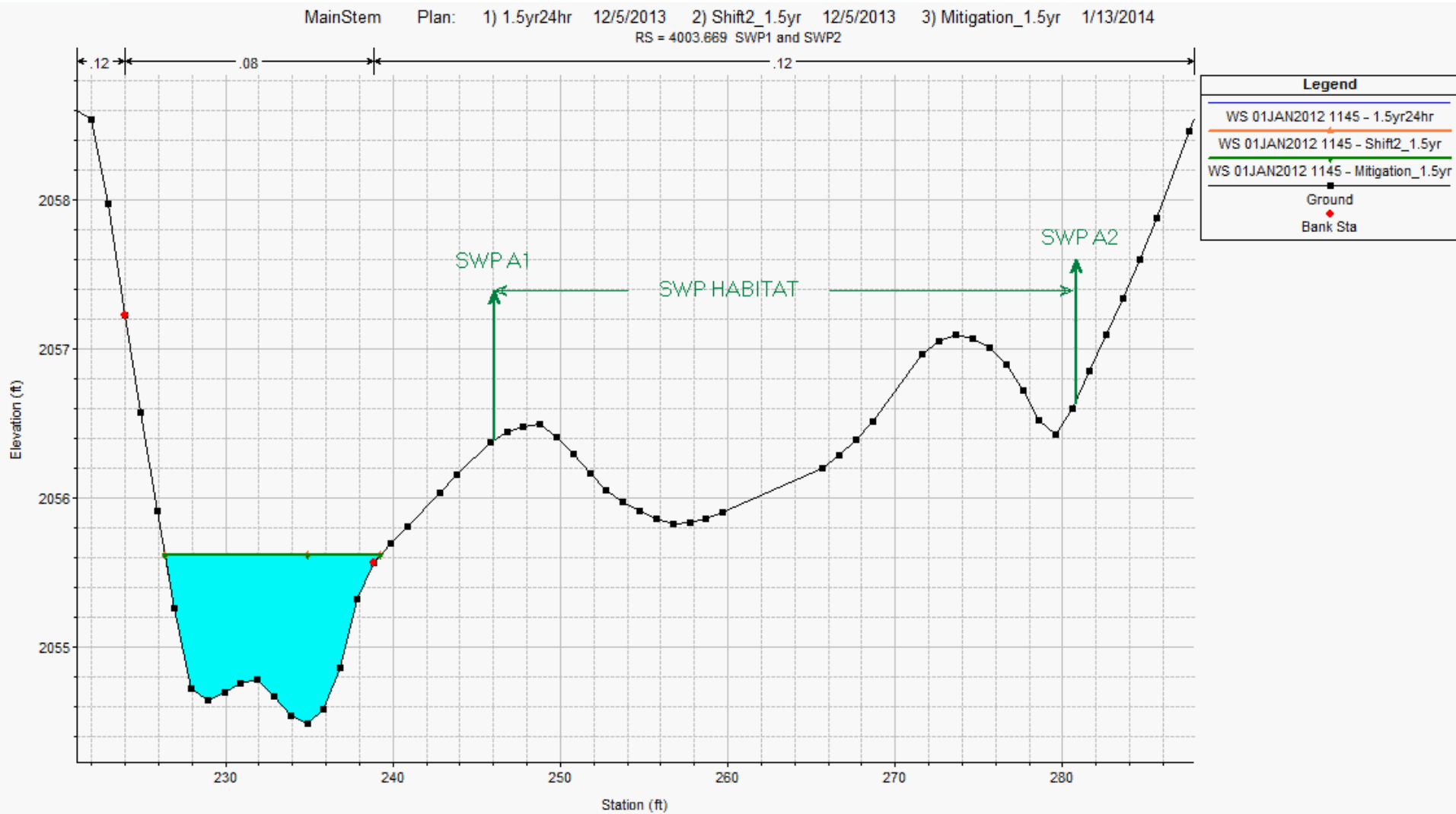
**Water Exposure Duration (Minutes) at SWP B**

Event	Existing	Shift 1	Shift 2	Shift 3	With Mitigation
	(min)	(min)	(min)	(min)	(min)
1-year	0	0	0	0	0
1.5-year	0	8	0	0	0
2-year	0	13	8	7	0
5-year	22	28	25	23	23
10-year	42	44	42	41	41
100-year	66	66	64	64	65

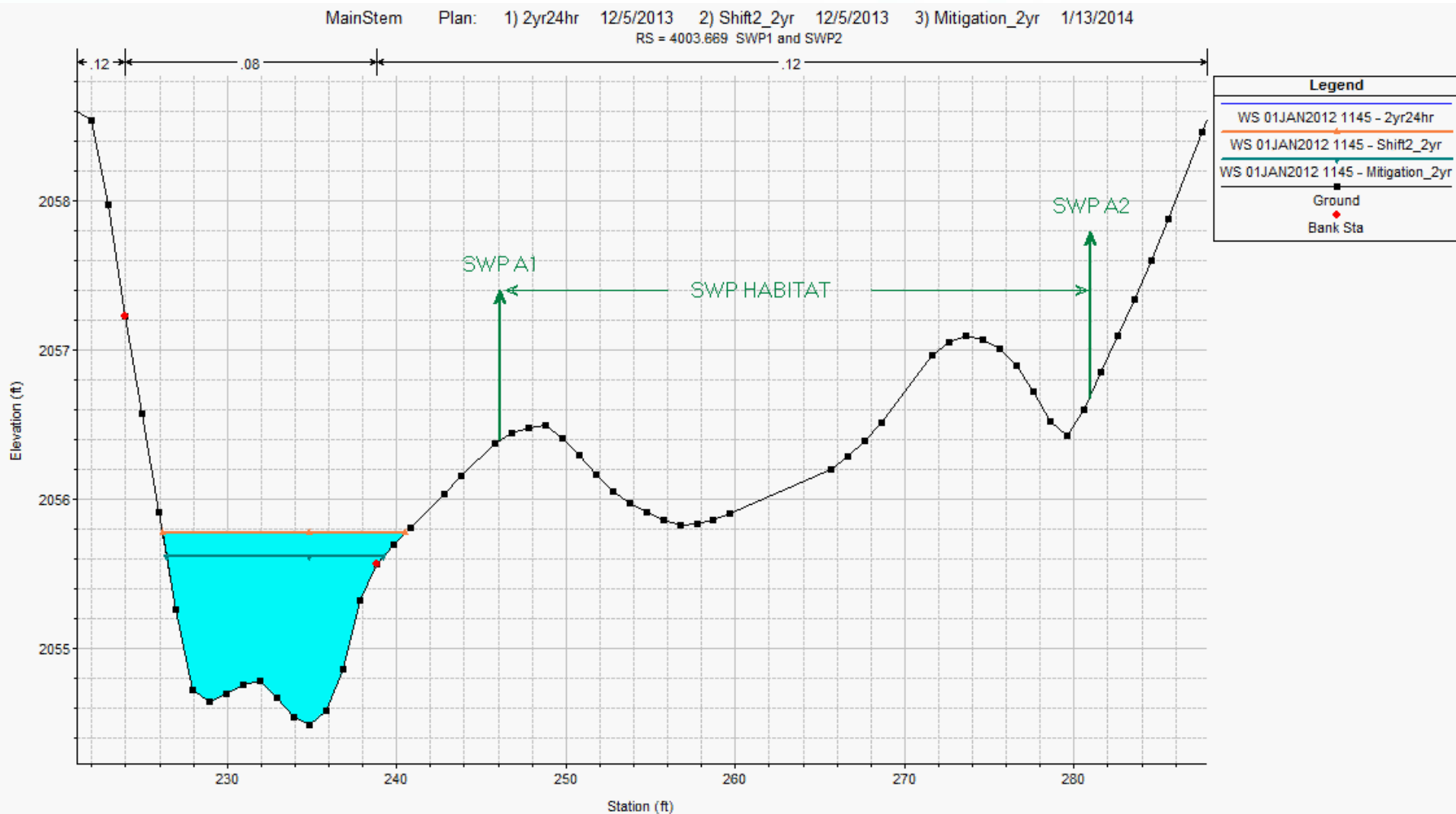
Water Surface Elevation (WSEL)  
Animations at SWP A1 and SWP A2  
(1.5, 2, 5, 100-year events)



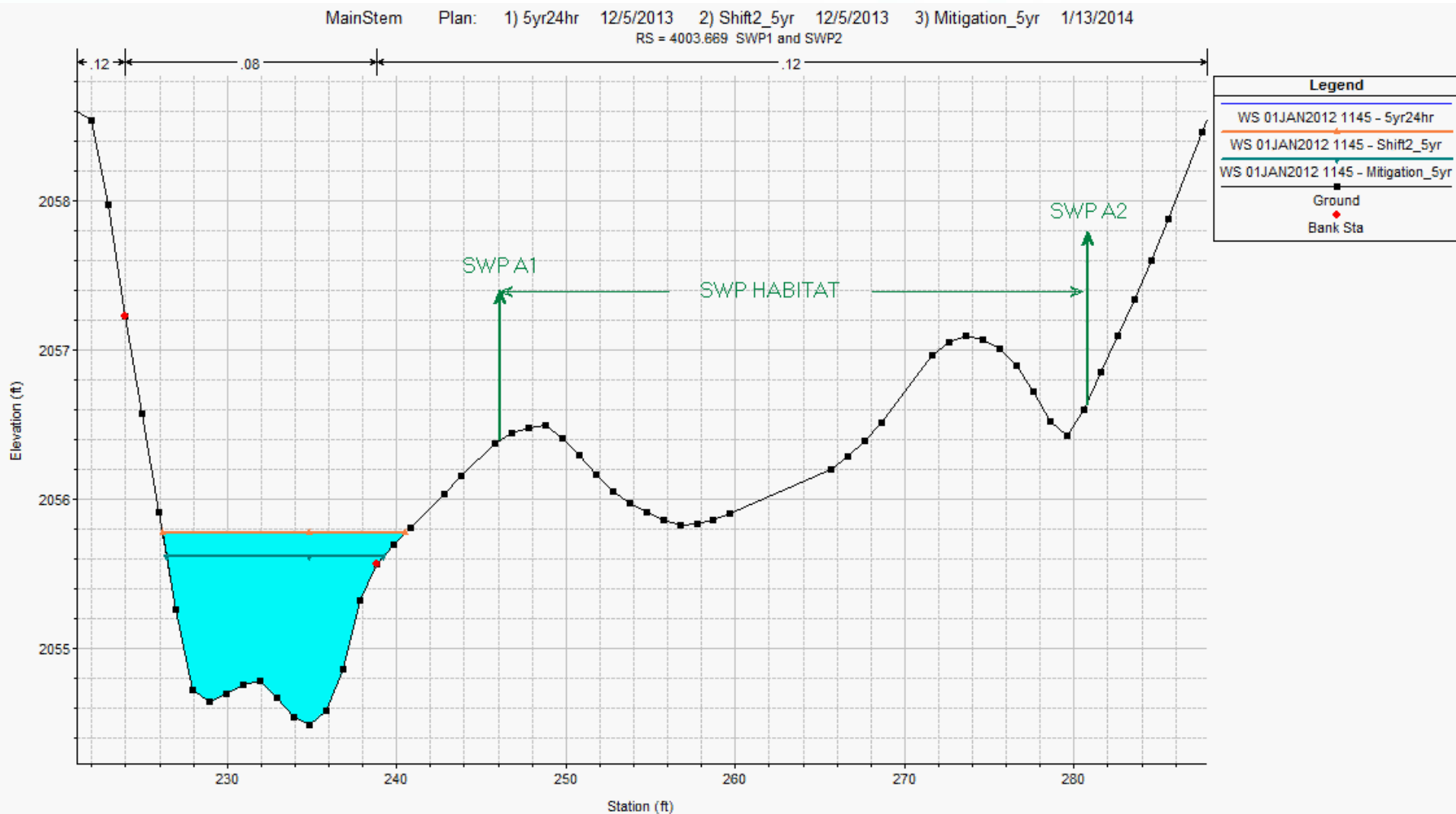
# 1.5-yr WSEL Animation at SWP A1, and A2



# 2-yr WSEL Animation at SWP A1 and A2

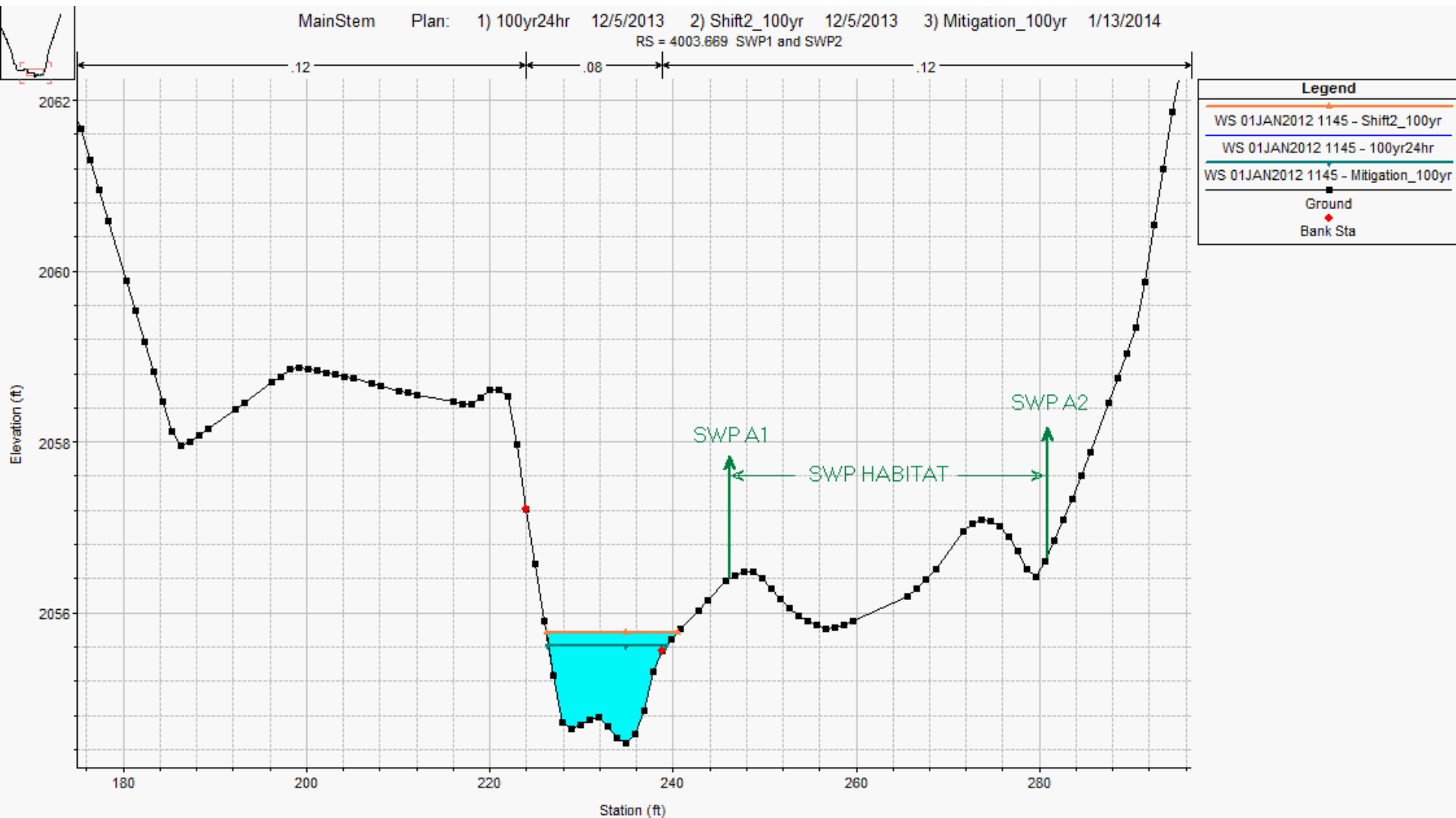


# 5-yr WSEL Animation at SWP A1 and A2

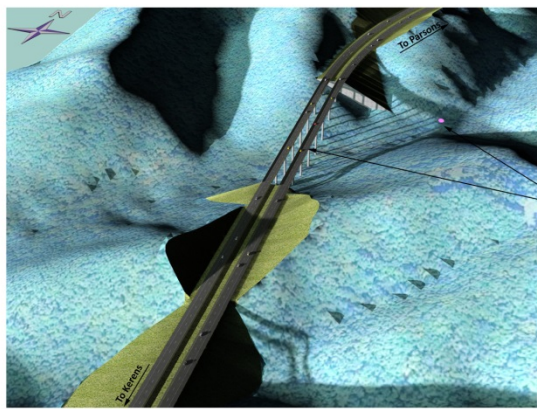




# 100-yr WSEL Animation at SWP A1 and A2

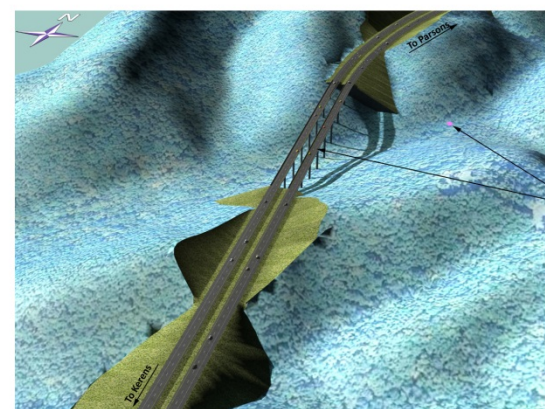


# Shadow Modeling Study at SWP



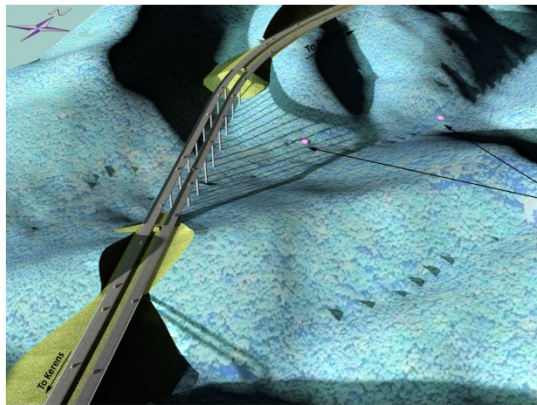
SWP Population

**PA-SDEIS Preferred Alignment**



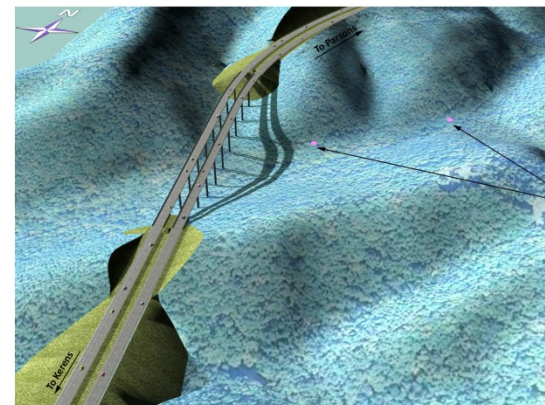
SWP Population

**PA-SDEIS Preferred Alignment**



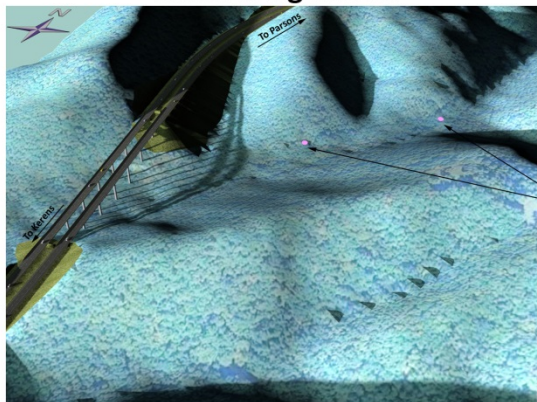
SWP Population

**Shift 1 Alignment**



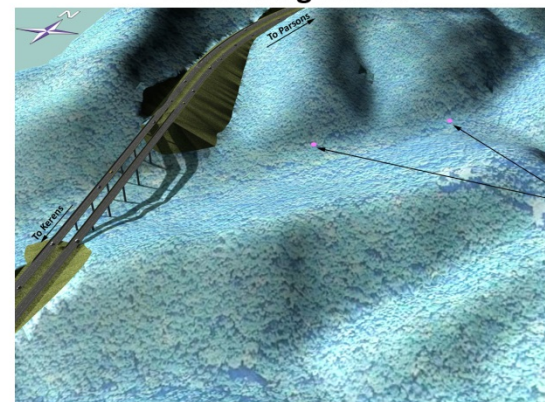
SWP Population

**Shift 1 Alignment**



SWP Population

**Shift 2 Alignment**



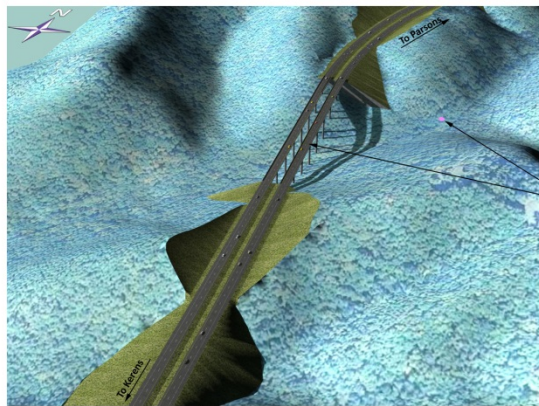
SWP Population

**Shift 2 Alignment**

**Panther Run Shadow Study**  
December 21st at 5:00 PM

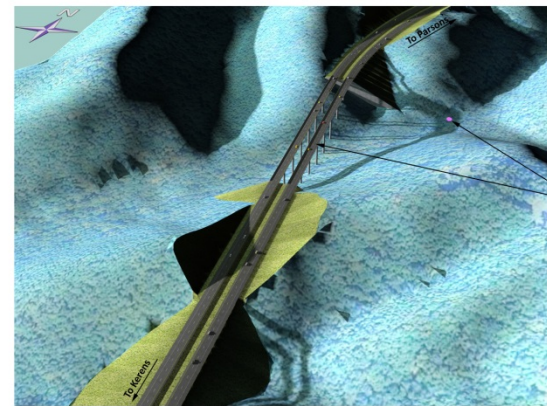
**Panther Run Shadow Study**  
June 21st at 6:00 PM





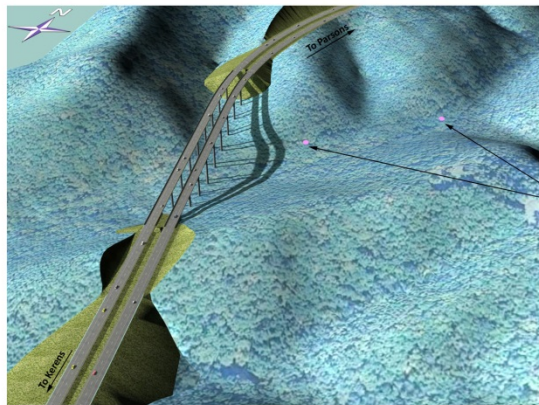
SWP Population

**PA-SDEIS Preferred Alignment**



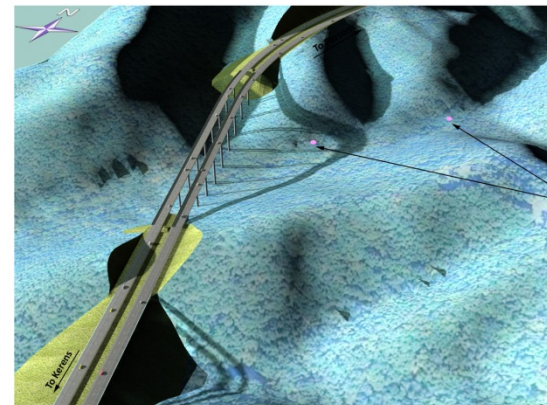
SWP Population

**PA-SDEIS Preferred Alignment**



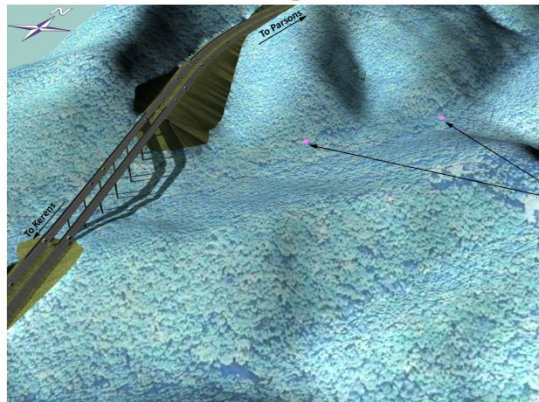
SWP Population

**Shift 1 Alignment**



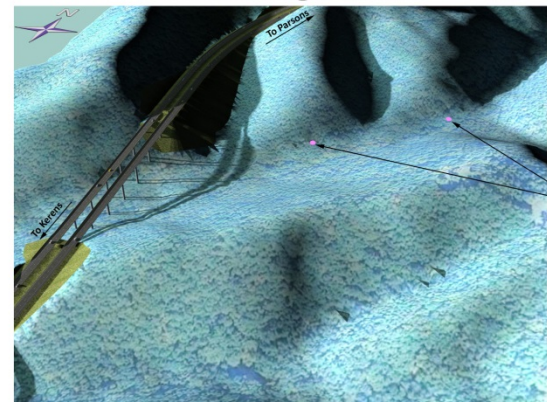
SWP Population

**Shift 1 Alignment**



SWP Population

**Shift 2 Alignment**



SWP Population

**Shift 2 Alignment**

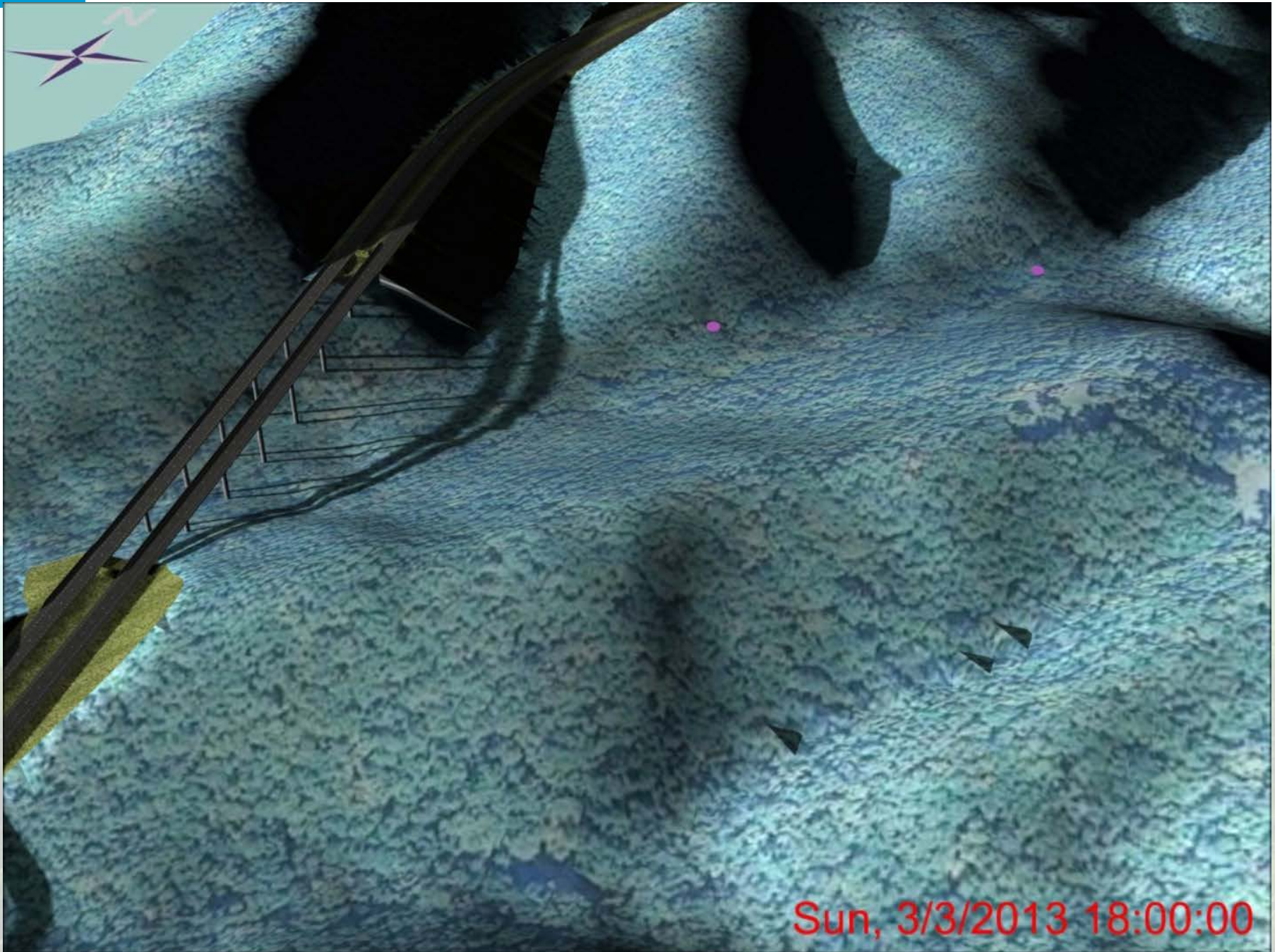
**Panther Run Shadow Study**  
March 21st at 5:00 PM

**Panther Run Shadow Study**  
September 22st at 6:00 PM

PA SDEIS  
Alignment  
March thru  
October



# Shadow Study – Shift 3 Alignment – March to October



Sun, 3/3/2013 18:00:00



# **Panther Run Storm Water Pollution Prevention Plan (SWPPP)**

## **Potential Strategies**

# General Management Controls

**Critical Source Control Elements to prevent rainfall and runoff from contacting potential pollutants**

➤ **Site Management – Good Housekeeping**

- Inventory on-site products and store chemicals safely
- Cover and berm stockpiles

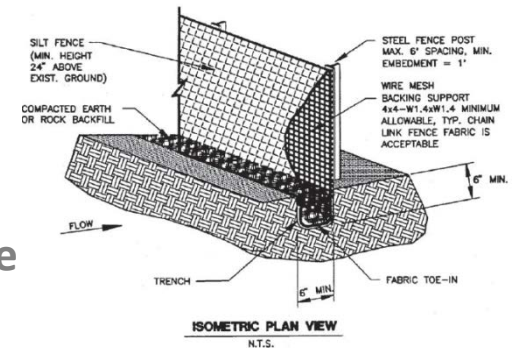
➤ **Non-storm Water Management**

- Eliminate non-stormwater (SW) un-permitted discharge
- Minimize allowable non-SW discharge

➤ **Erosion and Sediment Controls**

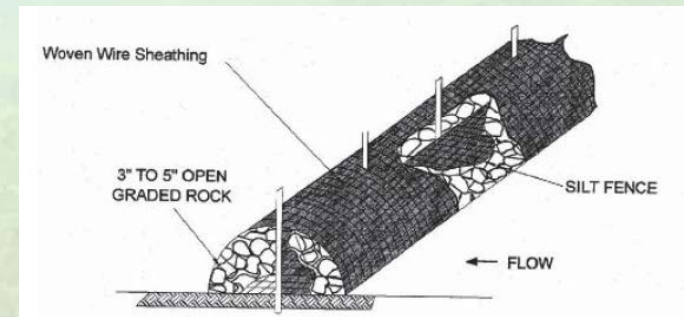
- Referenced in SWPPP Maps
- Limit disturbance of vegetation and topsoil where possible (perimeter controls)
- Using SWPPP development and BMP guidance documents from:
  - California Stormwater Quality Association (CASQA)
  - TCEQ Edwards Aquifer Guidance
  - Dr. Michael Barrett (University of Texas)
  - California Department of Transportation

**Silt Fence**



Complying with the Edward Aquifer Rules (TCEQ)

**Rock Berm**



Complying with the Edward Aquifer Rules (TCEQ)

# Structural BMPs

Project could incorporate the most effective controls to protect sensitive habitat, including consideration of:

## ➤ Pre-Construction BMPs:

- Silt Fence
- Check Dams
- Fiber Rolls
- Storm Drain Inlet Protection

## ➤ Post-Construction BMPs:

- Detention Ponds
- Infiltration Basin / Trench
- Retention / Irrigation
- Wet Basins
- Vegetated Strips and Swales
- Bio-retention
- Media Filter

### Media Filter



#### Description

Stormwater media filters are usually two-chambered including a pretreatment settling basin and a filter bed filled with sand or other absorptive filtering media. As stormwater flows into the first chamber, large particles settle out, and then finer particles and other pollutants are removed as stormwater flows through the filtering media in the second chamber. There are a number of design variations including the Austin sand filter, Delaware sand filter, and multi-chambered treatment train (MCIT).

#### California Experience

Caltrans constructed and monitored five Austin sand filters, two MCITs, and one Delaware design in southern California. Pollutant removal was very similar for each of the designs; however operational and maintenance aspects were quite different. The Delaware filter and MCIT maintain permanent pools and consequently mosquito management was a critical issue, while the Austin style which is designed to empty completely between storms was less affected. Removal of the top few inches of sand was required at 3 of the Austin filters and the Delaware filter during the third year of operation; consequently, sizing of the filter bed is a critical design factor for establishing maintenance frequency.

#### Advantages

- Relatively high pollutant removal, especially for sediment and associated pollutants.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency relationships resulting from the increase of impervious cover in a watershed.

#### Limitations

### TC-40

#### Design Considerations

- Aesthetics
- Hydraulic Head

#### Targeted Constituents

- |  |   |
|--|---|
| <input checked="" type="checkbox"/> Sediment       | ■ |
| <input checked="" type="checkbox"/> Nutrients      | ● |
| <input checked="" type="checkbox"/> Trash          | ■ |
| <input checked="" type="checkbox"/> Metals         | ■ |
| <input checked="" type="checkbox"/> Bacteria       | ▲ |
| <input checked="" type="checkbox"/> Oil and Grease | ■ |
| <input checked="" type="checkbox"/> Organics       | ■ |

#### Legend (Removal Effectiveness)

- |          |        |
|----------|--------|
| ● Low    | ■ High |
| ▲ Medium |        |



# Structural BMPs

## Infiltration Basin



Source: Caltrans

## Media Filter



Source: Stanard et al. (2008)

## Sand Filter



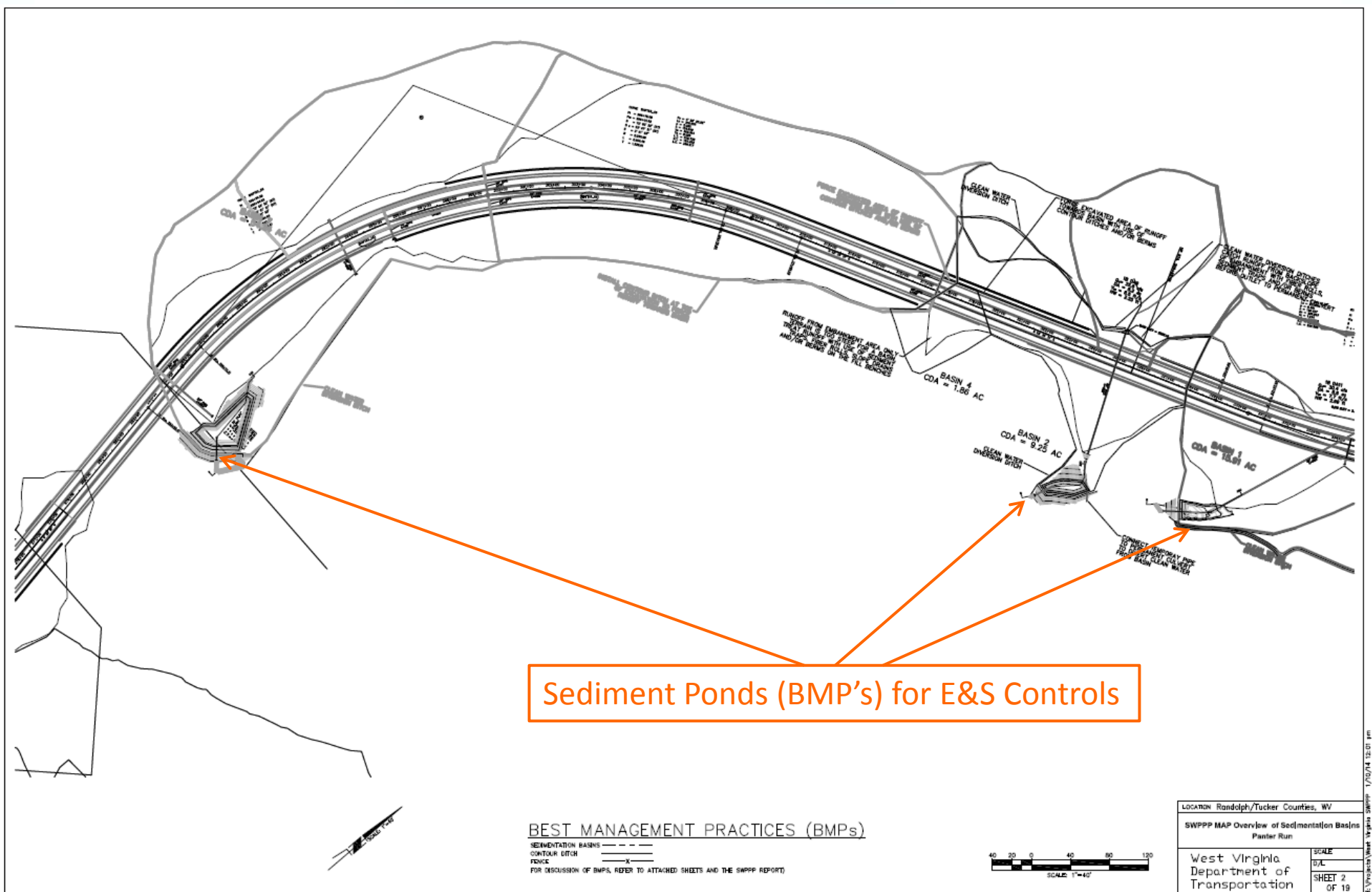
Source: Caltrans

## Vegetated Swale



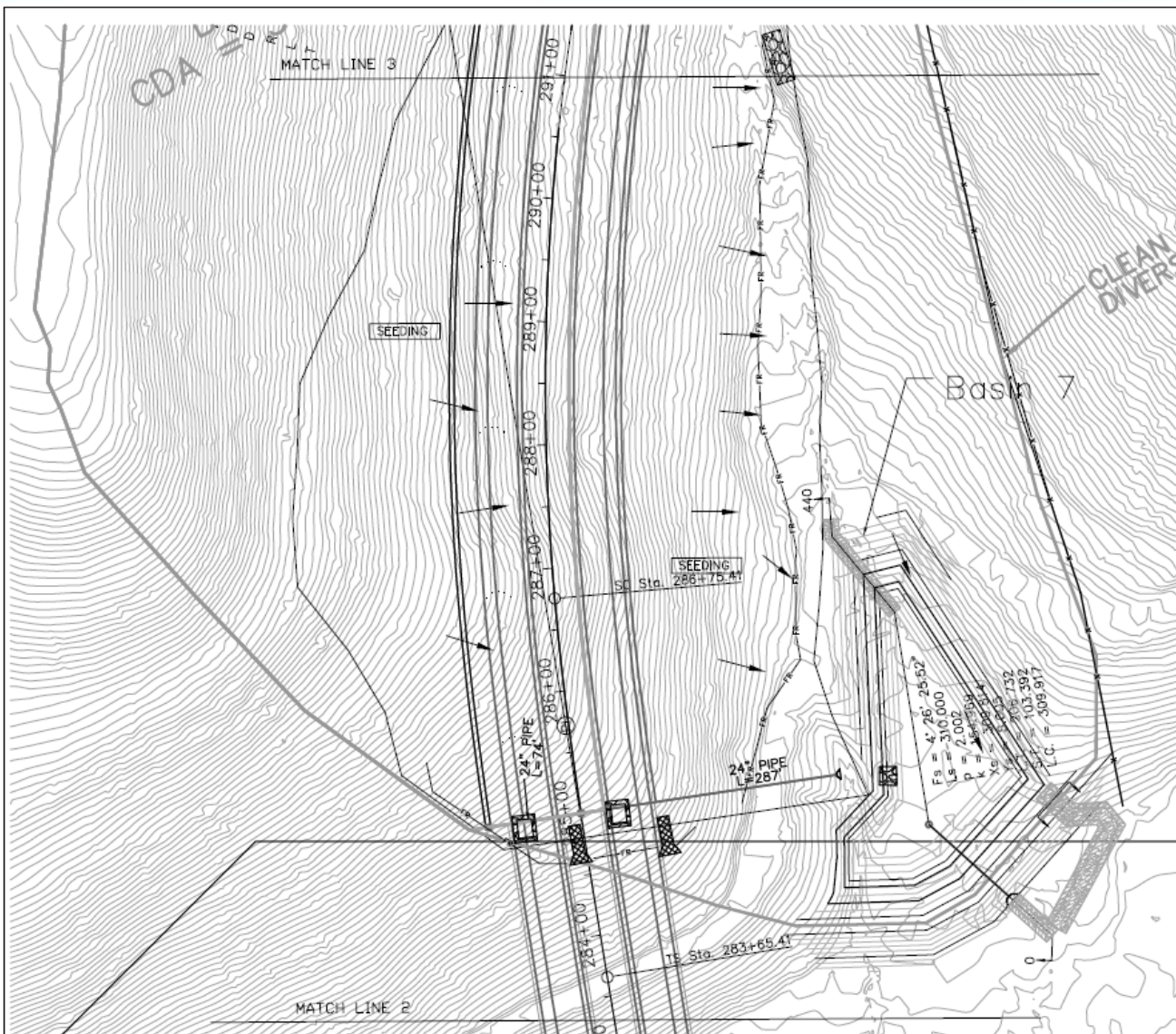
Source: Caltrans

# Shift 3 BMP's Conceptual Plan - Overview Map





# Shift 3 BMP's Conceptual Plan – Basin 7



## BEST MANAGEMENT PRACTICES (BMPs)

TYPICAL AT EACH CONSTRUCTION WORK AREA (REFER TO THE SWPPP REPORT)

SCHEDULING	MATERIAL DELIVERY AND STORAGE
PRESERVATION OF EXISTING VEGETATION	MATERIAL USE
WATER CONSERVATION PRACTICES	STOCKPILE MANAGEMENT
PAVING AND GRINDING OPERATIONS	SPILL PREVENTION AND CONTROL
LIQUID CONNECTION/DISCHARGE	SOIL WASTE MANAGEMENT
VEHICLE AND EQUIPMENT FUELING	HAZARDOUS WASTE MANAGEMENT
VEHICLE AND EQUIPMENT MAINTENANCE	CONTAMINATED SOIL MANAGEMENT
CONCRETE CURING	CONCRETE WASTE MANAGEMENT
CONCRETE FINISHING	SANITARY/SEPTIC WASTE MANAGEMENT
ACTIVE CONSTRUCTION BMPs (REFER TO SWPPP REPORT)	FINAL STABILIZATION BMPs (REFER TO SWPPP REPORT)
GEOTEXTILES AND MATS	NON-VEGETATIVE STABILIZATION
VELOCITY DISSIPATION DEVICES	
CHECK DAMS	
FIBER ROLLS	
STREET SWEEPING AND VACUUMING	
STABILIZED CONSTRUCTION ENTRANCE/EXIT	
WIND EROSION CONTROL	

## BMP LEGEND

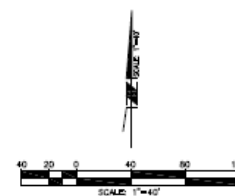
←	DIRECTION OF FLOWS
FR	FIBER ROLLS
—	CHECK DAMS
▨	STABILIZED CONSTRUCTION ENTRANCE
□	SILT FENCE
⊠	VELOCITY DISSIPATION DEVICES
⊞	INLET PROTECTION DEVICE
—	CONSTRUCTION BOUNDARY FENCE
—	CONTOUR DITCH

## TO BE FIELD LOCATED BY CONTRACTOR

□	TRAILER
⊠	CONCRETE WASHOUT
⊞	VEHICLE & EQUIPMENT MAINTENANCE/STORAGE AREA
⊞	STOCKPILE AREA
⊞	MATERIAL STORAGE
⊞	PORTABLE TOILET
⊞	CONSTRUCTION WASTE STORAGE

## NOTES

1. THE DITCH CHECK DEVICES SHALL BE SPACED IN ACCORDANCE WITH FIGURE 30.2.5.4 OF THE EROSION CONTROL MANUAL. THE SPACING IN FEET SHALL BE  $L=100/S$ , WHERE  $S$  IS SLOPE= RISE/RUN X 100. THERE WILL BE A MAXIMUM SPACING OF 50 FEET.
2. FIBER ROLLS, SILT FENCES, AND OTHER EROSION STRUCTURES WILL BE PLACED 10 FEET ABOVE THE TOPS OF CUTS AS DETAILED IN THE SWPPP. FOR AREAS DISTURBED AND NOT YET STABILIZED, SILT FENCES AND FIBER ROLLS WILL BE PLACED AT THE CORRECT SPACING AS DESCRIBED IN THE SWPPP REPORT.
3. A STABILIZED ENTRANCE/EXIT CONSISTING OF CRUSHED ROCK AND SHAKER PLATES SHALL BE INSTALLED AT ALL PROJECT ACCESS POINTS. THE STABILIZED ENTRANCE/EXIT SHALL REMAIN IN PLACE UNTIL A PAVED ACCESS DRIVEWAY IS INSTALLED.
4. ALL AREAS WITH DISTURBED AND EXPOSED SEDIMENTS SHALL BE STABILIZED WITH VEGETATION/NETTING ACCORDING TO THE SCHEDULE DESCRIBED IN THE SWPPP REPORT.
5. TEMPORARY BIRMS SHALL BE CONSTRUCTED AS NECESSARY DURING GRADING ACTIVITIES TO PREVENT EROSION.



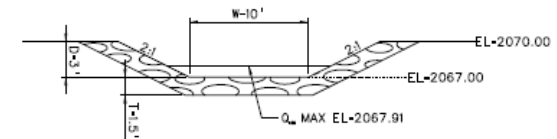
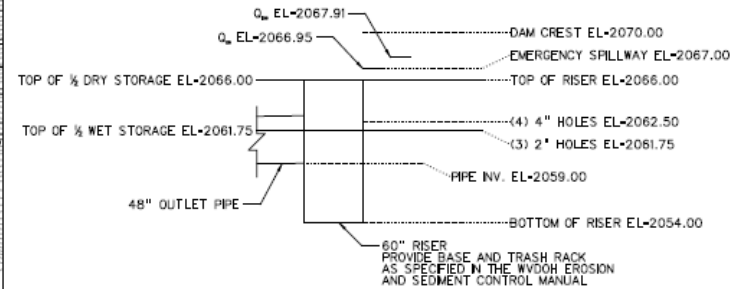
LOCATION: Randolph/Tucker Counties, WV
SWPPP MAP • Panther Run
West Virginia Department of Transportation
SCALE: D/A
SHEET 5 OF 19



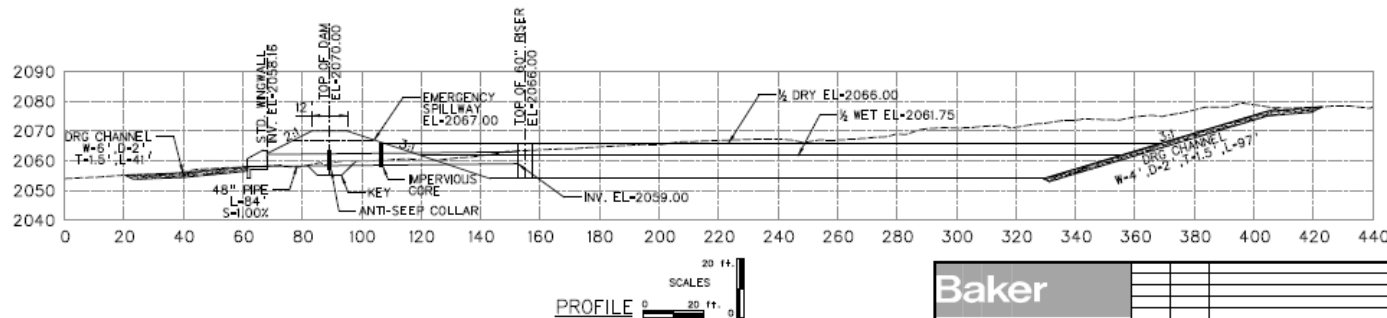
# Shift 3 BMP's Conceptual Plan – Basin 7

Public Agency	State Dist. No.	State Project No.	Federal Project No.	Fiscal Year	County	Sheet No.	Total Sheets
W. V.				200			

SEDIMENT BASIN #7	
CONTRIBUTING DRAINAGE AREA	= 54.24 ac
STORAGE REQUIRED	= 195,264 cf
STORAGE PROVIDED	= 205,350 cf



PLAN SCALE: 0 50 ft.



Baker

Michael Baker Jr., Inc.

REVISION	DATE	BY

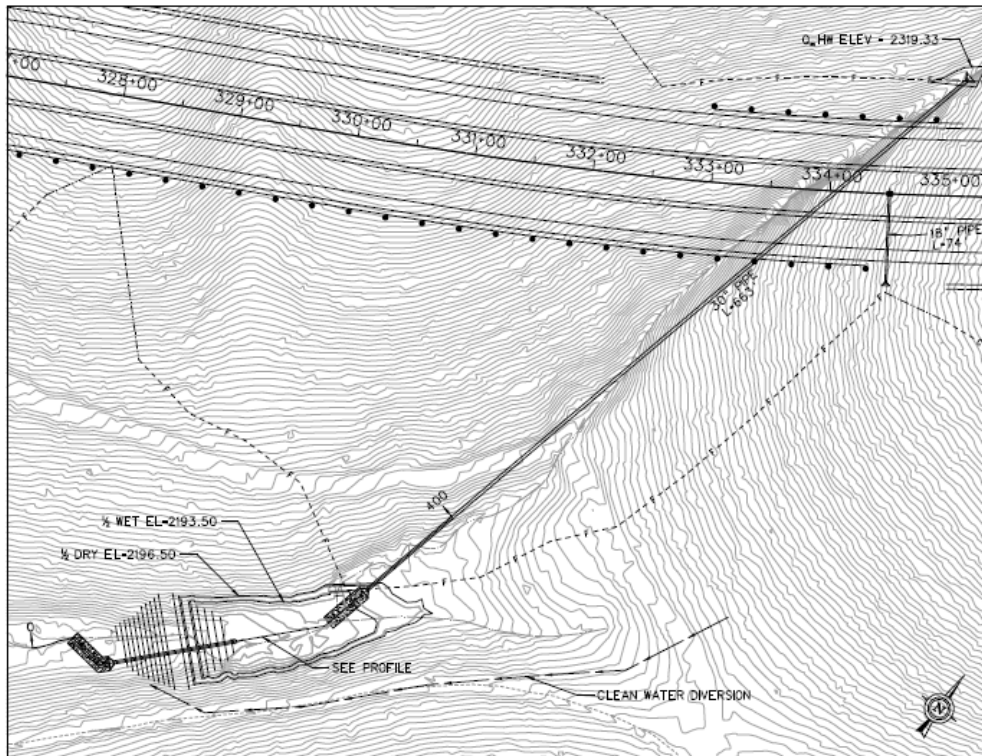
**PANTHER RUN BASIN #7**

THE WEST VIRGINIA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS

**TEMPORARY SEDIMENT BASIN  
DETAIL SHEET**

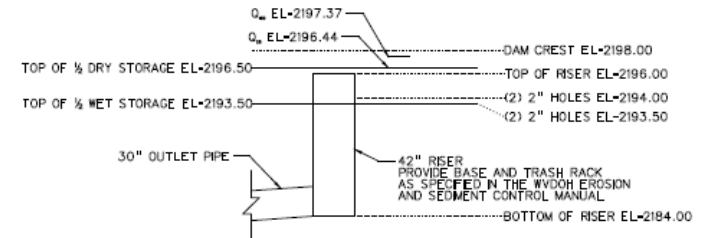
# Shift 3 BMP's Conceptual Plan – Basin 1

Pub. In Notes Sta.	Sheet Dist. No.	State Project No.	Federal Project No.	Fisc. Year	County	Sheet No.	Total Sheets
W. V.				200			

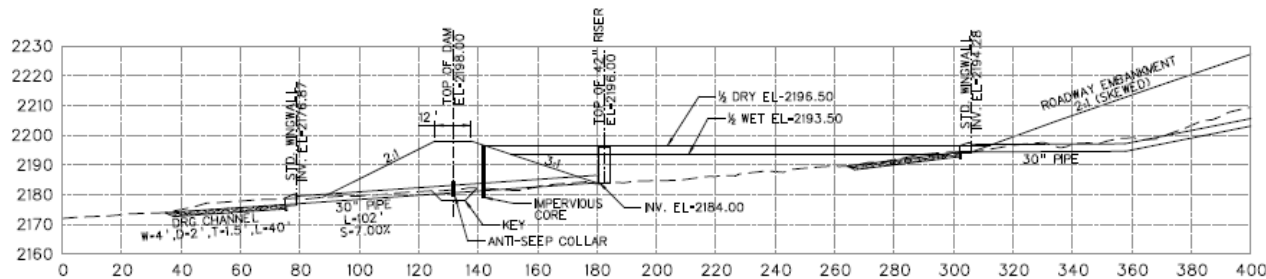


PLAN SCALE: 0 50 ft.

SEDIMENT BASIN #1	
CONTRIBUTING DRAINAGE AREA	15.91 ac
STORAGE REQUIRED	57,276 c.f.
STORAGE PROVIDED	60,898 c.f.



RISER DETAIL



PROFILE SCALE: 0 20 ft.

Baker

Michael Baker Jr., Inc.

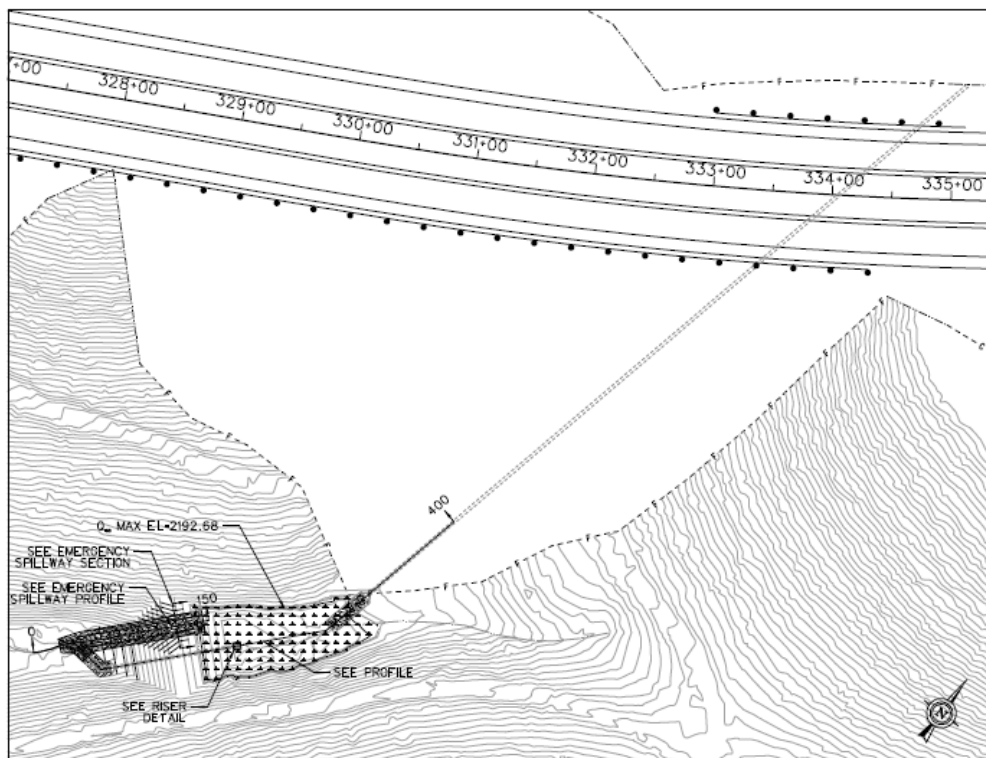
REVISION	DATE	BY

PANTHER RUN  
BASIN #1

THE WEST VIRGINIA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
**TEMPORARY SEDIMENT BASIN  
DETAIL SHEET**

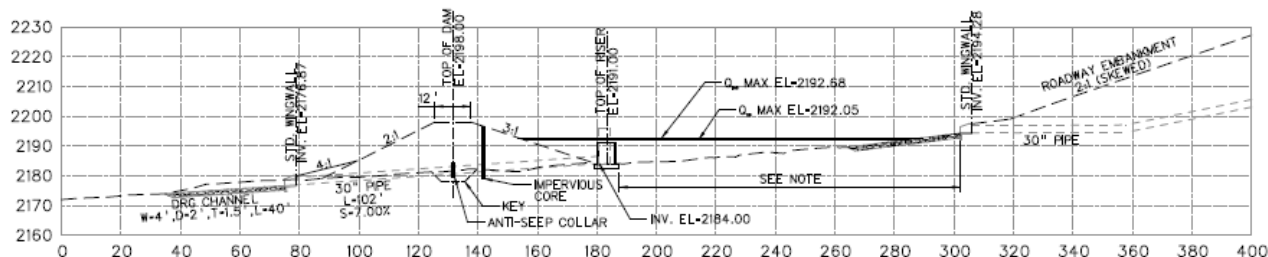
# Shift 3 BMP's Conceptual Plan – Basin 1

Public Route No.	State Dist. No.	State Project No.	Federal Project No.	Plant Year	County	Sheet No.	Total Sheets
W. V.				200			

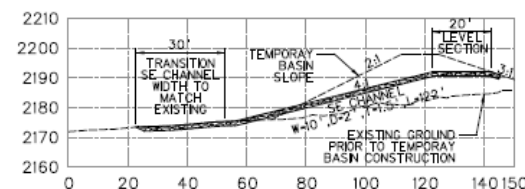


PLAN SCALE: 0 50 ft.

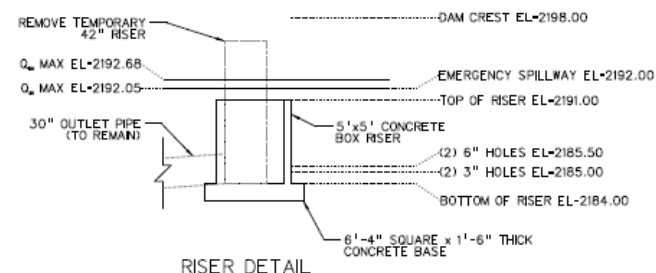
NOTE: AFTER THE BASIN HAS BEEN MODIFIED TO THE PERMANENT CONDITION AND SEDIMENT HAS BEEN REMOVED FROM THE TEMPORARY CONDITION, NATIVE SPECIES SHALL BE PLANTED IN THE BASIN TO CREATE A VEGETATIVE BUFFER BETWEEN THE OUTLET OF THE DRAINAGE CULVERT AND THE INLET OF THE CONCRETE BOX RISER.



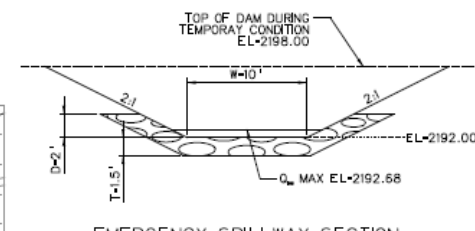
PROFILES  
0 20 ft. 0



EMERGENCY SPILLWAY PROFILE



RISER DETAIL



EMERGENCY SPILLWAY SECTION

PANTHER RUN  
BASIN #1

THE WEST VIRGINIA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
**PERMANENT DETENTION BASIN  
DETAIL SHEET**

Baker

Michael Baker Jr., Inc.

REVISION	DATE	BY



# Modeling Effort in Numbers

## Hydrology- HEC-HMS :

- **45** hydrologic elements (sub-basins, junctions, reaches, reservoirs) in hydrologic model.
- **8,496** Flow hydrographs generated in the HMS.
- **450MB** output file. (HEC-DSS)

## Hydraulics- HEC-RAS Unsteady

- **82** Unsteady Hydraulic model runs
- **97MB** – at **4.5 hours** when the runoff from the hypothetical 24-hr storm event is at its peak.
- **500MB** – for **24 hour** time period would result in each output file exceeding
- **8GB** plus Output data

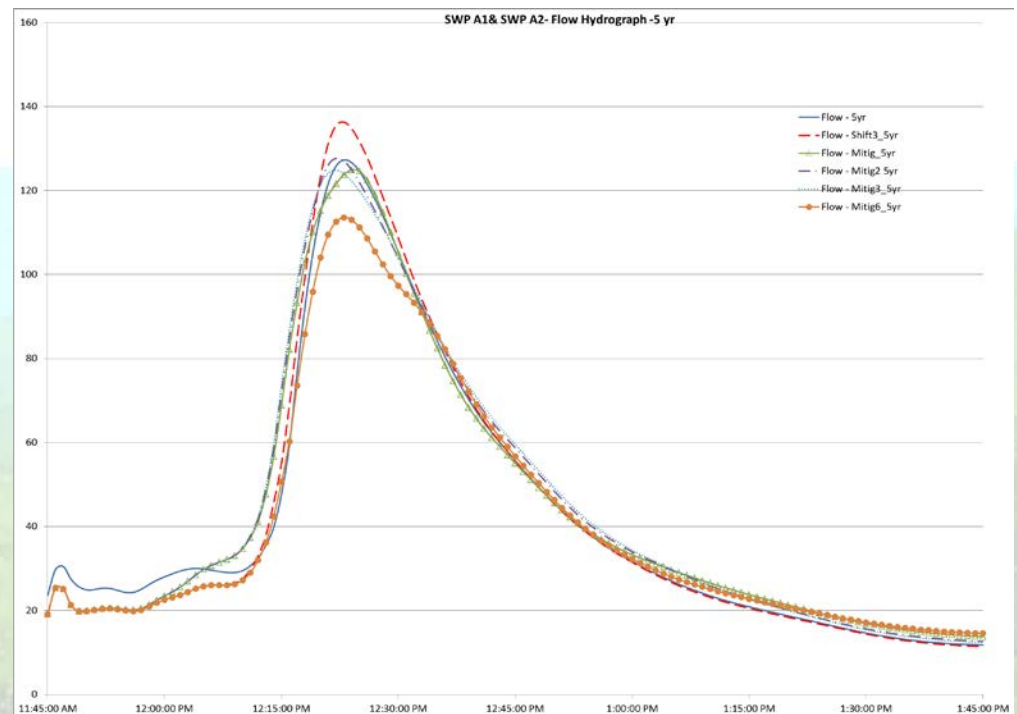
# Summary and Discussion

## Panther Run Watershed H&H analyses performed to:

1. Established **existing** hydrologic & hydraulic conditions at SWP Locations
2. Established **proposed** conditions due to roadway construction
3. Predicted **changes** due to the proposed roadway construction
4. **Conceptualized** mitigation measures and **Demonstrated** their effectiveness

H&H Models developed to predict changes in key H&H variables

- Peak Discharges
- WSEL or Stage
- Flow Depth
- Velocities
- Shear Stress
- Water Exposure Analysis



Hydrograph (Peak Discharge) – Comparing Existing/Shifts/Mitigation Conditions

# Project Team

## ■ Presenters – Baker/WVDOH Key Team Members



**Mohiuddin Shaik P.E., GISP, CFM**  
**Water Resources Engineering Manager**  
**Charleston, WV**

Email: [mshaik@mbakercorp.com](mailto:mshaik@mbakercorp.com)



**Brigham S. Ash, E.I.**  
**Highway Engineer Trainee**  
**WVDOH, H&D Unit**

Email: [Brigham.S.Ash@wv.gov](mailto:Brigham.S.Ash@wv.gov)

### Team Members:

**Douglas W. Kirk – WVDOH, Hydraulic & Drainage Unit**

**Lovell R. Facemire – WVDOH, Environmental Section**

**Lawrence D. Gale – Baker, Project Manager**

**Mohamed Bagha – Baker, H&H Engineer**