BIOLOGICAL ASSESSMENT

(continued)

APPENDIX V

ESA Avoidance and Minimization Plans

CONFIDENTIAL AND PRIVILEGED FILING

APPENDIX W

Pacific Connector's Waterbody Crossing Plans

Pacific Connector
GAS PIPELINE

Site Specific Plan
For
Open Cutting the North Fork Coquille River
At MP 23.06

Pacific Connector Gas Pipeline Project

June 9, 2008

Site Specific Plan For
Open Cutting
The North Fork Coquille River

PRE-CONSTRUCTION

General Description of the Area

The North Fork Coquille River is a perennial river located at approximately MP 23.06 (See North Fork Coquille SSP Drawings 3403-9_052), with a width of approximately 20-feet, in summertime conditions, and a depth ranging from 12 inches to 6 feet depending on the seasonal precipitation.

Vegetation immediately adjacent to the river banks includes primarily myrtle trees, however, Douglas fir and Red Cedar trees may also occur on the south side of the river. Blackberries, vine maple, other shrubs and grasses also occur as understory species along the river bank. The majority of the vegetation located within the confines of the Temporary Extra Work Area (TEWA) on west side of the river crossing is hayfields and pasture used for livestock grazing. TEWA on the east side of the river crossing is heavily forested with Douglas fir and Red Cedar trees.

In the Level 1 Scour Report compiled by GeoEngineers, Inc dated June 6, 2006 indicates the river banks are composed primarily of sand and gravel. The river bed is comprised of erosion resistant sedimentary bedrock. Several gravel bars overlie the bedrock in the channel and along the insides of the bends.

Based on the geologic information provided in the Level 1 Scour Report, as well as onsite investigations to determine conditions on the property immediately adjacent to the crossing, Pacific Connector Gas Pipeline, LP (Pacific Connector) expects a successful dry open cut crossing of the North Fork Coquille River via a flume or dam and pump crossing method.

Schedule

Contractor shall schedule the North Fork Coquille crossing such that all work is accomplished within the “fish window” which is July 1 through September 15. Company estimates the construction contractor will complete work during the Year 2 construction phase of the project. A presumed occupied Marbled Murrelet stand occurs on the forested slopes immediately south of the river crossing and where TEWA 23.09-N is located. This stand has not been surveyed or assessed for suitable nesting habitat, because of denied property access. This stand is not expected to cause seasonal timing conflicts with the proposed crossing schedule because other similar forested stands on BLM lands immediately adjacent to this stand have been surveyed and determined to not be suitable nesting habitat. The non-surveyed stand will be assessed for suitable Marbled Murrelet nesting habitat once access is provided. If the stand is determined to be suitable nesting habitat, consolation with the U.S. Fish and Wildlife Service and NOAA Fisheries will be reinitiated to determine the appropriate crossing schedule for both the stand and the river crossing.

Staking, Flagging and Signage

The right-of-way, TEWA, waterbody ordinary high water mark, and centerline for the pipeline will be staked before the contractor mobilizes to the work area. The contractor shall install signage addressing: fueling areas, waterbody, vehicle speed and access road identification. Wetland boundaries and any sensitive resource locations will also be marked with flagging, signage, and where appropriate, silt fenced.

Access

Contractor access to the west side of the North Fork Coquille Crossing is from Fairview Laverne Park Road to the construction right-of-way. As part of this river crossing a temporary bridge will be installed down stream of the river crossing location to allow construction personnel and equipment access to the east side of the river without creating a large equipment move around and heavy travel on the existing county roads. East side access is through Fisher Private Road to the construction right-of-way. The placement of the temporary access bridge will occur within the designated fish window and will require one pass across the river with installation equipment to place the bridge.

Workspace

TEWAs will be required to successfully construct the pipeline across the river, in addition to the 95 foot wide construction right-of-way on each side of the North Fork Coquille River. Four TEWAs adjacent to the construction right-of-way will be required to construct this crossing. As shown on the North Fork Coquille SSP Drawing 3403-9_052, there are two TEWAs located on the west side of the river. The NW TEWA is 0.59 acres (TEWA 22.59-N) and the SW TEWA is 0.68 acres (TEWA 23.09-W). There are two TEWAs located on the east side of the river crossing. The NE TEWA is 0.56 acres (TEWA 23.09-N) and the SE TEWA is 0.49 acres (TEWA 23.09-W). These TEWAs will be used for material and equipment staging and spoil storage as necessary.

Equipment and Materials

Equipment anticipated to construct the crossing consists of pickups, excavators, loaders, welding rigs, water pumps, bending machine, dozers, side-booms and other associated equipment. This equipment will be on-site when needed and located elsewhere on the project when not needed at this location. Materials will consist primarily of concrete coated pipe, flume pipe, timber mats, straw bales, silt fencing, plastic sheeting and sandbags for the dams. The Environmental Inspector (EI) will inspect all equipment and vehicles prior to entering the construction areas for the river crossing to ensure they are appropriately maintained, clean, are free of leaks and potential weed seed sources.

CONSTRUCTION

Pacific Connector's contractor will comply with the FERC Wetland and Water body Construction and Mitigation Procedures as well as all other federal, state and local permit conditions for both the wetland crossing and the water body crossing. This crossing will be conducted during the fish window and the dry low flow period between July 1 and September 15. This construction period will coincide with the lowest seasonal groundwater levels to minimize potential impacts associated with the river crossing. During the construction of the crossing, water quality monitoring will occur throughout the in-water construction phase as specified according to State and Federal permit conditions.

Environmental Controls

Sediment barriers shall be installed along edges of the right-of-way and the TEWAs to contain sediment and spoil within these workspaces from entering the waterbody. These barriers shall be maintained until revegetation is complete. The Environmental Inspector (EI) will be responsible for appropriate sediment barrier placement and maintenance during construction.

Clearing, Stripping and Grading

All brush and trees within the construction corridor will be cut at ground level. Stumps and root wads will be removed from the pipe ditch alignment. Any stumps in the workspace other than trench line will be cut to ground level. The topsoil will be segregated and stockpiled separately from the subsoil. The ordinary high water mark of the waterbody and any sensitive resource locations will also be marked with flagging, signage, and where appropriate, silt fences will be installed prior to grading activities.

Fluming North Fork Coquille River

Material

Steel pipe, plastic sheeting and sandbags will be the primary materials used in fluming of the North Fork Coquille River. The flume pipe will span the work area, have wings on upstream end sized appropriately for the river and will be clean and free of debris. Plastic sheeting will be at lease 10 mils thick and will have a width of at least 8 feet. The burlap sandbags will be filled with clean sand.

Flume Design

The flume pipe will incorporate wings welded on the upstream end to funnel the water flow into the flume pipe. The wings will extend to each bank and will be angled slightly upstream. The flume pipe will be approximately 95 feet in length with the pipe diameter to be determined in the field being based upon stream flow at the time of construction and anticipated seasonal storm events. The two ends of the flume pipe will be sandbagged and lined with plastic sheeting to seal the dam, as necessary. Sandbag material shall be a non-leachable material. A temporary equipment bridge will be installed downstream of the flume to allow equipment and personnel to access both sides of the river crossing during the construction window.

Flume Installation

The contractor will install 3 to 4 rows of sandbags on the upstream and downstream river beds, each with two sandbag layers. Sandbags will be packed as tightly as is possible. Once these first sandbags are in place, the flume pipe will be lowered into position.

After the flume pipe is laid on the sandbags, the contractor shall begin to build the upstream dam. The winged portion of the pipe will be pushed into the banks with sandbags put on each side of the wings to provide an adequate seal. The dams should extend three feet above water level of the river. Once the upstream and downstream flume dams have been installed and the work area has been isolated from river flow, fish salvaging efforts and dewatering of the isolated work area will commence. All dewater pumps will be appropriately screened according to ODFW and NOAA standards to prevent fish entrainment. Fish salvage efforts will be conducted by an ODFW certified biological contractor. Because of the potential presence of migrating adult spring chinook at the time of the crossing, the work area will be flushed out prior to installation of the flume to ensure adults are not initially trapped within the initial flume dams as requested by ODFW during a site visit in early 2008.

Pump containment will consist of an impervious straw bale structure, or other appropriate containment structure, surrounding the pumps. The bales will be secured to the ground with wooden stakes to secure the structure. The pumps will remove water from between the flume dams and discharge the water through hose pipe into a dewatering structure.

The dewatering structure will be constructed of straw bales and is designed to diffuse the energy in the pump discharge, filter the water, and create a sheet flow discharge of the water over the structure walls. The dewatering structure will be located so that discharge from the structure does not flow to work areas or to the river.

Trenching, Pipe Installation and Backfilling

Pipeline trenching will begin with a track hoe/excavator on each side of the river bank trenching under the flume and proceeding through the banks. Bedrock may be encountered on the river bed based on the information contained in the scour report compiled by GeoEngineers. A hard plug will be maintained near the river bank to maintain separation of the open trench and river channel. The drag section for the river crossing will placed under the flume as soon after the trench has been excavated to design depths as specified to accommodate potential scour. The drag section will be prefabricated and readied for installation prior to any in-stream trenching operations.

Spoil from the trenching to install the initial drag section under the flume will be stockpiled in the TEWAs. Since the topography of the TEWAs are flat, spoil storage runoff should not be an issue but silt fence and straw bales will be installed to contain the excavated river spoil.

Pumping of water from the trench may become necessary to avoid overflow from the two flume dams. Discharge will be through a discharge structure in an upland area to assure filtered dissipation back to the ground.

Backfilling with the stored spoil will begin under the flume pipe proceeding simultaneously through the river banks toward the ends of the pipe section. The backfilling will be restricted to assure the displaced water in the ditch can be adequately handled by the pumps. As the river is backfilled, the river bed will be recontoured and compacted to its preconstruction condition. Impermeable trench plugs will be installed and the river banks will be stabilized. The top one foot of the trench will be backfilled with washed gravel appropriately sized for spawning habitat.

Flume Removal

The downstream sandbags covering the flume pipe will be removed first shortly after completing the crossing. Sandbags under the flume pipe on the downstream end will be left in place until the flume pipe is removed. The sandbags covering the upstream end of the flume pipe will then be removed slowly by hand. After the water flow through the construction area is reconnected, the remainder of the sandbags and the flume pipe will be removed. The flume pipe will be lifted from its perch, not drug or pulled from its location.

Alternate Dam and Pump Option

It should be noted that if the seasonal flows are low enough, the construction contractor may choose to dam and pump this river crossing. Should this type of crossing be chosen, the contractor would install a temporary dam on the upstream side of the construction right-of-way and then install an isolation dam on the downstream side of the construction right-of-way. These isolation dams may be constructed of steel plates, sandbags, porta-dams, aqua dams or other similar devices that provide the same function and would be sited at the same location as the flume entrance and exit spots.

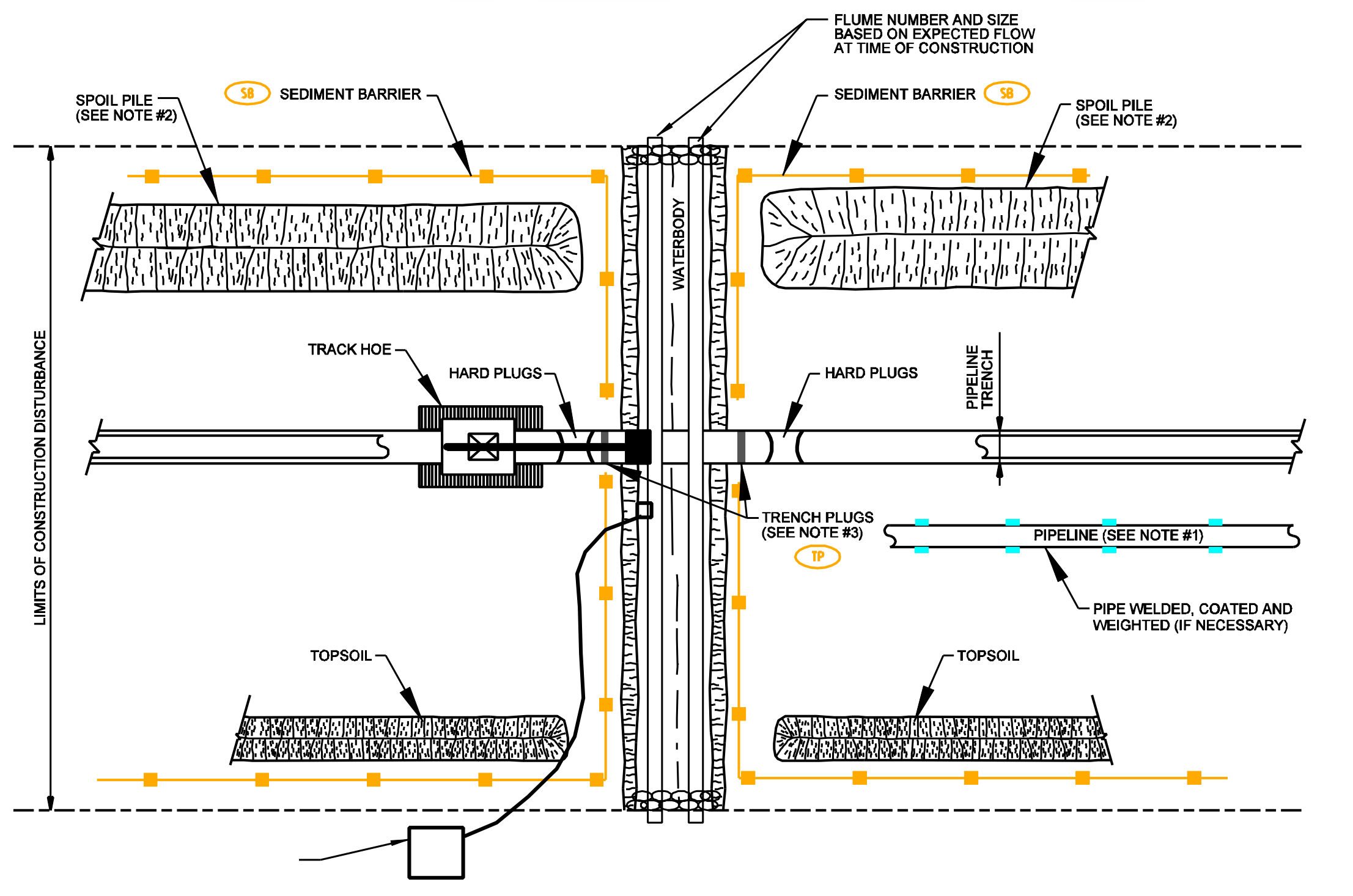
After the isolation dams have been installed, fish salvaging efforts will be completed within the isolation dams and the isolated area dewatered. Fish salvage efforts will be conducted by an ODFW certified biological contractor, as with a flumed crossing method

As soon as the work area is appropriately isolated, the pipeline trench will be excavated across the river. The pipeline trench will be excavated to design depths as specified to accommodate potential scour. If bedrock is encountered during excavation; the top of pipe will be buried 24 inches below the top of bedrock.

After the pipe strings have been tied-in, the pipeline trench will be backfilled with the native material excavated from the trench and the contours of the river bed and river banks will be restored to approximate preconstruction contours. The top one foot of the trench will be backfilled with washed gravel appropriately sized for spawning habitat. The isolation dams will be removed with the downstream dam being removed prior to the upstream dam.

Restoration and Habitat Improvements

During clean up, the river banks will be returned to approximate preconstruction contours or to a stable slope (i.e., 3:1) and stabilized with erosion control fabric as necessary. River banks will be reseeded and the river banks and riparian areas will be planted with appropriate riparian tree and shrub species using the procedures outlined in the Pacific Connectors Erosion Control and Revegetation and in accordance with the FERC Wetland and Waterbody Construction and Mitigation Procedures as well as applicable federal, state, and local permit conditions. Shrub cuttings will be planted on 3-4 foot centers except for a 10-foot corridor center over the pipeline to facilitate operational surveys. Final soil erosion measures will be installed and maintained until the area is successfully revegetated.



TYPICAL DRY OPEN-CUT (FLUMED)
WATERBODY CROSSING

OPEN CUT NOTES:

1. Designated workspace shown on the site specific plans is for spoil storage located on either side of the waterbody crossing adjacent to the proposed pipeline alignment. Additional Temporary Extra Work Area (TEWA) is necessary for support equipment/vehicles, supplies and materials, access to construction areas, including the temporary diversion channel and in stream diversion structures. Sediment barriers will be installed around workspace areas and spoil storage areas, where necessary to protect the waterbody from surface runoff.
2. The waterbody crossing will be installed as expeditiously as possible to minimize impacts to the waterway. The pipe trench will be backfilled using the native material excavated from the trench. Trench plugs will be installed at the banks on either side of the waterway.
3. If the waterway is navigable or used by recreational boaters, a mitigation plan for traffic interruption will be prepared.
4. Erosion and sediment control measures shall be inspected daily and repaired if necessary.
5. Schedule crossing during ODFW designated in water work window period between July 1 and September 15.
6. No refueling of mobile equipment within 100 feet of stream bank. Place sign posts 100 feet

   back from wetland boundary and advise no refueling. Refuel stationary equipment as per SPCC plan.
7. Leave hard plugs at the stream bank edge, until just prior to pipe installation.
8. Maintain stream flow throughout crossing construction.
9. Restore watercourse channel to approximate pre-construction profile and substrate.
10. This typical drawing is preliminary. Site specific design details will be completed prior to construction, based on site specific conditions at the time of construction. Construction phase sequence and specific details outlined in the site-specific plan may be approved in writing based on contractors written recommendations.

DEWATER NOTES:

1. Dewater structure shall be placed on a level, well vegetated site such that filtered water will flow away from structure and any work areas.
2. Flow rates into the discharge shall be such that water will be filtered through the structure and allowed to overflow.
3. Contractor shall utilize certified noxious weed free hay for structure.
4. Dewatering structures will be constructed and maintained according to the dewatering structure typical drawings found in the Erosion Control & Revegetation Plan (ECRP).

LEGEND

🟥	36-inch Proposed PCGP Project

Construction Right-of-Way

☐	Temporary Construction Right-of-Way (Shown as white on photography)
▨	Temporary Extra Work Area
▨	Uncleared Storage Area
-·-·	Access Road
✕✕✕	Drivable Berm or Straw Bales
⊏	Silt Fence

REFERENCE DRAWINGS

DRAWING NO.	TITLE
3430.29-023	CONSTRUCTION ALIGNMENT

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
1	JUNE-2007	KLL	PREFILING 3rd DRAFT			
2	SEPTEMBER-2007	KLL	ISSUED FOR FERC FILING			

PACIFIC CONNECTOR GAS PIPELINE PROJECT
PACIFIC CONNECTOR GAS PIPELINE, LP
NORTH FORK OF COQUILLE RIVER - OPEN CUT
MILE POST 23.06
SEC. 25, T-27-S, R-12-W
COOS COUNTY, OREGON

Pacific Connector GAS PIPELINE

DRAWN BY: KLL / JST	DATE: 5-29-2008	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY:	DATE:	ISSUED FOR CONSTRUCTION:	
APPROVED BY:	DATE:	DRAWING NUMBER: 3430.9-052 6/9/2008 %DATE% Q:\Oregon_gas\Mapping\Waterbodies\3430_9-052.dgn	SHEET OF
WO:			

Pacific Connector
GAS PIPELINE

Site Specific Plan
For
Open Cutting East Fork Coquille River
At MP 29.88

Pacific Connector Gas Pipeline Project

June 9, 2008

Site Specific Plan For
Open Cutting
The East Fork Coquille River

PRE-CONSTRUCTION

General Description of the Area

The East Fork Coquille River is a perennial river located at approximately MP 29.88 (See East Fork Coquille SSP Drawings 3403-9_053), with a width of approximately 30-feet, in summertime conditions, and a depth ranging from a few inches to 6 feet depending on the seasonal precipitation.

Vegetation immediately adjacent to the west river bank includes blackberry thickets along with several smaller sized, alder and Red Cedar trees. Vegetation immediately adjacent to the east river bank includes blackberry thickets willow and dogwood shrubs, Douglas fir and Red Cedar trees of various sizes. The majority of the vegetation located within the confines of the Temporary Extra Work Area (TEWA) on both sides of the river crossing is farm hayfields and pasture used for livestock grazing.

Two soil borings were taken on the west side of the East Fork Coquille crossing location. The soil analysis indicated alluvial soils generally consisting of medium stiff silts and loose to medium dense sands to a depth of approximately 15-feet. Weak to moderately strong siltstone was discovered below the alluvial soils in each of the borings down approximately 100-feet according to the GeoEngineers, Inc East Fork Coquille River-Feasibility Report dated June 19, 2006.

To facilitate the dry open cut of the East Fork Coquille River, the pipeline alignment was modified from Environmental Alignment Sheet 29 to the current layout on shown on the East Fork Coquille SSP Drawings 3403-9_053. The change was made to allow for a perpendicular crossing of the river which will help mitigate disturbances to the river, minimize riparian vegetation removal, and ensure a successful crossing. This realignment also avoids wetland BW250 and two potential Marbled Murrelet stands (G46 G47) which have not been surveyed because of denied access. Based on the geologic information provided in the GeoEngineers East Fork Coquille River-Feasibility Report dated June 19, 2006, as well as onsite investigations to determine conditions on the property immediately adjacent to the crossing, Pacific Connector Gas Pipeline, LP (Pacific Connector) expects a successful dry open cut crossing of the East Fork Coquille River via a flume or dam and pump crossing method.

Schedule

Contractor shall schedule the East Fork Coquille crossing such that all work is accomplished within the “fish window” which is July 1 through September 15. Company estimates the construction contractor will complete work during the Year 2 construction phase of the project.

Staking, Flagging and Signage

The right-of-way, TEWA, the waterbody ordinary high water mark, and centerline for the pipeline will be staked before the contractor mobilizes to the work area. The contractor shall install signage addressing: fueling areas, waterbody, vehicle speed and access road identification. Wetland boundaries and any sensitive resource locations will also be marked with flagging, signage, and where appropriate, silt fenced.

Access

Contractor access to the west side of the East Fork Coquille Crossing is from the Myrtle Point-Sitkum Road to the construction right-of-way. As part of this river crossing, a temporary bridge will be installed down stream of the river crossing location to allow construction personnel and equipment access to the east side of the river without creating a large equipment move around and heavy travel on the existing county roads. The placement of the temporary access bridge will occur within the designated fish window and will require one pass across the river with installation equipment to place the bridge.

Workspace

TEWAs will be required to successfully construct the pipeline across the river in addition to the 95 foot wide construction right-of-way on each side of East Fork Coquille River. Four TEWAs adjacent to the construction right-of-way will be required to construct the crossing. As shown on the East Fork Coquille SSP Drawing 3403-9_053, there are two TEWAs located on the west side of the river. The NW parcel is 0.74 acres (32,234 ft^2) and the SW parcel is 0.38 acres (16,552 ft^2). There are two TEWAs located on the east side of the river crossing. The NE parcel is 0.64 acres (27,878 ft^2) and the SE parcel is 0.48 acres (20,908 ft^2). These parcels will be used for material and equipment staging and spoil storage as necessary.

Equipment and Materials

Equipment anticipated to construct the crossing consists of pickups, excavators, loaders, welding rigs, water pumps, bending machine, dozers, side-booms and other associated equipment. The Environmental Inspector (EI) will inspect all equipment and vehicles prior to entering the construction areas for the river crossing to ensure they are appropriately maintained, clean, are free of leaks and potential weed seed sources. This equipment will be on-site when needed and located elsewhere on the project when not needed at this location. Materials will consist primarily of concrete coated pipe, flume pipe, timber mats, straw bales, silt fencing, plastic sheeting and sandbags for the dams.

CONSTRUCTION

Pacific Connector's contractor will comply with the FERC's Wetland and Water body Construction and Mitigation Procedures as well as all other federal, state and local permit conditions for both the wetland and the waterbody crossings. This crossing will be conducted during the fish window and the dry low flow period between July 1 and September 15. This construction period will also coincide with the lowest seasonal groundwater levels to minimize potential impacts associated with the river crossing.

Environmental Controls

Sediment barriers shall be installed along edges of the right-of-way and the TEWAs to contain sediment and spoil within these workspaces from entering the waterbody. These barriers shall be maintained until revegetation is complete. The EI will be responsible for appropriate sediment barrier placement and maintenance during construction. During the construction of the crossing, water quality monitoring will occur throughout the in-water construction phase as specified according to State and Federal permit conditions.

Clearing, Stripping and Grading

All brush and trees within the construction corridor will be cut at ground level. Stumps and root wads will be removed from the pipe ditch alignment. Any stumps in the workspace other than trench line will be cut to ground level. The topsoil will be segregated and stockpiled separately from the subsoil.

Fluming East Fork Coquille River

Material

Steel pipe, plastic sheeting and sandbags will be the primary materials used in fluming of the East Fork Coquille River. The flume pipe will span the work area, have wings on upstream end sized appropriately for the river and will be clean and free of debris. Plastic sheeting will be at lease 10 mils thick and will have a width of at least 8 feet. The burlap sandbags will be filled with clean sand.

Flume Design

The flume pipe will incorporate wings welded on the upstream end to funnel the water flow into the flume pipe. The wings will extend to each bank and will be angled slightly upstream. The flume pipe will be approximately 95 feet in length with the pipe diameter to be determined in the field being based upon stream flow at the time of construction and anticipated seasonal storm events. The two ends of the flume pipe will be sandbagged and lined with plastic sheeting to seal the dam. Sandbag material shall be a non-leachable material. A temporary equipment bridge will be installed downstream of the flume to allow equipment and personnel to access both sides of the river crossing during the construction window.

Flume Installation

The contractor will install 3 to 4 rows of sandbags on the upstream and downstream river beds, each with two sandbag layers. Sandbags will be packed as tightly as is possible. Once these first sandbags are in place, the flume pipe will be lowered into position.

After the flume pipe is laid on the sandbags, the contractor shall begin to build the upstream dam. The winged portion of the pipe will be pushed into the banks with sandbags put on each side of the wings to provide an adequate seal. The dams should extend three feet above water level of the river. Once the upstream and downstream flume dams have been installed and the work area has been isolated from river flow, fish salvaging efforts and dewatering of the isolated work area will commence. All dewater pumps will be appropriately screened according to ODFW and NOAA standards to prevent fish entrainment. Fish salvage efforts will be conducted by an ODFW certified biological contractor. Because of the potential presence of migrating adult spring chinook at the time of the crossing, the work area will be flushed out prior to installation of the flume to ensure adults are not initially trapped within the initial flume dams as requested by ODFW during a site visit in early 2008.

Pump containment will consist of an impervious straw bale structure, or other appropriate containment structure, surrounding the pumps. The bales will be secured to the ground with wooden stakes to secure the structure. The pumps will remove water from between the flume dams and discharge the water through hose pipe into a dewatering structure.

The dewatering structure will be constructed of straw bales and is designed to diffuse the energy in the pump discharge, filter the water, and create a sheet flow discharge of the water after traveling through the structure walls and into the ground. The dewatering structure will be located so that discharge from the structure does not flow to work areas or to the river.

Attached to this document are typical drawings depicting flumed stream crossing, pump containment structure, dewater structure, pipe placement plan view, sand bag dam, flume wings, and diversion structures.

Trenching, Pipe Installation and Backfilling

Pipeline trenching will begin with a track hoe/excavator on each side of the river bank trenching under the flume and proceeding through the banks. No bedrock is anticipated under the river per the information contained in the geotechnical report compiled by GeoEngineers. A hard plug will be maintained near the river bank to maintain separation of the open trench and river channel. The drag section for the river crossing will placed under the flume as soon after the trench has been excavated to design depths as specified to accommodate potential scour. The drag section will be prefabricated and readied for installation prior to any in-stream trenching operations.

Spoil from the trenching to install the initial drag section under the flume will be stockpiled in the TEWAs. Since the topography of the TEWAs are flat, spoil storage runoff should not be an issue but silt fence and straw bales will be installed to contain the excavated river spoil.

Pumping of water from the trench may become necessary to avoid overflow from the two flume dams. Discharge will be through a discharge structure in an upland area to assure filtered dissipation back to the ground.

Backfilling with the stored spoil will begin under the flume pipe proceeding simultaneously through the river banks toward the ends of the pipe section. The backfilling will be restricted to assure the displaced water in the ditch can be adequately handled by the pumps. As the river is backfilled, the river bed will be recontoured and compacted to its preconstruction condition. Impermeable trench plugs will be installed and the river banks will be stabilized. The top one foot of the trench will be backfilled with washed gravel appropriately sized for spawning habitat.

Flume Removal

The downstream sandbags covering the flume pipe will be removed first shortly after completing the crossing. Sandbags under the flume pipe on the downstream end will be left in place until the flume pipe is removed. The sandbags covering the upstream end of the flume pipe will then be removed slowly by hand. After the water flow through the construction area is reconnected, the remainder of the sandbags and the flume pipe will be removed. The flume pipe will be lifted from its perch, not drug or pulled from its location.

Alternate Dam and Pump Option

It should be noted that if the seasonal flows are low enough, the construction contractor may choose to dam and pump this river crossing. Should this type of crossing be chosen, the contractor would install a temporary dam on the upstream side of the construction right-of-way and then installing an isolation dam on the downstream side of the construction right-of-way. These isolation dams may be constructed of steel plates, sandbags, porta-dams, aqua dams or other similar devices that provide the same function and would be sited at the same location as the flume entrance and exit spots.

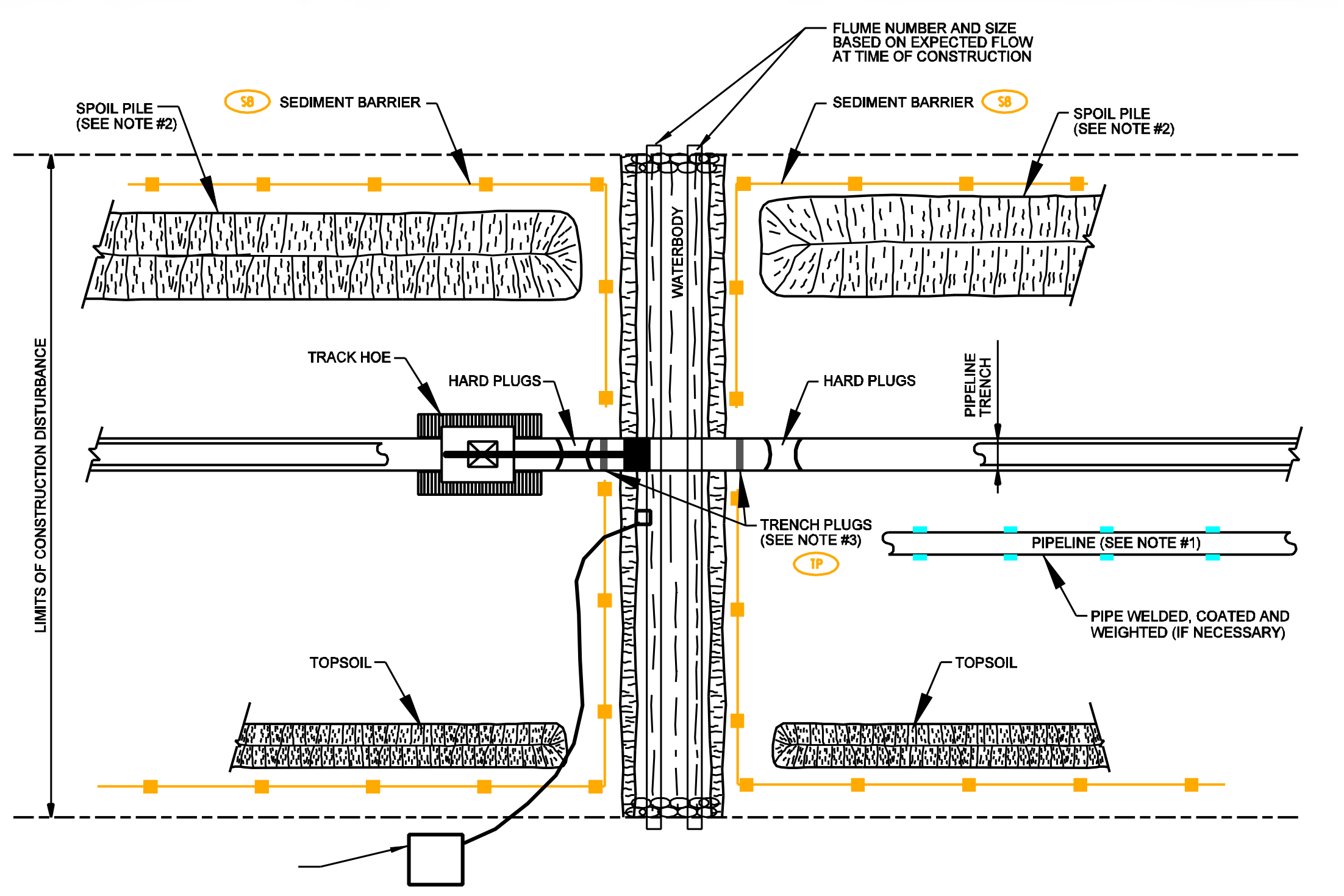
After the isolation dams have been installed, fish salvaging efforts will be completed within the isolation dams and the isolated area dewatered. Fish salvage efforts will be conducted by an ODFW certified biological contractor, as specified for the flumed crossing method.

As soon as the work area is appropriately isolated, the pipeline trench for the will be excavated across the river. The pipeline trench will be excavated to design depths as specified to accommodate potential scour. If bedrock is encountered during excavation; the top of pipe will be buried 24 inches below the top of bedrock.

After the pipe strings have been tied-in, the pipeline trench will be backfilled with the native material excavated from the trench and the contours of the river bed and river banks will be restored to approximate preconstruction contours. The top one-foot of the trench will be backfilled with washed gravel appropriately sized for spawning habitat. The isolation dams will be removed with the downstream dam being removed prior to the upstream dam.

Habitat Improvements

During clean up, the river banks will be returned to approximate preconstruction contours or to a stable slope (i.e., 3:1) and stabilized with erosion control fabric as necessary. River banks will be reseeded and the river banks and riparian areas will be planted with appropriate riparian tree and shrub species using the procedures outlined in Pacific Connectors Erosion Control and Revegetation Plan and in accordance with the FERC Wetland and Waterbody Construction and Mitigation Procedures as well as applicable federal, state, and local permit conditions. Shrub cuttings will be planted on 3-4 foot centers except for a 10-foot corridor center over the pipeline to facilitate operational surveys. Final soil erosion measures will be installed and maintained until the area is successfully revegetated.



TYPICAL DRY OPEN-CUT (FLUMED)
WATERBODY CROSSING

OPEN CUT NOTES:

1. Designated workspace shown on the site specific plans is for spoil storage located on either side of the waterbody crossing adjacent to the proposed pipeline alignment. Additional Temporary Extra Work Area (TEWA) is necessary for support equipment/vehicles, supplies and materials, access to construction areas, including the temporary diversion channel and in stream diversion structures. Sediment barriers will be installed around workspace areas and spoil storage areas, where necessary to protect the waterbody from surface runoff.
2. The waterbody crossing will be installed as expeditiously as possible to minimize impacts to the waterway. The pipe trench will be backfilled using the native material excavated from the trench. Trench plugs will be installed at the banks on either side of the waterway.
3. If the waterway is navigable or used by recreational boaters, a mitigation plan for traffic interruption will be prepared.
4. Erosion and sediment control measures shall be inspected daily and repaired if necessary.
5. Schedule crossing during ODFW designated in water work window period between July 1 and September 15.
6. No refueling of mobile equipment within 100 feet of stream bank. Place sign posts 100 feet

   back from wetland boundary and advise no refueling. Refuel stationary equipment as per SPCC plan.
7. Leave hard plugs at the stream bank edge, until just prior to pipe installation.
8. Maintain stream flow throughout crossing construction.
9. Restore watercourse channel to approximate pre-construction profile and substrate.
10. This typical drawing is preliminary. Site specific design details will be completed prior to construction, based on site specific conditions at the time of construction. Construction phase sequence and specific details outlined in the site-specific plan may be approved in writing based on contractors written recommendations.

DEWATER NOTES:

1. Dewater structure shall be placed on a level, well vegetated site such that filtered water will flow away from structure and any work areas.
2. Flow rates into the discharge shall be such that water will be filtered through the structure and allowed to overflow.
3. Contractor shall utilize certified noxious weed free hay for structure.
4. Dewatering structures will be constructed and maintained according to the dewatering structure typical drawings found in the Erosion Control & Revegetation Plan (ECRP).

LEGEND

- 36-inch Proposed PCGP Project
- Original Alignment

Construction Right-of-Way

- ☐ Temporary Construction Right-of-Way (Shown as white on photography)
- ▨ Temporary Extra Work Area
- ▨ Uncleared Storage Area
- Access Road
- Drivable Berm or Straw Bales
- Silt Fence

REFERENCE DRAWINGS

DRAWING NO.	TITLE
3430.29-029 & 030	CONSTRUCTION ALIGNMENT

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
1	JUNE-2007	KLL	PREFILING 3rd DRAFT			
2	SEPTEMBER-2007	KLL	ISSUED FOR FERC FILING			

PACIFIC CONNECTOR GAS PIPELINE PROJECT
PACIFIC CONNECTOR GAS PIPELINE, LP
EAST FORK OF COQUILLE RIVER - OPEN CUT
MILE POST 29.89
SEC. 10, T-28-S, R-11-W
COOS COUNTY, OREGON

Pacific Connector GAS PIPELINE SM

DRAWN BY: KLL / JST	DATE: 5-29-2008	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY:	DATE:	ISSUED FOR CONSTRUCTION:	
APPROVED BY:	DATE:	DRAWING NUMBER: 3430.9-053	SHEET
WO:		6/9/2008 %DATE% Q:\Oregon_gas\Mapping\Waterbodies\3430_9-053.dgn	OF

Pacific Connector

GAS PIPELINE

Site Specific Plan
For
Open Cutting South Umpqua #2
At MP 94.73

Pacific Connector Gas Pipeline Project

June 9, 2008

Site Specific Plan For
Open Cutting
The South Umpqua #2 River Crossing

PRE-CONSTRUCTION

General Description of the Proposed Crossing Area

The South Umpqua #2 River Crossing is a perennial river located at about MP 94.73, (See South Umpqua #2 SSP Drawings 3403-9_055), with a main channel width of approximately 60 feet in summertime conditions. The entire river width including the river channel and gravel bar along the west bank is approximately 175 feet from bank-to-bank at the proposed pipeline crossing location. The river depth ranges from a few inches to 15 feet depending on the precipitation.

Vegetation adjacent to South Umpqua River is mostly a growth of mixed conifer/mixed deciduous trees and shrubs.

The South Umpqua River #2 crossing river bed is comprised mostly of gravel and cobbles. Although bedrock is not observable on the streambed at the pipeline crossing, geotechnical borings located near the site taken by GeoEngineers, Inc. suggests that bedrock may underlie the channel floor at very shallow depths. Exploration of the bedrock contacts derived from the borings indicated that bedrock is likely present from 0.7 to 8.7 feet below the existing channel floor. The South Umpqua River #2 crossing river banks are comprised of alluvial gravel and cobbles underlain by bedrock. A collection of large angular boulders lie on the east bank and within the channel.

Based on the geologic investigation provided in the GeoEngineers Scour Report dated August 24, 2007, as well as onsite investigations to determine the river crossing conditions, Pacific Connector Gas Pipeline, LP (Pacific Connector) expects a successful dry open cut crossing of the South Umpqua River #2.

Schedule

Contractor shall schedule the South Umpqua #2 crossing such that all work is accomplished within the “fish window” which is July 1 through August 31. Pacific Connector estimates the construction contractor will complete work during the Year 2 construction phase of the project.

Staking, Flagging and Signage

The right-of-way, temporary extra work areas (TEWAs), the waterbody ordinary high water mark, and centerline for the pipeline will be staked before the contractor mobilizes to the work area. The contractor shall install signage addressing: fueling areas, vehicle speed, and access road identification. Wetland boundaries and any sensitive resource locations will also be marked with flagging, signage, and where appropriate, silt fenced.

Access

Contractor access to the west side of the river crossing is from Route 227/Tiller Trail Road, near the town of Milo in Douglas County, Oregon. To access the east side of the river, contactors will utilize the private bridge crossing to the Milo Academy depending on weight limits or will utilize a temporary bridge crossing. The temporary bridge would be installed within the construction right-of-way and would be set within the designated ODFW in-stream work window. One in-stream equipment pass may be necessary within the in-stream work window to install the temporary bridge.

Workspace

TEWAs will be required to successfully construct the pipeline across the river in addition to the 95 foot wide construction right-of-way. The TEWAs will be used for ingress and egress of construction personnel and equipment, material staging, and spoil storage as needed. All TEWAs will be reclaimed and revegetated to pre-construction conditions at the conclusion of the construction process. TEWA 94.69-W encompasses 0.6 acres. TEWA 94.69-N encompasses 1.93 acres and TEWA 94.77-W encompasses 0.22 acres. See Waterbody Crossing Drawing 3430_2-055 and Environmental Alignment sheet 67 for locations and geometry of the TEWA locations.

Equipment and Materials

Equipment is anticipated to consist of pickups, excavators, loaders, welding rigs, water pumps, a bending machine, dozers, side-booms and other associated equipment. The Environmental Inspector (EI) will inspect all equipment and vehicles prior to entering the construction areas for the river crossing to ensure they are appropriately maintained, clean, are free of leaks and potential weed seed sources. This equipment will be on-site when needed and located elsewhere on the project when not needed at this location. Materials will consist primarily of concrete coated pipe, flume pipe (if needed), timber mats, straw bales, silt fencing, plastic sheeting and sandbags (for dam construction, and water diversion).

CONSTRUCTION

Pacific Connector's contractor will comply with FERC's Wetland and Water body Construction and Mitigation Procedures as well as all other federal, state, and local permit conditions for both the wetland crossings and the water body crossing. This crossing will be conducted during the fish window and the dry low flow period between July 1 and August 31. This construction period will also coincide with the lowest seasonal groundwater levels to minimize potential impacts associated with the river crossing. During the construction of the crossing, water quality monitoring will occur throughout the in-water construction phase as specified according to State and Federal permit conditions.

The construction method for crossing this river is a diverted open cut. The main river flow will be diverted to one side of the river using a temporary diversion structure. The temporary diversion structure will be comprised of porta dams, aqua dams, steel plates, plastic sheeting and sandbags, or other similar devices that perform the same function. These diversion structures will be used to isolate the flow to one side of the river bed and allow fish passage during the construction window. The temporary river diversion will allow the contractor to work within one-half of the river bed to trench, lay pipe, backfill and re-contour the river bottom. Once work is completed, the diversion dam will be removed and relocated to push the main river flow to the opposite side of the river bed allowing construction activities on the unfinished half of the river. It will be necessary to use equipment in the river to assist in installation of the temporary diversion structures. The in-stream use of equipment will expedite the installation of the temporary diversion structure by assisting in moving large rocks in the river bed to ensure an adequate bottom seal and to carry large/heavy portions of the diversion structure. However, if flows during the construction window are low enough, the contractor may prefer to cross this river by using the flumed crossing method. Both crossing methodologies are dry open cuts that will maintain fish passage during the construction window. If a flumed crossing method can be utilized, base on flow conditions at the time of construction, it is expected that it would take less time to complete the crossing and would require less in-stream work to install the flume crossing compared to the diverted open cut crossing method.

Environmental Controls

Sediment barriers shall be installed along edges of the right-of-way and the TEWAs to contain sediment and spoil within these workspaces. These barriers shall be maintained until revegetation and site stabilization is complete. The EI will be responsible for appropriate sediment barrier placement and maintenance during construction. River bed cobble used as spawning habitat within the construction right-of-way will be removed from the top one foot of the trench line and stocked separately during the construction process. During the backfill and restoration stage of the project, the river bed cobble will be replaced to the top one-foot of the trench.

Clearing, Stripping and Grading

All brush within the construction corridor will be cut at ground level. Brushing and limbing may be required to some of these tree locations to maintain a safe construction work area. Stumps and root wads will be removed from the pipe ditch alignment. Any stumps in the workspace other than trench line will be cut to ground level. Grading may be required along the river banks to provide a level working surface or plane for construction activities. All contours will be restored to their approximate original condition or to a stable slope (i.e., 3:1) at the completion of the river crossing. River bed cobbles used for fish spawning habitat will be salvaged from the top one-foot of the trench and stockpiled separately and replaced to the top of the trench during backfilling/restoration work within the river bed.

Diverted Open Cut South Umpqua #2

Material

Temporary diversion structures, comprised of porta dams, aqua dams, steel plates, plastic sheeting, sandbags, or other similar devices, will be placed into the river upstream of the pipeline crossing to divert the main channel flow to the opposite side of the river. The temporary diversion dam will encompass the entire construction area to isolate the work area. Any burlap sandbags used during the crossing will be filled with clean sand.

Installation of Temporary Diversion Structure-West Side Construction-Phase 1

The diversion structure will be installed using one of the above mentioned structures to push the main river flow to the west side of the channel. The diversion structure will be installed approximately 170 feet upstream of the pipeline trench and travel out to the middle of the river bed. The diversion structure will then travel south approximately 100 feet past the construction area. As previously noted, it will be necessary to use equipment in the river to assist in installation of the temporary diversion structures. Once the diversion structure has been installed and the work area isolated from river flow, fish salvaging efforts and dewatering of the isolated work area will commence as needed. All fish salvage efforts will be conducted by an ODFW certified biological contractor.

The location of the diversion structure will be based on river conditions at the time of construction and will be located as close to the work area as possible to minimize streambed disturbance.

Installation of Pipeline Section 1-Phase 1

After the in-river work area for Pipe Section 1 has been isolated and dewatered, excavation of the pipeline trench will begin. The trench will be excavated to design depths as specified to accommodate potential scour. If bedrock is encountered during excavation; the top of pipe will be buried 24 inches below the top of bedrock. Excavated pipeline trench spoil will be stored adjacent to the trench and as necessary in the identified TEWAs.

The pipeline trench will be excavated across the riverbed up to the diversion structure. To ensure stability of the temporary diversion structure, the trench excavation limit will stop at a safe set-back distance from the temporary diversion structure.

Prior to completion of the trench excavation within the Phase 1 area, the pipe string for the Section 1 area will be fabricated and tested according to Pacific Connector's standards and readied for installation. The Section 1 pipe string will be installed in the trench and the trench will be backfilled with the native excavated material. The riverbed will be restored/contoured to blend into existing preconstruction contours. River banks will be restored to their preconstruction contours or to a stable configuration (i.e., 3:1 slopes).

A bell hole will be left open at the end of the pipeline trench which exposes the end of the Section 1 pipe string so that remaining Section 2 pipe string can be tied into the Section 1 pipe string to complete the pipeline crossing.

After Section 1 pipe string has been installed and the river bed restored/contoured, the in-river diversion structure will be relocated to allow work on the east side of the river. It will be necessary to use equipment in the river to assist in removal and relocation of the temporary diversion structures.

Installation of Pipeline Section 2-East Side Construction-Phase 2

To prepare for installation of the Section 2 pipe string, the diversion channel will be relocated to push the main river flow to the east side of the channel. The diversion structure will be installed approximately 170 feet upstream of the pipeline trench and travel out to the middle of the river bed. The diversion structure will then travel south approximately 100 feet past the construction area. Once the diversion structure has been installed and the work area isolated from river flow, fish salvaging efforts and dewatering of the isolated work area will commence as needed. All fish salvage efforts will be conducted by an ODFW certified biological contractor.

After any fish salvage efforts, the contractor will commence trench excavation, pipe installation, backfilling, and riverbed restoration. The location of the diversion structure will be based on river conditions at the time of construction and will be located as close to the work area as possible.

The pipeline trench for the Section 2 pipe string will be excavated across the east river bed and to the bell hole of the Section 1 pipe string. The pipeline trench will be excavated to design depths as specified to accommodate potential scour. If bedrock is encountered during excavation; the top of pipe will be buried 24 inches below the top of bedrock.

Prior to completion of the trench excavation within the Phase 2 area, the Section 2 pipe string will be fabricated and tested according to Pacific Connector’s standards and readied for installation. Once the Phase 2 area trench has been excavated to design depths, the Section 2 pipe string will be installed and tie-in to the Section 1 pipe string.   After the pipe strings have been tied-in, the pipeline trench will be backfilled with the native material excavated from the trench and the contours of the river bed will be restored to approximate preconstruction contours.

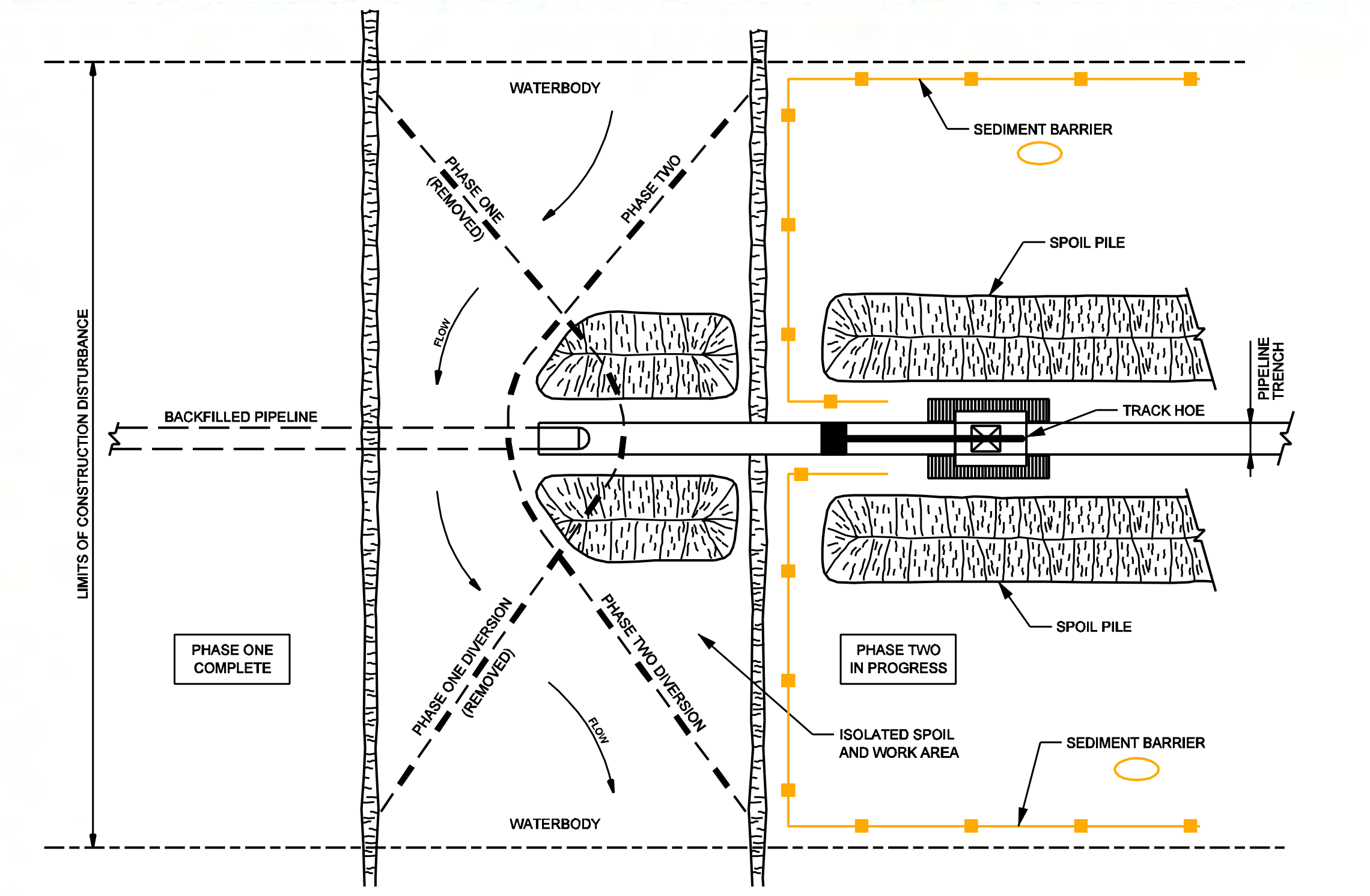
The banks of the river will be restored to the preconstruction contours or to a stable configuration (i.e., 3:1 slopes). Erosion control fabric and sediment barriers will be installed where appropriate.

Alternate Flumed Crossing Method

it should be noted that if the seasonal flows are low enough during the time of construction, the construction contractor may choose to flume this river crossing. This crossing would be similar in scope of work as the North and East Fork Coquille River Crossing Site Specific Plans and would require less work area than that needed for the currently proposed diverted open cut method. An alternate flume crossing method is also expected to take less time to complete and require less in-stream work and disturbance to complete. Fish passage would remain during the entire construction period with this crossing method. All dewater pumps will be appropriately screened according to ODFW and NOAA standards to prevent fish entrainment.

Restoration and Habitat Improvements

During clean up, the river banks will be returned to preconstruction contours or to a stable configuration (3:1 slopes) and stabilized with erosion control fabric as necessary. River banks will be revegetated using the procedures outlined in the Pacific Connectors Erosion Control and Revegetation Plan including reseeding and replanting with appropriate tree and shrub species and according to applicable federal, state, and local permit conditions.



OPEN CUT NOTES:

1. Designated workspace shown on the site specific plans is for spoil storage located on either side of the waterbody crossing adjacent to the proposed pipeline alignment. Additional Temporary Extra Work Area (TEWA) is necessary for support equipment/vehicles, supplies and materials, access to construction areas, including the temporary diversion channel and in stream diversion structures. Sediment barriers will be installed around workspace areas and spoil storage areas, where necessary to protect the waterbody from surface runoff.
2. The waterbody crossing will be installed as expeditiously as possible to minimize impacts to the waterway. The pipe trench will be backfilled using the native material excavated from the trench. Trench plugs will be installed at the banks on either side of the waterway.
3. If the waterway is navigable or used by recreational boaters, a mitigation plan for traffic interruption will be prepared.
4. Erosion and sediment control measures shall be inspected daily and repaired if necessary.
5. Schedule crossing during ODFW designated in water work window period between July 1 and August 31.
6. No refueling of mobile equipment within 100 feet of stream bank. Place sign posts 100 feet

   back from wetland boundary and advise no refueling. Refuel stationary equipment as per SPCC plan.
7. Leave hard plugs at the stream bank edge, until just prior to pipe installation.
8. Maintain stream flow throughout crossing construction.
9. Restore watercourse channel to approximate pre-construction profile and substrate.
10. This typical drawing is preliminary. Site specific design details will be completed prior to construction, based on site specific conditions at the time of construction. Construction phase sequence and specific details outlined in the site-specific plan may be approved in writing based on contractors written recommendations.

DEWATER NOTES:

1. Dewater structure shall be placed on a level, well vegetated site such that filtered water will flow away from structure and any work areas.
2. Flow rates into the discharge shall be such that water will be filtered through the structure and allowed to overflow.
3. Contractor shall utilize certified noxious weed free hay for structure.
4. Dewatering structures will be constructed and maintained according to the dewatering structure typical drawings found in the Erosion Control & Revegetation Plan (ECRP).

TYPICAL DIVERTED OPEN-CUT WATERBODY CROSSING

LEGEND

▬	36-inch Proposed PCGP Project Construction Right-of-Way
☐	Temporary Construction Right-of-Way (Shown as white on photography)
▨	Temporary Extra Work Area
▩	Uncleared Storage Area
-·-·	Access Road
✕✕✕	Drivable Berm or Straw Bales
▭	Silt Fence
▬	Phase I Construction Activity
▬	Phase II Construction Activity

REFERENCE DRAWINGS

DRAWING NO.	TITLE
3430.29-094	CONSTRUCTION ALIGNMENT

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
1	JUNE-2007	KLL	PREFILING 3rd DRAFT			
2	SEPTEMBER-2007	KLL	ISSUED FOR FERC FILING			

PACIFIC CONNECTOR GAS PIPELINE PROJECT
PACIFIC CONNECTOR GAS PIPELINE, LP
SOUTH UMPQUA #2 - DIVERTED OPEN CUT
MILE POST 94.75
SEC. 26, T-30-S, R-3-W
DOUGLAS COUNTY, OREGON

Pacific Connector GAS PIPELINE℠

DRAWN BY: KLL / JST	DATE: 5-29-2008	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY:	DATE:	ISSUED FOR CONSTRUCTION:	
APPROVED BY:	DATE:	DRAWING NUMBER: 3430.9-055	SHEET 1
WO:		6/9/2008 %DATE% Q:\Oregon_gas\Mapping\Waterbodies\3430_9-055.dgn	OF 2

Diverted Open Cut Crossing Design Support

South Umpqua River Crossing No. 2
Pacific Connector Gas Pipeline Project
Douglas County, Oregon

for
Pacific Connector Gas Pipeline, LP

August 25, 2017

Diverted Open Cut Crossing Design Support

South Umpqua River Crossing No. 2
Pacific Connector Gas Pipeline Project
Douglas County, Oregon

for
Pacific Connector Gas Pipeline, LP

August 25, 2017

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Diverted Open Cut Crossing Design Support

South Umpqua River Crossing No. 2
Pacific Connector Gas Pipeline Project
Douglas County, Oregon

File No. 22708-001-02

August 25, 2017

Prepared for:

Pacific Connector Gas Pipeline, LP
5616 Kirby Drive, Suite 500
Houston, Texas 77004

Attention: John Walls

Prepared by:

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Project Engineer

Trevor Hoyles

Trevor N. Hoyles, PE
Principal

RSC:JWP:JMA:TNH:cje

Table of Contents

INTRODUCTION

Project Overview

The proposed Pacific Connector Gas Pipeline (PCGP) project will construct over 229 miles of 36-inch-diameter gas pipeline to extend from the proposed Jordan Cove Liquefied Natural Gas Import Terminal to two interstate natural gas pipelines near Malin, Oregon. GeoEngineers prepared this report to support the construction of the PCGP crossing of the South Umpqua River between approximately milepost (MP) 94.7 and 94.8. The project site is located in Douglas County, approximately 0.5 miles east of Milo, Oregon. GeoEngineers developed this report to present the design basis for the South Umpqua (SUMP) No. 2 diverted open cut river crossing (crossing) as part of the PCGP project.

Report Overview

The body of this report provides a summary of rationale and analyses supporting the proposed design. Following the body of the report are three appendices including: Appendix A, Design Drawings; Appendix B; Log of Borings B-1 through B-4 (*Phase II Channel Migration and Scour Analysis*, dated August 24, 2007); and Appendix C, Hydrologic, Hydraulic and Hydrogeologic Analysis. This preliminary design report, drawings and supporting technical analyses are intended to serve as a basis for construction bids.

PURPOSE AND SCOPE OF SERVICES

The purpose of our services was to develop a crossing plan for the SUMP No. 2 crossing by means of diverted open cut construction methods. This report and accompanying documentation satisfy Task 6—Open Cut Crossing Design Support for South Umpqua No. 2 River Crossing.

- Completed a desktop study of readily available hydrologic and hydraulic data. We collected hydrologic gage data for calculating exceedance probability. We reviewed a previous hydraulic model and identified topographic data gaps necessary for a hydraulic model of the diverted channel.
- Reviewed of field reports prepared during previous field reconnaissance and directed a survey team to acquire necessary topographic information.
- Completed a hydrogeologic analysis using available subsurface data, anticipated trenching depths and proposed hydraulic conditions. We describe anticipated dewatering conditions and provided recommendations in the body of this report. We developed trenching recommendations in the body of this report.
- Developed an existing conditions hydraulic model with the additional topographic information and created a proposed conditions hydraulic model to calculate hydraulic parameters for both phases of diversion.
- Evaluated alternatives and feasibility of alternatives for the diversion including modular block and a braced frame/impermeable membrane system, and described their applicability in the body of this report.
- Prepared this basis of design report including a summary of hydrologic and hydraulic conditions, diversion recommendations, dewatering analysis and recommendations, and construction drawings.

SITE CONDITIONS

Geology/Geomorphology

The South Umpqua River drains foothills and valleys of the Cascade Mountains and includes an upper basin of forested foothills and a lower basin with a broad valley cleared for agricultural and rural industrial use. The tributaries of the South Umpqua River originate in the upper basin and flow down approximately 1,000 vertical feet before joining the main stem in the lower basin (GeoEngineers 2007).

The project site is located within the South Umpqua River watershed and includes approximately 572 square miles of the southern Cascade Range and Klamath Mountains. At the crossing location, the channel is confined by bedrock on the left bank and a side channel bar consisting of gravel and cobbles on the right bank. The crossing is proposed in a pool that is hydraulically controlled by an existing bedrock outcropping approximately 280 feet downstream of the crossing. However, bedrock was not observable on the streambed at the proposed crossing. Geotechnical borings located near the site suggest bedrock may underlie the streambed at shallow depths (GeoEngineers 2007).

Subsurface and Streambed Materials

GeoEngineers previously completed four geotechnical borings in the vicinity of the proposed crossing for the purposes of evaluating HDD feasibility (GeoEngineers 2007). The boring logs are included in Appendix B. The borings were completed within the floodplain adjacent to the channel upstream of the proposed crossing location. Extrapolation of the information suggests bedrock is present at shallow depths throughout the streambed and adjacent floodplain. The depth to bedrock varied between approximately 3 feet at boring B-3 to 21.5 feet at boring B-2. Boring B-2 also included sandy gravel with cobbles between the surface and the bedrock.

GeoEngineers performed a pebble count near the proposed crossing and classified the grain-size distribution of the existing alluvial material. The reported grain-size distribution is consistent with the materials identified in boring B-2. Grain-size diameter by percent passing is presented in Table 1 below.

TABLE 1. PEBBLE COUNT GRADATION SUMMARY

D16 (IN)	D50 (IN)	D84 (IN)	D95 (IN)
1.6	3.4	6.5	11.8

PROPOSED DIVERSION PLAN

General

GeoEngineers developed a two-phased diversion plan to provide a dry work space for the trenching and installation of the proposed gas pipeline. Phase I includes constructing a diversion of the west side of the river, dewatering, trenching, installing the pipeline through the west side of the river channel, backfilling the trench and removing the diversion. Phase II proposes the construction of the diversion of the east side of the river, dewatering, trenching, installation the pipeline, completing a mid-river tie-in weld and backfilling the trench and removing the diversion.

Recommended Diversion Methods

A variety of methods and materials are available for diverting the river and isolating the workspace. The selection of the diversion method is generally best left to the contractor. We recommend that the contractor select a diversion method based on the expected subsurface conditions and flow depths and velocities described in this report. We have provided the following considerations for use of four of the most common methods.

Modular Blocks

Modular blocks include the placement of concrete blocks equipped with a tongue and groove system for stability such as ecology blocks, a rebar hook used for mobility and an impermeable membrane system on the exterior for sealing. Blocks can be delivered to the site on a truck and will require an excavator to move blocks from the truck bed to the river. An excavator will be required to place blocks within the stream. Blocks are typically available with dimensions of 5 x 2.5 x 2.5 feet. Effectiveness of the seal when using modular blocks can vary depending on channel conditions. We recommend that the blocks are embedded into the streambed to create a more robust seal and prevent river water intrusion. We recommend a height limit of 7.5 feet (3 blocks) including embedment with an extension of the impermeable membrane to the existing bedrock to resist subsurface intrusion.

Braced Frame Dam

A braced frame diversion dam includes a series of prefabricated metal braces and an impermeable membrane placed on the exterior. Braced frame systems such as the PortaDam® system are available in heights up to 10 feet. Brace frame systems provide effective protection against the release of construction sediment into the river. Material can be delivered to the site by the manufacturer and installations are typically set up as a rental. The use of braced frame systems are limited by the depth and velocity of non-diverted and diverted streamflow. The applicability of a braced frame system can be evaluated by the supplier. Typically, the supplier will review the hydrology data and perform a site inspection. The frame elements can be maneuvered by a flatbed truck or by hand if needed. Sealing capacity is based on channel conditions. Seepage at the interface between the dam and the riverbed can vary and depends on the condition of the channel. However, the membrane should be extended to the bedrock layer beneath the alluvial material and backfilled to provide the greatest resistance to surface water intrusion. If installed properly, this system can be relatively effective for preventing seepage as compared to other methods.

Bladder Dam

GeoEngineers does not recommend inflatable bladder dams because they are limited to approximately 6 vertical feet, and the hydraulic analysis of the proposed diversion indicates heights in excess of 6 feet during the recommended in-water work period.

Sheet Pile Walls

We do not recommend sheet piles because of expected shallow bedrock within the channel.

PROPOSED DIVERSION LAYOUT

GeoEngineers prepared the preliminary design plans (drawings) included in Appendix A for the planned SUMP No. 2 crossing. The drawings illustrate recommended dimensions associated with each phase of diversion. For the purposes of this site-specific crossings design, we have established local stationing that can be tied into project stationing before construction once it is developed.

The diversion layout includes 185 feet of diversion structure for Phase I and 195 feet of diversion structure for Phase II. We recommend heights that vary between 2.5 and 7.5 feet for both phases as shown on Sheets 2.1 and 2.2 in Appendix A. The design plans show the extent of the pipeline installation trench relative to the diversion structure for each phase. As shown, the diversion layout provides for 17 feet of horizontal offset between the front face of the diversion structure and the termination of the pipeline trench. The 17 feet of offset allows for a diversion structure width up to 7 feet while maintaining a minimum required offset of 10 feet from the back face of the diversion structure to the trench excavation in Phase I and the pipe connection point in Phase II. There is insufficient space for the termination end of the excavation to be laid back, but rather the excavation facing the diversion structure will need to be vertical and supported with shoring. We recommend the contractor grade the channel west of the Phase II diversion structure to provide conveyance during Phase II as shown on Sheets 2.2 and 2.4 in Appendix A.

DIVERSION ANALYSIS

GeoEngineers completed a hydrologic analysis of the crossing and described our findings in a technical memorandum dated February 2, 2015 (GeoEngineers 2015). The following is a summary of the available data, our calculations and the anticipated discharge values during the recommended construction period.

Exceedance Discharge Calculations

GeoEngineers compiled average daily discharge data for the recommended in-water work period between July 1 and August 31. We ranked the discharge values from greatest to least and calculated the exceedance probabilities for recorded range of discharge values by dividing the rank by the number of days of available data.

Based on our data processing, the 50 percent exceedance flow during the construction period is 110 cubic feet per second (cfs). The 5 percent exceedance flow during the construction period is 340 cfs. We used these two values as the expected minimum and maximum discharge for the hydraulic analysis. Discharges and associated exceedance probabilities are shown in Table 2 below.

TABLE 2. DISCHARGES AND ASSOCIATED EXCEEDANCE PROBABILITIES (JULY 1-AUGUST 31)

Exceedance Probability (Percentage)	50	40	30	20	10	5
Discharge (cfs)	110	130	160	190	260	340

Hydraulic Analysis

GeoEngineers performed a hydraulic analysis of the Phase I and Phase II diversions using Version 4.1.0 of the USACE's HEC-RAS (USACE 2010) hydraulic computer model. HEC-RAS is a one-dimensional, steady-state, hydraulic model that computes water surface elevations using a step-wise methodology. Detailed output and graphics from the hydraulic analysis are shown in the, hydrologic, hydraulic and hydrogeologic analysis in Appendix C.

GeoEngineers used surveyed cross-sectional data of the channel and adjacent floodplain to develop a hydraulic model of each phase of diversion. The cross sections included the bankfull channel and a portion of the adjacent floodplain on both sides of the channel. The cross sections covered a reach of the river beginning approximately 200 feet downstream of the proposed crossing and extended to approximately 174 feet upstream of the proposed crossing.

GeoEngineers modeled the diversion structures as obstructions at the affected cross sections within the HEC-RAS model. The proposed Phase I diversion structure directs and concentrates flow into the existing channel thalweg (deepest section of the channel). The existing channel thalweg provides adequate conveyance without requiring excavation of the existing alluvial material in the channel. The proposed Phase II diversion directs flow away from the thalweg and onto the existing gravel bar on the western side of the channel as shown on Sheets 2.2 and 2.4 in Appendix A. Modifications to the channel are required to reduce instream velocities, maximum depth, and shear stresses. Therefore, the Phase II hydraulic model incorporated an approximate 10-foot-wide excavation of the alluvial material present in the existing gravel bar around the proposed diversion structure. The proposed removal of the existing alluvial material will lower the thalweg elevation and provide increased conveyance.

GeoEngineers used results from the HEC-RAS analysis for each diversion phase to evaluate the stability of the existing alluvial material during construction. We used the D_{84} material sizes to estimate the threshold channel shear stresses beyond which incipient motion, the mobilization of a given channel bed material particle size, and channel instability are expected. We calculated the critical shear stress value for the existing alluvial material gradation using the Shields Parameter. We compared the critical shear stress to the boundary shear values from the HEC-RAS hydraulic analysis. The ratio of these two values is the Relative Bed Stability (RBS). RBS values greater than 1.5 are considered stable. As shown in Table 3 below, RBS values exceeded 1.5 for flows ranging from the anticipated minimum to the anticipated maximum. Incipient motion calculations have been included in Appendix C.

Hydraulic Analysis Results

Table 3 below shows the computed maximum depth and velocity under the diverted condition, as well as the maximum shear stress and RBS. We recommend that the contractor consider this data for selecting the diversion method.

TABLE 3. HYDRAULIC ANALYSIS RESULTS

Discharge	110 CFS	130 CFS	160 CFS	190 CFS	260 CFS	340 CFS
Max Depth (ft)[1]	4.9	5.0	5.1	5.2	5.6	6.3
Max Velocity (ft/s)	1.9	2.2	2.6	2.9	4.1	4.7
Max Shear Stress (lb/ft^2)	0.1	0.2	0.2	0.3	0.6	0.7
Relative Bed Stability (RBS)	26.6	13.3	13.3	8.9	4.4	3.8

Note:

[1] The maximum depth is relative to the existing channel surface at the face of the diversion structure, not the anticipated bedrock elevation within the work zone.

DEWATERING ANALYSES

Use and Limitations of Groundwater Inflow Estimates

The purpose of this section is to provide an estimated range of groundwater inflow that could be anticipated by the project contractor. The information herein will be used to evaluate whether sump-based groundwater control is potentially feasible or if well-based groundwater control is necessary. Because of the lack of site-specific hydraulic testing information and subsurface channel conditions, dewatering analyses at this point are necessarily approximate. The contractor should expect that actual inflows could vary from those presented herein. As such, the contractor should perform any additional data collection and/or analyses necessary to support their specific construction dewatering design. Previous experience indicates that both GeoEngineers and the project owner should use the information herein with caution. Providing a contractor with groundwater inflow estimates that are either too high or too low can expose the project to “change of conditions” claims. As such, in our judgment it is important that, to the extent possible, project specifications obligate the contractor to establish their own anticipated project groundwater inflows and associated engineering controls.

Assumptions inherent to the below-described analyses included the following:

- Phase I and II operations will be performed at different times and will consist of similar excavations and spatial relationship to the river and groundwater table. The analyses described herein, therefore, are pertinent to both phases.
- Excavation will consist of a trench 5 feet in base width and 100 feet in length, extending perpendicular from the river and originating 15 feet (horizontally) from the margin of the diverted river.
- The bottom of the excavation will be a maximum of 15 feet below the groundwater table.
- The excavation will penetrate a stratigraphic section approximated by observed subsurface conditions in boring B-2. Although, depth to bedrock is expected to be substantially more shallow than encountered in B-2, we have assumed that the bedrock type and character are similar to that which is described in B-2. The bedrock is described as fractured sedimentary and metamorphic bedrock, consisting of sandstone, schist, and quartzite.

- During construction, all water from the gravel unit is assumed to be controlled by diversion structures. Therefore, all groundwater inflow is assumed to be derived from the bedrock aquifer system (note, that violation of this assumption during construction could result in groundwater inflows much greater than those summarized herein).
- The assumed range in aquifer hydraulic conductivity for the fractured bedrock aquifer system is 10^{-2} to 10^{-5} centimeters per second, based on typical values for fractured bedrock aquifers (Freeze and Cherry 1979).
- Aquifer thickness is 60 feet.
- The bedrock aquifer is unconfined, with specific yield of 0.24, based on typical values for sandstone aquifers (Johnson 1967).

Groundwater Inflow

To estimate groundwater inflow to the excavation described above, groundwater inflow into a long, narrow excavation from an unconfined aquifer was simulated using a steady-state solution introduced by Powers (1992). The presence of the South Umpqua River as a hydraulic boundary was simulated by establishing a maximum hydraulic radius of influence.

Results of these analyses are summarized in Figure C-19 in Appendix C, Hydrologic, Hydraulic and Hydrogeologic Analysis. The resulting groundwater inflow estimates vary widely as a function of time and assumed hydraulic conductivity. Using the high end of the range in hydraulic conductivity, analytical results suggest that initial inflows within the excavation could be on the order of 1,500 gallons per minute (gpm), decreasing to less than 600 gpm after a period of about a day. Using the low end of the range in hydraulic conductivity, analytical results suggest that initial inflows could be as low as about 10 gpm total for each phase, decreasing to less than about 5 gpm after a period of about a day.

Results for the high hydraulic conductivity scenario were evaluated for consistency with a steady-state solution introduced by Powers (1992) for groundwater inflow into a drainage trench from an unconfined aquifer. Use of similar assumptions yielded an early-time groundwater inflow estimate of about 10 gpm per linear foot of trench, which generally is consistent with the inflows described above.

In order to limit groundwater inflow, we recommend embedding the diversion structure into the existing alluvial material and extending an impermeable membrane down to the existing bedrock surface. The minimum required 10-foot buffer between the trench and the diversion structure provides sufficient clearance for access and the construction of either an interceptor trench or a constructed berm/sandbag barrier intended to capture surface water and drain it to a collection point to allow for it to be pumped from the construction area.

Construction Dewatering Considerations

For the low end of the range in assumed hydraulic conductivity, sump-based groundwater control is assumed.

For the high end of the range in assumed hydraulic conductivity, well-based groundwater control would likely be necessary. To evaluate potential discharge volumes associated with a well-based system of groundwater control, a simplified analytical model was developed. Modeling was based on superposition well theory; drawdown across the site was calculated with the Theis (1935) non-equilibrium well equation for confined aquifers and modified using the Jacob (Cooper and Jacob 1946) correction for unconfined aquifers. The presence of the South Umpqua River as a hydraulic boundary was simulated using image wells.

Modeling results suggest that, based on the aquifer assumptions listed above (and using an aquifer hydraulic conductivity of 10^{-2} centimeter per second), construction dewatering could be achieved using a system of large-diameter wells. Each well would be required to discharge on the order of 100 gpm and operate for at least 12 hours before excavation operations are initiated. Modeled dewatering wells were situated in an alternating arrangement along the margins of the trench. Within a horizontal distance of about 50 feet from the river, required well spacing was about 8 feet (measured perpendicular to the river). At a distance greater than about 50 feet from the river, required well spacing widened to about 15 feet. For an excavation 10 feet in width and 100 feet in length, this results in a total discharge on the order of 1,000 gpm.

SHORING CONSIDERATIONS

The stability of trench side slopes is a function of soil type, rock weathering and fracture pattern, groundwater seepage, slope inclination, slope height and nearby surface loads (including excavation equipment). Inadequately designed open cuts could impact the stability of adjacent work areas, and endanger personnel. In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to variable soil and groundwater conditions. Therefore, the contractor should be responsible for maintaining trench excavation support. With the limited space between the trench termination and the proposed diversion structure, the contractor should plan to provide support for a vertical excavation face at the trench termination. Temporary slopes and shoring for excavations must conform to the provisions of current Occupational Safety and Health Act (OSHA) and state requirements.

LIMITATIONS

We have prepared this report for Pacific Connector Gas Pipeline, LP, and their authorized agents for the Pacific Connector Gas Pipeline, South Umpqua Crossing Number 2 project as shown on Sheet 1.1 in Appendix A, Design Drawings.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of stream and river habitat enhancement, stabilization and restoration design engineering in this area at the time this report was prepared. The conclusions, recommendations and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to our services and this report.

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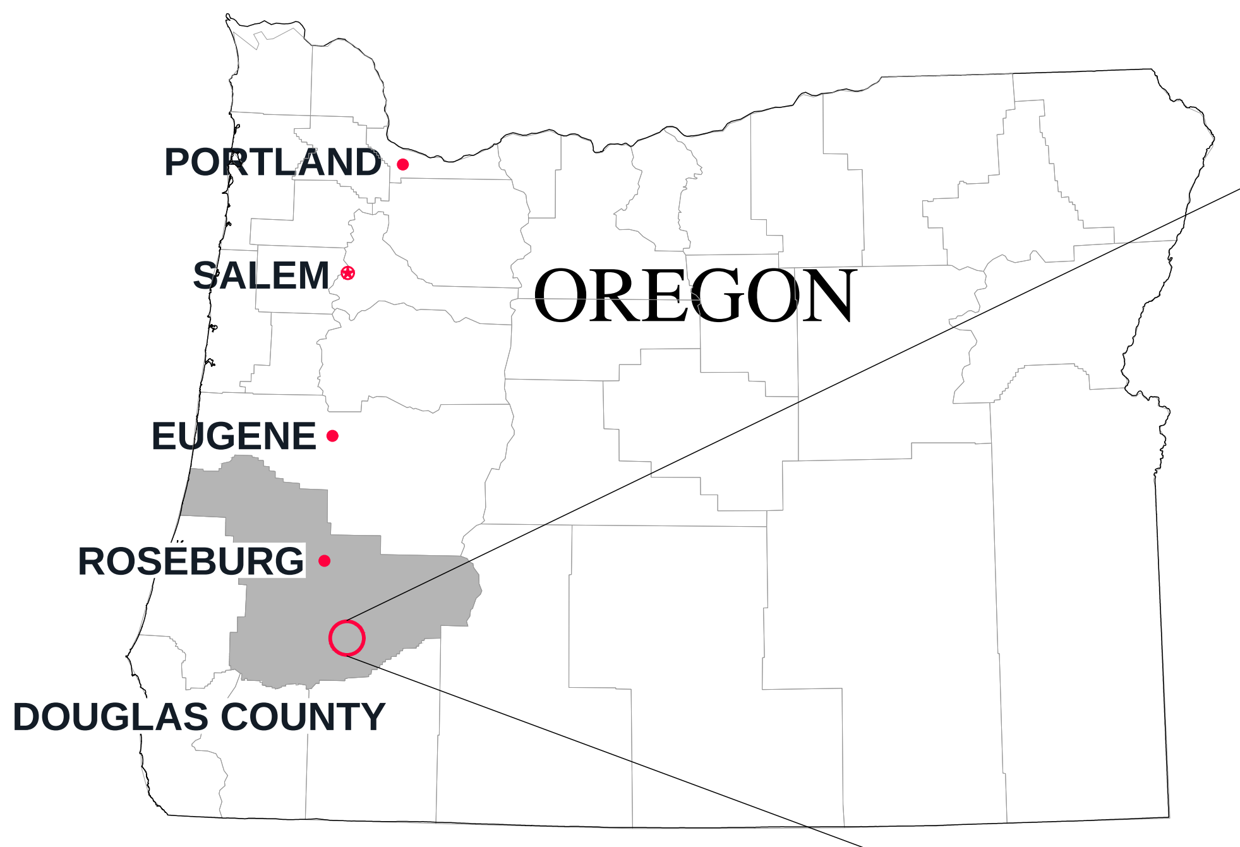
APPENDICES

APPENDIX A

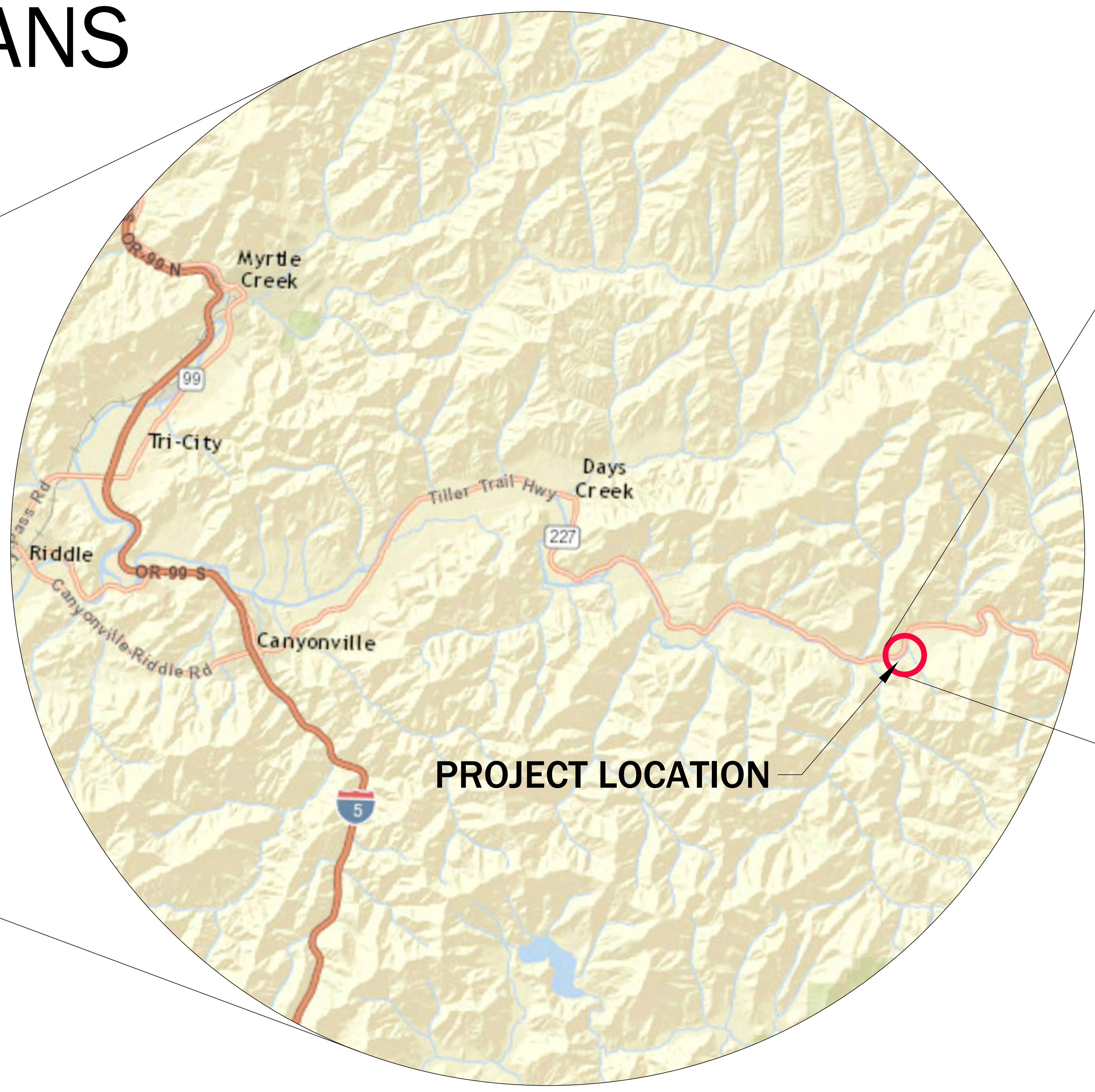
Design Drawings

PACIFIC CONNECTOR GAS PIPELINE SOUTH UMPQUA CROSSING 2 ALTERNATIVE

PRELIMINARY DESIGN PLANS



STATE MAP
NTS



REGION MAP
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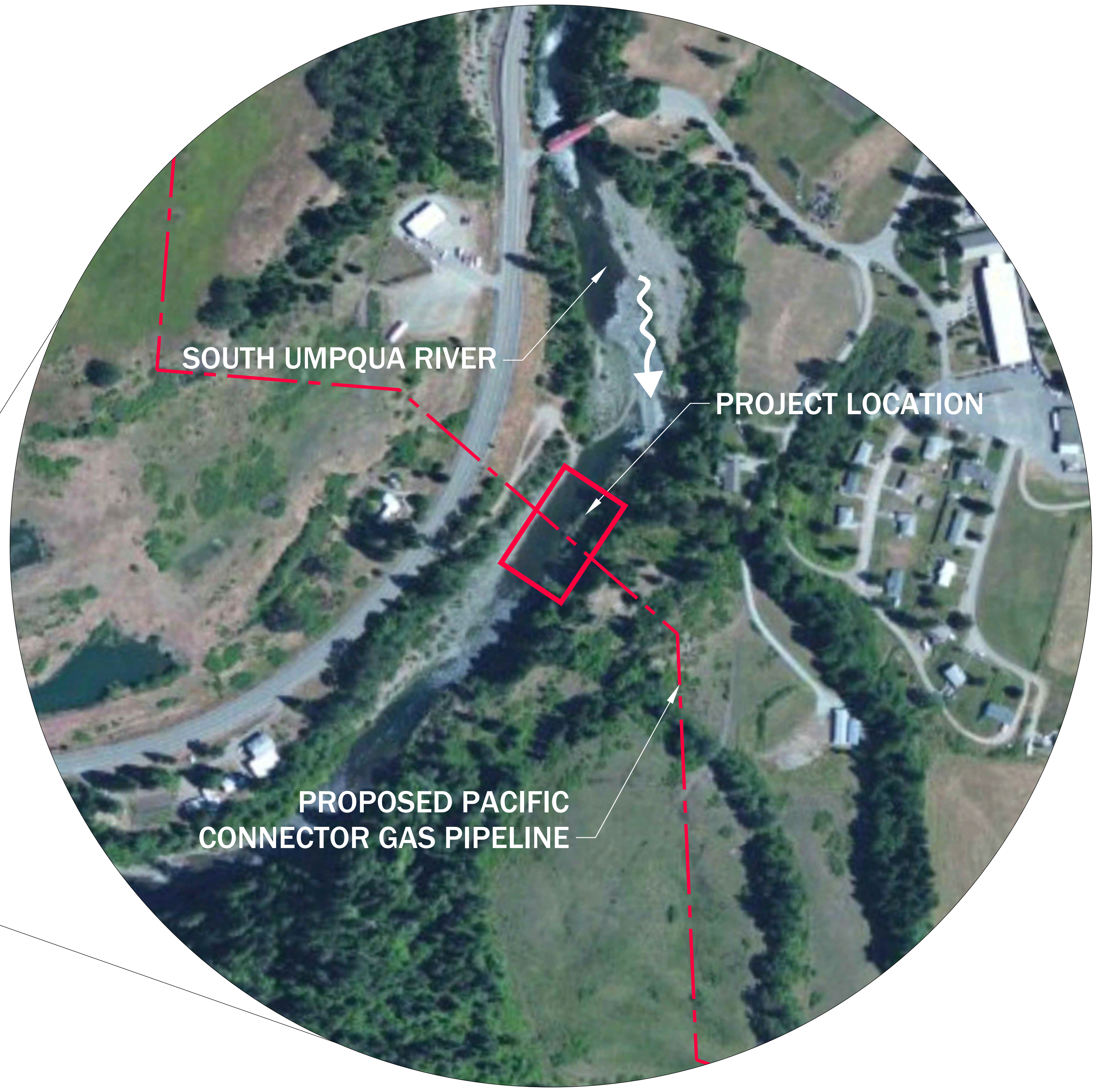

VICINITY MAP
NTS

SHEET INDEX

DIRECTIONS TO THE PROJECT SITE:
FROM ROSEBURG, TRAVEL ON I-5 SOUTH 25.4 MILES. TAKE EXIT 98 TOWARD CANYONVILLE/DAYS CREEK. TURN LEFT ONTO 1ST STREET/CANYONVILLE-RIDDLE RD. CONTINUE ONTO WEST 1ST STREET. TURN RIGHT ONTO SE MAIN STREET. TURN LEFT AT THE 2ND CROSS STREET ONTO SE 3RD STREET. CONTINUE ONTO DOUGLAS COUNTY HWY 1/TILLER TRAIL HWY. DRIVE APPROXIMATELY 17 MILES TO THE PIPELINE CROSSING LOCATION.
LATITUDE: 42°55'57.31"N
LONGITUDE: 123° 2'20.74"W

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Reference: Base map obtained from ESRI Maps and Data.

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REFERENCES

DRAWING NUMBER	REFERENCE DRAWING TITLE

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NO.	DESCRIPTION	BY	DATE	CHK'D	APP'D
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COVER SHEET

SOUTH UMPQUA CROSSING 2 ALTERNATIVE
DOUGLAS COUNTY, OREGON

Project No.
22708-001-02

Drawing No.
P1-000-CIV-CGS-GEI-00001-01.1

Sheet
1 of 6

GENERAL NOTES

1. THESE DESIGNS AND DRAWINGS HAVE BEEN PREPARED FOR THE EXCLUSIVE USE OF PACIFIC CONNECTOR GAS PIPELINE, LP AND THEIR AUTHORIZED AGENTS. NO OTHER PARTY CAN RELY ON THE PRODUCT OF OUR SERVICES UNLESS GEOENGINEERS INC. (GEOENGINEERS) AGREES IN WRITING IN ADVANCE OF SUCH USE.
2. THE DRAWINGS CONTAINED WITHIN SHOULD NOT BE APPLIED FOR ANY PURPOSE OR PROJECT EXCEPT THE ONE SPECIFIED; SPECIFICALLY THE DIVERSION AND DEWATERING OF THE SOUTH UMPQUA RIVER FOR THE INSTALLATION OF A GAS PIPELINE FOR PACIFIC CONNECTOR GAS PIPELINE, LP IN THE LOCATION DEPICTED ON SHEET 1.1.
3. THESE DESIGNS AND DRAWINGS ARE COPYRIGHTED BY GEOENGINEERS, INC. ANY USE, ALTERATION, DELETION, OR EDITING OF THIS DOCUMENT WITHOUT EXPLICIT WRITTEN PERMISSION FROM GEOENGINEERS IS STRICTLY PROHIBITED. ANY OTHER UNAUTHORIZED USE OF THIS DOCUMENT IS PROHIBITED.
4. THE DIVERSION DESIGNS DEPICTED HEREIN ARE APPROXIMATE AND ARE INTENDED TO EXPRESS THE OVERALL DESIGN INTENT OF THE PROJECT. THESE DESIGNS WILL NEED TO BE ADJUSTED IN THE FIELD DURING CONSTRUCTION IN ORDER TO MEET THE SPECIFIC SITE CONDITIONS AND INTENDED FUNCTION.
5. GEOMORPHIC CONDITIONS CAN CHANGE AND THESE DESIGNS ARE BASED ON CONDITIONS THAT EXISTED AT THE TIME THE DESIGN WAS PERFORMED. THE RESULTS OF THESE DESIGNS MAY BE AFFECTED BY THE PASSAGE OF TIME, BY MANMADE EVENTS SUCH AS CONSTRUCTION ON OR ADJACENT TO THE SITE, OR BY NATURAL EVENTS SUCH AS FLOODS, EARTHQUAKES, SLOPE INSTABILITY OR GROUNDWATER FLUCTUATIONS. ALWAYS CONTACT GEOENGINEERS BEFORE APPLYING THESE DESIGNS TO DETERMINE IF THEY REMAIN APPLICABLE.
6. THESE FIGURES WERE ORIGINALLY PRODUCED IN COLOR.

CONSTRUCTION NOTES

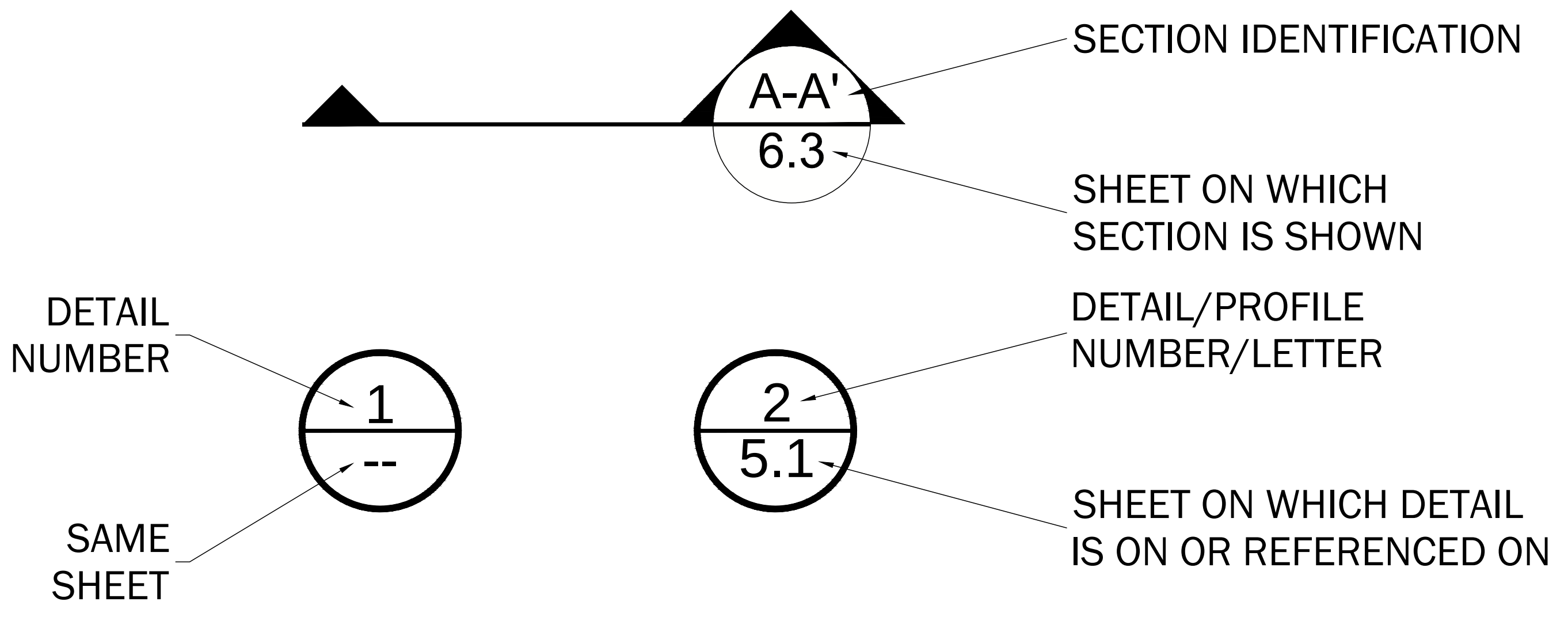
1. ALL CONTRACTORS WORKING WITHIN THE PROJECT BOUNDARIES ARE RESPONSIBLE FOR COMPLIANCE WITH ALL APPLICABLE SAFETY LAWS. THIS INCLUDES BUT IS NOT LIMITED TO ALL BARRICADES, SAFETY DEVICES AND CONTROL OF TRAFFIC WITHIN AND AROUND THE CONSTRUCTION AREA. IT ALSO INCLUDES TEMPORARY SHORING OF EXCAVATIONS AND STABILITY OF ALL TEMPORARY CUT SLOPES.
2. ALL MATERIAL AND WORKMANSHIP FURNISHED ON OR FOR THE PROJECT MUST MEET THE MINIMUM REQUIREMENTS OF PROJECT PERMITS, APPROVING AGENCIES, SPECIFICATIONS AS SET FORTH HEREIN, OR WHICHEVER IS MORE RESTRICTIVE.
3. CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS PRIOR TO ANY DEWATERING AND/OR RIVER DIVERSION ACTIVITIES ON SITE.
4. THE CONTRACTOR SHALL INSTALL AND MAINTAIN APPROPRIATE SEDIMENT CONTROL DEVICES THROUGHOUT THE WHOLE PROJECT SITE, INCLUDING THE CONSTRUCTION STAGING AREA AND STOCKPILE AREA THROUGHOUT THE PROJECT CONSTRUCTION. TEMPORARY CONSTRUCTION EROSION CONTROL MEASURES SHALL BE DESIGNED, CONSTRUCTED AND MAINTAINED IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND FEDERAL REGULATIONS.
5. RIVER DIVERSION, DEWATERING AND EXCAVATION ACTIVITIES SHALL OCCUR DURING PERIOD OF LOW-FLOW IN THE SOUTH UMPQUA RIVER. HISTORIC STREAM GAGE RECORDS INDICATE THAT PERIOD TYPICALLY FALLS BETWEEN JULY 1ST AND AUGUST 31ST AND CONSTRUCTION TIMING SHOULD COINCIDE WITH THE PERIOD OF LOW-FLOWS.
6. THE DIVERSION DESIGN IS APPLICABLE FOR FLOW DEPTHS UP TO 9 FEET ABOVE THE WORK ZONE. IF FLOW RATES ARE EXPECTED TO BE ABOVE 340 CFS DURING CONSTRUCTION, IT IS RECOMMENDED THAT CONSTRUCTION BE POSTPONED UNTIL FLOWS SUBSIDE TO A LEVEL LOWER THAN 340 CFS.
7. THE CLIENT AND CONTRACTOR SHALL REVIEW REAL TIME STREAM FLOW GAGE INFORMATION FOR USGS GAGE 14308000 AT TILLER, OREGON. MULTIPLY THE GAGE FLOW RATES BY AN AREA FACTOR OF 1.27 TO CALCULATE THE SITE FLOW RATES PRIOR TO MOBILIZATION TO ESTIMATE IF FLOWS DURING CONSTRUCTION WILL BE WITHIN AN ACCEPTABLE RANGE TO UTILIZE THE PLANS.
8. FISH EXCLUSION SHALL BE CONDUCTED IN THE AREA TO BE DEWATERED PRIOR TO AND DURING SURFACE WATER DEWATERING ACTIVITIES. FISH EXCLUSION PLANS WERE NOT INCLUDED IN THE SCOPE OF SERVICES PREPARED FOR THIS PROJECT, THEREFORE, ARE NOT INCLUDED IN THIS DESIGN.
9. SURFACE AND GROUNDWATER SHALL BE DRAINED AWAY FROM ACTIVE CONSTRUCTION AND INTO A SEDIMENT POND/TRAP TO ELIMINATE SEDIMENT FROM FLOWING INTO ACTIVE STREAM CHANNELS.
10. DISCHARGES ENTERING ACTIVE STREAMS ON-SITE SHALL SATISFY ALL STATE AND FEDERAL STANDARDS AND PROJECT PERMIT REQUIREMENTS FOR CONTAMINANTS AND TURBIDITY.
11. CONSTRUCTION SHALL MINIMIZE DISTURBANCE TO EXISTING RIPARIAN VEGETATION.

TRENCHING NOTES

1. PIPELINE TRENCHING SHALL BE EXCAVATED TO A DEPTH BELOW BEDROCK CONSISTENT WITH PACIFIC CONNECTOR GAS PIPELINE PROJECT SPECIFICATIONS.
2. THE CONTRACTOR IS RESPONSIBLE FOR LAYING BACK EXCAVATION SLOPES OF EXISTING ALLUVIAL MATERIAL NO STEEPER THAN 1.5H:1V, OR THE CONTRACTOR SHALL REMOVE THE ALLUVIAL MATERIAL WITHIN THE DEWATERED WORKSPACE TO THE EXISTING BEDROCK SURFACE PRIOR TO TRENCHING.
3. IF THE CUT SLOPES ARE GREATER THAN 4 VERTICAL FEET IN THE ALLUVIAL MATERIAL, THE CONTRACTOR SHOULD REMOVE THE ALLUVIAL MATERIAL ADJACENT TO THE PROPOSED PIPELINE TRENCH IN BEDROCK TO CREATE A SUFFICIENT WORKING BENCH.
4. TEMPORARY SLOPES FOR UTILITY EXCAVATIONS MUST CONFORM TO THE PROVISIONS OF CURRENT OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) AND STATE REQUIREMENTS.

LEGEND:

— — — 1820 — — —	EXISTING MAJOR CONTOUR
— — — — — — —	EXISTING MINOR CONTOUR
——— - ——— - ———	PROPOSED WILLIAMS PIPELINE
- - - - - - - - - -	CONSTRUCTION WORKSPACE BOUNDARY
—-—-—-—-—-—	PERMANENT EASEMENT BOUNDARY
—··—··—··—	CONSTRUCTION RIGHT-OF-WAY BOUNDARY
— - - — - - —	EXISTING PARCEL BOUNDARY
🟦	APPROXIMATE 5 PERCENT EXCEEDANCE (340 cfs) DISCHARGE INUNDATION AREA
▨	PROPOSED PHASE I DIVERSION
▨	PROPOSED PHASE II DIVERSION



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GENERAL NOTES AND LEGEND

SOUTH UMPQUA CROSSING 2 ALTERNATIVE
DOUGLAS COUNTY, OREGON

Project No.
22708-001-02

Drawing No.
P1-000-CIV-CGS-GEI-00001-01.2

Sheet
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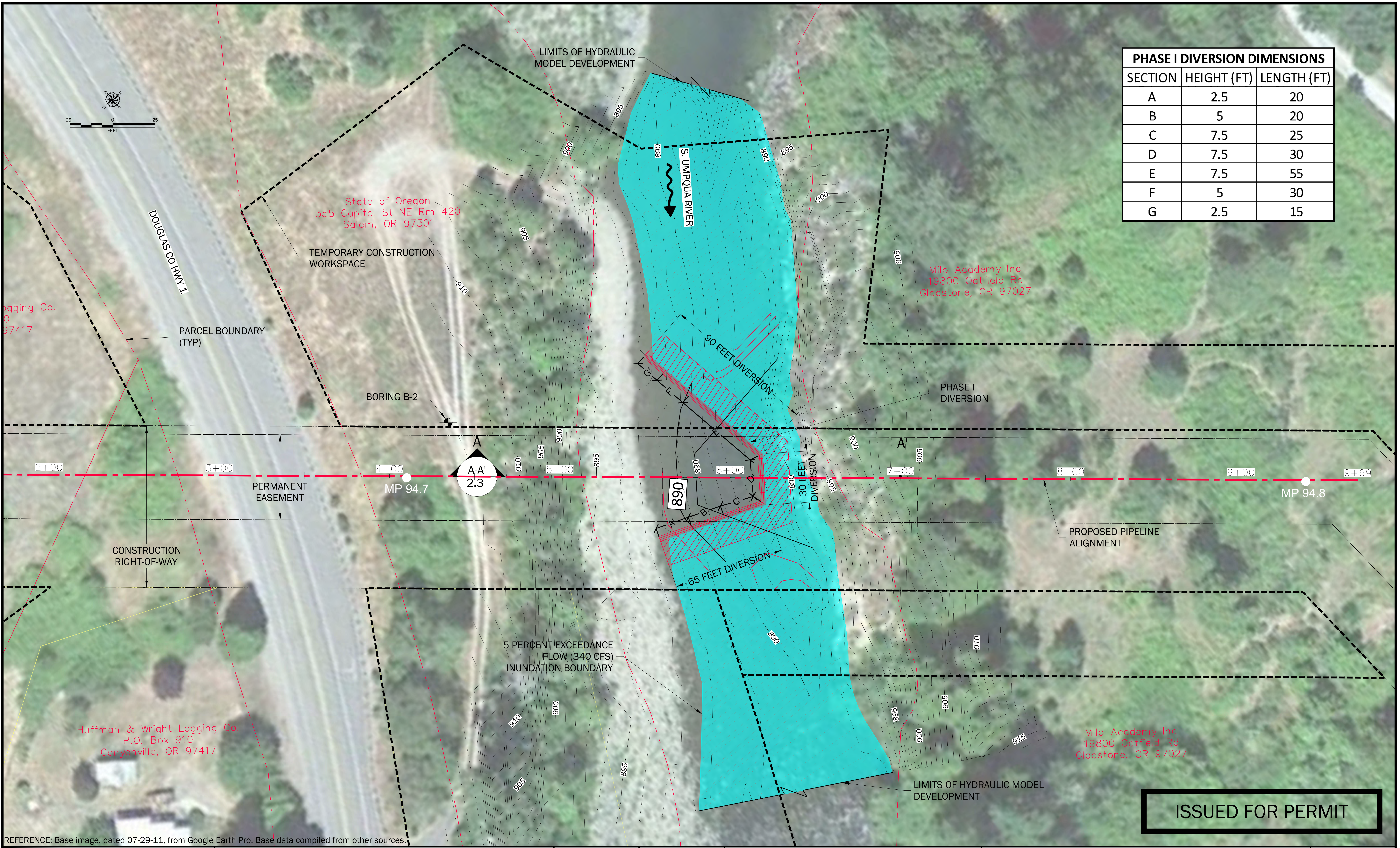

PHASE I DIVERSION DIMENSIONS

SECTION	HEIGHT (FT)	LENGTH (FT)
A	2.5	20
B	5	20
C	7.5	25
D	7.5	30
E	7.5	55
F	5	30
G	2.5	15

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REFERENCE: Base image, dated 07-29-11, from Google Earth Pro. Base data compiled from other sources.

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DIVERSION PLAN - PHASE I

SOUTH UMPQUA CROSSING 2 ALTERNATIVE
DOUGLAS COUNTY, OREGON

Project No. 22708-001-02

Drawing No. P1-000-CIV-CGS-GEI-00001-02.1

Sheet 3 of 6

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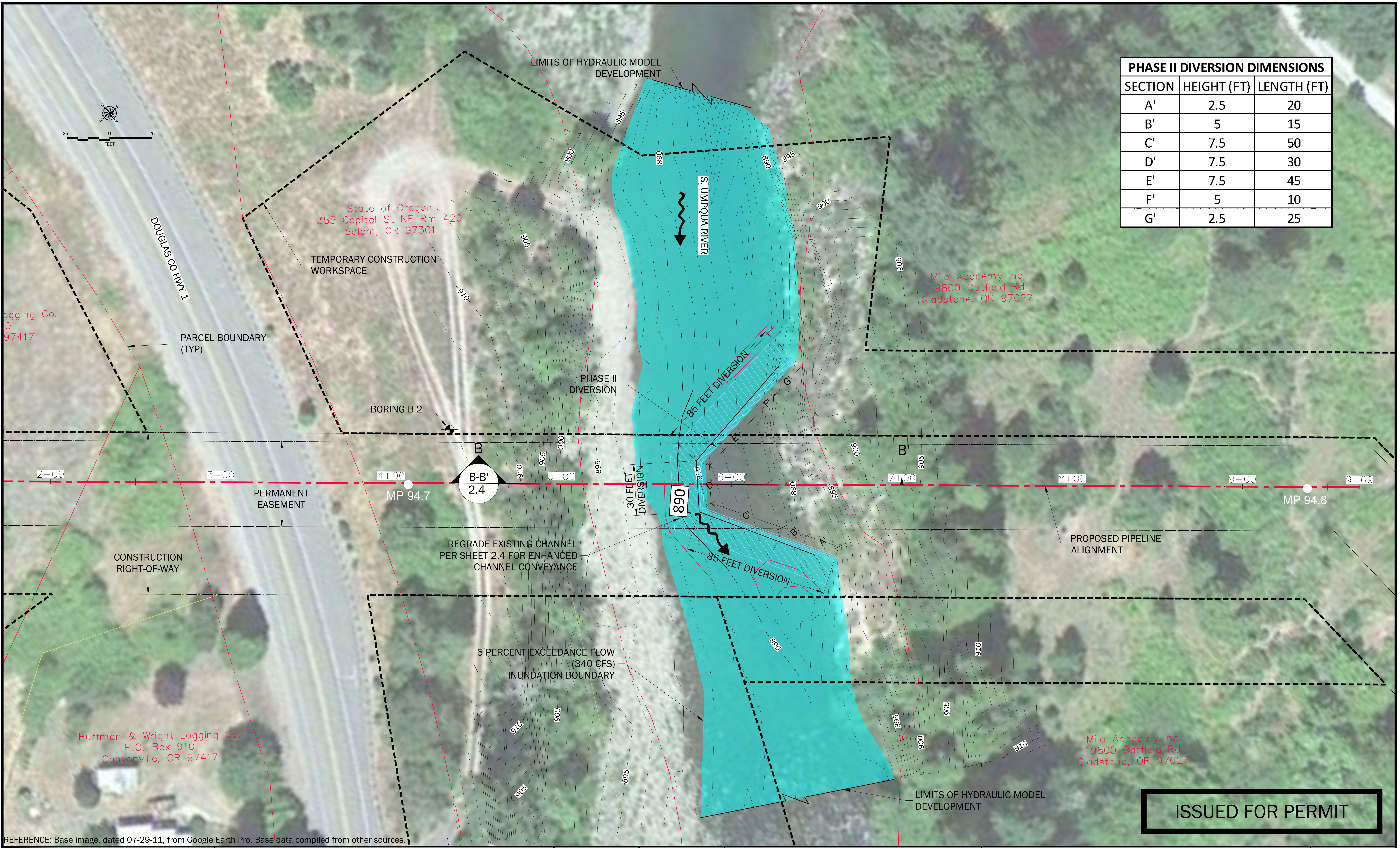

PHASE II DIVERSION DIMENSIONS

SECTION	HEIGHT (FT)	LENGTH (FT)
A'	2.5	20
B'	5	15
C'	7.5	50
D'	7.5	30
E'	7.5	45
F'	5	10
G'	2.5	25

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REFERENCE: Base image, dated 07-29-11, from Google Earth Pro. Base data compiled from other sources.

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DIVERSION PLAN - PHASE II

SOUTH UMPQUA CROSSING 2 ALTERNATIVE
DOUGLAS COUNTY, OREGON

Project No.
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Drawing No.
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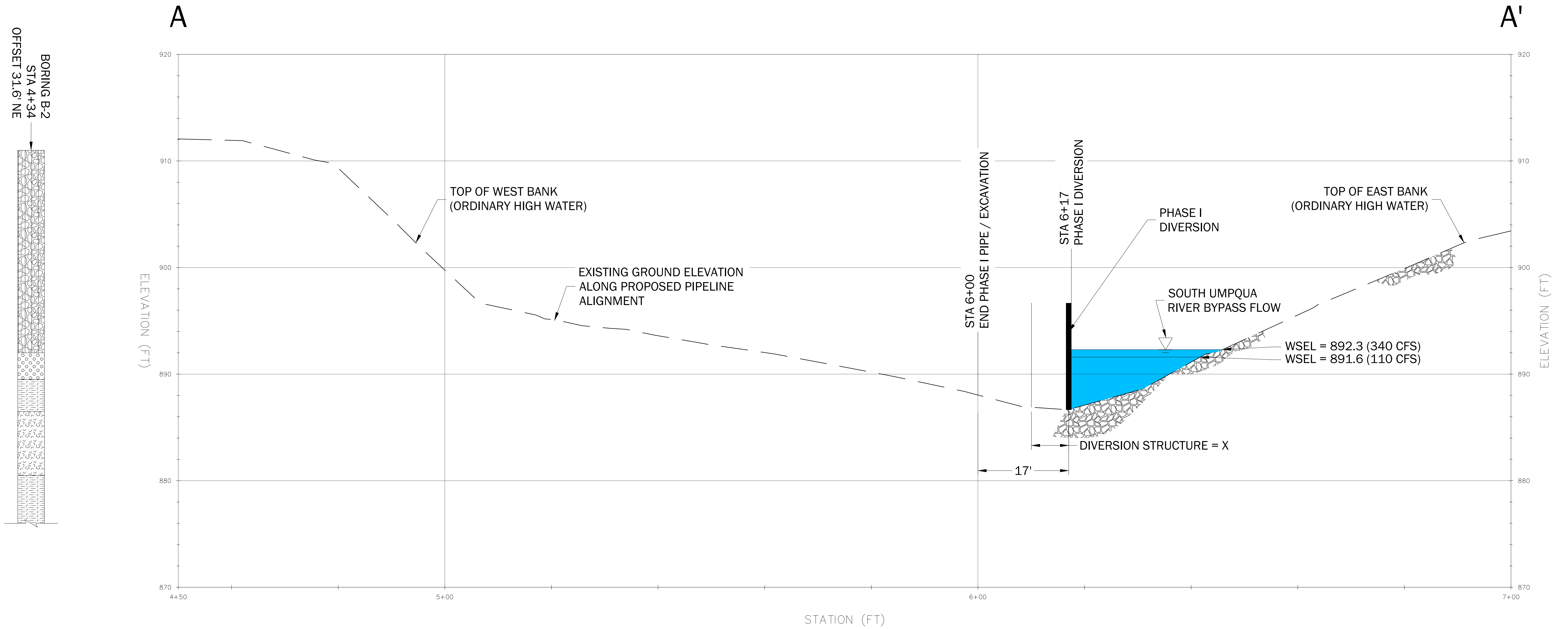

- ▨ BROWN TO GRAY SANDY GRAVEL WITH COBBLES AND SOME SILT (VERY DENSE, DRY TO MOIST)
- ▨ GENERALLY GRAY BELOW 15 FEET, LACKS SILT/GRAY COBBLY GRAVEL WITH SAND (VERY DENSE, MOIST)
- ▨ DARK GRAY GRAYWACKE SANDSTONE AND SCHIST; FRESH, EXTREMELY STRONG, CLOSELY FRACTURED
- ▨ LIGHT GRAY TO WHITE MUSCOVITE RICH QUARTZITE' FRESH, VERY STRONG TO EXTREMELY STRONG, CLOSELY FRACTURED

CROSS SECTION - PHASE I A-A' 2.1
SCALE: 1"=10' HORIZ.
1"=5' VERT.

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NOTE:
CONTRACTOR SHALL EXTEND THE IMPERMEABLE MEMBRANE OR DIVERSION STRUCTURE DOWN TO EXISTING BEDROCK TO LIMIT THE INTRUSION OF WATER INTO THE WORKSPACE.
THE DIVERSION STRUCTURE SHOWN ON THIS SHEET INCLUDES A VARIABLE WIDTH EQUAL TO "X" FEET. THE MINIMUM RECOMMENDED DISTANCE FROM THE TRENCH EXCAVATION TO THE DIVERSION STRUCTURE IS 10 FEET.
CONTRACTOR TO PROVIDE A ROW OF SANDBAGS OR A TEMPORARY CONSTRUCTED BERM ON THE LANDWARD SIDE OF THE DIVERSION STRUCTURE ON THE SURFACE OF THE WORKZONE TO INTERCEPT GROUNDWATER.

ISSUED FOR PERMIT

REFERENCES

DRAWING NUMBER	REFERENCE DRAWING TITLE

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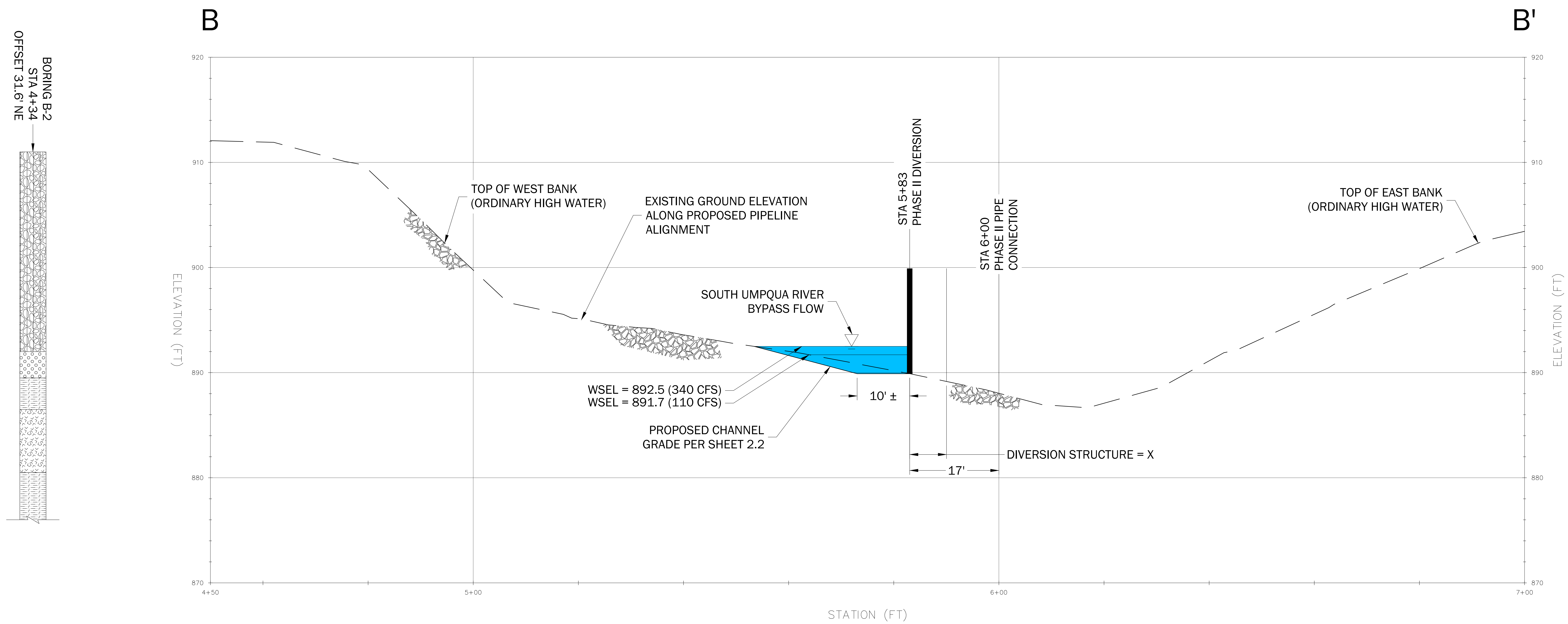
DIVERSION SECTIONS
PHASE I

SOUTH UMPQUA CROSSING 2 ALTERNATIVE
DOUGLAS COUNTY, OREGON

Project No. 22708-001-02
Drawing No. P1-000-CIV-CGS-GEI-00001-02.3
Sheet 5 of 6



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▨	GENERALLY GRAY BELOW 15 FEET, LACKS SILT/GRAY COBBLY GRAVEL WITH SAND (VERY DENSE, MOIST)
▨	DARK GRAY GRAYWACKE SANDSTONE AND SCHIST; FRESH, EXTREMELY STRONG, CLOSELY FRACTURED
▨	LIGHT GRAY TO WHITE MUSCOVITE RICH QUARTZITE' FRESH, VERY STRONG TO EXTREMELY STRONG, CLOSELY FRACTURED

CROSS SECTION - PHASE II B-B' 2.2
SCALE: 1"=10' HORIZ.
1"=5' VERT.

NOTE:
CONTRACTOR SHALL EXTEND THE IMPERMEABLE MEMBRANE OR DIVERSION STRUCTURE DOWN TO EXISTING BEDROCK TO LIMIT THE INTRUSION OF WATER INTO THE WORKSPACE.
THE DIVERSION STRUCTURE SHOWN ON THIS SHEET INCLUDES A VARIABLE WIDTH EQUAL TO "X" FEET. THE MINIMUM RECOMMENDED DISTANCE FROM THE TRENCH EXCAVATION TO THE DIVERSION STRUCTURE IS 10 FEET.
CONTRACTOR TO PROVIDE A ROW OF SANDBAGS OR A TEMPORARY CONSTRUCTED BERM ON THE LANDWARD SIDE OF THE DIVERSION STRUCTURE ON THE SURFACE OF THE WORKZONE TO INTERCEPT GROUNDWATER.

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NO.	DESCRIPTION	BY	DATE	CHK'D	APP'D
0	ISSUED FOR PERMIT	SCY	08/24/17	TNH	

RSC Design	08/24/17 Date
ESM/MGF/SCY Drawn	08/24/17 Date
JMA Checked	08/24/17 Date
TNH Approved	08/24/17 Date

GeoEngineers
3501 West Elder Street, Suite 300
Boise, Idaho 83705
Telephone (208) 258-8328
Fax (208) 861-6268

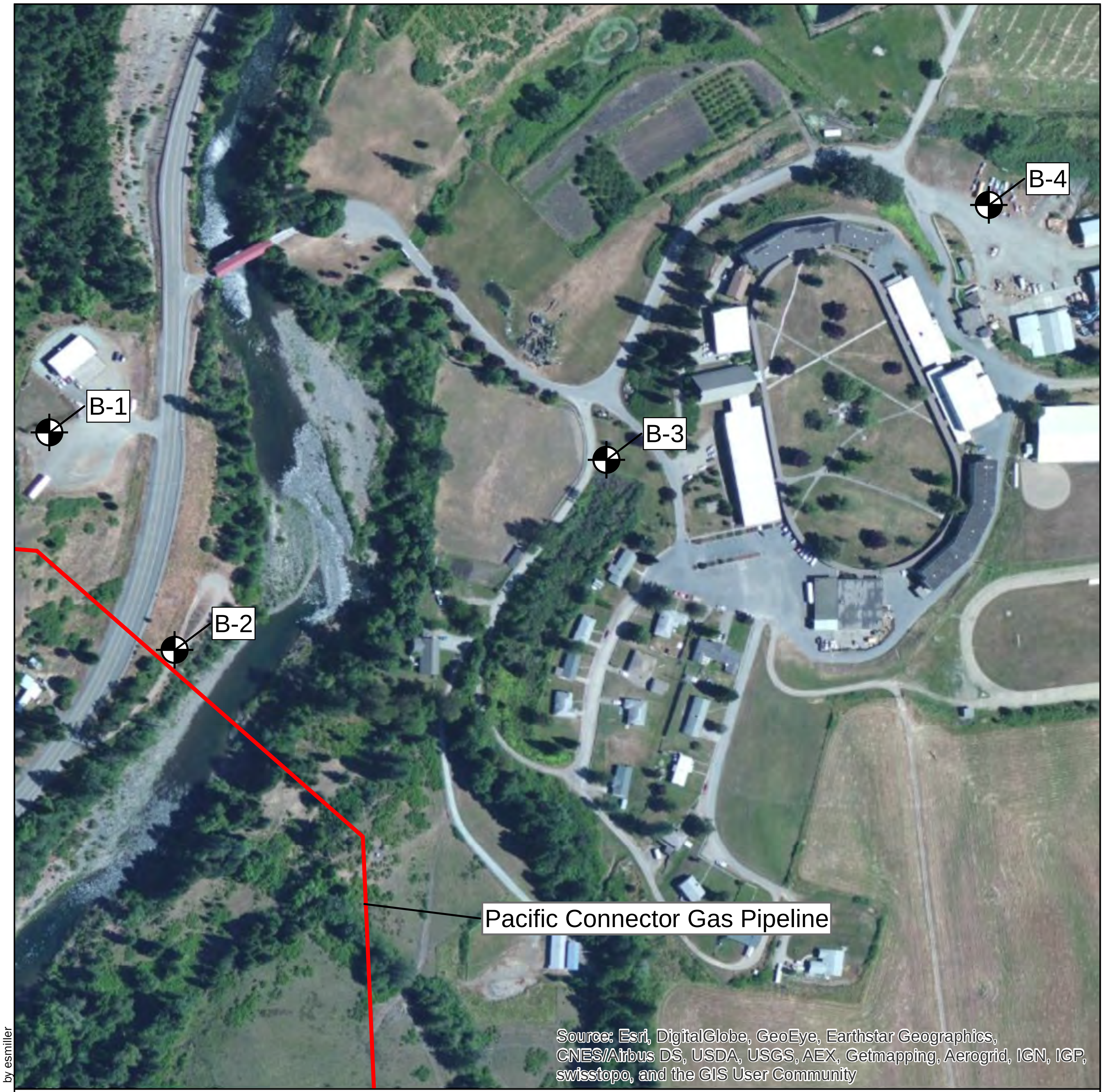
DIVERSION SECTIONS
PHASE II

SOUTH UMPQUA CROSSING 2 ALTERNATIVE
DOUGLAS COUNTY, OREGON

Project No.
22708-001-02
Drawing No.
P1-000-CIV-CGS-GEI-00001-02.4
Sheet
6 of 6

APPENDIX B

Log of Borings B-1 through B-4
(*Phase II Channel Migration and Scour Analysis*, dated August 24, 2007)



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- — Pipeline Alignment
- ⊕ Boring Locations

300 0 300

Feet

N W E S

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source:

Projection: NAD 1983 StatePlane Oregon North FIPS 3601 Feet

Boring Locations

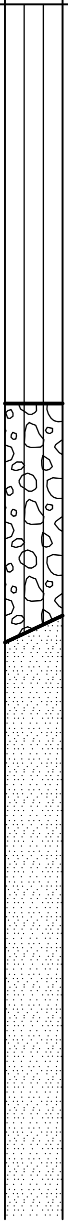
South Umpqua River Crossing No. 2
Douglas County, Oregon

GeoEngineers

Figure B-1

P:\16\16724002\00\GIS\Figure_B1\FigureB1.mxd Date Exported: 06/12/15 by esmiller

Date(s) Drilled	05/18/06	Logged By	BCR	Checked By	TNH
Drilling Contractor	Crux Drilling	Drilling Method	6" HWT / HQ-3	Sampling Methods	SPT / D&M / Coring
Auger Data	Tri-Cone	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Burley 4000 Track Rig
Total Depth (ft)	100.5	Surface Elevation (ft)		Groundwater Level (ft. bgs)	Not Determined
Vertical Datum		Datum/ System		Easting(x): Northing(y):	



Depth feet	SAMPLES: Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
0							ML	Brown gravelly silt with some sand (stiff, moist) (fill)			
5	S1	56			9						
10	S2	67			10						
							GM	Brown sandy fine gravel with silt and occasional cobbles (medium dense, wet)			
15	S3	56			25						
							SSTN	Dark gray to green hydrothermically altered graywacke sandstone and schist; fresh, moderately strong, very closely to closely fractured			
20	S4	100			50/3.5"						
	1	100	17	7							
25											
	2	65	0	3				intensely sheared between 25.8 to 26 feet moderately strong below 26 feet			
30											
	3	88	0	4				intensely sheared between 30.5 to 31 feet very closely fractured below 31 feet			
	4	72	0	8				with 2-4 inch thick quartz veins			
35											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING B-1

GEOENGINEERS

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 2
Sheet 1 of 3

	SAMPLES											
Depth feet	Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
35												
	5	100	0	16					intensely sheared, very weak Extremely to very closely fractured below 37 feet			
	6	94	0	7					Closely fractured below 38.3 feet, strong			
40												UC=384 psi
	7	100	0	11					Extremely closely fractured and sheared below 40.7 to 41.2 feet Very closely fractured below 42 feet			
	8	100	11	8					Closely fractured below 43.2 feet, very strong			
45												
	9	100	45	14								
50									Dark gray graywacke sandstone and schist			
	10	62	0	5					Fresh strong to very strong, closely fractured			
	11	100	0	1					intensely sheared and very weak between 52.1 to 54.1 feet			
55												
	12	100	25	14					intensely sheared and very weak between 54.5 to 56 feet Moderately strong to strong below 57.2 feet			
60												
	13	100	20	13					very closely fractured below 64.5 feet			
65												
	14	100	22	14					strong below 64.8 feet very closely fractured between 65.8 to 66.1 feet very closely fractured below 67.5 feet intensely sheared below 69.4 feet			
70												
	15	100	24	10					strong to very strong below 69.4 feet; closely fractured			
	16	100	67	2								
	17		46	5								
75												
	18	100	23	13					intensely sheared between 75.5 to 75.7 feet			

LOG OF BORING B-1 (continued)

GEOENGINEERS

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Depth feet	SAMPLES Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
80									Gray greywacke sandstone and schist; fresh, moderately strong to strong, closely fractured			
	19	95	50	15								
85									very closely fractured between 84.3 to 84.6 feet			
	20	100	20	9								
	21	100	37	3					moderately strong below 88 feet intensely sheared between 88.9 to 91.5 feet			
90												
	22	100	50	17					very closely fractured between 91 to 91.3 feet			
95									very closely fractured between 95 to 95.5 feet			
	23	100	29	14					very closely fractured between 95.5 to 101.1 feet			
100												

Bottom of hole at 100.5 feet
Groundwater not determined due to drilling fluid

105

110

115

120

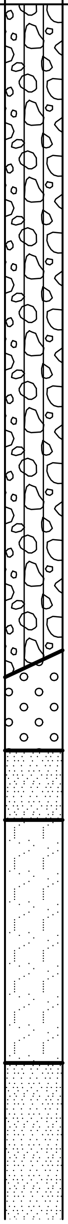
LOG OF BORING B-1 (continued)

GEOENGINEERS

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 2
Sheet 3 of 3

Date(s) Drilled	05/16/06 - 05/17/06	Logged By	BCR	Checked By	TNH
Drilling Contractor	Crux Drilling	Drilling Method	6" HWT / HQ-3	Sampling Methods	SPT / D&M / Coring
Auger Data	Tri-Cone	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Burley 4000 Track Rig
Total Depth (ft)	100.5	Surface Elevation (ft)		Groundwater Level (ft. bgs)	Not Determined
Vertical Datum		Datum/ System		Easting(x): Northing(y):	



Depth feet	SAMPLES: Sample Run	SAMPLES: Recovered (%)	SAMPLES: RQD %	SAMPLES: Fracture Cnt	SAMPLES: Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
0								GM	Brown to gray sandy gravel with cobbles and some silt (very dense, dry to moist)			
5	S1	6			79/2"							
	S2	0			50/0"							
10									Becomes cobbly below 10 feet			
15												
								GP	Generally gray below 15 feet, lacks silt			
20									Gray cobbly gravel with sand (very dense, moist)			
	1	98	19	18				SSTN	Dark gray graywacke sandstone and schist; fresh, extremely strong, closely fractured			
								QTZT	Light gray to white muscovite rich quartzite; fresh, very strong to extremely strong, closely fractured			
25	2	100	37	16								
30								SSTN	Gray to green hydrothermically altered graywacke sandstone and schist; fresh, very strong to extremely strong; closely fractured			
	3	100	50	18								
35												

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING B-2

GeoEngineers

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 3
Sheet 1 of 3

Depth feet	SAMPLES Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
35									Very closely fractured below 35 feet			
	4	100	23	16					Closely fractured below 36.1 feet			
40												
	5	100	30	26								
									Very closely fractured between 43.4 to 44.1 feet			
45												
	6	100	47	12					Very closely fractured between 46 to 46.5 feet			
									Medium fractured between 47.6 to 49.5 feet			
50												
	7	100	23	16								
									Very closely fractured between 53.5 to 55 feet			
55												
	8	100	65	12								
60									Grades to granite below 59 feet; from closely fractured very strong to extremely strong Very closely fractured between 59.5 to 60 feet			
	9	100	83	8								
65												
	10	100	75	9					Closely to medium fractured below 66 feet			
70	11	100	67	4								
	12	100	82	7								
									Dark gray below 73 feet			
75												
	13	100	77	8					Light gray below 78.5 feet			

LOG OF BORING B-2 (continued)

GeoEngineers

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 3
Sheet 2 of 3

Depth feet	SAMPLES Sample Run	 Recovered (%)	 RQD %	 Fracture Cnt	 Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
80								GRAN	Light gray medium grained granite; fresh, very strong to extremely strong, closely to medium fractured Gray below 81 feet			
	14	100	94	2								
85												
	15	100	87	4					Olive gray below 86 feet, medium fractured			
90												
	16	100	77	6								
95												
	17	100	73	5								
100												

Bottom of hole at 100.5 feet
Groundwater not determined due to drilling fluid

Depth feet
105
110
115
120

LOG OF BORING B-2 (continued)

GEOENGINEERS

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 3
Sheet 3 of 3

Date(s) Drilled	06/29/06 - 06/30/06	Logged By	BCR	Checked By	TNH
Drilling Contractor	Crux Drilling	Drilling Method	6" HWT / HQ-3	Sampling Methods	SPT / D&M / Coring
Auger Data	Tri-Cone	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Burley 4000 Track Rig
Total Depth (ft)	100.5	Surface Elevation (ft)		Groundwater Level (ft. bgs)	Not Determined
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Depth feet	SAMPLES Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
0								SM	Brown silty sand (loose, moist)			
								RX	Highly to completely weathered granitoid (weak rock/dense soil) (moist)			
5	S1	18			39							
	S2	0.4			50-1/4"							
10	1	83	27	13					Gray granitoid; slightly to moderately weathered, moderately, closely fractured			
15	2	87	12	26					Very closely to closely fractured below 15 feet			
20	3	12	20	3								
	4	100	36	7					Slightly weathered and strong below 23 feet; closely fractured below 23 feet			
25	5	100	33	5								
	6	100	38	9					Fresh below 27 feet; strong to extremely strong			
30												
	7	100	45	18								
35									Very closely fractured from 34-34.5 feet			

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING B-3

GEOENGINEERS

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 4
Sheet 1 of 3

Depth feet	SAMPLES					Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot							
35												
	8	100	72	5					Closely to medium fractured below 36 feet			
40												
	9	100	60	10								
45												
	10	100	30	18					Closely fractured below 46 feet			
									Very closely fractured from 48 to 48.5 feet			
50												
	11	100	0	6					Very closely to closely fractured below 51 feet			
	12	100	20	5								
	13	100	35	3								
55												
	14	100	87	5					Medium fractured below 56 feet			
60												
	15	100	87	6					Medium to closely fractured below 60.5 feet			
65									Closely fractured below 64.8 feet			
	16	100	69	6					Medium fractured from 66.2 to 67.8 feet			
	17	100	87	2					Very closely fractured below 68 feet Closely to medium fractured below 68.5 feet			
70												
	18	100	77	7								
75									Medium fractured below 75 feet			
	19	100	47	2								

LOG OF BORING B-3 (continued)

GeoEngineers

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 4
Sheet 2 of 3

Depth feet	SAMPLES Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
80	20	100	52	8					Very closely fractured from 79.5 to 80 feet; closely to medium fractured below 80 feet			
	21	100	47	7								
85									Closely fractured below 84.8 feet			
	22	100	23	8								
									Very closely fractured from 87.5 to 88.3 feet			
	23	100	65	10								
90									Medium fractured below 90.7 feet			
	24	100	90	2								
95												
100	25	100	73	3					Closely to medium fractured below 98.5 feet			
105												
110												
115												
120												

Bottom of hole at 100.5 feet
Groundwater not encountered due to drilling fluid

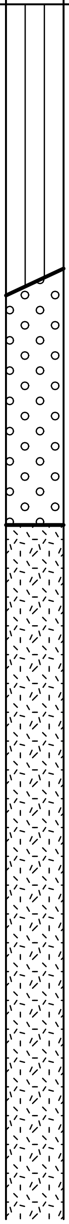
LOG OF BORING B-3 (continued)

GeoEngineers

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 4
Sheet 3 of 3

Date(s) Drilled	05/19/06	Logged By	BCR	Checked By	TNH
Drilling Contractor	Crux Drilling	Drilling Method	6" HWT / HQ-3	Sampling Methods	SPT / D&M / Coring
Auger Data	Tri-Cone	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Burley 4000 Track Rig
Total Depth (ft)	101	Surface Elevation (ft)		Groundwater Level (ft. bgs)	Not Determined
Vertical Datum		Datum/ System		Easting(x): Northing(y):	



Depth feet	SAMPLES Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
0							ML	Dark gray sandy silt with clay (medium stiff, moist)			
5	S1	100			6						
							GP	Brown sandy gravel with cobbles (very dense)			
10	S2	100			61/5.5"						
	1	71	0								
	2	100	0	9							
15	S3	100			50/0.5"		GRAN	Gray granite, highly weathered, moderately weak, very closely fractured - closely fractured below 15 feet			
	3	100	13	28				Fresh, strong to extremely strong below 16 feet Very closely fractured from 18-19.5 feet			
20											
	4	100	14	13				Very closely to closely fractured below 21 feet			
25	5	100	25	4							
	6	100	22	22							
30											
	7	100	50	15				Closely fractured below 31 feet			
35											

Note: See Figure A-1 for explanation of symbols.

V6_ROCKCORE P:\8\8169021\00\FINALS\816902100_S_UMPQUE RIVER_#2.GPJ GEIV6_1.GDT 7/31/06

LOG OF BORING B-4

GEOENGINEERS

Project:	Williams Northwest Pipeline
Project Location:	South Umpqua River No. 2
Project Number:	8169-021-00

Figure: A- 5

Sheet 1 of 3

Depth feet	SAMPLES Sample Run	Recovered (%)	RQD %	Fracture Cnt	Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
35												
	8	100	27	19					Very closely to closely fractured below 36 feet			
40												
	9	100	28	19								
45												
	10	100	50	14					Very closely fractured from 46-47.8 feet			
									Closely fractured and strong below 47.8 feet			
50												
	11	100	58	11								
55												
	12	100	25	22					Very closely to closely fractured below 56 feet			
60												
	13	100	25	16					Very closely fractured from 61 to 61.8 feet			
									Very closely fractured from 63.7 to 64.7 feet			
65												
	14	100	52	13					Closely fractured below 66 feet			
70												
	15	100	45	15								
75												
	16	100	52	12								

LOG OF BORING B-4 (continued)

GeoEngineers

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 5
Sheet 2 of 3

Depth feet	SAMPLES Sample Run	 Recovered (%)	 RQD %	 Fracture Cnt	 Blows/foot	Water Level	Graphic Log	Group Symbol Rock Classification	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
80												
	17	100	58	6					Closely to medium fractured below 82 feet			
85												
	18	100	64	11					Closely fractured below 86 feet			
90												
	19	100	30	17					Very closely to closely fractured below 91 feet			
									Closely fractured below 94 feet			
95												
	20	100	45	11					Medium fractured below 99 feet			
100												

Bottom of hole at 101 feet
Groundwater not determined due to drilling fluid

105

110

115

120

V6_ROCKCORE P:\8\8169021\00\FINALS\816902100_S_UMPQUE RIVER_#2.GPJ GEIV6_1.GDT 7/31/06

LOG OF BORING B-4 (continued)

GEOENGINEERS

Project: Williams Northwest Pipeline
Project Location: South Umpqua River No. 2
Project Number: 8169-021-00

Figure: A- 5

APPENDIX C
Hydrologic, Hydraulic and Hydrogeologic Analysis

Introduction to Hydrology Workbook

Project: South Umpqua River
Project Number: 16724-02-00

Analyst: RC / BM
Latest Revision: 1/9/2015

Workbook Description

- This workbook is:
- proprietary to GeoEngineers, Inc.,
- contains spreadsheets that facilitate the analysis and/or design of this project,
- lists the general project and workbook information that is consistent throughout the workbook,
- lists the titles of the spreadsheets contained in this workbook, and
- is intended for use with ENGLISH UNITS.

Filename: *https://projects.geoengineers.com/sites/1672400200/Draft/Task 0600 - Open Cut Crossing S Umpqua 2/Hydrology/[95 and 5 percent Exceedance During*

Sheet Titles:

Introduction to Hydrology Workbook
Exceedance Probability / Discharge
Duration Curve of Daily Flows

Exceedance Probability / Discharge

Project: South Umpqua River **Analyst:** RC / BM

Project Number: 16724-02-00 **Latest Revision:** 1/9/2015

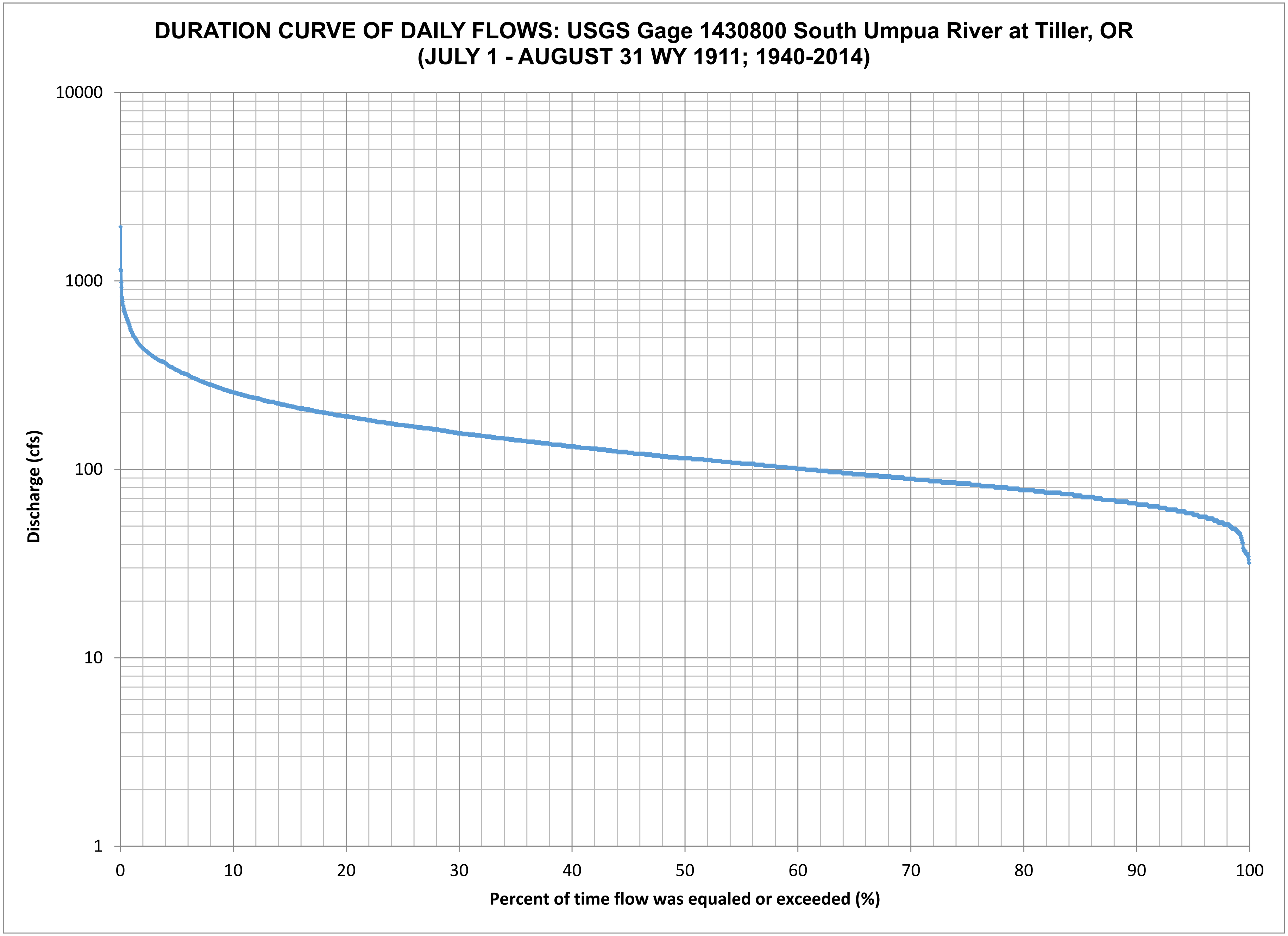
Spreadsheet Description:

- The data must be saved from the website in tabular form in a text file. Use Excel to open the file and set to "fixed width" to bring the data into Excel. This is done initially in another workbook.
- Clean the data up and paste into this sheet in the four shaded columns indicated below.
- Copy the data over to the two columns following "rank" and sort the data by peak flows from highest to lowest.
- Add or delete rows, add or delete rank numbers and adjust the formula ranges as necessary to facilitate the data.
- The column headings and cells that are shaded indicate that user input is required.
- K coefficient values are found on the "K" worksheet - these data are not linked.
- Results for Discharge vs. Return Period are shown below.
- Probability Analysis is presented graphically on the next worksheet.

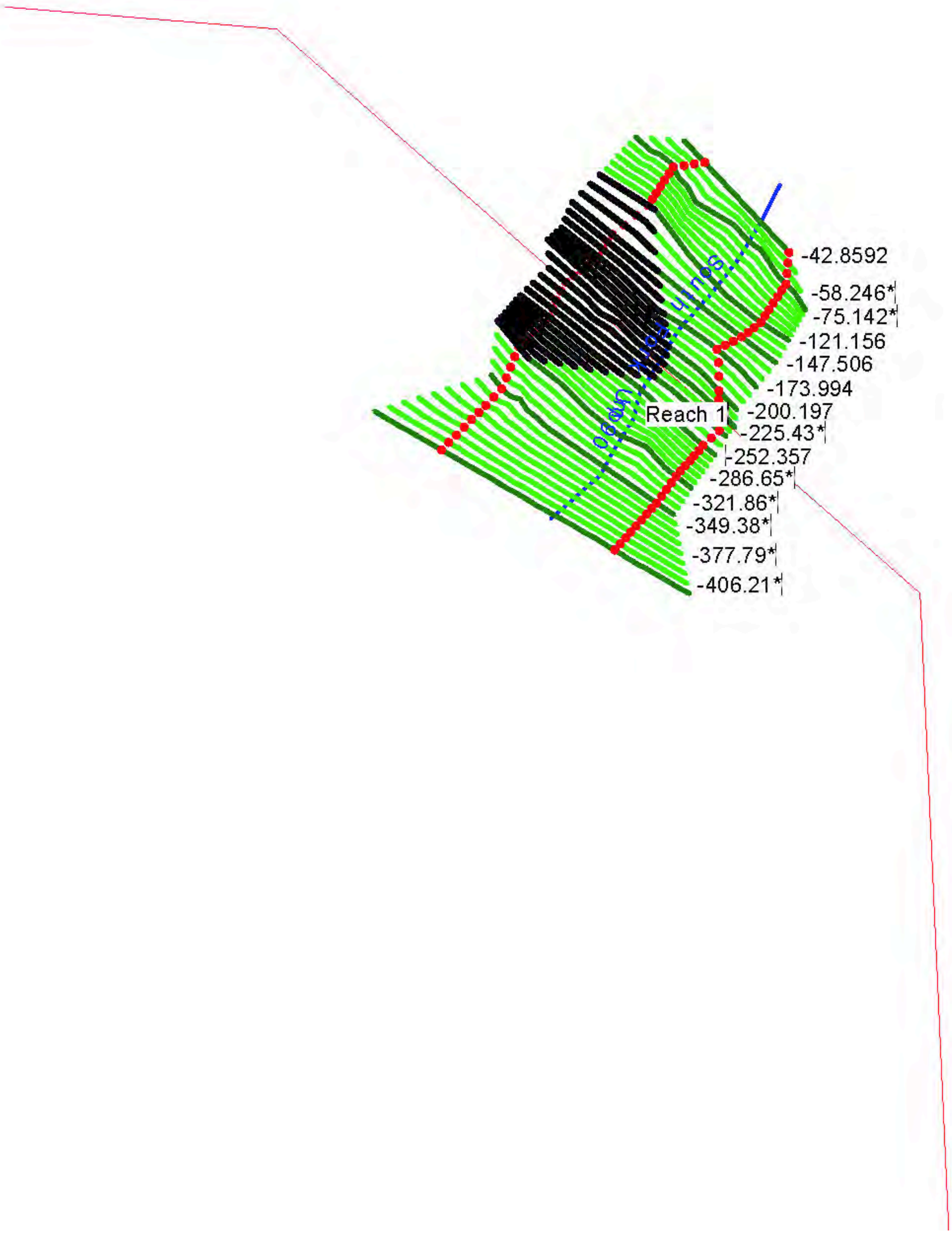
Auto-calculations, User Input (K column), and Predicted Discharge Results based on Gage Data below:

Statistics							
Count	**Minium Flow (cfs)**	**Maximum Flow (cfs)**	**Average of Flow (cfs)**	**Standard Deviation (cfs)**	**Skew**		
4712	**32**	**1936**	**145**	**103**	**3.78**		

Results	
Exceedance Probablility	**Discharge (cfs)**
95	60
90	70
80	80
70	90
60	100
50	110
40	130
30	160
20	190
10	260
5	**340**



DURATION CURVE OF DAILY FLOWS: USGS Gage 1430800 South Umpua River at Tiller, OR
(JULY 1 - AUGUST 31 WY 1911; 1940-2014)



HEC-RAS Results
Plan View

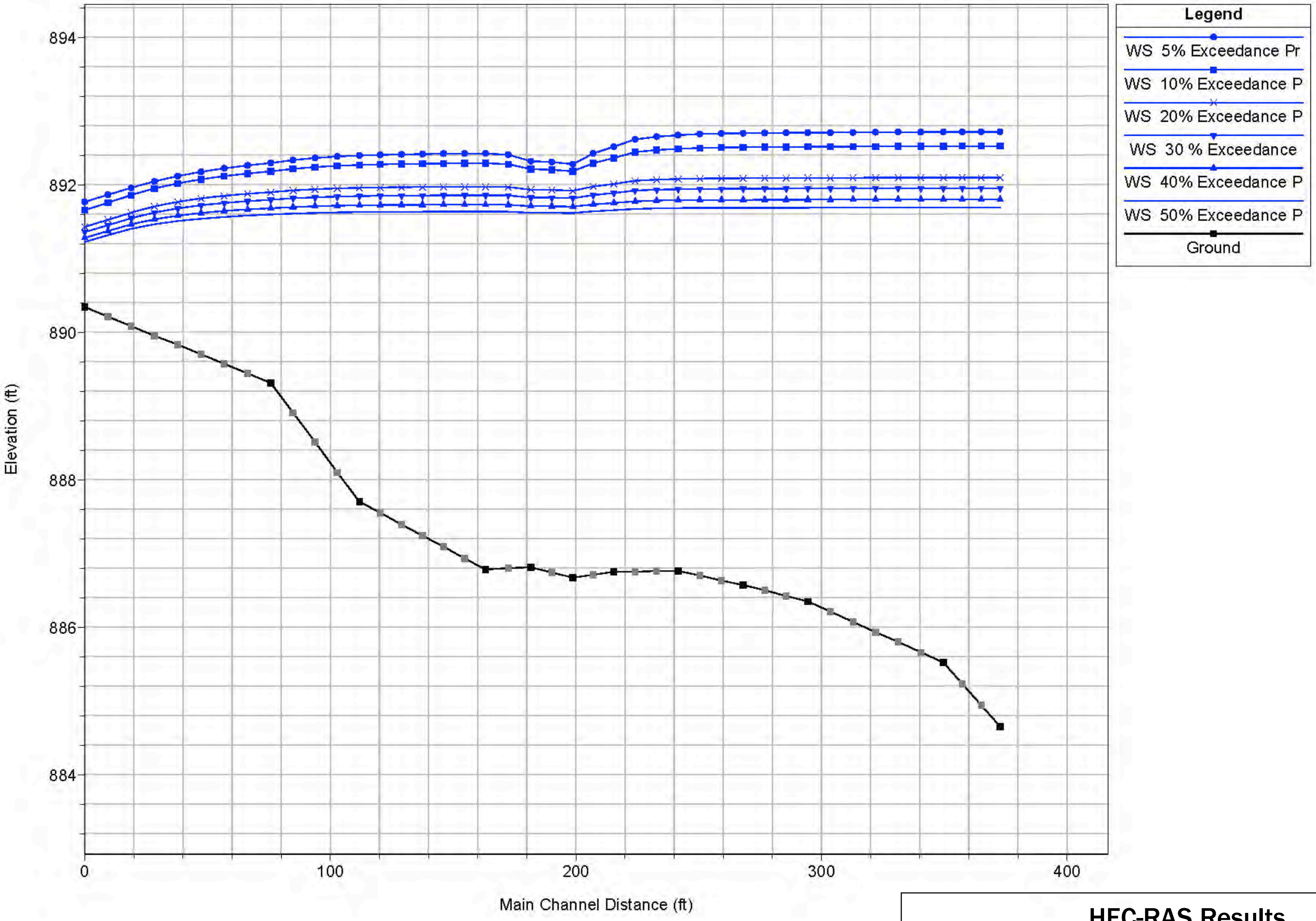
South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

Figure C-1

Data Source: Model output obtained from HEC-RAS v4.1.0

16724-002-00 Date Exported: 06/11/15



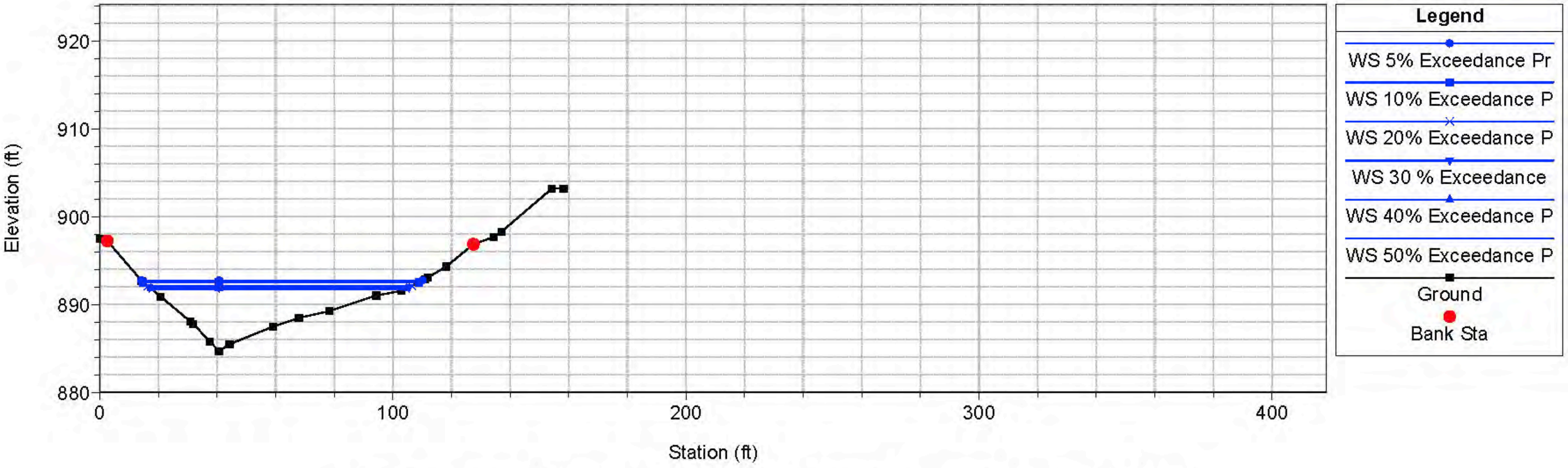
HEC-RAS Results
Profile View

South Umpqua River Crossing No. 2
Douglas County, Oregon

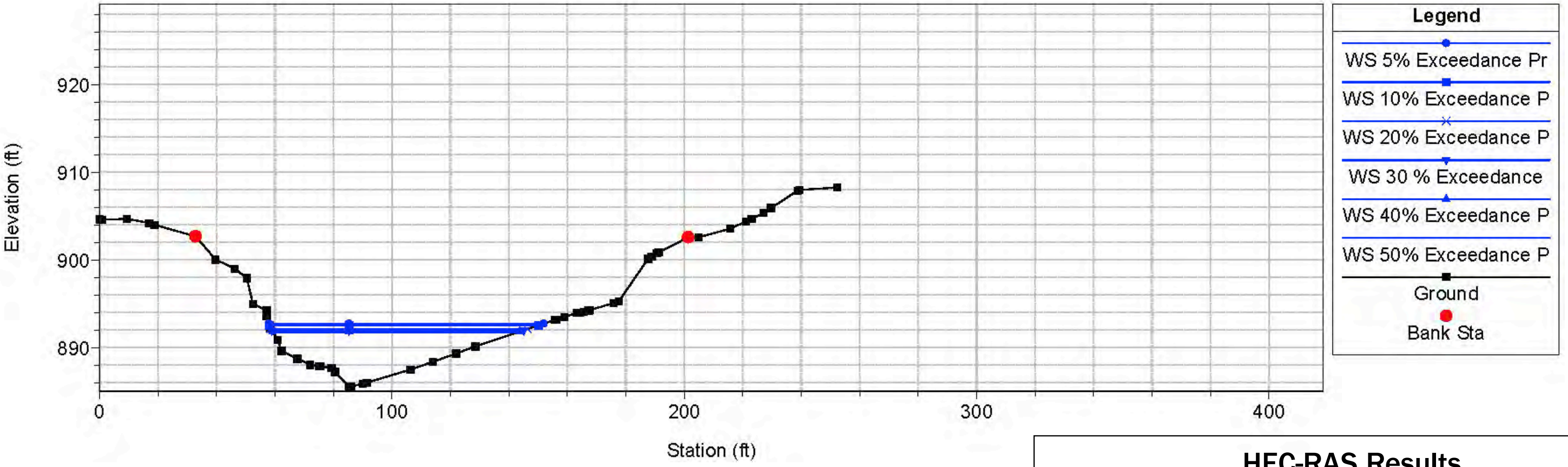
GEOENGINEERS

Figure C-2

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 1 Umpqua Mp90 5/11/2015
River = South Fork Ump90 Reach = Reach 1 RS = -65.9397



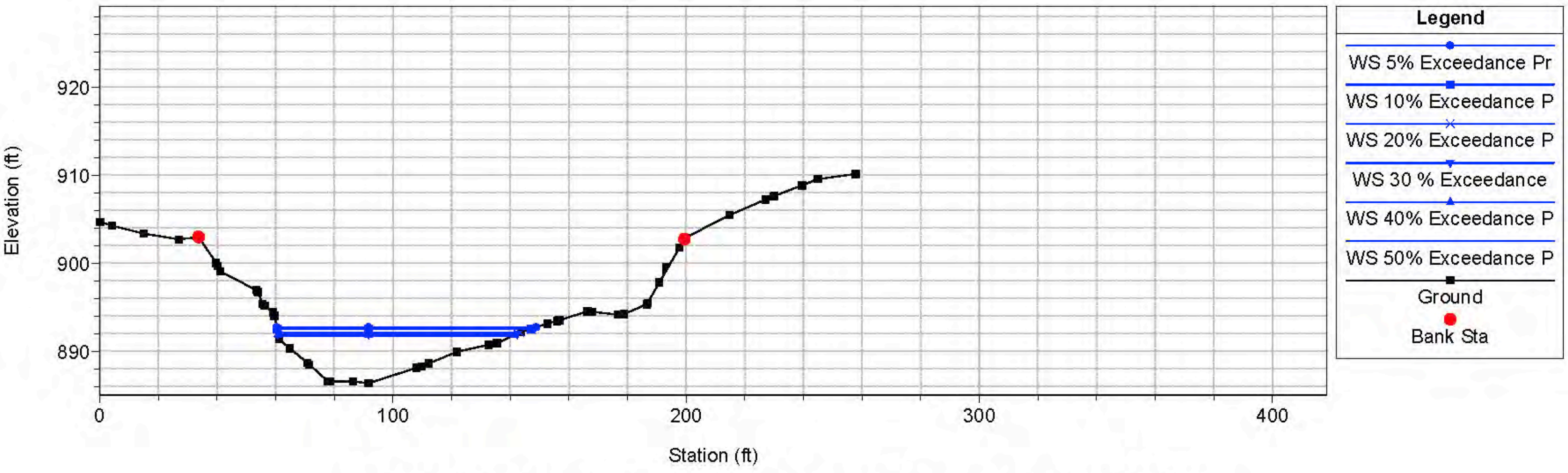
HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

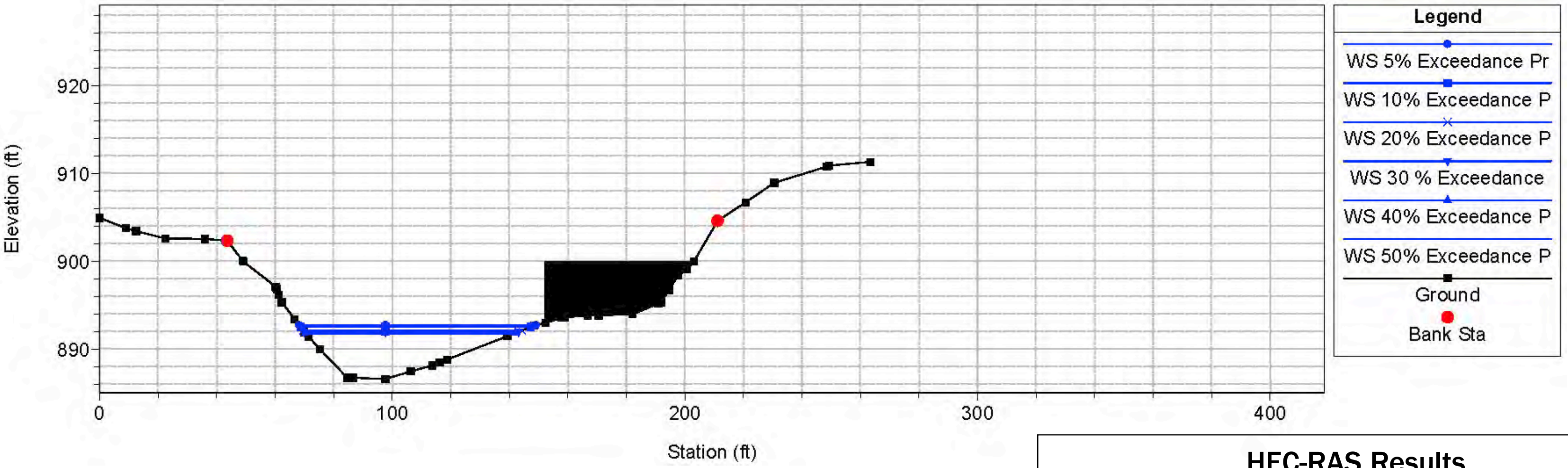
GEOENGINEERS

Figure C-3

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 1 Umpqua Mp90 5/11/2015
River = South Fork Ump90 Reach = Reach 1 RS = -147.506



HEC-RAS Results
Cross Sections

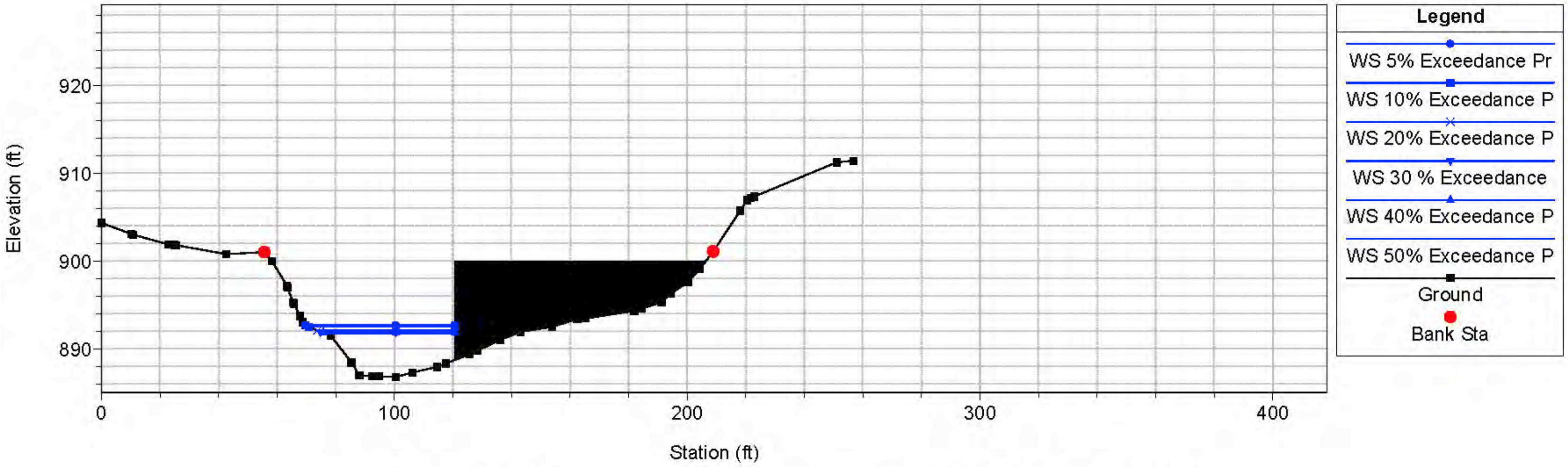
South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

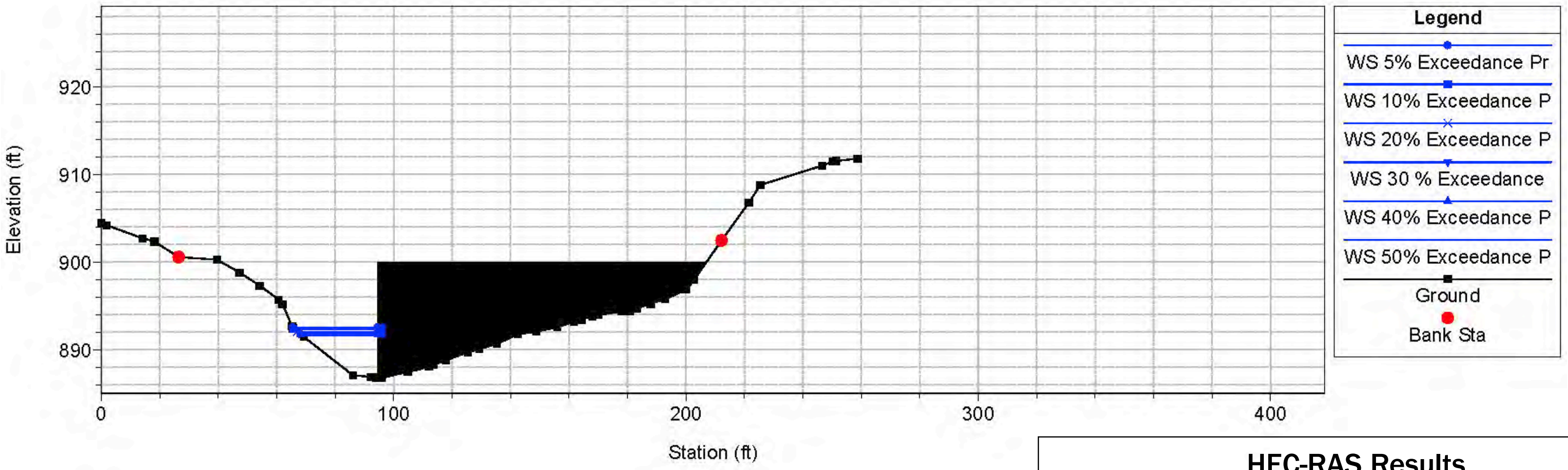
Figure C-4

Data Source: Model output obtained from HEC-RAS v4.1.0

16724-002-00 Date Exported: 6/11/15



South Umpqua Mp90 Plan: Proposed Phase 1 Umpqua Mp90 5/11/2015
River = South Fork Ump90 Reach = Reach 1 RS = -200.197 Pipeline crossing



HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

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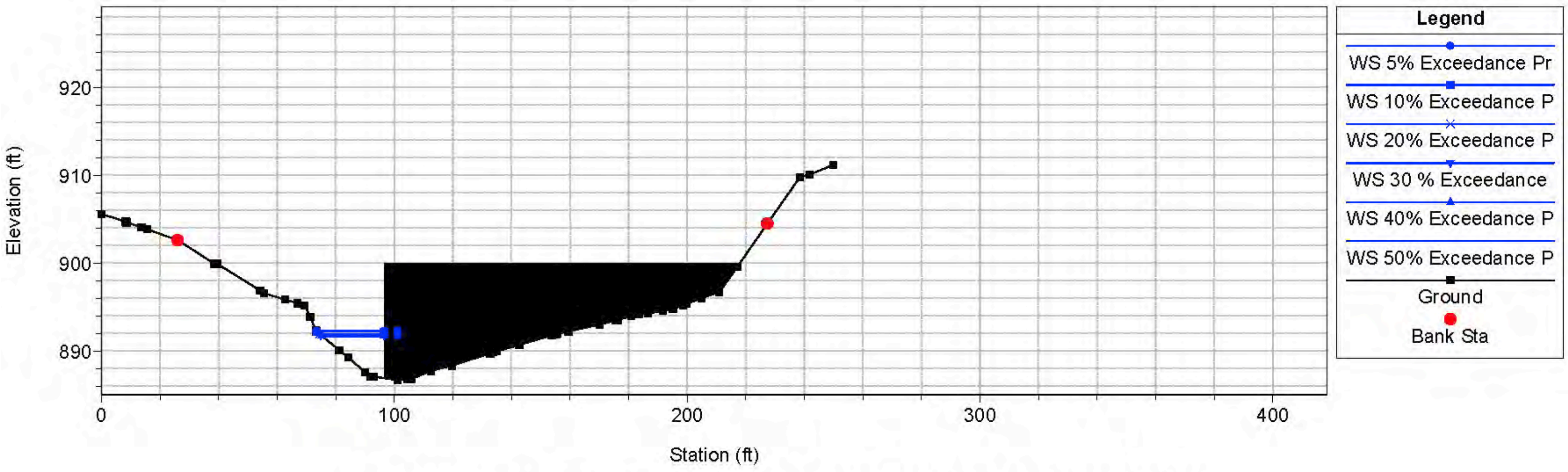
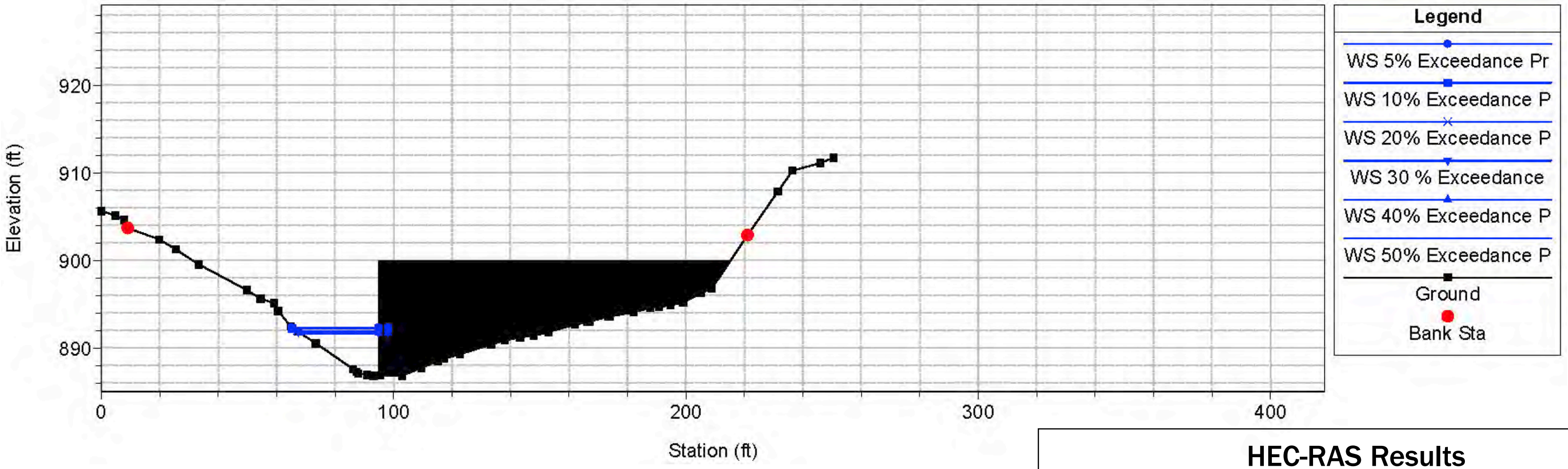
Figure C-5

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 1 Umpqua Mp90 5/11/2015

River = South Fork Ump90 Reach = Reach 1 RS = -233.989 Pipeline crossing



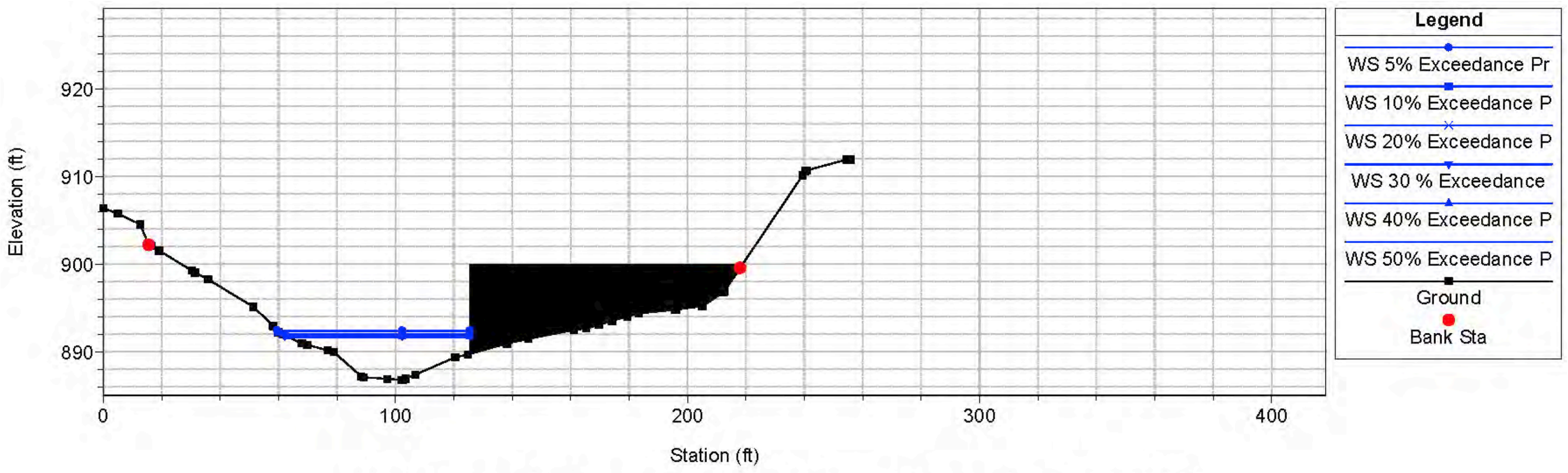
HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

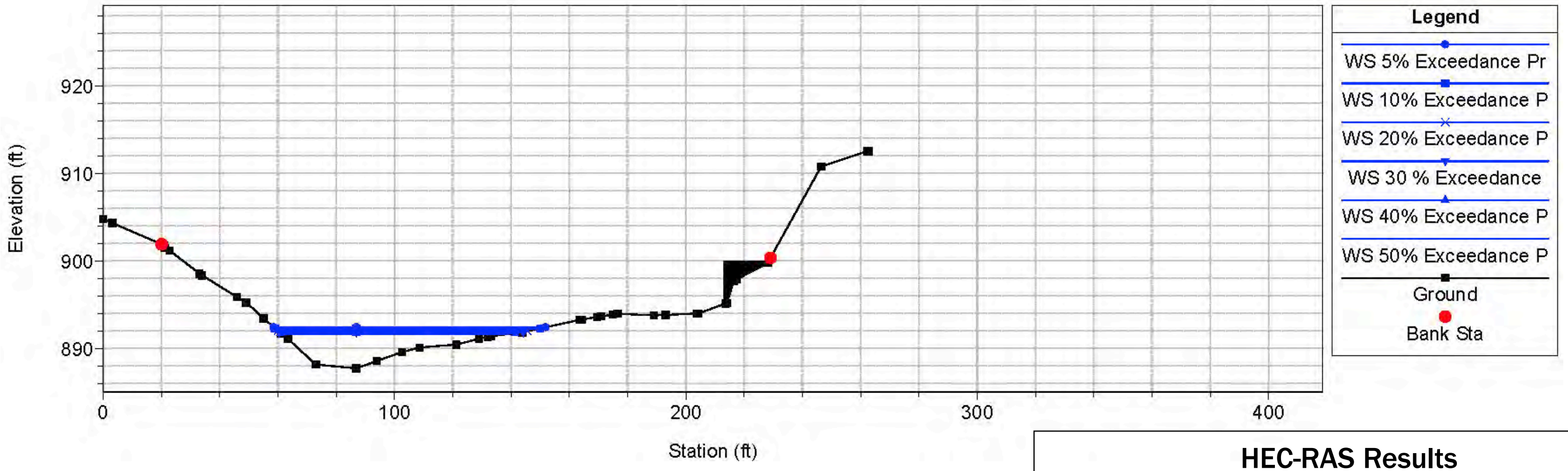
GEOENGINEERS

Figure C-6

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 1 Umpqua Mp90 5/11/2015
River = South Fork Ump90 Reach = Reach 1 RS = -303.811



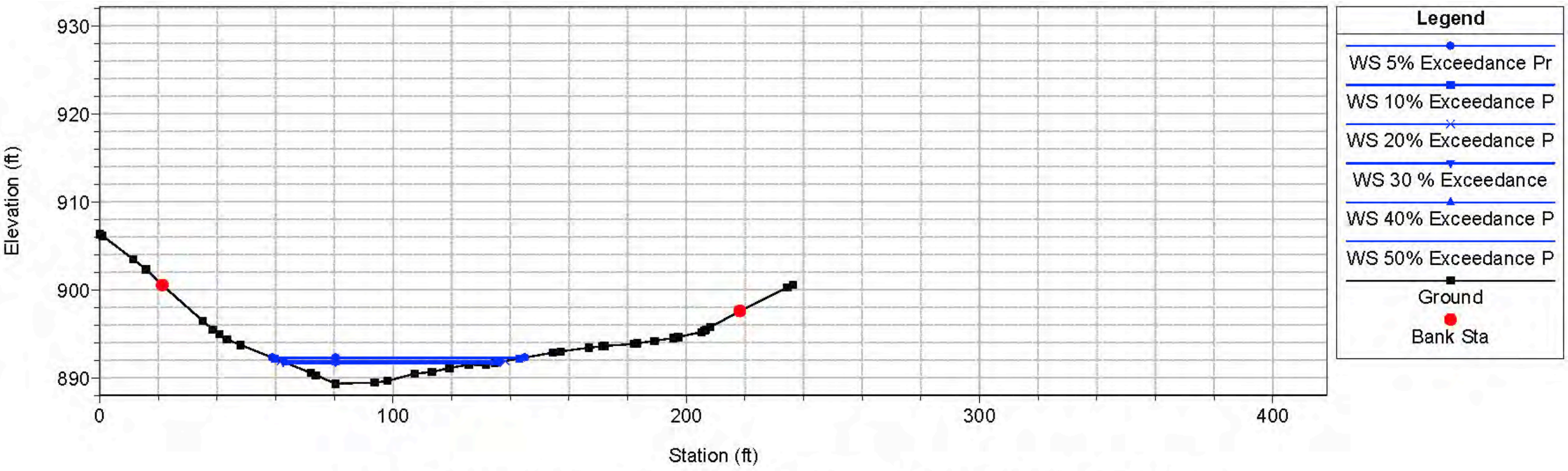
HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

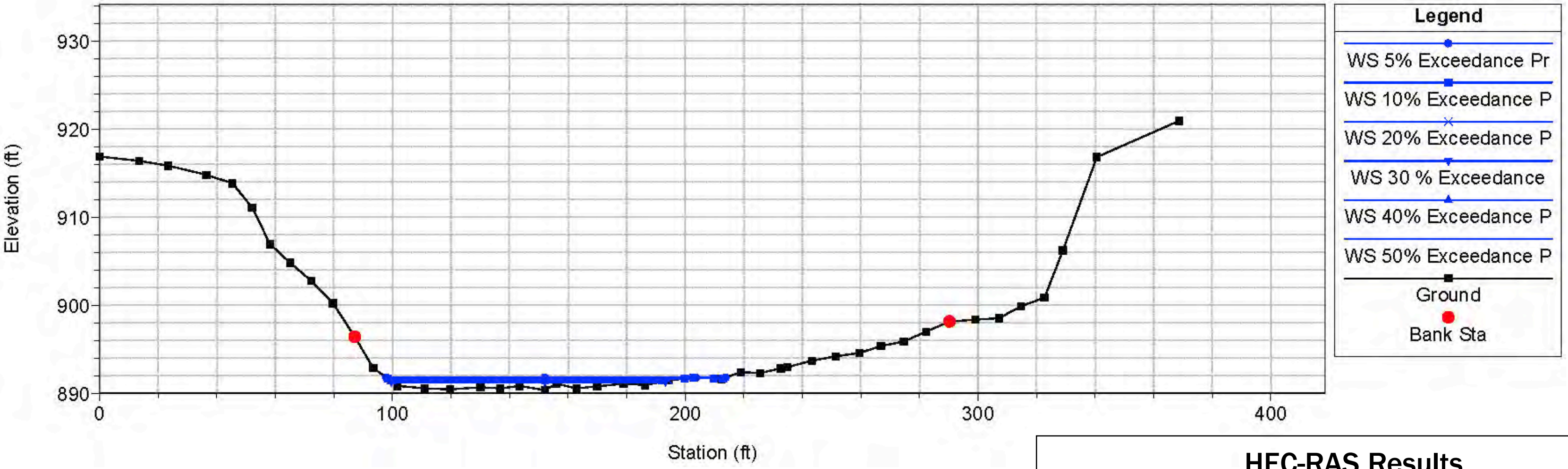
GEOENGINEERS

Figure C-7

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 1 Umpqua Mp90 5/11/2015
River = South Fork Ump90 Reach = Reach 1 RS = -415.69



HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

Figure C-8

Data Source: Model output obtained from HEC-RAS v4.1.0

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	-43	5% Exceedance Pr	340.0	884.7	892.72	887.9	893	0.0001	0.9	362.26	96	0.09
Reach 1	-50.552*	5% Exceedance Pr	340.0	884.9	892.72		893	0.0001	0.9	360.77	96.91	0.09
Reach 1	-58.246*	5% Exceedance Pr	340.0	885.2	892.72		893	0.0001	0.9	362.31	93.59	0.08
Reach 1	-66	5% Exceedance Pr	340.0	885.5	892.72		893	0.0001	0.9	366.89	94.01	0.08
Reach 1	-75.142*	5% Exceedance Pr	340.0	885.7	892.71		893	0.0001	0.9	359.99	93.18	0.08
Reach 1	-84.345*	5% Exceedance Pr	340.0	885.8	892.71		893	0.0001	1.0	353.55	92.34	0.09
Reach 1	-93.547*	5% Exceedance Pr	340.0	885.9	892.71		893	0.0001	1.0	347.54	91.39	0.09
Reach 1	-102.75*	5% Exceedance Pr	340.0	886.1	892.71		893	0.0001	1.0	341.84	90.47	0.09
Reach 1	-111.95*	5% Exceedance Pr	340.0	886.2	892.71		893	0.0001	1.0	336.6	89.42	0.09
Reach 1	-121	5% Exceedance Pr	340.0	886.4	892.71		893	0.0001	1.0	331.73	88.52	0.09
Reach 1	-129.93*	5% Exceedance Pr	340.0	886.4	892.70		893	0.0001	1.1	319.28	86.23	0.1
Reach 1	-138.72*	5% Exceedance Pr	340.0	886.5	892.70		893	0.0002	1.1	307.53	83.92	0.1
Reach 1	-148	5% Exceedance Pr	340.0	886.6	892.70		893	0.0002	1.2	296.31	80.9	0.11
Reach 1	-156.33*	5% Exceedance Pr	340.0	886.6	892.69		893	0.0002	1.2	282.56	71.63	0.11
Reach 1	-165.16*	5% Exceedance Pr	340.0	886.7	892.69		893	0.0002	1.3	255.01	60.1	0.11
Reach 1	-174	5% Exceedance Pr	340.0	886.8	892.67		893	0.0003	1.6	211.88	51	0.14
Reach 1	-182.72*	5% Exceedance Pr	340.0	886.8	892.65		893	0.0004	1.9	180.16	38.93	0.15
Reach 1	-191.46*	5% Exceedance Pr	340.0	886.8	892.61		893	0.0007	2.3	146.07	33.81	0.2
Reach 1	-200	5% Exceedance Pr	340.0	886.8	892.52		893	0.0018	3.3	104.11	29.06	0.3
Reach 1	-208.53*	5% Exceedance Pr	340.0	886.8	892.42		893	0.0027	3.9	88.1	25.03	0.36
Reach 1	-217	5% Exceedance Pr	340.0	886.9	892.28		893	0.0047	4.7	73.05	23.22	0.46
Reach 1	-225.43*	5% Exceedance Pr	340.0	886.8	892.31		893	0.0033	4.0	84.6	26.26	0.39
Reach 1	-234	5% Exceedance Pr	340.0	886.8	892.32		893	0.0025	3.6	95.3	29.75	0.35
Reach 1	-243.17*	5% Exceedance Pr	340.0	886.8	892.41		892	0.0005	1.9	174.87	45.07	0.17
Reach 1	-252	5% Exceedance Pr	340.0	886.8	892.42		892	0.0003	1.4	236.19	66.07	0.13
Reach 1	-260.93*	5% Exceedance Pr	340.0	886.9	892.42		892	0.0003	1.3	257.94	80.91	0.13
Reach 1	-269.50*	5% Exceedance Pr	340.0	887.1	892.42		892	0.0003	1.3	259.87	95.28	0.14
Reach 1	-278.08*	5% Exceedance Pr	340.0	887.2	892.42		892	0.0004	1.4	250.73	96.72	0.15
Reach 1	-286.65*	5% Exceedance Pr	340.0	887.4	892.41		892	0.0004	1.4	241.44	95.34	0.16
Reach 1	-295.23*	5% Exceedance Pr	340.0	887.6	892.40		892	0.0005	1.5	232.01	94.32	0.16
Reach 1	-304	5% Exceedance Pr	340.0	887.7	892.40		892	0.0005	1.5	222.63	93.33	0.17
Reach 1	-312.83*	5% Exceedance Pr	340.0	888.1	892.38		892	0.0007	1.7	201.28	92.17	0.2
Reach 1	-321.86*	5% Exceedance Pr	340.0	888.5	892.36		892	0.0010	1.9	180.38	90.78	0.24
Reach 1	-330.88*	5% Exceedance Pr	340.0	888.9	892.33		892	0.0015	2.1	159.74	89.03	0.28
Reach 1	-340	5% Exceedance Pr	340.0	889.3	892.29		892	0.0023	2.4	139.21	86.29	0.34
Reach 1	-349.38*	5% Exceedance Pr	340.0	889.4	892.26		892	0.0027	2.6	133.13	87.9	0.37
Reach 1	-358.85*	5% Exceedance Pr	340.0	889.6	892.22		892	0.0033	2.7	126.75	90.27	0.4
Reach 1	-368.32*	5% Exceedance Pr	340.0	889.7	892.17		892	0.0041	2.8	120.5	93.64	0.44
Reach 1	-377.79*	5% Exceedance Pr	340.0	889.8	892.12		892	0.0052	3.0	114.26	97.96	0.49
Reach 1	-387.27*	5% Exceedance Pr	340.0	890.0	892.04		892	0.0066	3.1	108.73	103.25	0.54
Reach 1	-396.74*	5% Exceedance Pr	340.0	890.1	891.96		892	0.0083	3.3	103.57	108.38	0.59
Reach 1	-406.21*	5% Exceedance Pr	340.0	890.2	891.86		892	0.0096	3.4	100.93	113.21	0.63
Reach 1	-416	5% Exceedance Pr	340.0	890.3	891.77	891.5	892	0.0100	3.4	100.26	114.72	0.64

16724-002-00 Date Exported: 06/11/15

Data Source: Model output obtained from HEC-RAS v4.1.0

HEC-RAS Results
Model Output Table

South Umpqua River Crossing No. 2
Douglas County, Oregon

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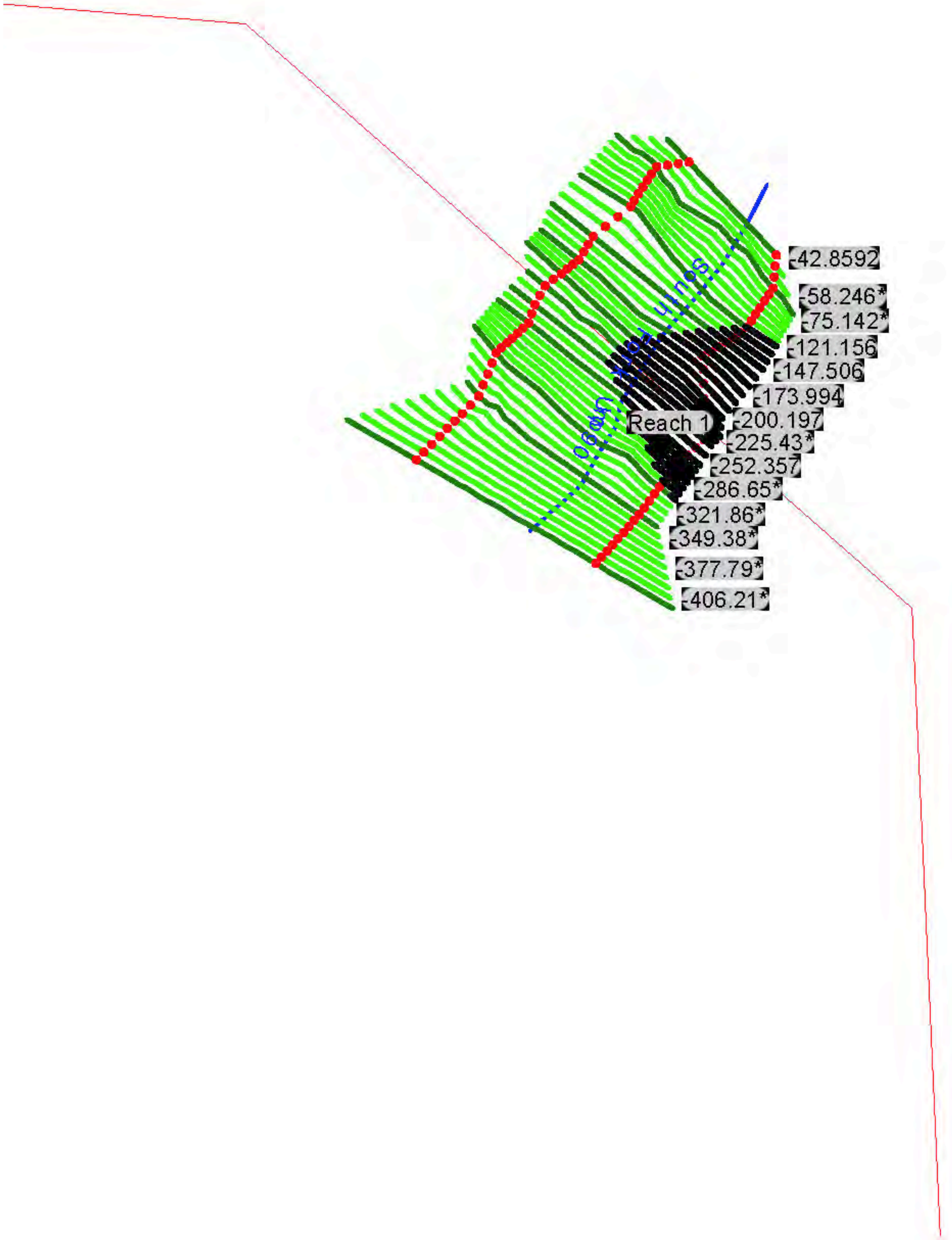
Figure C-9



HEC-RAS Results
Plan View

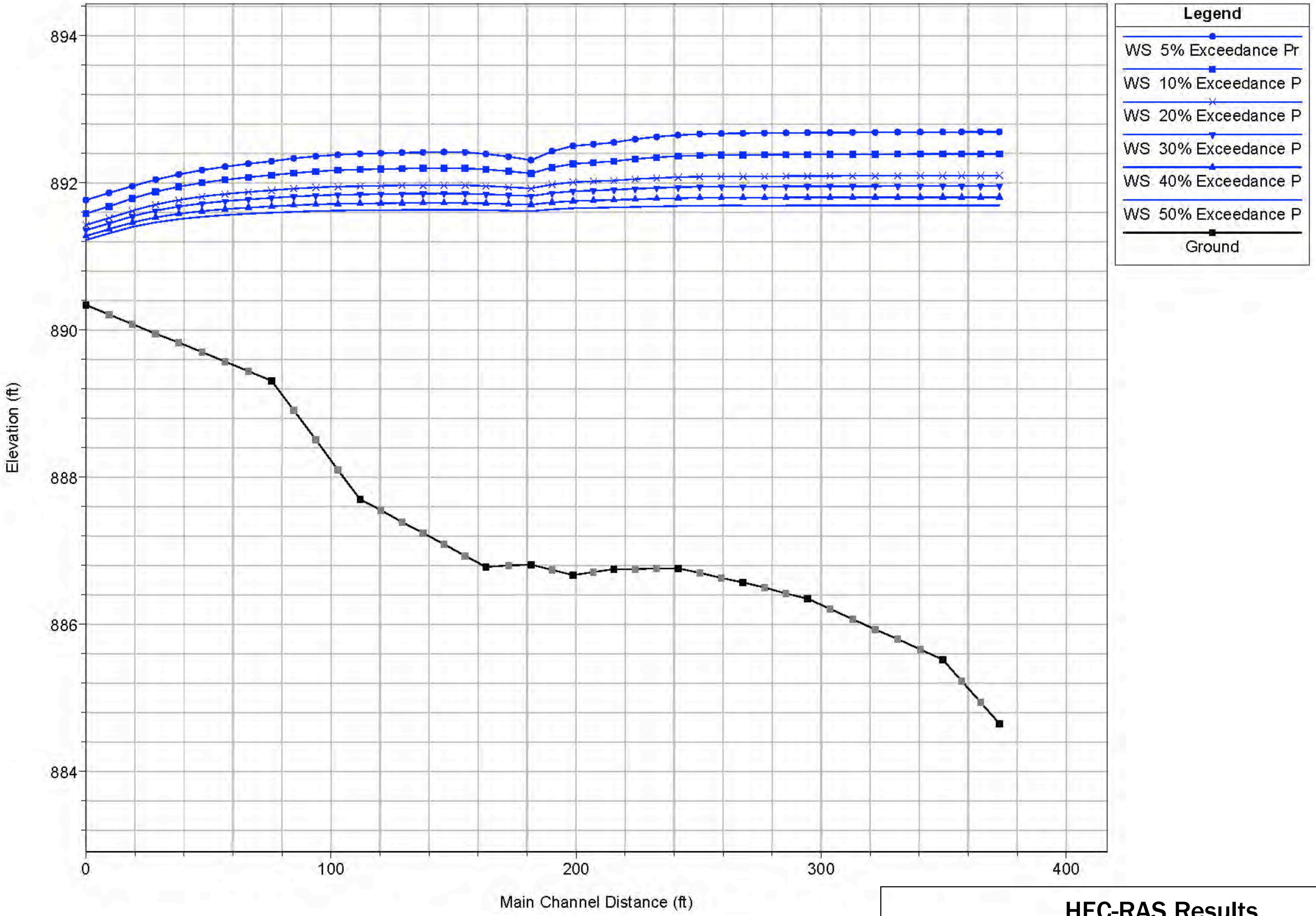
South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

Figure C-10

Data Source: Model output obtained from HEC-RAS v4.1.0

16724-002-00 Date Exported: 06/11/15



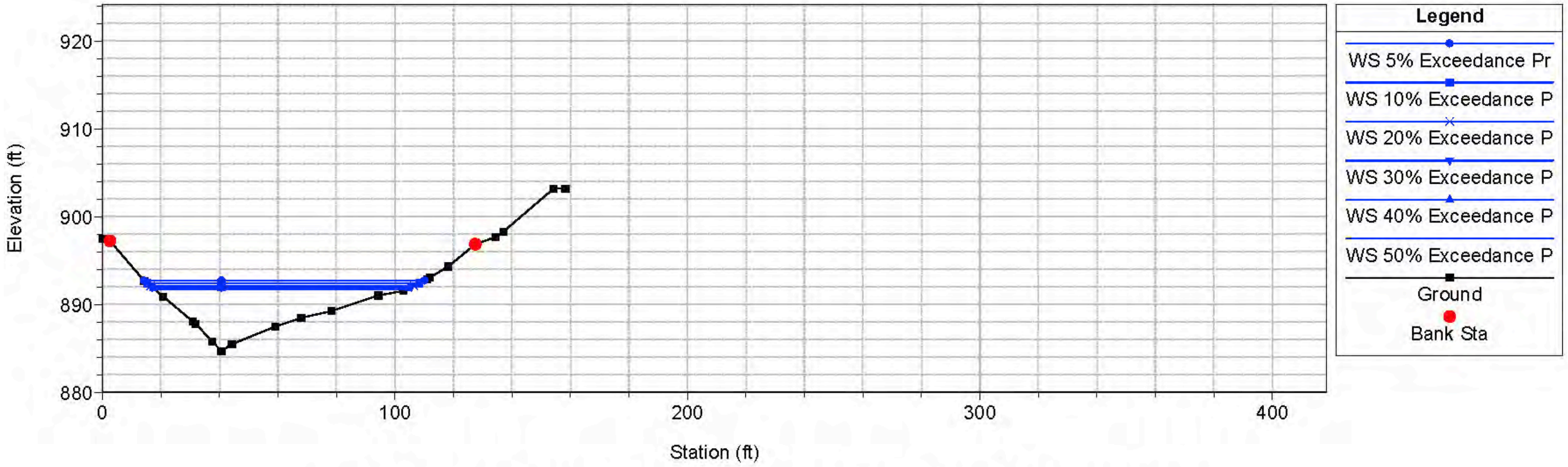
HEC-RAS Results
Profile View

South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

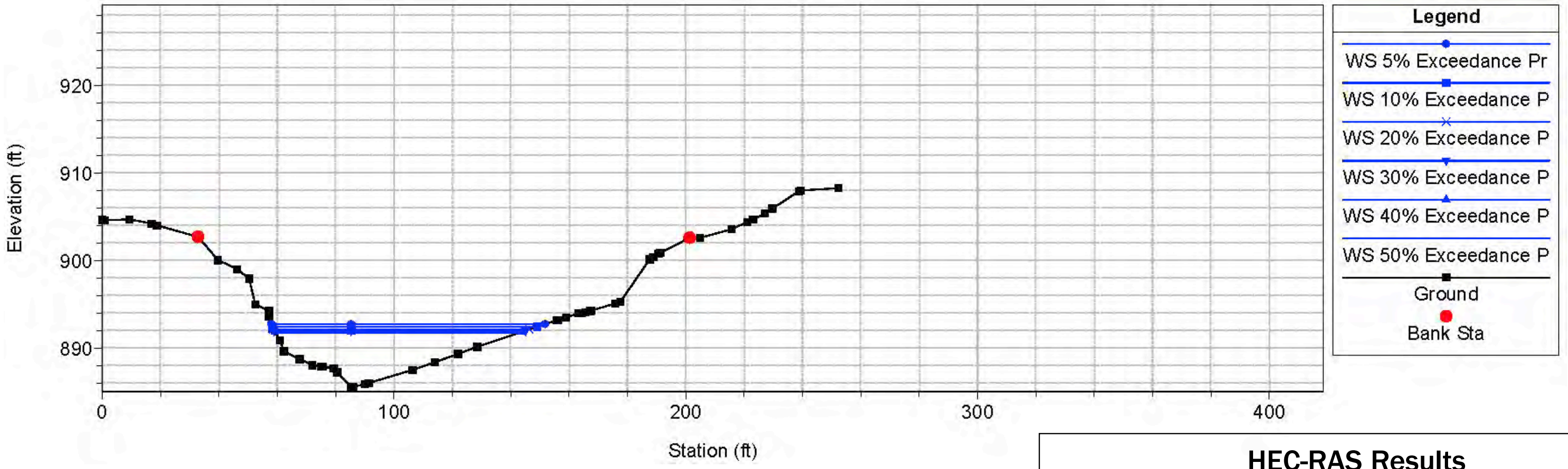
Figure C-11

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 2 Umpqua Mp90 5/18/2015

River = South Fork Ump90 Reach = Reach 1 RS = -65.9397



HEC-RAS Results
Cross Sections

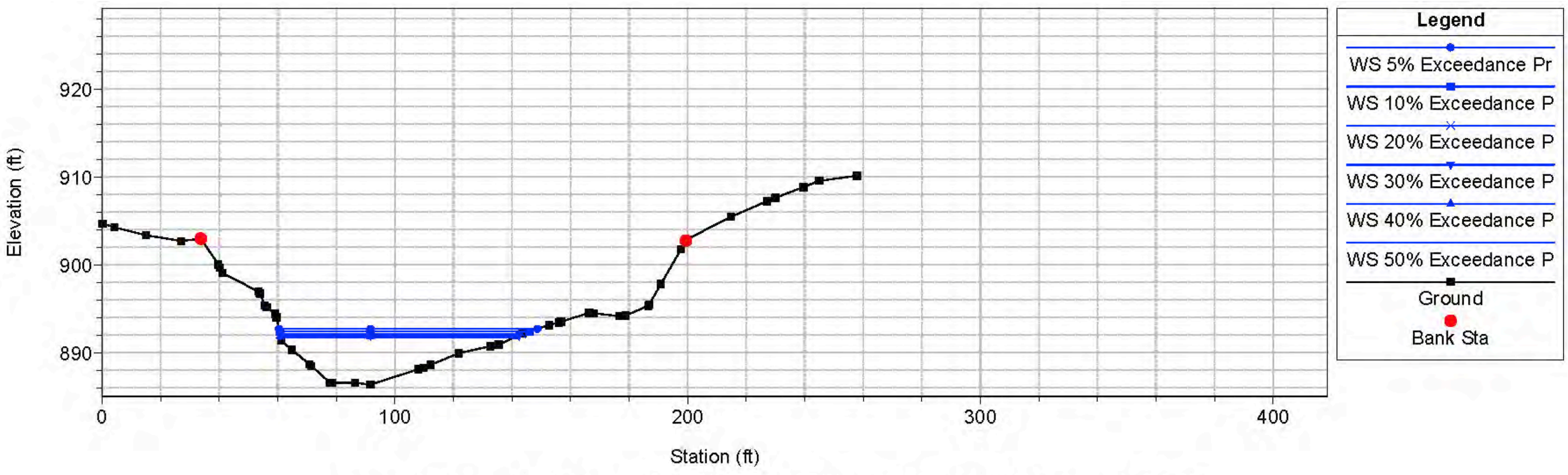
South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

Figure C-12

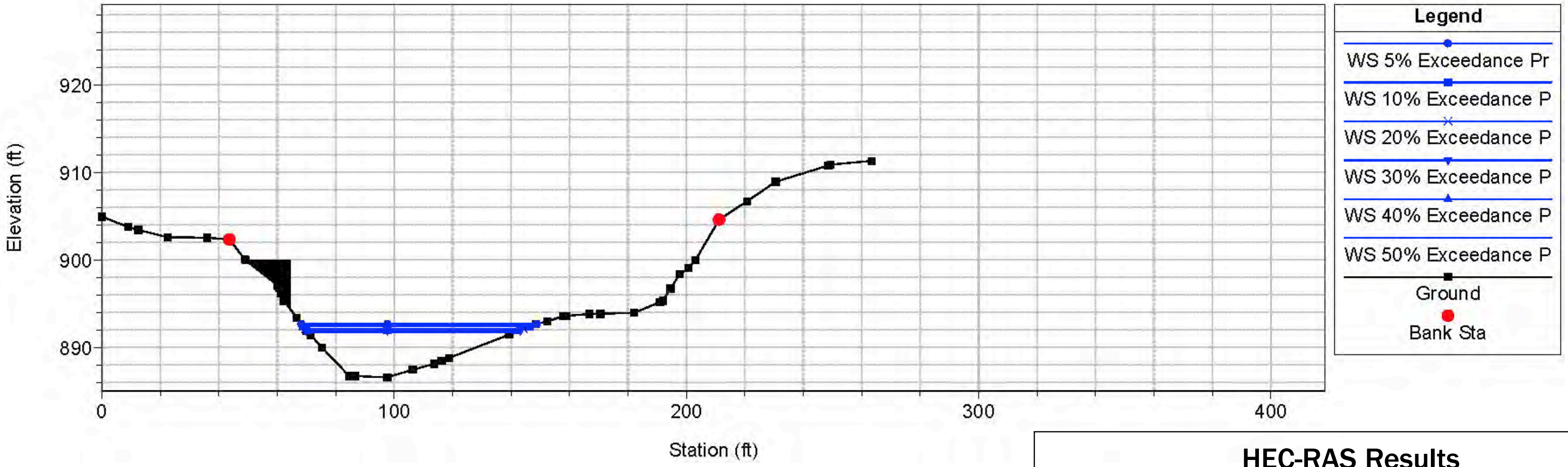
Data Source: Model output obtained from HEC-RAS v4.1.0

16724-002-00 Date Exported: 6/11/15



South Umpqua Mp90 Plan: Proposed Phase 2 Umpqua Mp90 5/18/2015

River = South Fork Ump90 Reach = Reach 1 RS = -147.506



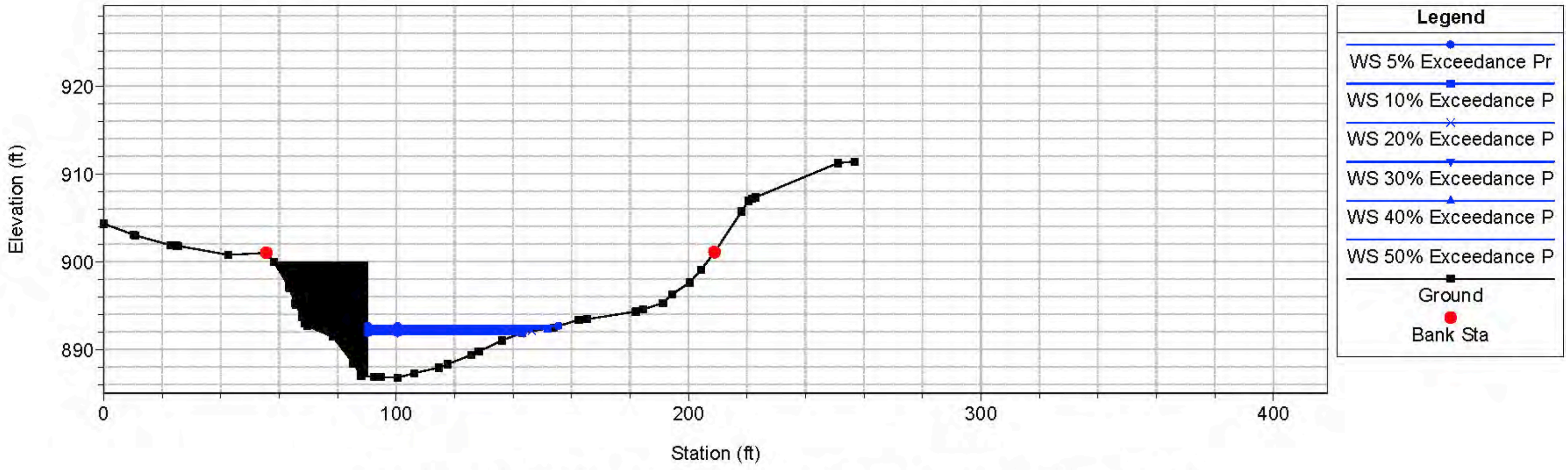
HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

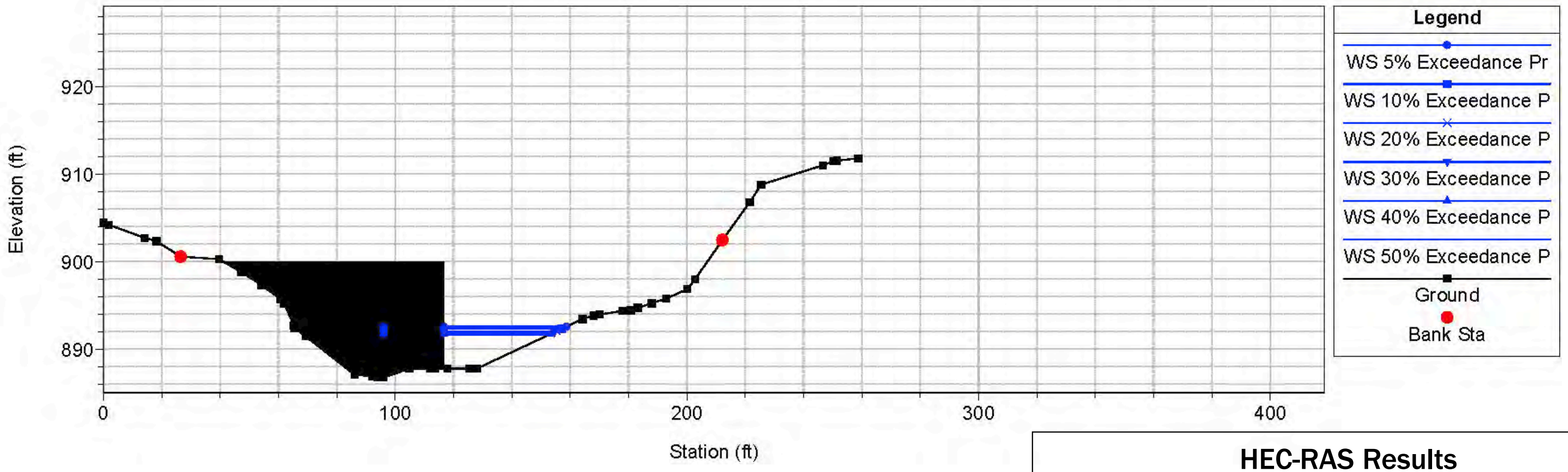
Figure C-13

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90   Plan: Proposed Phase 2 Umpqua Mp90   5/18/2015

River = South Fork Ump90   Reach = Reach 1   RS = -200.197 Pipeline crossing



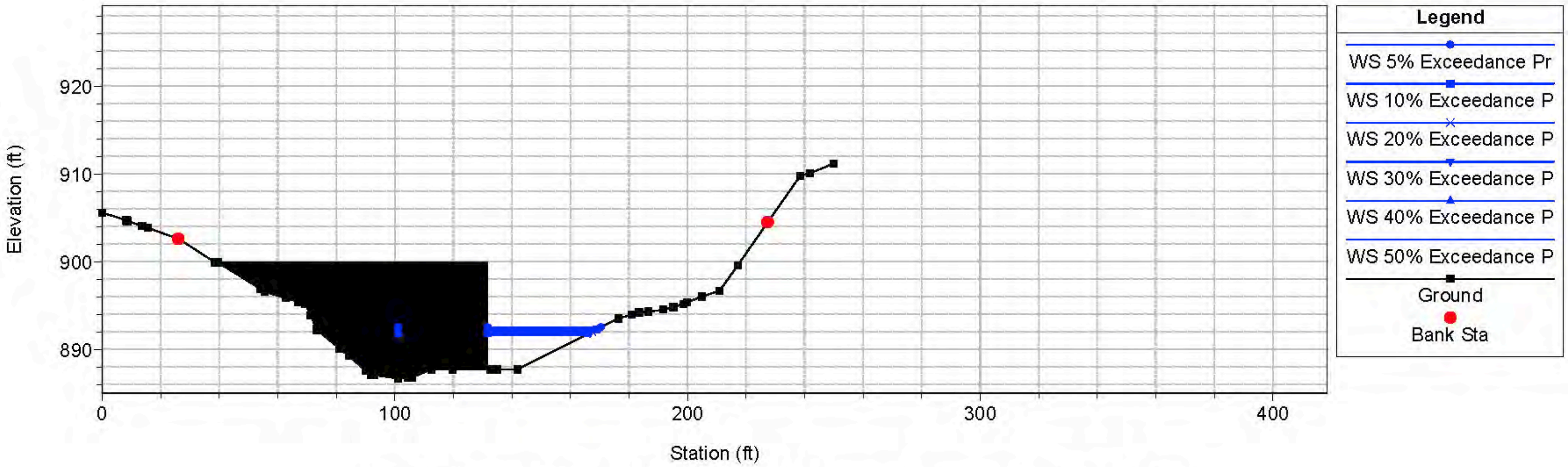
HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

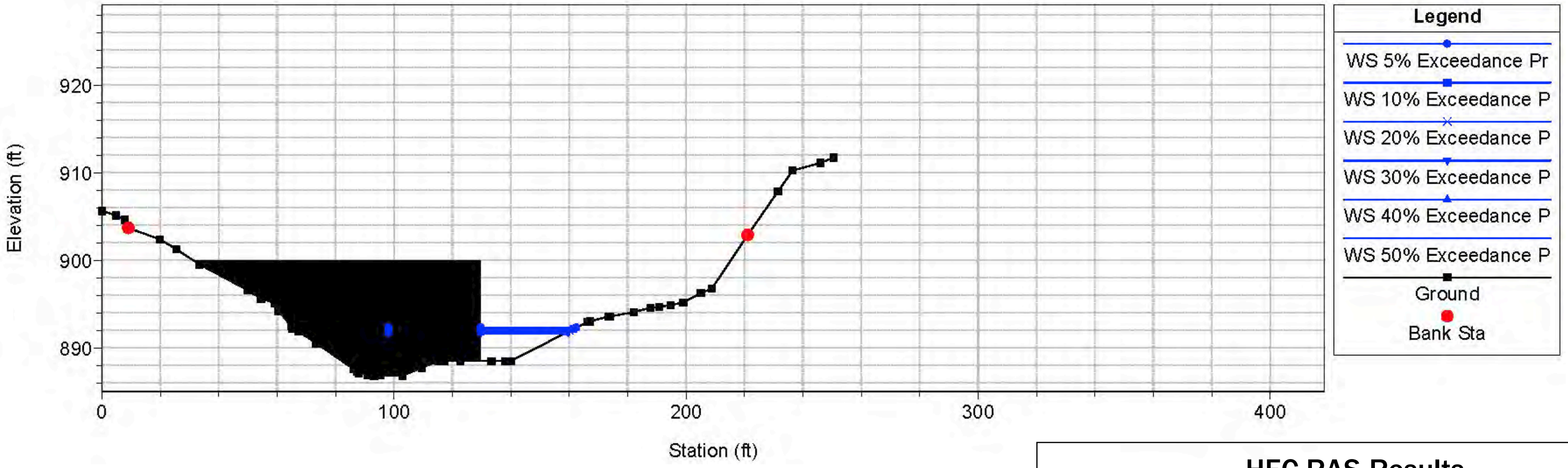
GEOENGINEERS

Figure C-14

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 2 Umpqua Mp90 5/18/2015
River = South Fork Ump90 Reach = Reach 1 RS = -233.989 Pipeline crossing



HEC-RAS Results
Cross Sections

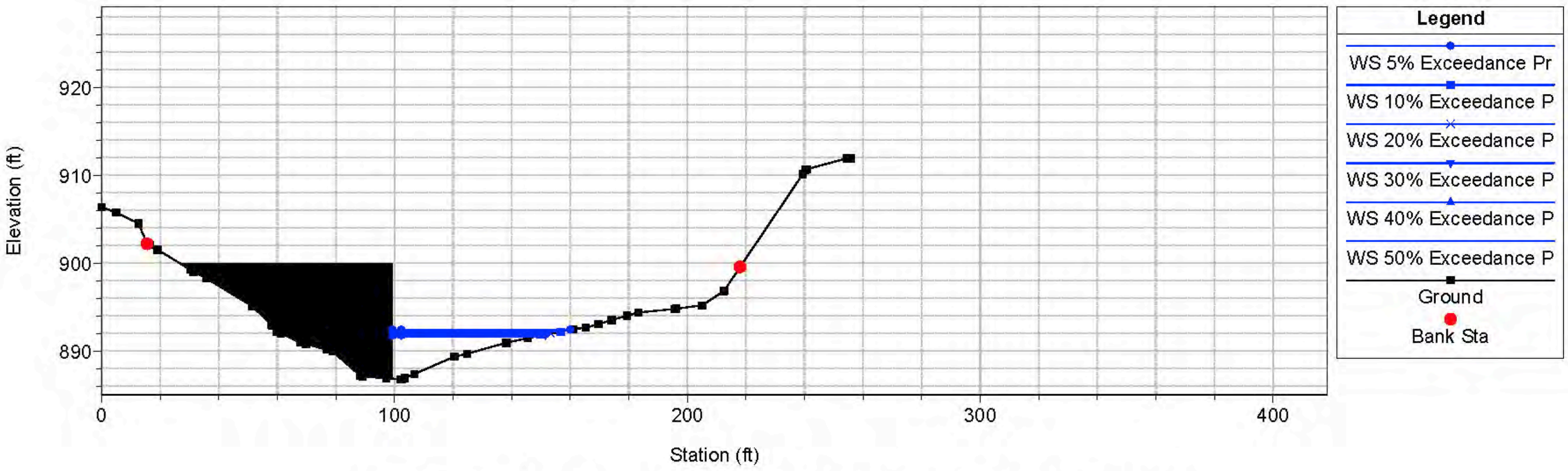
South Umpqua River Crossing No. 2
Douglas County, Oregon

GeoEngineers

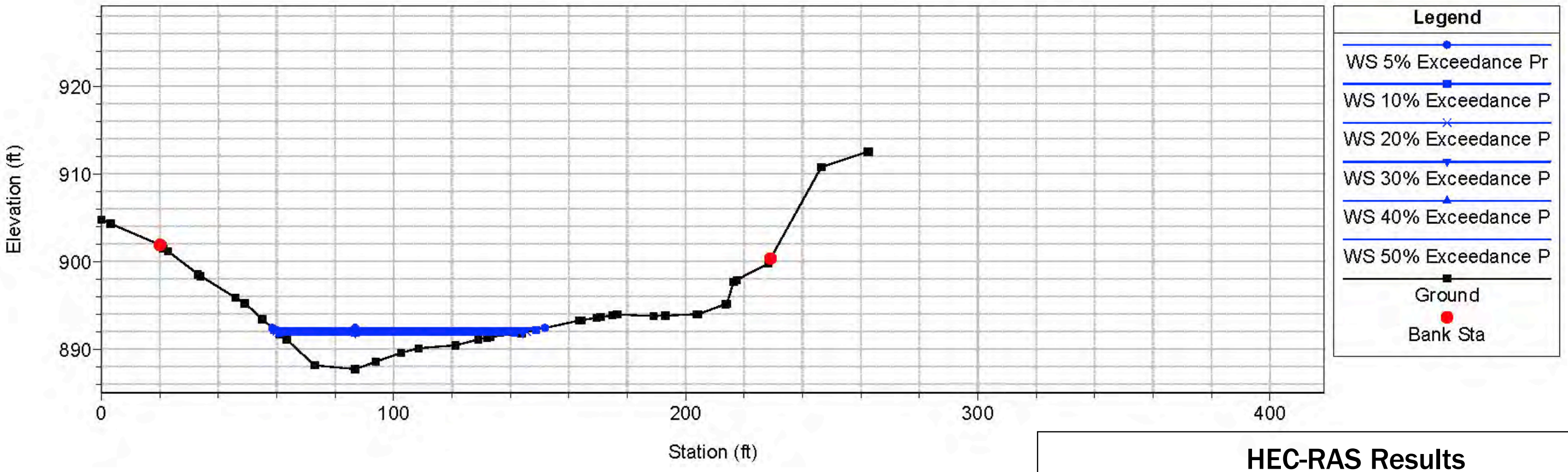
Figure C-15

Data Source: Model output obtained from HEC-RAS v4.1.0

16724-002-00 Date Exported: 6/11/15



South Umpqua Mp90 Plan: Proposed Phase 2 Umpqua Mp90 5/18/2015
River = South Fork Ump90 Reach = Reach 1 RS = -303.811



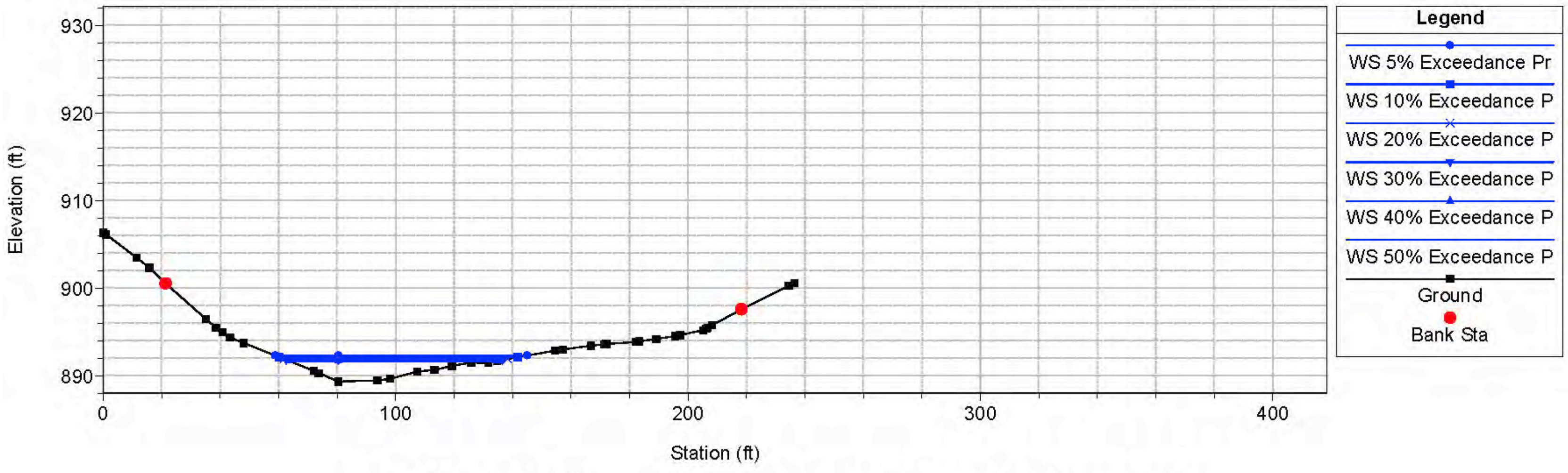
HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

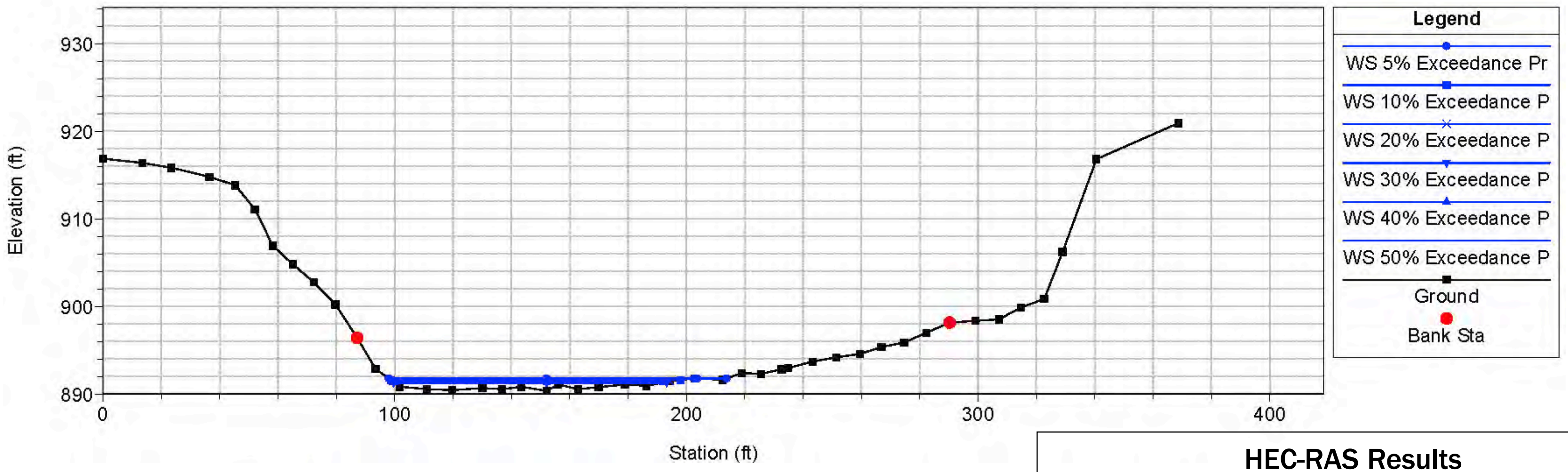
Figure C-16

Data Source: Model output obtained from HEC-RAS v4.1.0



South Umpqua Mp90 Plan: Proposed Phase 2 Umpqua Mp90 5/18/2015

River = South Fork Ump90 Reach = Reach 1 RS = -415.69



HEC-RAS Results
Cross Sections

South Umpqua River Crossing No. 2
Douglas County, Oregon

GeoEngineers

Figure C-17

Data Source: Model output obtained from HEC-RAS v4.1.0

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach 1	-43	5% Exceedance Pr	340.0	884.7	892.69	887.9	893	0.0001	0.9	360.03	95.8	0.09
Reach 1	-50.552*	5% Exceedance Pr	340.0	884.9	892.69		893	0.0001	1.0	358.5	96.64	0.09
Reach 1	-58.246*	5% Exceedance Pr	340.0	885.2	892.69		893	0.0001	0.9	360.13	93.33	0.08
Reach 1	-66	5% Exceedance Pr	340.0	885.5	892.69		893	0.0001	0.9	364.7	93.78	0.08
Reach 1	-75.142*	5% Exceedance Pr	340.0	885.7	892.69		893	0.0001	1.0	357.81	92.94	0.09
Reach 1	-84.345*	5% Exceedance Pr	340.0	885.8	892.69		893	0.0001	1.0	351.39	92.11	0.09
Reach 1	-93.547*	5% Exceedance Pr	340.0	885.9	892.69		893	0.0001	1.0	345.39	91.16	0.09
Reach 1	-102.75*	5% Exceedance Pr	340.0	886.1	892.69		893	0.0001	1.0	339.7	90.24	0.09
Reach 1	-111.95*	5% Exceedance Pr	340.0	886.2	892.68		893	0.0001	1.0	334.49	89.19	0.09
Reach 1	-121	5% Exceedance Pr	340.0	886.4	892.68		893	0.0001	1.0	329.64	88.29	0.09
Reach 1	-129.93*	5% Exceedance Pr	340.0	886.4	892.68		893	0.0002	1.1	317.24	85.99	0.1
Reach 1	-138.72*	5% Exceedance Pr	340.0	886.5	892.68		893	0.0002	1.1	305.53	83.74	0.1
Reach 1	-148	5% Exceedance Pr	340.0	886.6	892.67		893	0.0002	1.2	294.38	80.54	0.11
Reach 1	-156.33*	5% Exceedance Pr	340.0	886.6	892.67		893	0.0002	1.2	283.17	77.82	0.11
Reach 1	-165.16*	5% Exceedance Pr	340.0	886.7	892.66		893	0.0002	1.3	259.36	71.86	0.12
Reach 1	-174	5% Exceedance Pr	340.0	886.8	892.65		893	0.0004	1.6	218.04	65.25	0.15
Reach 1	-182.72*	5% Exceedance Pr	340.0	886.8	892.63		893	0.0006	1.9	181.96	57.94	0.19
Reach 1	-191.46*	5% Exceedance Pr	340.0	887.7	892.59		893	0.0009	2.2	151.78	50.14	0.23
Reach 1	-200	5% Exceedance Pr	340.0	887.8	892.55		893	0.0014	2.7	127.88	41.99	0.27
Reach 1	-208.53*	5% Exceedance Pr	340.0	887.7	892.53		893	0.0015	2.8	122.17	40.37	0.28
Reach 1	-217	5% Exceedance Pr	340.0	887.7	892.50		893	0.0017	2.9	117.08	38.67	0.29
Reach 1	-225.43*	5% Exceedance Pr	340.0	888.1	892.43		893	0.0025	3.4	99.91	35.88	0.36
Reach 1	-234	5% Exceedance Pr	340.0	888.5	892.31		893	0.0043	4.1	82.2	32.75	0.46
Reach 1	-243.17*	5% Exceedance Pr	340.0	888.4	892.36		893	0.0026	3.1	108.61	46.91	0.36
Reach 1	-252	5% Exceedance Pr	340.0	886.8	892.39		892	0.0012	2.2	152.3	60.73	0.25
Reach 1	-260.93*	5% Exceedance Pr	340.0	886.9	892.42		892	0.0004	1.5	220.5	75.22	0.16
Reach 1	-269.50*	5% Exceedance Pr	340.0	887.1	892.42		892	0.0003	1.4	252.55	89.31	0.14
Reach 1	-278.08*	5% Exceedance Pr	340.0	887.2	892.42		892	0.0004	1.4	250.73	96.72	0.15
Reach 1	-286.65*	5% Exceedance Pr	340.0	887.4	892.41		892	0.0004	1.4	241.44	95.34	0.16
Reach 1	-295.23*	5% Exceedance Pr	340.0	887.6	892.40		892	0.0005	1.5	232.01	94.32	0.16
Reach 1	-304	5% Exceedance Pr	340.0	887.7	892.40		892	0.0005	1.5	222.63	93.33	0.17
Reach 1	-312.83*	5% Exceedance Pr	340.0	888.1	892.38		892	0.0007	1.7	201.28	92.17	0.2
Reach 1	-321.86*	5% Exceedance Pr	340.0	888.5	892.36		892	0.0010	1.9	180.38	90.78	0.24
Reach 1	-330.88*	5% Exceedance Pr	340.0	888.9	892.33		892	0.0015	2.1	159.74	89.03	0.28
Reach 1	-340	5% Exceedance Pr	340.0	889.3	892.29		892	0.0023	2.4	139.21	86.29	0.34
Reach 1	-349.38*	5% Exceedance Pr	340.0	889.4	892.26		892	0.0027	2.6	133.13	87.9	0.37
Reach 1	-358.85*	5% Exceedance Pr	340.0	889.6	892.22		892	0.0033	2.7	126.75	90.27	0.4
Reach 1	-368.32*	5% Exceedance Pr	340.0	889.7	892.17		892	0.0041	2.8	120.5	93.64	0.44
Reach 1	-377.79*	5% Exceedance Pr	340.0	889.8	892.12		892	0.0052	3.0	114.26	97.96	0.49
Reach 1	-387.27*	5% Exceedance Pr	340.0	890.0	892.04		892	0.0066	3.1	108.73	103.25	0.54
Reach 1	-396.74*	5% Exceedance Pr	340.0	890.1	891.96		892	0.0083	3.3	103.57	108.38	0.59
Reach 1	-406.21*	5% Exceedance Pr	340.0	890.2	891.86		892	0.0096	3.4	100.93	113.21	0.63
Reach 1	-416	5% Exceedance Pr	340.0	890.3	891.77	891.5	892	0.0100	3.4	100.26	114.72	0.64

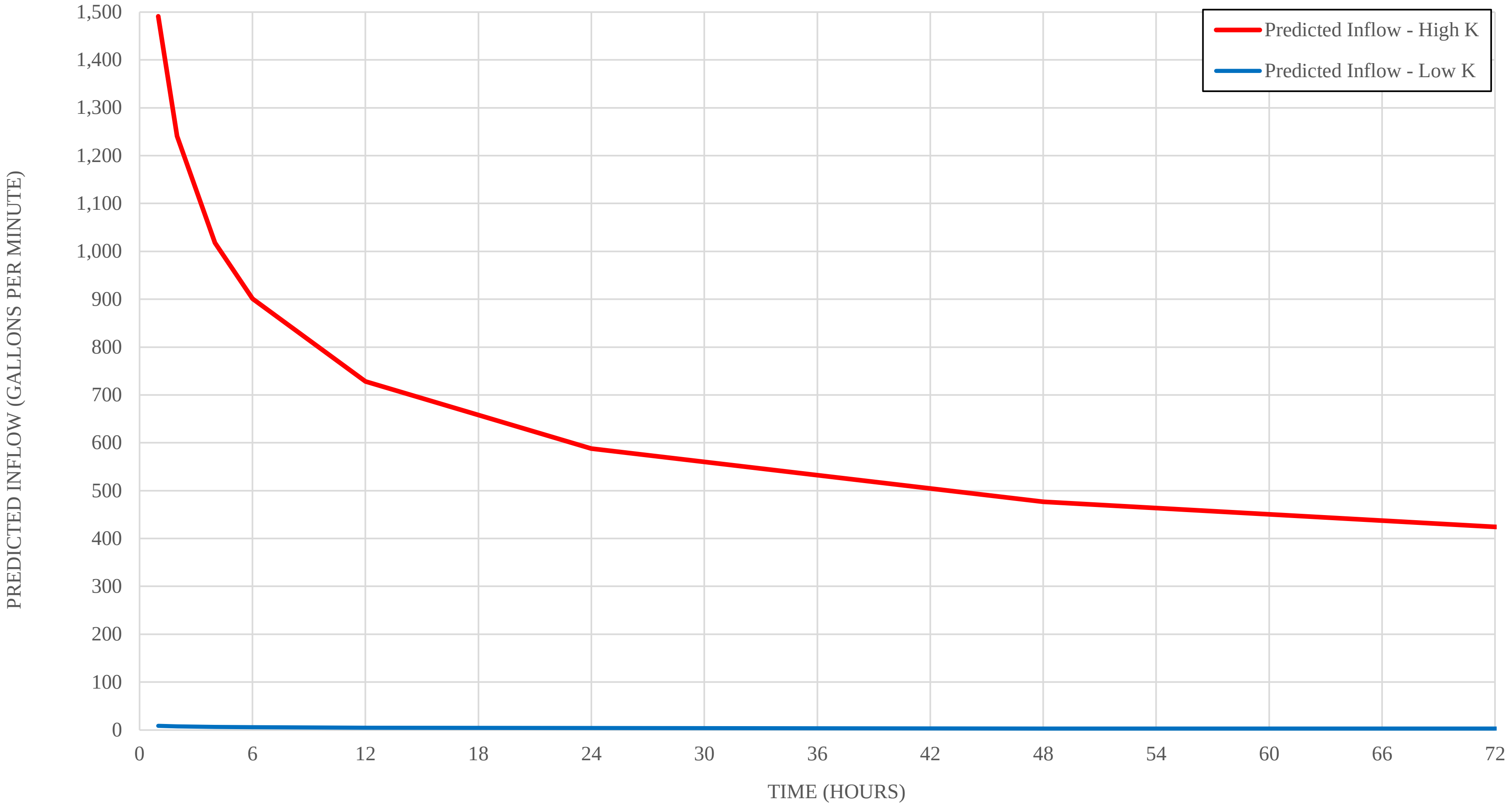
Data Source: Model output obtained from HEC-RAS v4.1.0

HEC-RAS Results
Model Output Table

South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

Figure C-18



Predicted Groundwater Inflow Summary

South Umpqua River Crossing No. 2
Douglas County, Oregon

GEOENGINEERS

Figure C-19

South Umpqua Crossing Phase 1

Project: S. Umpqua Crossing **Site:** Phase 1
Project Number: 16724-002-00 **Analyst:** ESM
Watercourse: S. Umpqua River **Latest Revision:** 5/15/2015

Spreadsheet Description

- This spreadsheet calculates the critical velocity and critical shear stress for the channel's bed material for the temporary diverted condition.
- **The bed material tested below represents the existing aluvial material in the South Umpqua River near the proposed diversion.**
- It compares the critical velocity and critical shear stress to the values calculated in a hydraulic model of the channel. This comparison is represented in the Relative Bed Stability (RBS) factor. Incipient motion occurs when the RBS is 1.0. If the RBS is < 1.0, the material is mobile. A channel's bed material becomes more stable as the RBS increases (above 1.0).
- The velocity analysis below uses a channel's D_{50}, while the shear stress analysis uses the D_{84}.
- Several equations are used for comparison.
- Note, these equations are generalizations, and should be used with caution and judgement.
- The velocity equations assume the specific gravity of the bed material is 2.65.

Evaluated using the existing gradation from pebble count and the 5% exceedance discharge (340 cfs). Depth, velocity and shear values are from the HECRAS model at the location of the pipeline crossing.

Filename: *https://projects.geoengineers.com/sites/1672400200/Draft/Task 0600 - Open Cut Crossing S Umpqua*

Velocity Analysis (Using D_{50})

	mm	cm	in	ft	
Coarse Gravel	40.6	4.06	1.60	0.13	**= D_{16} of the existing channel bed**
Cobble	86.4	8.64	3.40	0.28	**= D_{50} of the existing channel bed**
Cobble	165.1	16.51	6.50	0.54	**= D_{84} of the existing channel bed**
Cobble	304.8	30.48	12.00	1.00	**= D_{100} of the existing channel bed**

Input From Cross-Section Spreadsheet

4.7 = V = $Q_{5\%}$ Velocity (fps)
6.3 = $Q_{5\%}$ Channel Depth (ft)
0.7 = t = $Q_{5\%}$ Shear Stress in Channel (lbs/sf)

Results (Neill's Equation)

10.28 = Vc = Critical Velocity (fps)
2.19 = RBS = Relative Bed Stability (dimensionless)

D50 is very stable.

Results (Laursen's Equation)

9.77 = Vc = Critical Velocity (fps)
2.08 = RBS = Relative Bed Stability (dimensionless)

D50 is very stable.

Shear Stress Analysis (Using D_{84})

Typical Constants (Input)

0.283 = D_{50} = Mean Diameter of Bed Material (From Above) (ft)
0.542 = D_{84} = 84th percentile grain size of bed material (ft)
62.400 = γ_w = Specific weight of water (lbs/ft^3)
165.000 = γ_p = Specific Weight of Sediment (lbs/f^2)

Results (Shield's Equation)

0.047 $= \tau_* =$ Shields Number: $\tau_* = 0.0834(D_{84}/D_{50})^{-0.872}$
2.634 $= \tau_c =$ $Q_{5\%}$ Critical Shear Stress: $\tau_c = \tau_*(\gamma_p - \gamma_w)D_{84}$
3.763 = RBS = Relative Bed Stability (dimensionless)

D84 is very stable.

South Umpqua Crossing Phase 2

Project: S. Umpqua Crossing
Site: Phase 2
Project Number: 16724-002-00
Analyst: ESM
Watercourse: S. Umpqua River
Latest Revision: 5/15/2015

Spreadsheet Description

- This spreadsheet calculates the critical velocity and critical shear stress for the channel's bed material for the temporary diverted condition.

- The bed material tested below represents the existing aluvial material in the South Umpqua River near the proposed diversion.

- It compares the critical velocity and critical shear stress to the values calculated in a hydraulic model of the channel. This comparison is represented in the Relative Bed Stability (RBS) factor. Incipient motion occurs when the RBS is 1.0. If the RBS is < 1.0, the material is mobile. A channel's bed material becomes more stable as the RBS increases (above 1.0).
- The velocity analysis below uses a channel's D_{50}, while the shear stress analysis uses the D_{84}.
- Several equations are used for comparison.
- Note, these equations are generalizations, and should be used with caution and judgement.
- The velocity equations assume the specific gravity of the bed material is 2.65.

Evaluated using the existing gradation from pebble count and the 5% exceedance discharge (340 cfs).
Depth, velocity and shear values are from the HECRAS model at the location of the pipeline crossing.

Filename: *https://projects.geoengineers.com/sites/1672400200/Draft/Task 0600 - Open Cut Crossing S Umpqua*

Velocity Analysis (Using D_{50})

	mm	cm	in	ft	
Coarse Gravel	40.6	4.06	1.60	0.13	**= D_{16} of the existing channel bed**
Cobble	86.4	8.64	3.40	0.28	**= D_{50} of the existing channel bed**
Cobble	165.1	16.51	6.50	0.54	**= D_{84} of the existing channel bed**
Cobble	304.8	30.48	12.00	1.00	**= D_{100} of the existing channel bed**

Input From Cross-Section Spreadsheet

4.1 = V = $Q_{5\%}$ Velocity (fps)
6.3 = $Q_{5\%}$ Channel Depth (ft)
0.7 = t = $Q_{5\%}$ Shear Stress in Channel (lbs/sf)

Results (Neill's Equation)

10.28 = Vc = Critical Velocity (fps)
2.51 = RBS = Relative Bed Stability (dimensionless)

D50 is very stable.

Results (Laursen's Equation)

9.77 = Vc = Critical Velocity (fps)
2.38 = RBS = Relative Bed Stability (dimensionless)

D50 is very stable.

Shear Stress Analysis (Using D_{84})

Typical Constants (Input)

0.283 = D_{50} = Mean Diameter of Bed Material (From Above) (ft)
0.542 = D_{84} = 84th percentile grain size of bed material (ft)
62.400 = γ_w = Specific weight of water (lbs/ft^3)
165.000 = γ_p = Specific Weight of Sediment (lbs/f^2)

Results (Shield's Equation)

0.047 $= \tau_* =$ Shields Number: $\tau_* = 0.0834(D_{84}/D_{50})^{-0.872}$
2.634 $= \tau_c =$ $Q_{5\%}$ Critical Shear Stress: $\tau_c = \tau_*(\gamma_p - \gamma_w)D_{84}$
3.763 = RBS = Relative Bed Stability (dimensionless)

D84 is very stable.

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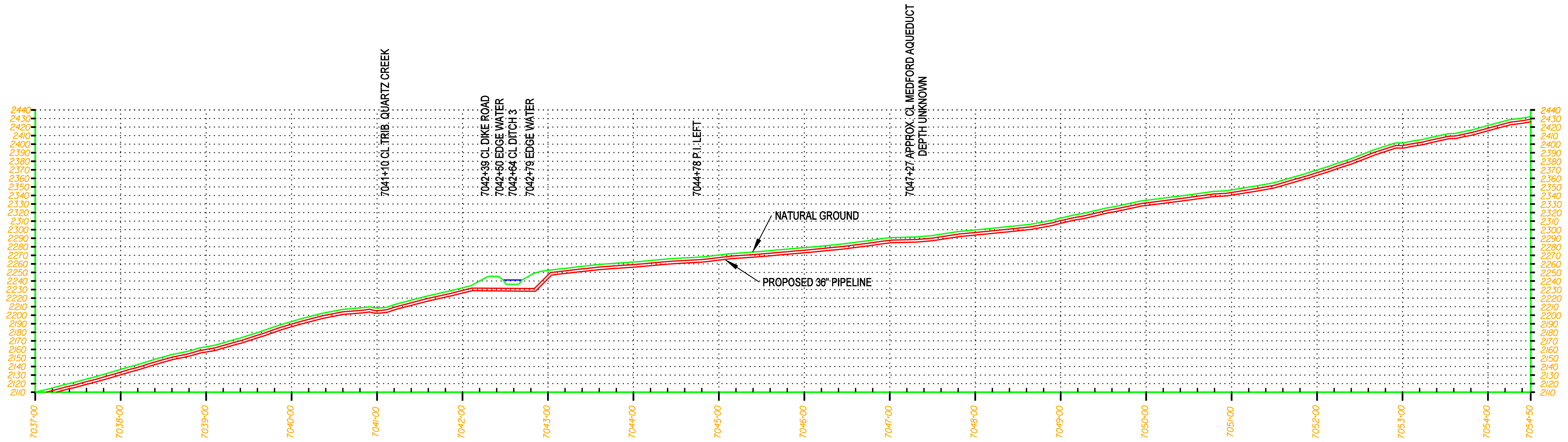
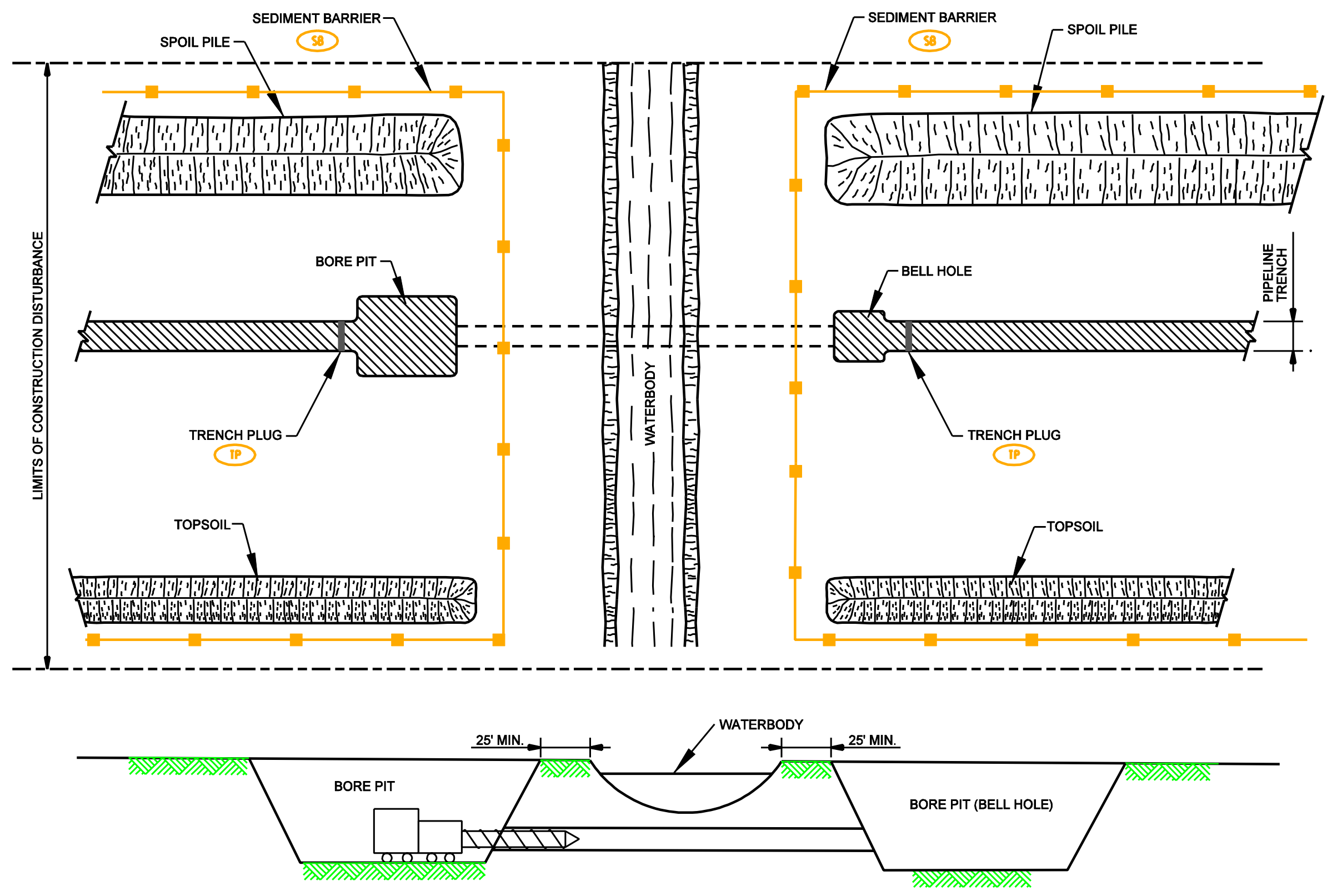




BORE NOTES:

1. Contractor shall install sediment barriers at the base of slopes adjacent to stream crossings where vegetation is disturbed, to intercept surface runoff.
2. Contractor shall install sediment barriers to protect spoil piles where sediment barriers across the entire disturbed area are not required.
3. Horizontal bores will be used primarily for crossing transportation corridors and waterbodies.
4. Maintain a minimum 10 feet vegetative buffer along both sides of the waterbody if possible.
5. The sides of the bore pits, shall be sloped back to a stable configuration, unless shoring is necessary. Install safety fence around bore pits as necessary.
6. Dewater bore pit to control seepage water inflow. Water removed from bore pit and bell hole shall be filtered through a trench dewatering facility (TDW). to prevent entry of uncontrolled water into waterbody. Minimize draw down of waterbody and maintain stream flow.
7. Upon completion of pipe installation and tie-ins, backfill and compact the bore pits.

DEWATER NOTES:

1. Dewater structure shall be placed on a level, well vegetated site such that water will flow away from structure and any work areas.
2. Flow rates through discharge shall be such that structure will not overflow.
3. Contractor shall utilize certified noxious weed free hay for structure.
4. Dewatering structures will be constructed and maintained according to the dewatering structure typical drawings found in the Erosion Control Revegetation Plan (ECRP)

TYPICAL CONVENTIONAL BORE WATERBODY CROSSING

REFERENCE DRAWINGS

DRAWING NO.	TITLE
3430.29-134	ALIGNMENT SHEET

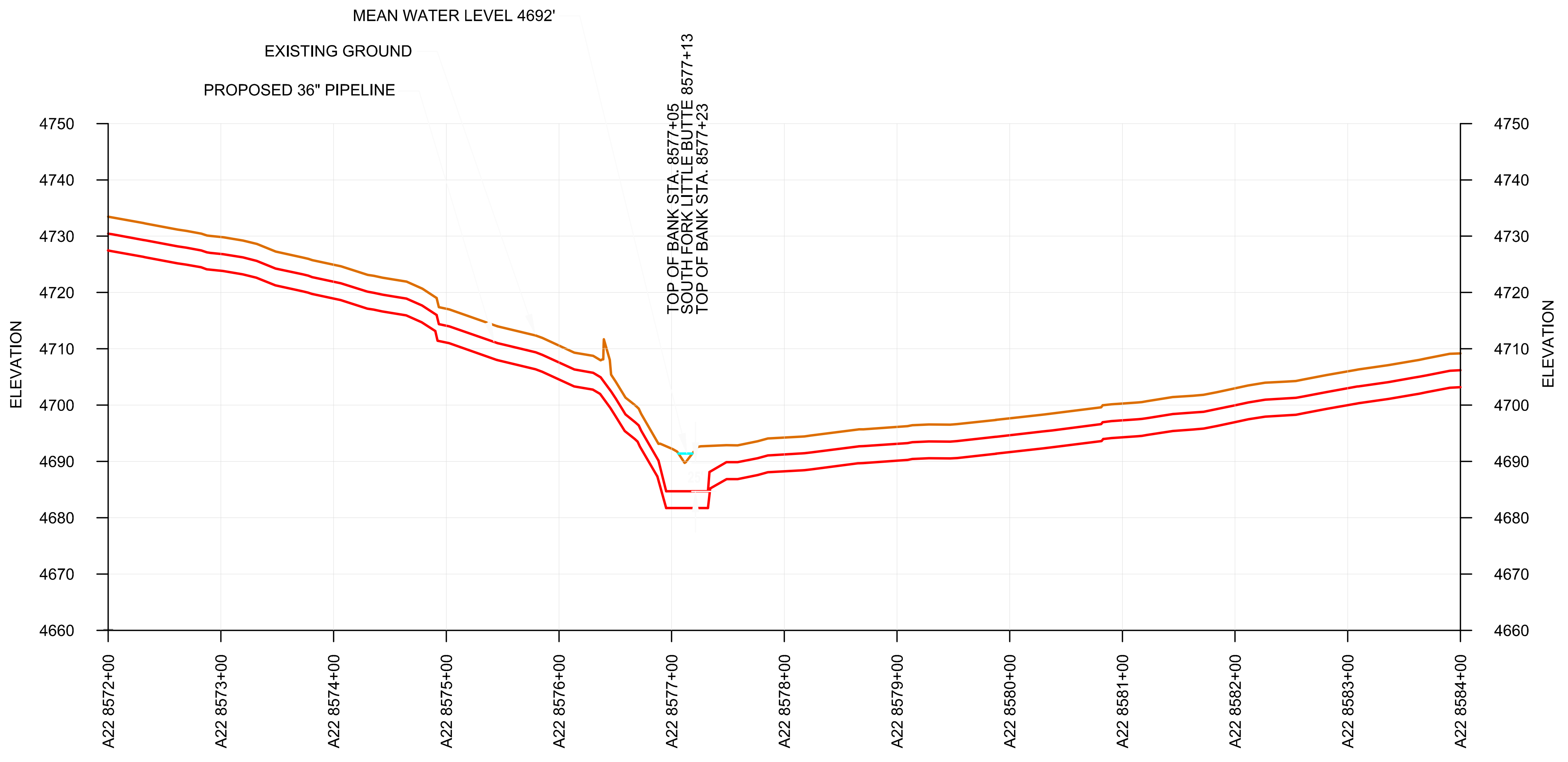
REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.

PACIFIC CONNECTOR GAS PIPELINE PROJECT
PACIFIC CONNECTOR GAS PIPELINE, LP
PLAN AND PROFILE - MEDFORD AQUEDUCT
36" O.D. PACIFIC CONNECTOR GAS PIPELINE
M.P. 133.4, T-34-S, R-1-E
JACKSON COUNTY, OREGON

Pacific Connector GAS PIPELINE SM

DRAWN BY: RGD	DATE: 8/30/2007	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY:	DATE:	ISSUED FOR CONSTRUCTION:	
APPROVED BY:	DATE:	DRAWING NUMBER: 3430.2-062	SHEET
WO:		%TIME% 8/31/2007 Q:\Oregon_gas\Mapping\Waterbodies\3430_2-062.dgn	OF

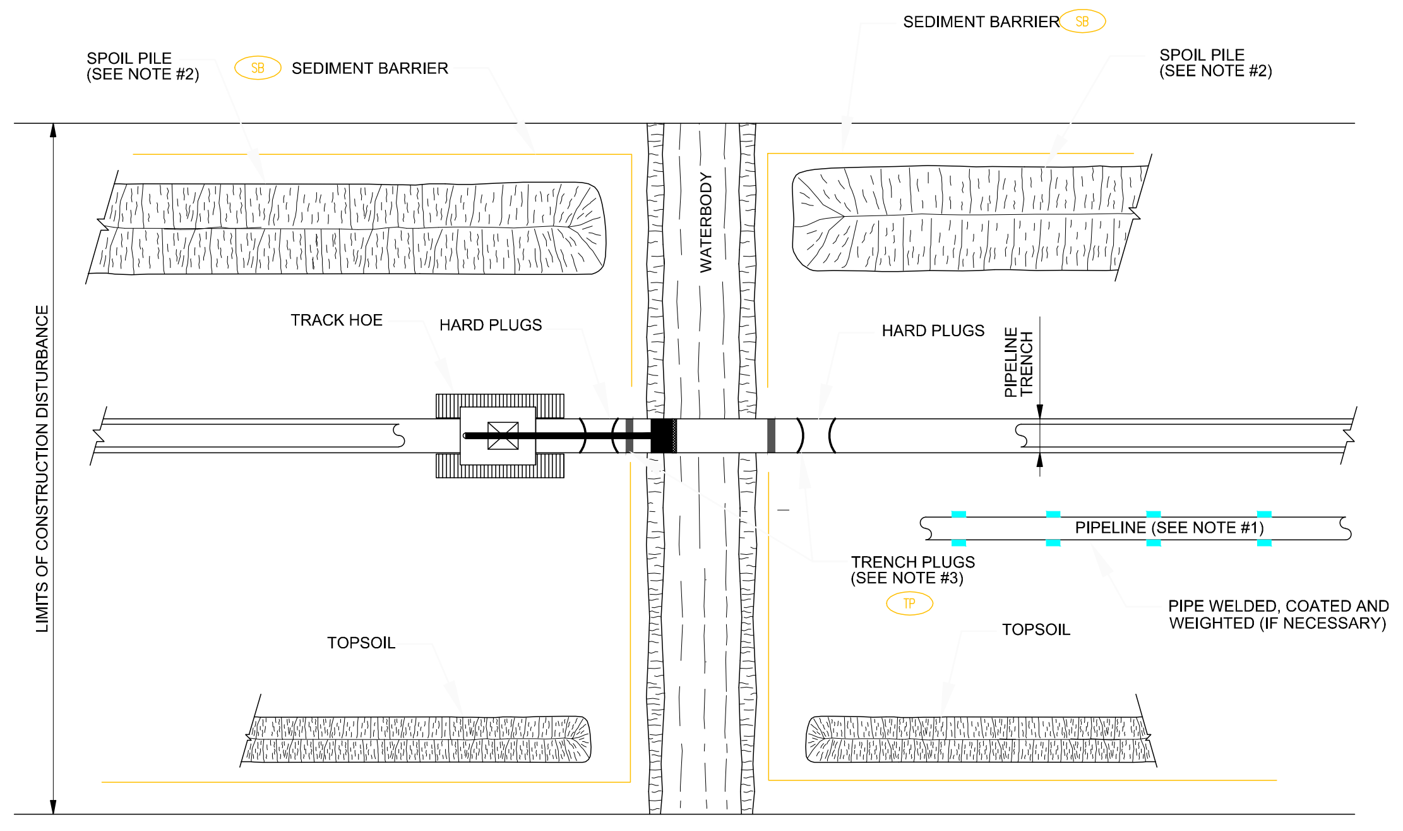


PROFILE SCALE
HORIZ. = 1"-100'
VERT. = 1"-20'

NOTES:

1. ALL EROSION CONTROL BMP'S TO BE INSTALLED WITH THE PROJECT EROSION CONTROL AND REVEGETATION PLAN (ECRP).
   ALL BMP DETAILS ARE DESCRIBED IN THE ECRP.

2. REVEGETATION WITHIN RIPARIAN AREA AND ELSEWHERE TO BE COMPLETED IN ACCORDANCE WITH PROJECT EROSION CONTROL AND REVEGETATION PLAN (ECRP).



TYPICAL OPEN-CUT
WATERBODY CROSSING

OPEN CUT NOTES:

1. This method will be used for crossing waterways using conventional open-trenching methods. The pipe will be installed to a depth of approximately 5' below the bottom of the waterbody channel unless bedrock is present. Where bedrock exists, the pipe will be buried at a safe depth below bedrock to be determined during construction.
2. Workspace for spoil storage is located on either side of the waterbody crossing adjacent to the proposed pipeline alignment. Additional workspace for support vehicles, supplies and materials, construction equipment and access construction area including areas to turn equipment around are shown on the site specific plans. Sediment Barriers will be installed around workspace areas and spoil storage areas to protect waterbody from surface runoff.
3. The waterbody crossing will be installed as expeditiously as possible to minimize impacts to the waterway. The pipe trench will be backfilled using mechanical placement. Trench plugs will be installed at the banks on either side of the waterway.
4. If the waterway is navigable or used by recreational boaters, a mitigation plan for traffic interruption will be prepared.
5. Erosion and sediment control measures shall be inspected daily and repaired if necessary.
6. This method applies to stream and river crossings, where flows exceed the capacity of flume or pump crossing methods, or are not feasible to bore.
7. Schedule crossing during low flow period, if possible.
8. No refueling of mobile equipment within 100 feet of stream bank. Place sign posts 100 feet back from wetland boundary and advise no refueling. Refuel stationary equipment as per SPCC plan.
9. Leave hard plugs at the stream bank edge, until just prior to pipe installation
10. Maintain stream flow throughout crossing construction.
11. Restore watercourse channel to approximate pre-construction profile and substrate.
12. This typical drawing is preliminary. Site specific design will be completed prior to construction.

DEWATER NOTES:

1. Dewater structure shall be placed on a level, well vegetated site such that water will flow away from structure and any work areas.
2. Flow rates through discharge shall be such that structure will not overflow.
3. Contractor shall utilize certified noxious weed free hay for structure.
4. Dewatering structures will be constructed and maintained according to the dewatering structure typical drawings found in the Erosion Control Revegetation Plan (ECRP)

REFERENCE DRAWINGS

DRAWING NO.	TITLE
3430.29-0162	CONSTRUCTION ALIGNMENT

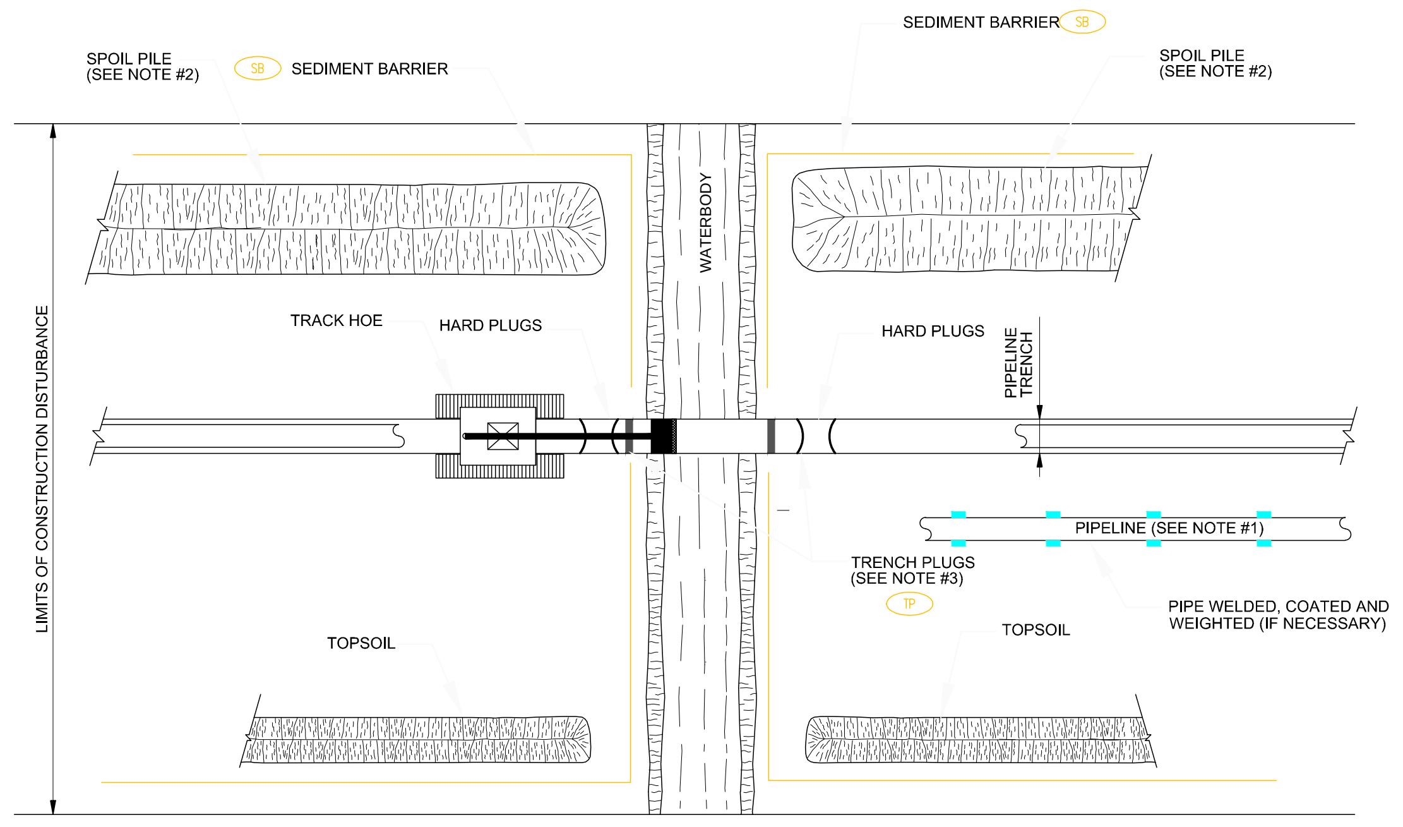
REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
A	MAY 2013	JCP	PRELIMINARY			

PACIFIC CONNECTOR GAS PIPELINE PROJECT
PACIFIC CONNECTOR GAS PIPELINE, LP
SOUTH FORK LITTLE BUTTE - OPEN CUT
MILE POST 162
SEC. 15, T-37-S, R-4-E
JACKSON COUNTY, OREGON

Pacific Connector GAS PIPELINE SM

DRAWN BY: JCP	DATE: MAY 2013	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY:	DATE:	ISSUED FOR CONSTRUCTION:	
APPROVED BY:	DATE:	DRAWING NUMBER: 3430.2-0060	SHEET 1 OF 1



TYPICAL OPEN-CUT
WATERBODY CROSSING

OPEN CUT NOTES:

1. This method will be used for crossing waterways using conventional open-trenching methods. The pipe will be installed to a depth of approximately 5' below the bottom of the waterbody channel unless bedrock is present. Where bedrock exists, the pipe will be buried at a safe depth below bedrock to be determined during construction.
2. Workspace for spoil storage is located on either side of the waterbody crossing adjacent to the proposed pipeline alignment. Additional workspace for support vehicles, supplies and materials, construction equipment and access construction area including areas to turn equipment around are shown on the site specific plans. Sediment Barriers will be installed around workspace areas and spoil storage areas to protect waterbody from surface runoff.
3. The waterbody crossing will be installed as expeditiously as possible to minimize impacts to the waterway. The pipe trench will be backfilled using mechanical placement. Trench plugs will be installed at the banks on either side of the waterway.
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5. Erosion and sediment control measures shall be inspected daily and repaired if necessary.
6. This method applies to stream and river crossings, where flows exceed the capacity of flume or pump crossing methods, or are not feasible to bore.
7. Schedule crossing during low flow period, if possible.
8. No refueling of mobile equipment within 100 feet of stream bank. Place sign posts 100 feet back from wetland boundary and advise no refueling. Refuel stationary equipment as per SPCC plan.
9. Leave hard plugs at the stream bank edge, until just prior to pipe installation
10. Maintain stream flow throughout crossing construction.
11. Restore watercourse channel to approximate pre-construction profile and substrate.
12. This typical drawing is preliminary. Site specific design will be completed prior to construction.

DEWATER NOTES:

1. Dewater structure shall be placed on a level, well vegetated site such that water will flow away from structure and any work areas.
2. Flow rates through discharge shall be such that structure will not overflow.
3. Contractor shall utilize certified noxious weed free hay for structure.
4. Dewatering structures will be constructed and maintained according to the dewatering structure typical drawings found in the Erosion Control Revegetation Plan (ECRP)

REFERENCE DRAWINGS

DRAWING NO.	TITLE
3430.29-0211	CONSTRUCTION ALIGNMENT

REVISIONS

NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
A	MAY 2013	JCP	PRELIMINARY			

PACIFIC CONNECTOR GAS PIPELINE PROJECT
PACIFIC CONNECTOR GAS PIPELINE, LP
LOST RIVER - OPEN CUT
MILE POST 212.05
SEC. 27, T-40-S, R-10-E
KLAMATH COUNTY, OREGON

Pacific Connector GAS PIPELINE SM

DRAWN BY: JCP	DATE: MAY 2013	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY:	DATE:	ISSUED FOR CONSTRUCTION:	
APPROVED BY:	DATE:	DRAWING NUMBER: 3430.2-0057	SHEET 1 OF 1