

# In-stream Remediation of a Hydrocarbon Release in North Central Alberta, Canada

Presented by

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## Background

- Release identified on May 6, 2005
  - 3 ½" diameter steel pipeline failed, caused by stress fracture due to unstable slope at stream bank
  - Released volume was estimated at 65 barrels of light crude oil
  - Breakpoint was located adjacent to streambed of watercourse



## Background

- Watercourse was an unnamed tributary of major river in north central Alberta, Canada
- Spill response activities included access construction, stream diversion, removal of impacted materials, construction of bioremediation/storage area, reconstruction of streambed following remediation activities, in-stream monitoring, wildlife monitoring and shoreline clean-up
- WES Inc. was responsible for and coordinated the first four activities listed above
- Regulatory relations were handled by client





Overview of breakpoint (initial stream diversion in place)



## Area Description

- Heavily forested area approximately 44 miles southwest of the town of Valleyview, Alberta
- Situated within Crown Land (Green Zone) and managed through Alberta Sustainable Resource Development
- Boreal - Cordilleran climatic regime with mean summer and winter temperatures of 55.0 °F and 18.0 °F, respectively
- Area used primarily for forestry and oil and gas industries



# Site Location



## Spill Site Description

- Occurred on the south bank of an unnamed tributary to the Waskahigan River
- The break occurred approximately 33 ft south of the stream high water mark
- Located on a level flood terrace, at the base of a steep bank that drains towards the stream with slopes ranging between 5% and 15%
- The breakpoint area has a vegetative cover comprised of mature spruce, poplar and pine forest, with willow understory
- Pipeline right of way:
  - overgrown with willows and some poplar
  - surface has a 1 - 1.6 ft thick cover of organic deposits (muskeg)
  - frost layer with a variable thickness ranging between 1 – 1.6 ft was identified at a depth of approximately 0.5 ft below grade



## Initial Response Activities

- Conducted a reconnaissance of the area and determined the approximate location of the pipeline break point
- Shut-in the source
- Installed containment booms downstream of pipeline break
- Established control/sampling points to allow for ongoing monitoring of water quality on the river. Initiated water sampling program
- Notified regional agencies and obtained necessary approvals for spill response operations from Alberta Environment, Alberta Energy and Utilities Board, Alberta Sustainable Resource Development, and Fisheries and Oceans Canada





## Environmental Assessment Program

- Delineated the plume using truck-mounted 6" and 2" solid stem augers (12 boreholes), 2" Dutch hand auger (10 testholes), excavated test pits (for comparison to background)
- Maximum depth of investigation was 19.7 ft below ground surface
- Soil profile consisted of sandy clays, with inter-bedded sand lenses and a gravelly sand seam at approximately 7.5 ft. Low permeability clay soil at 9.8 ft
- Contaminant migrated radially from the breakpoint via sand lenses and gravel seam, into the streambed
- No evidence of migration across the stream into the north bank



# Environmental Assessment Program

- Contaminant characterization:
  - Maximum hydrocarbon concentrations of 2500 ppm ( $C_6 - C_{10}$ ), 7100 ppm ( $C_{10} - C_{16}$ ), 12000 ppm ( $C_{16} - C_{34}$ ), and 2900 ppm ( $C_{34} - C_{50}$ )
  - Maximum BTEX concentrations of 30 ppm benzene, 150 ppm toluene, 23 ppm ethylbenzene, and 290 ppm xylenes
  - All hydrocarbon and BTEX concentrations exceeded Alberta guidelines
  - Elevated phenol concentrations (0.17 ppm) were below guidelines
  - Salinity and sodicity, measured as electrical conductivity (EC) and sodium adsorption ratio (SAR), respectively, were within guideline values



## Access Road



Road was constructed using 'swamp mats' and was approximately 0.6 miles long



Followed general direction of a previously reclaimed forestry road

## Access Road

To minimize interference with the natural drainage patterns, a series of drainage culverts were installed across the access road



Erosion control blankets (ECB) and silt fences were installed at the discharge of the drainage culverts

# Pipeline Exposure and Contaminant Removal

- Initiated in conjunction with emergency spill response operations
- Limited to removal of accessible contaminated soils on the south stream bank and exposure of the pipeline
- Hydrocarbon-contaminated soils extended north into streambed
- Excavation operations put on hold so that a diversion could be constructed to allow access to streambed
- A contaminated soil treatment area was constructed so that excavated soil could be stockpiled for bioremediation activities (The impacted materials removed during the initial stages of the remediation activities were stored on two temporary storage cells constructed at the pipeline break point)



# Pipeline Exposure



Initial pipeline exposure



Exposed pipeline



## Treatment Area Construction

- Two treatment cells constructed at an adjacent inactive oil wellsite
- To ensure proper containment, clayey backfill material was placed and compacted at the base and on the berms of the treatment cells
- To contain fluids and prevent contaminant migration, berms with a height of approximately 4 ft were constructed around the treatment cells
- Each treatment cell was contoured to allow for drainage toward a leachate collection area
- The treatment cells were lined with a 30 mil Enviro-Liner



# Treatment Area Construction





## Stream Diversion

- The results of the subsurface investigations indicated the presence of hydrocarbon impacts on soil quality extending down gradient, beyond the shoreline, into the streambed
- To prevent fresh water flow from entering the impacted areas, and assist with the containment activities, the initial stages of the remediation program included stream diversion and isolation of the impacted portion of the stream bed
- It was determined that the construction and installation of a flume would be the most appropriate diversion technique



## Diversion Flume

- The flume consisted of two steel culverts 6.5 ft in diameter and 118 ft in length fastened together and moved into place using excavators
- To direct water from the stream into the flume, and to prevent backflow from the downstream portion, two diversion walls were constructed
- The diversion walls consisted of concrete blocks (Jersey blocks) installed on a prepared (levelled) portion of the stream
- A 30 mil Enviro-Liner weighted with bulk sand bags was used to seal the diversion walls



## Diversion Flume

- To prevent bank erosion and stream siltation, the north bank of the stream along the intake and the discharge portion of the flume were lined with woven polypropylene (PP) geotextile
- Non-woven geotextile was installed at the discharge portion of the flume to prevent scouring of the river bed
- A “grey water” pit, and a series of bellholes excavated along the isolated portion of the stream bed were used to collect fugitive flow through the flume, and dewater the work area



# Diversion Flume Construction



# Diversion Flume Installation



# Site Overview



## Remediation Program

- Removal of impacted material from the pipeline break point was initiated on May 07, 2005
- Excavation activities resulted in exposure of the pipeline and identification of the break point on May 11, 2005
- Removal of impacted material from the pipeline break point, and the south bank of the stream were completed on June 16, 2005



# Remediation Program





## Remediation Program

- Ongoing remediation and assessment identified the presence of hydrocarbon impacts on soil quality extending along the pipeline right of way, under the flume and under the downstream diversion wall
- To complete the stream bed cleanup operations it was decided to construct a second diversion structure along the north bank of the stream, and remove the existing flume



## Diversion Channel

- The diversion structure consisted of swamp mats keyed together, and installed as a wall along the north bank of the stream
- Steel piping anchored into the stream bed was used to support the structure
- A 40 mil Enviro-Liner was used to seal the constructed diversion channel
- The liner anchored onto the constructed swamp mat wall and on the north bank of the stream
- The upstream diversion wall was extended and keyed into the constructed structure



# Diversion Channel



# Diversion Channel



## Remediation Activities

- Once the new diversion channel was constructed and the original diversion flume removed, excavation operations re-commenced
- Removal of impacted material from the stream bed was completed on July 18, 2005
- Approximately 14,000 tons of hydrocarbon contaminated materials were removed from the area
- Backfilling activities were conducted throughout the duration of the spill site remediation activities
- Clean backfill material originated from a borrow pit excavated along the access road to the pipeline break point



## Streambed Reconstruction

- The streambed reconstruction program was initiated on Aug. 08, 2005 and completed on Aug. 11, 2005
- The program was initiated upon completing the remediation activities and removal of the stream diversion structure
- The reconstruction activities were planned and supervised by a consulting team specializing in aquatic/biological engineering
- Including re-contouring, placement of boulder and cobble rip rap, stabilization of stream banks, placement of habitat structures



# Streambed Reconstruction



Questions?

