

IROQUOIS GAS TRANSMISSION SYSTEM, L.P.

08/09 EXPANSION PROJECT

**DRAFT
RESOURCE REPORT 6**

GEOLOGICAL RESOURCES

PUBLIC

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RESOURCE REPORT 6 – GEOLOGIC RESOURCES FERC ENVIRONMENTAL CHECKLIST

Part 380 – Minimum Filing Requirements for Environmental Reports	Company Compliance or Inapplicability of Requirement
Identify the location (by milepost) of mineral resources and any planned or active surface mines crossed by the proposed facilities. (§ 380.12 (h)(1 and 2)).	Section 6.3
Identify any geologic hazards to the proposed facilities. (§ 380.12 (h)(2)).	Section 6.4
Discuss the need for and locations where blasting may be necessary in order to construct the proposed facilities. (§ 380.12 (h)(3)).	Section 6.2
For LNG Projects in seismic areas, the materials required by “Data Requirements for the Seismic Review of LNG Facilities,” NBSIR84-2833. (§ 380.12 (h)(5)).	Not Applicable
For underground storage facilities, how drilling activity by others within or adjacent to the facilities would be monitored, and how old wells would be located and monitored within the facility boundaries. (§ 380.12 (h)(6)).	Not Applicable

RESOURCE REPORT 6: GEOLOGICAL RESOURCES

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6.0 GEOLOGICAL RESOURCES

Resource Report 6 provides geologic information for the proposed Boonville and Wright, New York and Newtown, Connecticut natural gas pipeline loop segments, the proposed natural gas compressor station in the City of Milford, Connecticut, and the proposed Brookfield Compressor Station modifications in Brookfield, Connecticut. Information presented includes physiographic setting, surficial and bedrock geology, mineral resources, and potential geologic hazards along the proposed pipeline route and at aboveground facility locations. Also addressed within this report are potential impacts to existing geologic, mineral, and paleontological resources in the project area due to construction, operation and maintenance of the project facilities. The assessments of potential geologic hazards in the project area are based on the opinion of ENSR environmental scientists resulting from the review of available mapping and reports as well as discussions with applicable government agencies.

6.1 GEOLOGIC SETTING

6.1.1 Pipeline Facilities

6.1.1.1 Boonville Loop Segment

This loop segment is located in the Erie-Ontario Lowlands physiographic province situated between the Tug Hill Plateau to the west and the Adirondack Highlands to the east. The loop is located within the Black River Valley with bedrock geology comprised of sedimentary rock formations of limestone, shale and chert formed approximately 450 million years ago during the middle Ordovician period. The terrain along the pipeline alignment is relatively flat to gently sloping with elevations ranging from 1000 feet to 1300 feet in elevation above mean sea level.

The current landforms and landscapes in the project area are primarily the result of late Quaternary glacial events that ended approximately 12,000 years ago (Allmon and Ross 2005). During the latter part of the Wisconsin stage, the Ontarian Lobe of the Laurentide glacial ice sheet experienced a series of advancements and retreats, scouring the landscape and forming present-day landforms through deposition of massive amounts of sediment and subsequent erosion. Surficial geology in the project area consists primarily of glacial sand, gravel and till (See Figure 6.1-1a in Volume III – Appendix J).

6.1.1.2 Wright Loop Segment

The loop segment is located in the Appalachian Uplands physiographic province located in south-central New York. The primary bedrock geology in this region is comprised of near-horizontal beds of sedimentary rock formations consisting of limestone and shale with minor compositions of sandstone and dolostone formed approximately 400 million years ago during the early to middle Devonian period (FERC 1989, Miller 1925). The terrain along the pipeline alignment is relatively flat to gently sloping with elevations ranging from 500 feet to 1000 feet in elevation above mean sea level. Surficial geology in the area is comprised of glacial till deposits of varying thickness, with surface cover to bedrock varying from 0.5 to five feet (See Figure 6.1-1b in Volume III – Appendix J). Minor amounts of karst terrain have been identified along this segment of the pipeline route.

6.1.1.3 Newtown Loop Segment

The Newtown Loop Segment is located within the New England physiographic province (Rodgers 1985), a plateau-like upland that rises gradually from the sea but includes numerous mountain ranges and

individual peaks. The project area is located within the Western Uplands section of this province where the topography is characterized by rolling hills and low, rounded mountains interrupted by numerous generally narrow valleys (Alter 1995). Throughout the general vicinity of the alignment, the hills and valleys have a fairly well-developed NE-SW grain that is largely the result of glacial motion from the northwest (Standley and Caldwell 1976). Elevations in the project area range from approximately 300-600 feet.

Bedrock underlying the area is composed primarily of gray to silvery, medium to coarse grained schist (Collinsville Formation) as well as gray, medium-grained, well-laminated granofels (Taine Mountain Formation) (Thomas 2007a). The schist is a metamorphic rock primarily composed of mica, quartz, feldspar and occasionally spotted with conspicuous garnets. Granofels is a metamorphic rock composed primarily of quartz and feldspar.

The surficial geology is characterized as glacial till comprised of a mixture of gravel and sand with individual and alternating layers (Flint 1968) (See Figure 6.1-1c in Volume III – Appendix J). Sand and gravel layers generally range from 25 to 50 percent gravel particles and from 50 to 75 percent sand particles (Stone et. al., 1992).

TABLE 6.1-1 GEOLOGIC CONDITIONS ALONG THE PROPOSED BOONVILLE, WRIGHT AND NEWTOWN LOOP PIPELINE ROUTES				
Loop Segment	Milepost	Bedrock Geology	Surficial Geology	Depth to Bedrock (ft)
Boonville	105.3 – 111.1	Limestone & shale	Glacial sand, gravel & till	>6
Wright	190.9 – 191.9	Sandstone, shale limestone, dolostone	Till of variable thickness	0.5-5
Newtown	318.3 – 319.9	Gneiss & schist	Glacial till	0-5

6.1.2 Aboveground Facilities

6.1.2.1 Milford Compressor Station

The project area is located on a sand and gravel terrace (Pleistocene Age) on the banks of the Housatonic River within the New England physiographic province, a plateau-like upland that rises gradually from the sea but includes numerous mountain ranges and individual peaks (Thomas 2007b, Rodgers 1985). The project area has been extensively altered by past clearing and grading activities, and now has a nearly level topography. A man-made berm feature, which is approximately 5 to 10 feet high, is located around much of the site perimeter. The United States Geological Survey (USGS) topographic mapping shows the project area occurring at an approximate elevation of 40 feet. Further to the west, the landscape becomes steeper and grades down to the Housatonic River.

Bedrock underlying the project area is Oronoque Schist of the Iapetos Terrane (Rodgers 1985; Fritts, 1965, Thomas 2007b), which has formed in the Ordovician period of Paleozoic age about 505 to 440 million years ago (See Figure 6.1-1d in Volume III – Appendix J). This bedrock consists of gray to silver, medium to fine grained schist and granofels. The schist is a metamorphic rock primarily composed of mica, quartz, feldspar and occasionally spotted with conspicuous garnets. Granofels is a metamorphic rock composed primarily of quartz and feldspar. The surficial geology is a mixture of gravel and sand with individual and alternating layers (Flint 1968, Thomas 2007b). Sand and gravel layers generally range from 25 to 50 percent gravel particles and from 50 to 75 percent sand particles (Stone et. al., 1992).

6.1.2.2 Brookfield Compressor Station Modifications

The Brookfield site is located in the New England physiographic province (Rodgers 1985), a plateau-like upland that rises gradually from the sea but includes numerous mountain ranges and individual peaks. The project area is located within the Western Uplands section of this province where the topography is characterized by rolling hills and low, rounded mountains interrupted by numerous generally narrow valleys (Alter 1995). Throughout much of the project's general vicinity, the hills and valleys have a fairly well-developed NE-SW grain that is largely the result of glacial motion from the northwest (Standley and Caldwell 1976). Elevations in the project area range from approximately 432 feet along High Meadow Road down-gradient southward to an elevation of 380 feet along the Iroquois pipeline right-of-way.

Bedrock underlying the project area is Ratlum Mountain Schist of the Iapetos Terrane (Rodgers 1985, Thomas 2007c), which has formed in the Ordovician period of Paleozoic age about 505 to 440 million years ago. This bedrock consists of gray medium-grained schist and granofels. The schist is a metamorphic rock primarily composed of mica, quartz, feldspar and occasionally spotted with conspicuous garnets. Granofels is a metamorphic rock composed primarily of quartz and feldspar. Stone et al. (1992) identifies the surficial geology at the site being a mixture of gravel and sand with individual and alternating layers. Sand and gravel layers generally range from 25 to 50 percent gravel particles and from 50 to 75 percent sand particles (Stone et al. 1992) (See Figure 6.1-1e in Volume III – Appendix J). A review of drilling logs for monitoring wells installed at the site suggests that the coarse-grained stratified drift surficial deposits have been removed and that the near surface surficial deposits are till and stratified deposits composed of mixtures of gravel, sand, silt and clay.

6.2 BLASTING

6.2.1 Pipeline Facilities

6.2.1.1 Boonville Loop Segment

The entire pipeline loop alignment is located in soft sediments of the Black River Valley, underlain by sedimentary bedrock formations consisting of shale and limestone. Depth to bedrock varies in the project area, though in general, bedrock is located at a depth of six feet or greater below the soil surface (FERC 1989, NRCS 2006). No areas of exposed bedrock or bedrock outcrops were observed along the proposed route during field surveys completed in 2006 and 2007. The depth to bedrock in the general area is likely greater than four feet.

In the unlikely event that bedrock is encountered, the technique used for bedrock removal would depend on the factors such as strength and hardness of the rock. Iroquois would attempt to use mechanical methods such as ripping or conventional excavation to remove the bedrock where possible. If required,

bedrock blasting would be conducted in accordance with all applicable State and local regulations to ensure that it is done in a safe manner and that off-site wells are not affected.

6.2.1.2 Wright Loop Segment

The Wright Loop pipeline segment is located along the northern fringe of the Appalachian Uplands above the Mohawk River Valley where sedimentary bedrock formations consisting of shale and limestone are located within close proximity to the soil surface (FERC 1989, NRCS 2006). While the majority of the project site is currently in active agricultural use, localized removal of bedrock will likely be required for proper installation of the pipeline facilities.

In the event that bedrock is encountered, the technique used for bedrock removal would depend on the factors such as strength and hardness of the rock. Iroquois would attempt to use mechanical methods such as ripping or conventional excavation to remove the bedrock where possible. If required, bedrock blasting would be conducted in accordance with all applicable State and local regulations to ensure that it is done in a safe manner and that off-site wells are not affected.

6.2.1.3 Newtown Loop Segment

This segment of pipeline is located within the Western Uplands of the New England Physiographic Province with surficial geology composed primarily of a thin layer glacial till deposited over bedrock consisting of metamorphic gneiss and schist. Areas of this pipeline segment contain bedrock within 10 to 20 inches of the soil surface with areas of exposed bedrock outcrops, while valleys may have a bedrock depth below 60 inches from the soil surface (FERC 1989, NRCS 2006, Thomas 2007a).

The technique used for bedrock removal would depend on the factors such as strength and hardness of the rock. Iroquois would attempt to use mechanical methods such as ripping or conventional excavation to remove the bedrock where possible. If required, bedrock blasting would be conducted in accordance with all applicable State and local regulations to ensure that it is done in a safe manner and that off-site wells are not affected. Iroquois shall develop a plan for disposal of excess rock created by blasting activities prior to the commencement of construction.

6.2.2 Aboveground Facilities

6.2.2.1 Milford Compressor Station

It is unlikely that bedrock would be encountered during grading activities at the Milford Compressor Station site as the property is situated on a sand and gravel terrace on the banks of the Housatonic River (Thomas 2007b). In the event that bedrock is encountered, the technique used for bedrock removal would depend on the factors such as strength and hardness of the rock. Iroquois would attempt to use mechanical methods such as ripping or conventional excavation to remove the bedrock where possible. If required, bedrock blasting would be conducted in accordance with all applicable State and local regulations.

6.2.2.2 Brookfield Compressor Station Modifications

Blasting of bedrock is not anticipated at the site of the Brookfield Compressor Station modifications as the property is located on a deposit of stratified drift, which consists of alternating layers of sand and gravel (Thomas 2007c). Near surface bedrock or bedrock outcrops have not been identified by ENSR during field surveys in November 2005 or by subsurface investigations associated with remedial activities previously conducted within the site. Bedrock was not observed during these investigations, which typically extended down to approximately eight feet below the ground surface. Available surficial

geologic mapping and soil survey mapping also generally supports that bedrock is unlikely to be encountered. Of mention is the General Soil Map in the Soil Survey of Fairfield County, Connecticut (USDA Soil Conservation Service 1981), which denotes that part or the entire Brookfield, Connecticut site as occurring within the “Paxton-Woodbridge-Ridgebury” soil association. The description for this association indicates that bedrock is typically found at depths greater than five feet in Paxton, Woodbridge, and Ridgebury soils (USDA Soil Conservation Service 1981).

In the unlikely event that bedrock is encountered, the technique used for bedrock removal would depend on the factors such as strength and hardness of the rock. Iroquois would attempt to use mechanical methods such as ripping or conventional excavation to remove the bedrock where possible. If required, bedrock blasting would be conducted in accordance with appropriate regulations to ensure that it is done in a safe manner and that off-site wells are not affected.

6.3 MINERAL RESOURCES

6.3.1 Pipeline Facilities

The primary exploitable mineral resources located along Iroquois’ mainline pipeline facilities throughout New York and Connecticut consists of deposits of sand and gravel (FERC 1989). Consultation with the applicable state agencies regulating mining of mineral resources did not identify any active mining operations within any of the project areas, therefore, no impacts to any surface or underground mining operations are anticipated with construction of the pipeline facilities. Detailed information regarding mineral resources located in the vicinity of the individual project areas is provided below.

6.3.1.1 Boonville Loop Segment

According to the NYSDEC – Division of Mineral Resources website and consultation (Zaykoski 2007), there are three active mines located within proximity to the project area. The closest is a privately owned and operated sand and gravel pit known as the Sperry Hill Mine (NYSDEC Mine ID# 60204) located off Valley View Road. This pit is located within 0.25-miles of Iroquois’ existing ROW and the proposed construction work area. The other two mines consist of sand and gravel pits owned and operated by the Town of Boonville and are located on Moose River Road (NYSDEC Mine ID# 61024) and Hayes Road (NYSDEC Mine ID# 60098), approximately 2.5 and 0.5-miles away from the proposed loop pipeline facilities alignment, respectively.

The FERC Draft Environmental Impact Statement published for the Iroquois / Tennessee Pipeline Project in November 1989 identifies an active limestone quarry approximately 0.7-miles east of the proposed loop segment at approximate MP 1.5 (MP 106.5 as measured along Iroquois’ mainline) (FERC 1989). However, review of the NYSDEC Division of Mineral Resources online databases does not identify any active limestone mines in the vicinity of the project location.

Construction of the Boonville Loop segment will not impact any existing mineral resources or mining operations. The identified mining operations within close proximity to the Project alignment are not located within the proposed construction area and therefore will not be directly affected by the localized clearing, trenching, installation, backfill, and restoration of the construction site. Additionally, construction of the Project is unlikely to have indirect effects on the identified mining operations as they consist of surface mining activities that would not be adversely affected if blasting is required to properly construct the Project facilities.

6.3.1.2 Wright Loop Segment

Construction of the proposed Wright Loop pipeline facilities will not impact any mineral resources. Consultation with the NYSDEC Division of Mineral Resources – Region 4 (Hewitt 2007) and review of online databases did not identify any active, inactive, closed, or permitted mineral resource mining operations within close proximity to the Wright Loop project site. Additionally, the FERC Draft Environmental Impact Statement for the Iroquois / Tennessee Pipeline Project (1989) did not identify any mining operations in proximity of the Iroquois mainline pipeline facilities in the Town of Wright. As a result, construction of the proposed Wright Loop segment will not directly or indirectly affect any mineral resources or mining operations.

6.3.1.3 Newtown Loop Segment

Consultation with the CTDEP – Geological and Natural History Survey indicated two old and inactive mining operations, consisting of a copper prospect and rock quarry, located over a mile to the east of the Project alignment on the opposite side of the Housatonic River (Thomas 2007a). No active or planned mining operations are located in close proximity of the proposed Project alignment, and no mineral resources are known to exist within the Project alignment (Thomas 2007a). A closed pegmatite and marble quarry located approximately 0.4-miles west of MP 1.5 (MP 319.8 as measured along Iroquois' mainline) was identified in the initial Environmental Impact Statement for construction of Iroquois' mainline pipeline (FERC 1989).

6.3.2 Aboveground Facilities

6.3.2.1 Milford Compressor Station

The proposed project will not affect any active mining operations for mineral resources. The Milford Compressor Station is located on a sand and gravel terrace on the banks of the Housatonic River that has been mined in the vicinity of the Project site (Thomas 2007b), however the project area is not currently being mined, and the proposed compressor station would be constructed on a property that is currently owned by Iroquois and contains the Milford Sales Meter Station.

6.3.2.1 Brookfield Compressor Station Modifications

The proposed construction of the Brookfield Compressor Station modifications is not expected to adversely affect existing or future extraction of mineral resources. The Project site is located on deposit of stratified drift that has been mined in the past, however the remaining potential for resource extraction is unknown (Thomas 2007c). Iroquois owns the subject property which does not possess any active mines or sand and gravel pits.

A 1963 aerial photograph shows that the entire 68.3-acre site in Brookfield, CT was actively being excavated and/or used for the gravel processing/asphalt production operations (ENSR 2000). A 1979 aerial photograph shows less of the property being used for these operations, and vegetation re-establishing in previously disturbed areas, suggesting that the majority of the deposit may have been extracted. The Mines Master Index File identifies the property as a non-coal mining facility that has been permanently abandoned (ENSR 2000). An old, abandoned marble quarry is located about two miles to the west of the Project site and should not be affected as a result of construction activities (Thomas 2007c).

6.4 GEOLOGIC HAZARDS

Geologic hazards are conditions or phenomena that present a risk or are potentially dangerous to life and/or property, either naturally occurring or man-made (Bates and Jackson 1984). The following is a discussion of several geologic hazards and their relation to Iroquois' proposed 08/09 Expansion Project. Geologic hazards discussed include earthquakes, soil liquefaction, land subsidence, and karst terrain.

6.4.1 Seismic Risk

Most earthquakes that occur in the United States are located in the tectonically active western portion of the United States, primarily in California and Alaska. Areas of the eastern United States also experience significant seismic activity, although at lower rates. Earthquake activity in the eastern United States has included large earthquakes such as the 1811-1812 New Madrid earthquakes that occurred in Missouri and Arkansas and the 1886 Charleston, South Carolina earthquake, though the vast majority of earthquakes originating in the eastern U.S. can only be detected by the ultra-sensitive equipment designed for recording seismic activity.

Consultation with the New York State Geological Survey has been initiated relative to seismic activity along the Boonville and Wright Loop alignments, though no response has been received to date.

In Connecticut, one of the most famous faults is the eastern border fault which begins south of New Haven (the exact origin is under water) and extends for 130 miles north to Keene, New Hampshire. Though inactive for 140 million years, it helped to create the Connecticut Valley. The only active faults in Connecticut are located east along the Connecticut River in the Moodus region. Since 1980, several hundred quakes have occurred here, but most were only detectable by extremely sensitive seismology instruments (Little 1986).

The U.S. Geological Survey ("USGS") has developed seismic hazard maps that depict earthquake hazards by showing contour values that represent earthquake ground motion in terms of peak acceleration, defined as percent of gravity, that have a common given probability of being exceeded in 50 years. The ground motion indicated by a contour at a given location is that predicted from all future possible earthquake magnitudes at all possible distances from that location. Information regarding seismic risk mapped for the individual project sites is provided below.

6.4.1.1 Pipeline Facilities

6.4.1.1.1 Boonville Loop Segment

According to the map entitled "Peak Acceleration (percent of gravity) with 10% probability of Exceedance in 50 years" (Frankel et. al. 2002), the Boonville Loop project area has a 10 to 12 percent probability, which is relatively low compared to parts of California where the probability is 100 percent (See Figure 6.4-1a in Volume III – Appendix J).

Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Boonville Loop alignment, though no response has been received to date.

6.4.1.1.2 Wright Loop Segment

This seismic probability for the Wright Loop project area as mapped by Frankel, et. al. (2002) is listed at 12 to 14 percent, which poses little risk for damage to pipeline facilities resulting from seismic activity (See Figure 6.4-1b in Volume III – Appendix J).

Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Wright Loop alignment, though no response has been received to date.

6.4.1.1.3 Newtown Loop Segment

The Newtown, Connecticut area has a seismic risk probability of 16 to 18 percent according to the map entitled “Peak Acceleration (percent of gravity) with 10% probability of Exceedance in 50 years” (Frankel et. al. 2002). Again, this probability is relatively low compared to parts of California where the probability is 100 percent (See Figure 6.4-1c in Volume III – Appendix J).

Consultation with the CTDEP – Connecticut Geological and Natural History Survey indicates that no active or inactive faults are shown on geologic maps of the area and that, in general, Connecticut does not have a lot of seismic activity (Thomas 2007a).

6.4.1.2 Aboveground Facilities

6.4.1.2.1 Milford Compressor Station

The Bedrock formation beneath the Milford Compressor Station site is rather complexly folded, however no active or inactive faults have been mapped in the vicinity of the project area (Thomas 2007b). Based on USGS seismic hazard mapping and lack of active faults near the project area, the seismic risk to the proposed compressor station facility should be low (See Figure 6.4-1d in Volume III – Appendix J).

6.4.1.2.1 Brookfield Compressor Station Modifications

The lack of historical and instrumental reports of strong earthquakes in Connecticut suggests that it is a region of very minor seismic activity, even when compared to other States in the northeast region (USGS 2006). There are no known active or inactive faults mapped in the vicinity of the Project site, although a major geologic terrane boundary that is an inactive deformation zone is located approximately two miles to the west (Thomas 2007c). Based on USGS seismic hazard mapping and the lack of active faults near the project area, the seismic risk to the proposed compressor station facility should be low (See Figure 6.4-1e in Volume III – Appendix J).

6.4.2 Soil Liquefaction

This hazard occurs when a sudden shock is delivered to the sediment mass in a location where either water in interstitial spaces supports sediment grains as they settle, or where pore water is forced upward rapidly as a result of the shock, greatly separating the space between grains (Boggs 1987). Due to the low probability of seismic activity and the lack of widespread areas of soils susceptible to liquefaction along the proposed pipeline loop routes, soil liquefaction is not considered to be a significant hazard to the proposed facilities (FERC 1989, Thomas 2007a, 2007b, 2007c).

6.4.2.1 Pipeline Facilities

6.4.2.1.1 Boonville Loop Segment

Due to the low probability of seismic activity and the lack of widespread areas of soils susceptible to liquefaction along the proposed pipeline loop routes, soil liquefaction is not considered to be a significant hazard to the proposed facilities (FERC 1989). Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Boonville Loop alignment, though no response has been received to date.

6.4.2.1.2 Wright Loop Segment

Due to the low probability of seismic activity and the lack of widespread areas of soils susceptible to liquefaction along the proposed pipeline loop routes, soil liquefaction is not considered to be a significant hazard to the proposed facilities (FERC 1989).

Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Wright Loop alignment, though no response has been received to date.

6.4.2.1.3 Newtown Loop Segment

The Newtown Loop alignment is located in an area with thin deposits of till overlaying bedrock. As a result, the project area is at low risk from soil liquefaction and landslides (Thomas 2007a).

6.4.2.2 Aboveground Facilities

6.4.2.2.1 Milford Compressor Station

The area in the vicinity of the Milford Compressor Station site is not known for soil liquefaction (Thomas 2007b). Furthermore, the potential for seismic activity in the Project area is extremely low and as a result, the potential for liquefaction is low.

6.4.2.2.2 Brookfield Compressor Station Modifications

Soil liquefaction is not likely on the Project site (Thomas 2007c). Additionally, given the low seismic risk at the Project site, the potential risk from soil liquefaction is minimal.

6.4.3 Land Subsidence

Land subsidence is the local downward movement of surface material with little or no horizontal movement (Nuhfer et al. 1993). Three distinct processes account for most of the water-related subsidence – compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and the dissolution and collapse of susceptible rocks. These processes are reviewed below, followed by a discussion of the individual project areas and their susceptibility to ground failure via gravity in the form of land subsidence.

The compaction of aquifer systems, particularly unconsolidated systems, from excessive groundwater pumping is a major cause of land subsidence (USGS 2000). The overdraft of such aquifer systems has resulted in permanent subsidence and related ground failures. In aquifer systems that include semi-consolidated silt and clay layers referred to as “aquitards” of sufficient aggregate thickness, long-term groundwater level declines can result in vast one-time release of “water of compaction” from compacting aquitards, which manifests itself as land subsidence. Locations where significant subsidence from groundwater mining has been documented include Santa Clara Valley in northern California, Houston-Galveston area in Texas, and Las Vegas Valley in Nevada (USGS 2000).

The drainage of organic soils causes its microbial decomposition to be oxidized. Whereas rates of accumulation of organic soil are on the order of a few inches per 100 years, the rate of loss of drained organic soils can be a few inches per year (USGS 2000). It is believed that oxidation-related loss can be halted only by complete re-saturation of the soil or complete consumption of its organic carbon content. The Florida Everglades, as an example, is experiencing land subsidence from draining wetlands.

Land subsidence from the localized collapse of subsurface cavities is commonly caused by groundwater level declines and enhanced percolation of groundwater. Collapse features tend to be associated with

specific rock types, such as evaporates (i.e., salt, gypsum, and anhydrite) and carbonates (limestone and dolomite) that are susceptible to dissolution in water (Davis 1987).

6.4.3.1 Pipeline Facilities

6.4.3.1.1 Boonville Loop Segment

The USGS (2000) does not identify the Boonville area as being affected by land subsidence due to extensive groundwater mining. Additionally, significant areas of organic soils are not present along the Boonville Loop pipeline route (See Resource Report 7 – Soils) and as such, land subsidence due to the drainage of organic soils is not anticipated. Accordingly, Godt (1997) identifies the project as occurring in an area of low landslide incidence. Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Boonville Loop alignment, though no response has been received to date.

6.4.3.1.2 Wright Loop Segment

The USGS (2000) does not identify the Wright Loop project area as being affected by land subsidence due to significant groundwater mining. Additionally, the Wright Loop project area does not contain significant areas of organic soils (See Resource Report 7 – Soils), so land subsidence of this form does not pose a threat to the proposed pipeline facilities. Godt (1997) identifies the project as occurring in an area of low landslide incidence.

Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Wright Loop alignment, though no response has been received to date.

6.4.3.1.3 Newtown Loop Segment

The Newtown Loop project area is at low risk from land subsidence (Thomas 2007a). The USGS (2000) does not identify Connecticut as being affected by land subsidence due to significant groundwater mining. Land subsidence due to drainage of organic soils does not pose a risk to the Newtown Loop project area as the segment does not contain significant areas of organic soils along the pipeline route (See Resource Report 7 – Soils). Additionally, the Newtown Loop project area is known to be underlain by metamorphic bedrock formations, which do not pose a hazard relative to land subsidence (Davies et al. 1976, USGS 2000, Cadwell 1989). Accordingly, Godt (1997) identifies the project as occurring in an area of low landslide incidence.

6.4.3.2 Aboveground Facilities

6.4.3.2.1 Milford Compressor Station

The USGS (2000) does not identify Connecticut as being affected by land subsidence due to significant groundwater mining. The CTDEP – Connecticut Geological and Natural History Survey does not indicate any underground mining or karst in the vicinity of the Milford Compressor Station site that would cause land subsidence or slumping (Thomas 2007b).

6.4.3.2.2 Brookfield Compressor Station Modifications

The USGS (2000) does not identify Connecticut as being affected by land subsidence due to significant groundwater mining. The CTDEP – Connecticut Geological and Natural History Survey does not indicate any underground mining or karst in the vicinity of the Brookfield Compressor Station site that would cause land subsidence or slumping (Thomas 2007c).

6.4.4 Karst Terrain

Karst is a special type of landscape that is formed by the dissolution of soluble rocks, including limestone and dolomite. Karst regions contain aquifers that are capable of providing large supplies of water. In the United States, 20 percent of the land surface is karst and 40 percent of the groundwater used for drinking comes from karst aquifers. Natural features of the landscape such as caves and springs are typical of karst regions (USGS 2007).

Common geological characteristics of karst regions that influence human use of its land and water resources include ground subsidence, sinkhole collapse, groundwater contamination, and unpredictable water supply.

6.4.4.1 Pipeline Facilities

6.4.4.1.1 Boonville Loop Segment

While the predominant underlying bedrock in the Boonville region is comprised of limestone, no karst terrain has been identified along the Boonville Loop pipeline route.

Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Boonville Loop alignment, though no response has been received to date.

6.4.4.1.2 Wright Loop Segment

Karst terrain is present within the south central region of New York, with a single, minor area of karst identified in the Wright Loop area. A small area of karst terrain has been identified along the east side of Iroquois' existing pipeline at approximate MP 0.53 (MP 190.9 as measured along Iroquois' mainline) (FERC 1989).

Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Wright Loop alignment, though no response has been received to date.

6.4.4.1.3 Newtown Loop Segment

The predominant underlying bedrock along the Newtown Loop segment is composed of metamorphic rock comprised of gneiss' and schist's, precluding the presence of karst terrain in the project area. Consultation with the CTDEP – Connecticut Geological and Natural History Survey did not indicate and karst present in the immediate vicinity of the Newtown Loop alignment (Thomas 2007a).

6.4.4.2 Aboveground Facilities

6.4.4.2.1 Milford Compressor Station

Karst features are rare in New Haven County (Davies et. al., 1984), and no such features exist in the project area (Thomas 2007b).

6.4.4.2.2 Brookfield Compressor Station Modifications

The project site is at low risk from the solution of bedrock. The CTDEP – Connecticut Geological and Natural History Survey reports that the closest instance of karst terrain is located over two miles to the west of the Project site and should not pose a problem for construction (Thomas 2007c).

6.4.5 Landslides

6.4.5.1 Pipeline Facilities

6.4.5.1.1 Boonville Loop Segment

Steep slopes are relatively non-existent along the Boonville Loop segment alignment. As a result, the potential for landslides is minimal. Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Boonville Loop alignment, though no response has been received to date.

6.4.5.1.2 Wright Loop Segment

Steep slopes are relatively non-existent along the Wright Loop segment alignment. As a result, the potential for landslides is minimal. Consultation with the New York State Geological Survey has been initiated relative to geologic hazards along the Wright Loop alignment, though no response has been received to date.

6.4.5.1.3 Newtown Loop Segment

Unstable slopes are unlikely along the Newtown Loop Segment and it is only the steepest slopes that pose any risk relative to slope instability and even then, the risk for landslides is minimal (Thomas 2007a).

6.4.5.2 Aboveground Facilities

6.4.5.2.1 Milford Compressor Station

The project area is not at risk from landslides. According to the USGS Open File Report 97-289 (Godt 1997) *Landslide Overview of the Conterminous United States*, the project site has a low landslide incidence of less than 1.5 percent. Steep slopes are practically non-existent in the Project vicinity and the area is not known for landslides (Thomas 2007b). Also, the proposed construction activities are not expected to involve work activities in steeply sloping areas, which could potentially become destabilized resulting in a landslide.

6.4.5.2.2 Brookfield Compressor Station Modifications

The project area is not at risk from landslides. The USGS Open File Report 97-289 (Godt 1997) *Landslide Overview of the Conterminous United States*, the project site has a low landslide incidence of less than 1.5 percent. Also, the proposed construction activities are not expected to involve work activities in steeply sloping areas, which could potentially become destabilized resulting in a landslide. Additionally, the CTDEP – Connecticut Geological and Natural History Survey reports that landslide potential for the Project site is unlikely (Thomas 2007c).

6.5 PALEONTOLOGICAL RESOURCES

6.5.1 Pipeline Facilities

6.5.1.1 Boonville Loop Segment

The construction of the project area should generally only involve trenching in surficial deposits laid down following the last period of glaciation approximately 12,000 years ago and are unlikely to contain significant paleontological resources. Hundreds of millions of years of alternating cycles of glaciation have severely scoured the landscape and caused extensive erosion, virtually eliminated all rock

formations and fossil records originating from the Mesozoic era (approx. 240 million to 65 million years ago) when dinosaurs existed (Allmon and Ross 2005).

The sedimentary bedrock underlying the project area formed during the middle Ordovician period of the Paleozoic era approximately 470 Million years ago, well before the age of dinosaurs. This bedrock may possess paleontological resources; however impacts to bedrock should be minimal and localized to specific areas where bedrock removal is required to allow for sufficient cover of pipeline facilities, limiting the impact to regional paleontological resources. Consultation with the New York State Geological Survey has been initiated relative to paleontological resources along the Boonville Loop alignment, though no response has been received to date.

6.5.1.2 Wright Loop Segment

The sedimentary bedrock underlying the Wright Loop project area, which formed during the Devonian period of the Paleozoic era, may possess paleontological resources; however impacts to bedrock should be minimal and localized to specific areas where bedrock removal is required to allow for sufficient cover of pipeline facilities, limiting the impact to regional paleontological resources. Consultation with the New York State Geological Survey has been initiated relative to paleontological resources along the Wright Loop alignment, though no response has been received to date.

6.5.1.3 Newtown Loop Segment

The Newtown Loop segment is not expected to impact paleontological resources as the bedrock underlying the Project area consists of metamorphic rock (Thomas 2007a). In Connecticut, paleontological resources are generally associated with the sandstones and shales underlying the Connecticut River valley (Farrand 1990), which formed during the Triassic and Jurassic period of the Mesozoic era. Metamorphic rock formations may possess paleontological resources; however the incidence of fossils in metamorphic rock is substantially less than in sedimentary rock formations. Impacts to bedrock should be minimal and localized to specific areas where bedrock removal is required to allow for sufficient cover of pipeline facilities, limiting the impact to regional paleontological resources.

6.5.2 Aboveground Facilities

6.5.2.1 Milford Compressor Station

There are no known areas of paleontological significance in the vicinity of the proposed compressor station (Thomas 2007b). The geologic units underlying the proposed project are comprised of metamorphosed bedrock and glacial deposits, limiting the possibility of encountering geologic units containing paleontologic specimens.

6.5.2.2 Brookfield Compressor Station

There are no known areas of paleontological significance in the vicinity of the Brookfield Compressor Station site (Thomas 2007c). The geologic units underlying the Brookfield, CT project site is comprised of metamorphosed bedrock and glacial deposits, limiting the possibility of encountering significant paleontological resources.

6.6 IMPACT MINIMIZATION AND MITIGATION

Impacts to geological resources will be insignificant and limited to construction activities. The primary impacts will include temporary slope disturbance along the ROW resulting from the grading and

trenching operations. The potential for damage to the pipeline due to subsidence will be minimized through routine inspection of the pipeline. The potential for slope failure due to earthflow along the proposed ROW will be minimized through specialized construction techniques and the use of erosion control procedures outlined in the FERC Plan and Procedures.

The Project is not expected to be affected by seismic activity due to the low probability of significant magnitude earthquakes within the Project area. Iroquois will comply with all applicable regulations regarding pipe wall thickness and strength. Therefore, Iroquois anticipates that the proposed facilities will be able to withstand all but the most extreme fault movements.

Excavation and trenching procedures, including blasting in areas with shallow bedrock, will be conducted in compliance with all federal, state and local laws, codes and regulations. Blasting procedures outlined in the FERC Plan will minimize the potential for associated impacts. Prior to construction, Iroquois will develop a plan for disposal of excess rock generated during construction activities primarily associated with the Newtown Loop Segment.

Topographic impacts will be limited to temporary alteration of terrain during construction of the Project. Based on specific site conditions, slopes may be re-contoured to ensure safe working conditions. Upon completion of pipe installation, disturbed areas and drainage patterns will be restored to pre-construction contours and elevations. Revegetation of the ROW in accordance with the FERC Plan and Procedures will ensure that the disturbed areas are stabilized and prevent erosion. In addition, routine inspection of the pipeline will help anticipate any possible geologic hazards that may affect operation of the facility.

Proper construction techniques including drainage and stormwater management will minimize potential erosion within the workspace. These techniques may include diversion terraces, erosion control devices and other site-specific best management practices as appropriate. Iroquois will adhere to the FERC Plan and Procedures to minimize potential impacts during construction and operation of the pipeline, and construction personnel will be properly trained and instructed to comply with and implement the techniques described therein. Construction and restoration activities will be monitored throughout the process to ensure compliance. Operation and maintenance activities will include routine revegetation monitoring as a standard operational procedure.

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