

APPENDIX L

Karst Features

APPENDIX L

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
172.4	None	Sinkhole	Yes	Sinkhole mapped approximately 300 feet to right (Southwest).	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Summers
172.5	None	Sinkhole	Yes	Sinkhole approximately 650 feet left (Northeast). Proposed MVP crosses surface drainage leading to sinkhole.	Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	See Notes 3,4 at bottom of this table.	Summers
172.8	Moderate	Sinkhole	Yes	Sinkhole approximately 400 feet right (Southwest). Proposed MVP crosses surface drainage leading to sinkhole.	Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	See Notes 3,4 at bottom of this table.	Summers
172.8	Moderate	Spring	Yes	Small spring approximately 260 feet right (west). Proposed MVP crosses surface drainage leading to sinkhole.	Construction run-off and fluid discharge may impact spring.	See Notes 2 at bottom of this table.	Summers
172.9	None	Sinkhole	Yes	Compound sinkhole approximately 500 feet right (southwest) of the proposed alignment.	Sinkhole is upstream of the proposed alignment.	See Notes 3,4 at bottom of this table.	Summers
173.1	Minor	Sinkhole	Yes	Sinkhole mapped by desktop review approximately 100 feet to left (east) of proposed MVP alignment. Proposed alignment crosses watershed associated with the sinkhole, and crosses a topographic drainage leading to the south.	Construction across or in near vicinity of sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trench location to right (west) as needed (1's to 10's of feet) to avoid direct encounter with sinkhole. Implement construction ESC to prevent run-off into the sinkhole. Ensure that construction ESC prevents run-off to south along topographic drainage.	Summers

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190.9	None	Losing Stream, Insurgence	Yes	Below the pond there is an area where a very small stream sinks into the ground. Elevation is about 30 feet above creek base level.	Construction run-off and fluid discharge may impact sinking stream and groundwater.	See Note 3 at bottom of this table.	Monroe
191.1	None	Springs (2)	Yes	440 feet Left, and 105 feet SW of Access Road MVP-MO-230, is a small wet weather seep. 705 feet Left, and 370 feet SW of Access Road MVP-MO-230, is a spring.	n/a	n/a	Monroe
194.2	Minor	Sinkhole	No	Sinkhole mapped by desktop review approximately 100 feet to right (east) of the proposed alignment. Proposed alignment crosses watershed associated with the sinkhole. Other small sinkholes are located approximately 150 feet to the right (Northeast).	Construction across or in near vicinity of sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater. Sinkhole may have a hydraulic connection to near-by Bobcat Cave or Rich Creek Cave/Spring.	Current alignment as mapped will not directly encounter sinkhole. If needed, adjust construction trench in the field left (east) as needed to avoid direct encounter with sinkhole. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s).	Monroe
194.4	None	Sinkhole	No	Sinkholes mapped by desktop review more than approximately 800 feet right (West) of alignment.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Monroe

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194.4	None	Sinkhole and Cave	No	Bobcat Cave, described as a small room located in a large sinkhole, location uncertain, to right (west). Mapped by desktop review.	Construction across or in near vicinity of an open throat sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater. Sinkhole may have a hydraulic connection to near-by Bobcat Cave or Rich Creek Cave/Spring.	Adjust construction trench location as needed based on field observations to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s).	Monroe
194.6	Moderate	Spring and Cave	No	Rich Creek Spring (headwaters of Rich Creek, water supply for Red Sulphur PSD and Town of Peterstown, WV), Rich Creek Cave, and Rich Creek Fish Hatchery were mapped approximately 1,500 feet right (west) of the proposed alignment. The proposed alignment is at a higher elevation than the spring which distances it from potential impact. However, the presence of sinking streams and open throat sinkholes could provide direct conduit to the subsurface flow. Rich Creek Spring is large, serves a fish hatchery, headwater of Rich Creek which is back up water supply for Peterstown.	The primary concern is potential impact on water resources. Construction and maintenance may impact Rich Creek Cave and Spring, and the downstream surface water body Rich Creek.	As noted earlier, do not discharge fluids to ground. Ensure construction ESC prevents migration of sediment and fluids from the construction footprint. Refer to Note 2 at end of this table for baseline water quality testing recommendations for Rich Creek and Red Sulphur PSD.	Monroe

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194.5	Minor	Sinkhole	No	Open throat sinkhole located approximately 600 feet (right) west of the proposed alignment.	These sinkholes are upstream of the MVP alignment.	See Notes 2, 4,5 at bottom of this table.	Monroe
194.6	Minor	Sinkhole	No	Sinkhole located approximately 80 feet left (east) of the proposed alignment.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observations to avoid direct encounter with sinkhole. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s).	Monroe
194.6	Minor	Sinkhole	No	Several sinkholes mapped by desktop review approximately 300 feet to the right (west) of the proposed alignment.	These sinkholes are upstream of the MVP alignment.	See Notes 2, 4,5 at bottom of this table.	Monroe
199.3	None	Sinkhole	No	Sinkholes mapped greater than 1,000 feet left (Northeast) of alignment.	Construction run-off and fluid discharge may impact sinkholes.	See Notes 3,4 at bottom of this table.	Giles
199.9	None	Lhoist Cave	Yes	Lhoist Cave is located approximately 370 feet right (southwest) of the proposed alignment.	Construction run-off and fluid discharge may impact cave.	See Notes 3,4 at bottom of this table.	Giles
200.1	None	Several sinkholes	Yes	Several sinkholes mapped by desktop review to left (northeast) of proposed alignment from approximately 400 to 1,000 feet.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles

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200.5	None	Sinkhole complex	Yes	Sinkhole complex approximately 1,000 feet right (southwest) and on the other side of a topographic high from the proposed alignment. Spring and swallet associated with sinkhole.	Due to distance and intervening ridge no impact is anticipated.	See Notes 2, 4,5 at bottom of this table.	Giles
200.8	Moderate	Sinkholes	Yes	Sinkholes observed within 150 feet left and right of proposed MVP alignment. Current alignment would need to be adjusted to avoid sinkholes. Another cluster of sinkholes further to the right (southwest) prevents avoidance of sinkholes altogether.	Current alignment traverses between two (2) sinkholes. Construction across or in near vicinity of sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	If avoidance by minor adjustment of the construction trench is not feasible to avoid sinkhole, see notes at end of this table for sinkhole stabilization recommendation. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s).	Giles
200.9	Minor	Karst	Yes	Exposed bedrock, heavy benches, shallow to no overburden cover, very epi-karst like. Rainwater percolates into bedrock with little surface flow. This observation is characteristic of the relatively near vicinity of the proposed alignment and not limited to the specific mile post.	A thin overburden mantle to shallow bedrock presents risk for rapid infiltration of construction-related or operations-related fluid to the subsurface.	As noted, do not discharge fluids to ground. Ensure that construction ESC prevents migration of sediment and fluids from the construction footprint. See Note 2 at end of this table for baseline water quality testing plan.	Giles
201.1	Minor	Possible Cave	Yes	A small natural opening is within 50 feet left (northeast) of alignment.	Construction run-off and fluid discharge may impact cave (assuming it is a cave).	See Notes 3,4 at bottom of this table.	Giles

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201.2	None	Cave	Yes	Crooks Crevice, 50-foot pit along roadside approximately 800 feet right (southwest) of proposed alignment.	Construction run-off and fluid discharge may impact cave.	See Notes 3,4 at bottom of this table.	Giles
202.6	None	Note	Yes	No karst-related features were mapped by desktop review or identified through field confirmation from MP 201.5 to 202.6 (Sheet 11 of 37).	n/a	n/a	Giles
203.2	None	Spring	No	Little Stoney Spring is located approximately 1,000 feet right (west) of proposed MVP alignment.	Construction run-off and fluid discharge may impact Little Stoney Spring located topographically below the proposed alignment.	Ensure construction ESC measures are in-place particularly in drainage toward Little Stoney Spring. See Note 2 at bottom of this table.	Giles
203.9	Moderate	Cave	Yes	Cave (Williams Contact Shaft) entrance approximately 140 feet right (west). In addition, a potential new cave called Mahaffey Trash Cave, a trash-filled entrance, was also observed approximately 800 feet right (west).	Construction across or in the near vicinity of a cave may lead to impacts on that natural resource, and long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the cave. If needed, adjust construction trench in the field left (east) as required to avoid direct encounter with cave. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the cave and surface drainage(s).	Giles

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204.1	Moderate	Cave	Yes	High Voltage Cave is located approximately 150 feet left (east), in APCO high voltage electric transmission easement clearing. Though survey flags were to the east of the electric line. The area particularly to the west of the electric line has large bedrock benches and pinnacles.	Construction across or in the near vicinity of a cave may lead to impacts on that natural resource, and long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the cave. If needed, adjust construction trench in the field left (east) as required to avoid direct encounter with cave. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the cave and surface drainage(s).	Giles
204.2	None	Karst	Yes	Exposed bedrock, heavy benches, thin overburden mantle. This observation is characteristic of the relatively near vicinity of the proposed alignment and not limited to the specific mile post.	A thin overburden mantle to shallow bedrock presents risk for rapid infiltration of construction-related or operations-related fluid to the subsurface.	Ensure that construction ESC prevents migration of sediment and fluids from the construction footprint. Refer to Note 2 at end of this table for water resources for pre-construction baseline water quality monitoring.	Giles
204.4	None	Sinkhole	Yes	Shallow sinkhole approximately 250 feet left (northeast) of proposed alignment.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles

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204.4	None	Sinkhole and cave	Yes	Sinkhole is approximately 150 feet left (northeast) of MVP alignment. Conklin Sink Cave entrance is approximately 440 feet left (east) of alignment. Proposed MVP alignment crosses watershed surface drainage to Conklin Sink Cave.	Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the sinkhole. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the cave and surface drainage(s) that lead northeast toward Conklin Sink Cave.	Giles
206.7	Minor	Swallet	No	Sinking stream dye traced to Doe Creek Spring on New River by VaDCR. 430 feet to right (west) of proposed alignment. No sink point was identified during field review (wet weather). Probably not an issue beyond standard E&S.	Construction run-off and fluid discharge may impact the swallet and surface drainage to the south-southwest.	Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off to the south-southwest, toward the swallet. See Note 2 at bottom of this table.	Giles
207.8	None	Sinkholes	Yes	Several sinkholes on east side of access road, approximately 1,000 feet right (southwest) of alignment.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles
208.0	Minor	Swallet, Losing stream	Yes	Crossing a losing stream. Multiple stream sink points mapped by desktop review approximately 760 feet left (northeast) of proposed alignment.	Potential for numerous small near surface voids and conduits under the sinking stream. Construction run-off and fluid discharge may impact the swallet and surface drainage to the south-southwest.	Geophysics. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off to the south- southwest, toward the swallet.	Giles

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208.0	Minor	Sinkhole and Cave	Yes	Proposed MVP alignment is on edge of sinkhole, to left (northeast).	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
208.1	None	Cave	Yes	Pighole cave system located more than 1/4-mile left (northeast) of proposed alignment.	Proposed alignment was adjusted to avoid the cave system. No negative impacts anticipated at this time.	n/a	Giles
208.3	None	Cave	Yes	Echols Cave approximately 800 feet right (southwest) of alignment, and 150 feet above proposed access road.	Construction across or in the near vicinity of a cave may lead to impacts on that natural resource, and long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the cave. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the cave and surface drainage(s).	Giles
208.6	Moderate	Sinkhole	Yes	Proposed alignment crosses a shallow sinkhole.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust alignment northerly to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles

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208.7	Minor	Sinkholes	Yes	Numerous sinkholes left and right of alignment.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust alignment northerly to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
208.9	Moderate	Sinkhole	Yes	Proposed alignment crosses a shallow sinkhole.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust alignment northerly to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
209.5	None	Sinkhole	Yes	Several sinkholes mapped by desktop review within 500 feet left (northeast) of proposed MVP alignment. The MVP alignment ROW does not cross the local sinkhole watersheds.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles
209.8	None	Caves, Spring, Well	Yes	Tawneys Cave and Spring at base of hill and road embankment. Two cave entrances approximately 800 feet to left (northeast) of alignment. Extent of Tawney's cave does not extend beneath the alignment.	MVP alignment adjustment to the southwest avoids impact on Tawney's cave and associated karst features.	See Notes 3,4 at bottom of this table.	Giles

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210.4	None	Caves	Yes	Cave (Hog Hole No. 2). Reported as a small cave approximately 160 feet to right (southwest).	Construction across or in the near vicinity of a cave may lead to impacts on that natural resource, and long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the cave. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the cave and surface drainage(s).	Giles
211.7	None	Sinkhole	Yes	Sinkhole approximately 180 feet left (northeast) of alignment.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles
212.8	None	Sinkholes	Yes	Several sinkholes between 50 and 150 feet left (northwest) of the proposed alignment.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
213.0	Moderate	Spring	Yes	Proposed alignment cuts immediately above a large spring at the convergence of two hollows.	Construction activities may impact spring flow patterns and may encounter conduit flow channels immediately behind the spring..	Adjust alignment to the north, downstream side, between MP 212.9 and MP 213.2 to avoid the spring. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the surface drainage(s).	Giles

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213.2	None	Sinkholes	Yes	Several sinkholes greater than 800 feet right (southeast) of the proposed alignment, but in vicinity of a proposed access road.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust road construction as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
213.5	None	Sinkholes	Yes	Two (2) sinkholes within 500 to 800 feet right (southwest) of the proposed alignment and near proposed access road.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
213.6	Moderate	Spring	Yes	Large spring located approximately 300 feet left (northwest) and downstream of the proposed alignment.	Construction run-off and fluid discharge may impact spring.	See Notes 2 at bottom of this table.	Giles
213.7	Minor	Sinkhole	Yes	Sinkhole containing debris approximately 400 feet left (northwest) of proposed alignment. Alignment crosses watershed to sinkhole at approximately MP 213.8	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles
213.7	Minor	Sinkhole	Yes	Sinkhole approximately 160 feet left (northwest) of proposed alignment.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Giles

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213.7	Significant	Cave	Yes	Canoe Cave extends below alignment. The cave is approximately 1,000 feet in length. The cave entrance UTM coordinates are 547535, 4128962. The proposed alignment overlies the surface-projection of a portion of Canoe Cave. Very small sinkholes were observed at the ground surface during field confirmation of the cave location, suggesting that portion of the cave below the proposed alignment is relatively near the ground surface. Historic (1943) mapping of the cave indicated underground stream flow derived most likely from the northeast along the flank of the upland mountain ridge.	Construction across or in the near vicinity of a cave may lead to impacts on that natural resource, and long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	Adjust construction activities as needed based on field observation, on the order of a few hundred feet to the south (right of the current mapped alignment) to avoid direct encounter with area overlying cave. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the cave and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles
213.8	Minor	Sinkhole	Yes	Sinkhole approximately 60 feet right (southeast) of the proposed alignment.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles

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214.1	None	Several sinkholes	Yes	Sinkholes ranging from 400 to 1,000 feet left (northwest) of proposed alignment (and one possible sinkhole to right of alignment). Proposed alignment crosses watershed of the main sinkholes.	Construction run-off and fluid discharge may impact the sinkholes, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkholes. See Notes 3,4 at bottom of this table.	Giles
214.3	None	Sinkholes	Yes	Two sinkholes approximately 500 feet right (southeast) of proposed alignment.	Sinkholes are upstream of the proposed alignment. Nonetheless, construction run-off and fluid discharge may impact the sinkholes, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkholes. See Notes 3,4 at bottom of this table.	Giles
214.6	None	Sinkhole	Yes	Sinkholes approximately 300 feet left (northwest) of proposed alignment. Sinkhole is downstream of proposed alignment, which crosses the sinkhole watershed.	Construction run-off and fluid discharge may impact the sinkholes, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkholes. See Notes 3,4 at bottom of this table.	Giles

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214.9	Minor	Cave, Stream insurgence	Yes	A possible cave with stream insurgence approximately 200 feet right (southeast) of the proposed alignment.	Proposed alignment crosses downstream of insurgence drainage, that appears to be associated with a possible small cave. This observation suggests that karst-related groundwater flow is relatively near the ground surface in the topographic drainage crossed by the alignment. Construction run-off and ground disturbance may impact the shallow groundwater system.	The proximity of the cave and insurgence within the topographic drainage crossed by the proposed alignment suggests that additional care and enhanced ESC should be implemented during construction activities. See Notes 3,4 at bottom of this table.	Giles
215.2	Minor	Cave, spring, stream insurgence and sinkholes	Yes	Jones Cave, a large spring, and sinkholes, one with a stream insurgence are 400 to 600 feet left (northwest) of the proposed alignment. The proposed alignment also crosses the watershed leading to the sinkholes and crosses the conveyance of a spring-fed stream where the spring is located upslope of the proposed alignment. A proposed access road is located near the sinkholes and Jones Cave.	Construction run-off and fluid discharge may impact the sinkholes, which may in turn lead to subsurface discharge to groundwater and/or the spring. Access road construction across or in the near vicinity of a cave or spring may lead to impacts on that natural resource, and long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact the cave, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkholes. The proposed access road construction alignment, as mapped, does not appear to directly encounter the cave. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkholes and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles / Craig

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215.6	Minor	Sinkholes	Yes	Two (2) sinkholes approximately 70 feet right (southeast) of the proposed alignment, and a historic report of a filled sinkhole approximately 300 feet left (northwest) of the proposed alignment.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Giles / Craig
215.7	Minor	Sinkhole	Yes	Proposed alignment located along edge of a 1.2 Ac, 14 feet deep sinkhole.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching northwest as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Craig
215.8	Moderate	Sinkholes	Yes	Proposed alignment located along edge of a sinkhole.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching southeast as needed based on field observation (10's of feet) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Craig

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
215.8	None	Sinkholes	Yes	Sinkholes 150 to 400 feet left (northwest) of the proposed alignment.	Construction run-off and fluid discharge may impact the sinkholes, which may in turn lead to subsurface discharge to groundwater.	The proposed construction alignment, as mapped, does not appear to directly encounter the sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkholes. See Notes 3,4 at bottom of this table.	Craig
216.8	None	Sinkhole	Yes	A sinkhole is located approximately 300 feet left (north) of the proposed alignment. The alignment crosses the local watershed that leads to the sinkhole.	Construction across or in near vicinity of sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Implement construction ESC to prevent run-off into the sinkhole. Ensure that construction ESC prevents run-off to north along topographic drainage.	Craig
216.8	Moderate	Cave and stream resurgence sinkhole	Yes	Cave, stream resurgence within a sinkhole approximately 140 feet left (northeast), and about 40 feet down a very steep hill from the proposed alignment.	The proposed alignment proceeds up a ridge alongside the edge of the watershed for a stream that sinks into an open throat sinkhole at a potential cave entrance. This observation suggests the karst groundwater flow could be relatively near the ground surface in the immediate area. Construction run-off and ground disturbance may impact the shallow groundwater system and karst resources.	The proximity of the cave, stream resurgence, and groundwater flow patterns within the topographic drainage adjacent to the proposed alignment suggests that additional care and enhanced ESC should be implemented during construction activities. See Notes 3,4 at bottom of this table.	Craig

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
220.6	Minor	Contact - Pulaski Fault, begin dolomite. Begin Mount Tabor sinkhole plain	Yes	Approximate beginning of Mt Tabor sinkhole plain (MP 220.63 to 222.10). Approximate location of Pulaski Fault. Geology is poorly mapped in this area. This area is historically known to have extensive and well documented cave and karst development. Extensive sinkhole development and karst water flow eastward to TNC-DCR natural area preserve. A DCR dye trace study conducted in 2004 in sinkholes located in the vicinity of what is now MP 220.8 indicated that karst water flow from the sinkholes trended toward Slussers Chapel Cave and further on to Mill Creek Cave and spring. This area includes Fred Bulls Cave (MP 220.66) and several smaller cave features, sinkholes within the proposed alignment footprint, and many sinkholes and insurgences.	The proposed MVP pipeline encounters the Mount Table Sinkhole Plain as it progresses from MP 220.63. Karst features including sinkholes, swallets and caves, are intensely and densely developed in this area. There is potential for negative impact on karst resources and water resources, as well as potential for ground instability risk to pipeline.	The density of karst features in this area (i.e., from MP 220.63 to 222.10) will likely require several minor adjustments during construction to avoid sinkholes, and also likely to require stabilization and mitigation efforts. Refer to Notes 2, 3 and 4 at end of this table.	Montgomery
220.7	Minor	Cave, sinkhole, and sinking stream insurgence	Yes	A sinking stream and related cave are located 800 feet to 1200 feet east of the alignment in a very large sinkhole. VaDCR dye trace 2004 shows flow to Slussers Chapel Cave, then to Mill Creek Cave and Spring.	See Concerns for MP 220.63.	See Recommendations for MP 220.63.	Montgomery

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
221.0	Minor	Spring, cave, sinkhole and wet-weather insurgence	Yes	Spring at 650 feet left, very large sinkhole with stream insurgence and small cave at approximately 1,200 feet left (east) of the proposed alignment. VaDCR dye trace 2004 shows flow to Slussers Chapel Cave, then to Mill Creek Cave and Spring.	The proposed alignment crosses the surface drainage upstream of the sinkhole and related features. The source water of the spring is unknown. Construction run-off and ground disturbance may impact the shallow groundwater system and karst resources.	The spring, sinkhole, and insurgence being downstream of the proposed alignment and construction activities suggests that additional care and enhanced ESC should be implemented during construction activities. See Notes 3,4 at bottom of this table.	Montgomery
220.9	Minor	Coal Mines and wet weather insurgence	Yes	Area of historic coal mining, numerous surface pits, mounds, and one tunnel were observed. A collapse implies additional tunnels may be present. A wet weather insurgence about 250 feet left is probably sinking into abandoned mine workings. These features were misidentified by commenter to FERC as karst-related cave and sinkholes.	Ground stability related to historic, abandoned coal workings. Addressed elsewhere in non-karst module of Resource Reports.	Refer to non-karst module of Resource Report. These features are not considered a karst-related hazard.	Montgomery
221.0	Minor	Sinkhole	Yes	Crossing Pulaski Fault and start of dolomite.	Begin area of potential karstification.	Additional care and enhanced ESC should be implemented during construction activities in this area.	Montgomery
221.1	None	Sinkhole	Yes	Sinkhole karst window located more than 1/4-mile left (northeast) of proposed alignment.	Distance separating feature from proposed alignment reduces potential for impact to negligible.	n/a	Montgomery
221.1	Minor	Sinkhole	Yes	Numerous sinkholes are located in the vicinity of the proposed alignment.	See Concerns for MP 220.63.	See Recommendations for MP 220.63.	Montgomery

APPENDIX L (continued)							
Karst Features Identified Within 0.25 mile of the Mountain Valley Project							
MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
221.3	None	Sinkhole	Yes	A sinkhole is located 70 feet right (west) of the proposed alignment.	See Concerns for MP 220.63.	See Recommendations for MP 220.63.	Montgomery
221.4	Minor	Sinkhole	Yes	A compound sinkhole is located immediately right (south) of the proposed alignment, with an open throat ~100 feet distant.	See Concerns for MP 220.63.	See Recommendations for MP 220.63.	Montgomery
221.8	Minor	Sinkhole	Yes	Proposed alignment located along edge of a sinkhole.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation to avoid direct encounter with sinkhole. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Montgomery
222.2	Moderate	Sinkholes	Yes	Multiple sinkholes in vicinity of proposed alignment. The proposed alignment is located along edge and between two sinkholes in particular.	Construction across sinkholes, or narrow ridge separating two sinkholes, may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust alignment as needed to avoid two prominent sinkholes, possibly southward by crossing under the electric line at MP 222.05 instead of MP 222.80, while maintaining parallel co-location. Ground stabilization and sinkhole mitigation is likely required. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Montgomery

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
222.3	None	Contact - End Ellbrook dolomite. Approximate end of Mount Tabor Sinkhole Plain	Yes	Geologic contact, Ellbrook - Conococheague dolomite, approximate end of high density karst features found in the Mount Tabor Sinkhole Plain.	Dolomite continues, but karstification is much less dense.	n/a	Montgomery
222.9	None	Cave	No	A 90 foot deep vertical surface shaft, Zipper Pit, is located about 1600 feet left (north) of the alignment.	This cave illustrates the potential for deep voids intersecting the surface or near surface in the area.	n/a	Montgomery
222.9	Minor	Spring	Yes	A spring is located 325 feet right (south) of the alignment.	There is potential for impacts on water resources from construction.	See Note 2 at bottom of this table.	Montgomery
223.5	Moderate	Sinkholes	Yes	Large deep open throat sinkhole within 100 to 250 feet left (northeast) of MVP alignment. A second smaller open throat sinkhole is located about 200 feet left of MP 223.55.	Construction near a sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching to as needed to avoid direct encounter with sinkhole. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Montgomery
223.5	Moderate	Wet weather spring	Yes	A wet weather spring is located in the proposed access road 570 feet right, south, and downhill of the MVP alignment.	Road construction over spring site could impact flow patterns.	Adjust road construction or location as needed to avoid direct encounter with spring. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into surface drainage(s).	Montgomery

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
224.3	None	Cave, Springs	Yes	Old Mill Cave and three springs, the resurgences from Dry Branch, ~7,200 feet northeast, are located approximately ~2,000 feet right (south) of MVP alignment. Va DCR dye trace studied show flow connection under the ridge that the alignment crosses.	There is potential for impacts on water resources from construction.	See Note 2 at bottom of this table.	Montgomery
224.5	Minor	Sinkhole	Yes	Sinkhole is located within 150 feet right (South) of proposed MVP alignment. Virginia DCR dye trace study indicated flow from Dry Branch passes under this ridge.	Construction run-off and fluid discharge may impact sinkhole and surface water (see note on dye trace study).	See Notes 3,4 at bottom of this table.	Montgomery
224.6	Moderate	Caves, Sinkholes	Yes	Two cave entrances within 160 feet of proposed alignment, Hancock's Blowhole Caves No 1 and No 2. Also, and several sinkholes located 200 to 250 feet right (southwest) of proposed MVP alignment. This is also in the vicinity of the south edge of the APCO high voltage power line easement. A small spring is located approximately 800 feet right (southwest) of the alignment, within a drainage leading from the sinkholes.	The proposed alignment is routed over and in the near vicinity of two caves. Impacts on cave resources are a concern regarding pipeline construction. Ground stability is a concern for pipeline integrity if the caves are extensive. A thin overburden mantle to shallow bedrock presents risk for rapid infiltration of construction-related or operations-related fluid to the subsurface.	Avoidance of these caves is recommended. (Flagged route was on northeast side of electric line, away from these features.) See notes 2, 3 and 4 at end of this table.	Montgomery
224.7	Minor	Sinkhole lineament	Yes	Several sinkholes were found in a linear distribution approximately 250 to 600 feet left (northeast) of MVP alignment.	This cluster of sinkholes may represent voids, a fracture, or zone of weakness in the bedrock. There is a possibility of unconsolidated bedrock along this lineament extended.	Refer to Karst Mitigation Plan in RR6 for more detailed recommendations for construction in this area. See Notes 3,4 at bottom of this table.	Montgomery

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
224.9	None	Cave	Yes	Thompsons Cave mapped by desktop review, approximately 1,200 feet to right (south) of proposed alignment.	Construction run-off and fluid discharge may impact cave.	See Notes 3,4 at bottom of this table.	Montgomery
224.9	Minor	Possible cave	Yes	A possible cave entrance in a shallow sinkhole was located approximately 200 feet left (north) of proposed alignment.	Depending on actual route this feature may or may not be in the area of concern (the flagged route was easterly of the planning alignment).	See Notes 3,4 at bottom of this table.	Montgomery
224.9	Minor	Sinkhole	Yes	A sinkhole was observed approximately 60 feet to the right (south) of the proposed alignment.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed to avoid direct encounter with sinkhole. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s).	Montgomery
225.0	Moderate	Spring	Yes	Farm spring observed within 50 feet of proposed alignment. The spring is at the contact of a band of shale; a line of sinkholes is formed along this band to the northeast. Water likely flows along this contact.	Alignment and route flagging appears close enough to the spring that trenching could potentially cut the flow path immediately behind the spring disrupting water flow. Construction run-off and fluid discharge may impact the farm spring.	Adjust left to avoid impact. Refer to Note 2 at end of this table regarding baseline water quality testing recommendations for the farm spring. Refer to Karst Mitigation Plan in RR6 for more detailed recommendations for construction in this area.	Montgomery
225.0	Minor	Sinkhole lineament	Yes	Several sinkholes are mapped by desktop review within a linear cluster roughly perpendicular to the proposed MVP pipeline, ranging from approximately 200 to 2,000 feet to left (northeast).	This lineament may represent a fracture or zone of weakness in the bedrock. There is a possibility of unconsolidated bedrock along this lineament extended.	See Notes 3,4 at bottom of this table.	Montgomery

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
225.5	None	Spring, Cave	Yes	Johnsons spring, water probably from the hollow to (northeast). Johnsons Cave carries a small stream and is approximately 400 feet right (southwest) of proposed MVP alignment. Several sinkholes located near Johnsons Cave and spring.	There is potential for impacts on cave stream, and water resources from construction.	See Notes 2, 3, 5 at bottom of this table.	Montgomery
225.9	Minor	Sinkhole lineament	Yes	Sinkholes observed right (west).	This lineament may represent a fracture or zone of weakness in the bedrock. There is a possibility of unconsolidated bedrock along this lineament extended.	See Notes 3,4 at bottom of this table.	Montgomery
225.9	Minor	Losing Stream, Insurgence	Yes	Losing stream and wet weather insurgence was observed approximately 100 feet right of proposed MVP alignment. May be associated with sinkhole lineament along ridge. Very likely the source of the water flowing through Johnsons Cave and spring.	Potential unconsolidated bedrock, small voids along stream way. Pipeline construction may impact subsurface water resources in this losing stream environment.	Ensure construction ESC retains fluids and sediment in the construction footprint. Refer to Note 2 at end of this table.	Montgomery
226.0	Minor	Stream insurgence	Yes	Stream insurgence was observed approximately 30 feet left of farm road / proposed access road. May be associated with sinkhole lineament along ridge. Very likely contributes to the water flowing through Johnsons Cave and spring.	There is potential for impacts on subsurface stream, and water resources from access road use or improvements.	Ensure construction ESC retains fluids and sediment in the construction footprint. Refer to Note 2 at end of this table.	Montgomery

APPENDIX L (continued)

Karst Features Identified Within 0.25 mile of the Mountain Valley Project

MP	Level of Concern	Feature Identification <u>a/</u>	Field Confirmed?	Description of Feature	Potential Hazard and Concerns	Construction Recommendations <u>a/</u>	County
233.1	Minor	Sinkhole	Yes	Proposed alignment along steep edge of a 1.0 Ac., 34 foot deep sinkhole.	Construction across sinkhole may lead to long-term differential settlement and pipeline instability. Construction run-off and fluid discharge may impact sinkhole, which may in turn lead to subsurface discharge to groundwater.	Adjust construction trenching as needed based on field observation (10's of feet right, or to other side) to avoid direct encounter with sinkholes. Ensure construction ESC will retain fluid and sediment within construction footprint, and prevent run-off into the sinkhole and surface drainage(s). See Notes 3,4 at bottom of this table.	Montgomery
233.4	None	Sinkhole	Yes	Several sinkholes approximately 400 feet left (east) of in this portion of the proposed alignment.	Construction run-off and fluid discharge may impact sinkhole.	See Notes 3,4 at bottom of this table.	Montgomery

Source: Draper Aden Associates, 2015a

- a/
- (1)- See Karst Mitigation Plan for recommendations if a previously unidentified karst feature is encountered during construction.
 - (2) - See Karst Area Baseline Water Resources Testing Plan for a detailed catalogue and recommendations regarding water resources and water supplies encountered by the proposed alignment within karst terrain.
 - (3) - All recommendations include the overall statements: 1) do not discharge fluids to the ground and particularly not into a sinkhole or cave or drainage leading thereto; 2) implement Project Erosion-Sediment Control in accordance with all local and state regulations and ordinances.
 - (4) - Where sinkholes are mapped or observed within the construction right-of-way, the recommendation is made to adjust the trench footprint as needed to avoid the sinkhole. If avoidance is not possible, refer to Karst Mitigation Plan for recommendations on sinkhole stabilization.