

E.2.13 Geology, Mineral Resources, and Soils

The 500 kV BCD Alternative would be 19.5 miles long and would diverge from the I-8 Alternative (See E.1) at approximately I8-MP-39.5. The BCD Alternative heads north-northwest to MP BCD-6.5 where the route would turn northwest briefly before heading west at MP BCD-9. The route would continue west, passing through the CNF and ultimately joining the Interstate 8 Alternative at MP I8-58. This alternative does not follow existing transmission lines or existing roads, so it would require construction of new access roads along much of its length.

E.2.13.1 Environmental Setting

Geology

The BCD Alternative traverses gently sloping hill and terraces along the eastern side of McCain Valley from approximately mileposts BCD-0 to BCD-11.5 where it begins to cross dissected hills and plateaus of the western In-Ko-Pah Mountains and the southern Laguna Mountains. Geologic units crossed by the BCD Alternative are Alluvium (Qal), Green Valley Tonalite (gr₃), La Posta Quartz Diorite (gr₄), Bonsall Tonalite (gr₅), Woodson Mountain Granodiorite (gr₆), and Julian Schist (ms), and mixed granitic and metamorphic rocks (gr-m). These units are described in Table E.1.13-1 (Section E.1). Approximate locations of these units along the BCD Alternative are listed below.

- Alluvium (Qal): BCD-MPs 0.85-1.35.
- Green Valley Tonalite (gr₃): BCD-MPs 14.55-18.95.
- La Posta Quartz Diorite (gr₄): BCD-MPs 0-0.85 and 1.35-11.75.
- Bonsall Tonalite (gr₅): BCD-MPs 13.55-14.15.
- Julian Schist (ms): BCD-MPs 11.75-13.55.
- Mixed granitic and metamorphic rocks (gr-m): BCD-MPs 14.15-14.55 and 18.95-19.75.

Slope Stability. The BCD Alternative route traverses near and across gently sloping alluvial fans and sloping hillsides from approximately BCD-MPs 0 to 11.5. The remaining 8.1 miles of the alignment crosses moderately sloping hills and valleys of the In-Ko-Pah Mountains and Laguna Mountains which are underlain by primarily by granitic and metamorphic bedrock. This alignment does not cross any mapped landslides and the granitic and metamorphic terrain underlying the slopes in the area are not typically prone to landslides, although it may be susceptible to rock-fall and soil slides in over-steepened areas.

Soils. Four soil associations are mapped underlying the BCD Alternative route, s1014, s1015, s1016, and s1018. Basic characteristics of these soils are presented in Table D.13-20. The Tollhouse–Rock Outcrop–La Posta (s1014), the Hotaw–Crouch–Boomer (s1015), and the Sheephead–Rock Outcrop–Bancas (s1016) associations are formed in material weathered from the underlying granitic and metamorphic rocks. The Oak Glen–Mottsville–Calpine (s1018) soils are generally formed in granitic alluvium. The risk of erosion for off-road/off-trail ranges from slight to very severe and for on-road/on-trail ranges from slight to severe. Shrink/swell (expansive) potential of this soil association varies from low to moderate. Corrosive potential of soils along the BCD Alternative route are moderate for uncoated steel and low to moderate for concrete.

Approximate locations of the soil associations along the BCD Alternative are listed below, in order of approximate first order of appearance along the alignment.

- s1014: BCD-MPs 0–1.3, 9.55–11.85, and 14.75–19.05
- s1018: BCD-MPs 0.7–1.3
- s1016: BCD-MPs 1.3–9.55
- s1015: BCD-MPs 11.85–14.75 and 19.05–19.75

Mineral Resources. No known active mines, mineral resource sites, or BLM mining claims are located along this alternative route.

Seismicity – Fault Rupture. This alternative does not cross any known active faults and is thus not likely to experience damage due to fault rupture and or offset. No active faults are located in the immediate vicinity of this alternative.

Seismicity – Groundshaking. The BCD Alternative would be susceptible to groundshaking from an earthquake on nearby active faults, i.e. the Elsinore or Laguna Salada, or on any of the other significant active faults in the vicinity of this alignment. Most of the BCD Alternative route would only experience minor groundshaking, with moderate groundshaking located only near the eastern end of the alignment. The peak horizontal accelerations for this alignment are presented in Table E.2.13-1.

Table E.2.13-1. Approximate Peak Ground Accelerations – BCD Alternative

Approximate Alternative (BCD) Milepost	Total Length of Segments (miles)	Peak Ground Acceleration
0-0.85, 1.6-4.7, and 7.8-19.7	15.75	0.1-0.2g
4.7-7.8	3.1	0.2-0.3g
0.85-1.6	0.75	0.3-0.4g

Source: CGS, 2006; USGS, 2006a.

Seismicity – Liquefaction. Most of this alignment has no potential for liquefaction as it is primarily underlain by igneous and metamorphic bedrock. The BCD Alternative route may have moderate potential liquefaction in areas where the alignment crosses and is within active washes and flood plains of Tule Creek and its associated tributaries, where local pockets of saturated and loose sandy soils may be located. These local pockets of loose sandy soils could potentially liquefy in the event of a large earthquake.

Earthquake-Induced Landslides. Most accounts of historical earthquakes in this area describe damaging landslides resulting from earthquake groundshaking (SCEC, 2006). Most of BCD Alternative route does not cross through areas with significant slopes; however portions of the ROW west of milepost BCD-11.5 cross moderately sloping hills of the In-Ko-Pah Mountains and Laguna Mountains and may be susceptible to damage from landslides or rock-falls in the event of a large earthquake on nearby faults.

E.2.13.2 Environmental Impacts and Mitigation Measures

This section presents a discussion of impacts and mitigation measures for the BCD Alternative as a result of construction, operation, and maintenance of the project. Table E.2.13-2 summarizes the impacts of the BCD Alternative for geology, mineral resources, and soils.

Construction Impacts

No desert pavement is mapped along the BCD Alternative and thus Impact G-2 (Unique geologic features would be damaged due to construction activities) is not expected to occur along this route. No impacts associated with this alternative would occur from construction activities interfering with access to known mineral resources (Impact G-9).

Table E.2.13-2. Impacts Identified – Alternatives – Geology, Mineral Resources, and Soils

Impact No.	Description	Impact Significance
Route BCD Alternative and BCD South Option		
G-1	Erosion would be triggered or accelerated due to construction activities.	Class III
G-3	Project would expose people or structures to potential substantial adverse effects as a result of problematic soils.	Class II
G-4	Project would expose people or structures to potential substantial adverse effects as a result of seismically induced groundshaking and/or ground failure.	Class II and III
G-6	Project would expose people or structures to potential substantial adverse effects as a result of slope instability created during excavation and/or grading.	Class II
G-7	Project would expose people or structures to potential substantial adverse effects as a result of landslides, earthflows, debris flows, and/or rockfall.	Class II

Impact G-1: Erosion would be triggered or accelerated due to construction activities. (Class III)

Excavation and grading for tower foundations, work areas, access roads, and spur roads would loosen soil and trigger or accelerate erosion. Soils along the BCD Alternative route have an erosion hazard for off-road/off-trail ranges from slight to very severe and for on-road/on-trail ranges from slight to severe. SDG&E’s GEO-APMs 1, 2, 5, and 6 (see Table D.13-11) reduce the amount of erosion that would result from construction by limiting construction traffic and grading of existing roads in areas with sensitive soils, planning construction to minimize new ground disturbance, and using Best Management Practices (BMPs) such as sand bags and road bars to control water erosion. In addition, a Stormwater Pollution Prevention Plan (SWPPP) that would limit erosion from the construction site would be required in accordance with the Clean Water Act. This would result in a less than significant impact (Class III).

Impact G-6: Project would expose people or structures to potential substantial adverse effects as a result of slope instability created during excavation and/or grading (Class II)

Destabilization of natural or constructed slopes would potentially occur as a result of construction activities due to excavation and/or grading operations for the BCD Alternative. Construction consisting of grading and excavation within the hills of the In-Ko-Pah and Laguna Mountains west of milepost BCD-11.5 would potentially cause slope instability, triggering rock-falls or landslides. Landslides, rock fall, earth flows, and debris flows have the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy project components and would potentially cause damage to the environment, to project or other nearby structures, and could cause injury or death to workers and/or the public. SDG&E’s GEO APMs 4 and 8 (see Table D.13-11) would partially reduce impacts related to slope instability by avoiding placing structures in unstable areas and removing or stabilizing boulders upslope of structures thus reducing the threat of possible slope failures or rockfalls. The BCD Alternative would still result in significant impacts if unidentified unstable slopes were disturbed or undercut by construction activities resulting in slope failures. Slope failures would potentially cause damage to the environment, to project or other nearby structures, and could cause injury or death to workers and/or the public, a significant impact. To ensure that slope instability impacts would be reduced to less than significant (Class II), implementation of Mitigation Measure G-6a is required west of milepost BCD-11.5 to delineate potential areas of unstable slopes near and within work areas and minimize the potential from construction triggered slope failures by avoidance or implementation of slope stabilizing design measures.

Mitigation Measure for Impact G-6: Project would expose people or structures to potential substantial adverse effects as a result of slope instability created during excavation and/or grading

G-6a Conduct geotechnical surveys for landslides and protect against slope instability.

Operational Impacts

There would be no impacts associated with this alternative on project structures due to fault rupture (Impact G-5) as the alignment does not cross any active faults.

Impact G-3: Project would expose people or structures to potential substantial adverse effects as a result of problematic soils (Class II)

Soils along the BCD Alternative route have moderate potential for corrosion to uncoated steel and a low to moderate potential for corrosion to concrete. Expansion potential for the soils varies from low to moderate. Corrosive and expansive subsurface soils may exist in places along the proposed route which would potentially damage project structures. Application of standard design and construction practices and implementation of GEO APM 3 (see Table D.13-11) would partially reduce the adverse affects of problematic soils by avoiding placement of structures in areas of high shrink/swell potential, to the extent feasible. However, actual locations of high shrink/swell (expansive) soils and the presence, absence, and location of corrosive soils needs to be determined to fully reduce the potential for adverse affects of problematic soils to less than significant. Unidentified expansive and corrosive soils would damage project structures and facilities potentially resulting in collapse. Collapse of project structures would potentially result in power outages, damage to nearby roads or structures, and injury or death to nearby people. This would be a significant impact. Accordingly, implementation of Mitigation Measure G-3a (Conduct geotechnical studies for soils to assess characteristics and aid in appropriate foundation design) would ensure that impacts associated with problematic soils are reduced to less than significant levels (Class II).

Mitigation Measure for Impact G-3: Project would expose people or structures to potential substantial adverse effects as a result of problematic soils

G-3a Conduct geotechnical studies for soils to assess characteristics and aid in appropriate foundation design.

Impact G-4: Project would expose people or structures to potential substantial adverse effects as a result of seismically induced groundshaking and/or ground failure (Class II and III)

Moderate groundshaking is expected along portions of this alignment in the event of an earthquake originating from a major fault in the region. Seismically induced groundshaking would potentially damage project structures. Collapse of project structures could result in power outages, damage to nearby roads of structures, and injury or death to people, a significant impact. SDG&E indicates in the PEA that project structures would be designed to withstand geologically induced stresses and that appropriate tower design accounting for lateral wind loads and conductor loads would likely exceed any creditable seismic loading, minimizing potential damage to tower structures from groundshaking. This would result in a less than significant impact (Class III).

Moderate groundshaking would potentially result in seismically induced ground failures, including liquefaction related phenomena and slope failures along the BCD Alternative. Where the alternative alignment crosses and is within active washes and flood plains of Tule Creek and its associated tributaries,

local pockets of saturated and loose sandy soils would potentially liquefy in the event of a large earthquake. Seismically induced slope failures such as landslides and rockfalls would potentially occur along west of BCD-11.5 where the alternative ROW traverses along and adjacent to moderate to steep slopes. This would potentially result in damage to project structures. Collapse of project structures could result in power outages, damage to nearby roads or structures, and injury or death to people, a significant impact. To ensure that impacts associated with seismically induced ground failures from strong groundshaking would be reduced to less than significant levels (Class II), implementation of Mitigation Measures G-4b (Conduct Geotechnical Investigations for Liquefaction) and G-6a (Conduct Geotechnical Surveys for Landslides and Protect Against Slope Instability) is required prior to final project design to ensure that people or structures are not exposed to hazards associated with strong to severe seismic groundshaking.

Mitigation Measure for Impact G-4: Project would expose people or structures to potential substantial adverse effects as a result of seismically induced groundshaking and/or ground failure

G-4b Conduct geotechnical investigations for liquefaction.

G-6a Conduct geotechnical surveys for landslides and protect against slope instability.

Impact G-7: Project would expose people or structures to potential substantial adverse effects as a result of landslides, earthflows, debris flows, and/or rockfall (Class II)

Slope instability including landslides, earth flows, debris flows, and rock fall during project operation has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy project components. The area where landslides would potentially cause damage to project structures is along moderate to steep slopes west of milepost BCD-11.5 where the alignment crosses the mountains. SDG&E's GEO APMs 4 and 8 (see Table D.13-11) would partially reduce impacts related to landslide hazards during operations of the project. However unidentified unstable slopes would potentially fail during the lifetime of the BCD Alternative. Slope failures would potentially cause collapse of project structures resulting in power outages, damage to nearby roads or structures, and injury or death to nearby people, a significant impact. To ensure that landslide impacts to project structures would be reduced to less than significant levels (Class II), To ensure that potential landslide impacts to project structures would be mitigated to less than significant levels (Class II), implementation of Mitigation Measure G-6a (Conduct Geotechnical Surveys for Landslides and Protect Against Slope Instability) is required.

Mitigation Measure for Impact G-7: Project would expose people or structures to potential substantial adverse effects as a result of landslides, earthflows, debris flows, and/or rockfall (Class II)

G-6a Conduct geotechnical surveys for landslides and protect against slope instability.

E.2.13.3 BCD South Option

The BCD South Option would extend south approximately 5.6 miles from the BCD Alternative near the BCD Alternative's crossing of La Posta Truck Trail to the point of intersection with the Modified Route D Alternative route south of I-8. From the point of divergence from the BCD Alternative route, the BCD South Option would generally follow La Posta Truck Trail south, crossing La Posta Valley, just north of I-8 and then spanning I-8 and ascending the ridges south of I-8. The BCD South Option would terminate at the Modified Route D Alternative route at BCDS Milepost 5.6 and near Modified Route D Milepost 2.5.

Environmental Setting

Geology

The BCD South Option traverses southward across dissected hills and plateaus of the western In-Ko-Pah Mountains and the southern Laguna Mountains approximately parallel to La Posta Valley. The BCD South Option crosses three geologic units: Alluvium (Qal), La Posta Quartz Diorite (gr₄), and Bonsall Tonalite (gr₅). These units are described in Table E.1.13-1. Approximate locations of these units along the BCD Alternative are listed below.

- Alluvium (Qal): BCDS-MPs 0.85-1.35.
- La Posta Quartz Diorite (gr₄): BCDS-MPs 0-0.85 and 1.35-11.75.
- Bonsall Tonalite (gr₅): BCDS-MPs 13.55-14.15.

Slope Stability. The BCD South Option route traverses near and across gently sloping alluvial fans and sloping hillsides from approximately BCD-MPs 0 to 11.5. The remaining 8.1 miles of the alignment crosses moderately sloping hills and valleys of the In-Ko-Pah Mountains and Laguna Mountains which are underlain by primarily by granitic and metamorphic bedrock. This alignment does not cross any mapped landslides and the granitic and metamorphic terrain underlying the slopes in the area are not typically prone to landslides, although it may be susceptible to rock-fall and soil slides in over-steepened areas.

Soils. The BCD South Option route is underlain for its entire length by one soil association, s1014 - Tollhouse-Rock Outcrop-La Posta. Basic characteristics of these soils are presented in Table D.13-20. The Tollhouse-Rock Outcrop-La Posta (s1014) association soils are formed in material weathered from the underlying granitic bedrock. This soil association has a hazard of erosion for off-road/off-trail of moderate and for on-road/on-trail of severe, shrink/swell (expansive) potential varying from low to moderate, and corrosive potential of moderate for both uncoated steel and concrete.

Mineral Resources. No known active mines, mineral resource sites, or BLM mining claims are located along this alternative route.

Seismicity – Fault Rupture. This alternative does not cross any known active faults and is thus not likely to experience damage due to fault rupture and or offset. No active faults are located in the immediate vicinity of this alternative.

Seismicity – Groundshaking. The BCD South Option would be susceptible to groundshaking from an earthquake on nearby active faults, i.e. the Elsinore or Laguna Salada, or on any of the other significant active faults in the vicinity of this alignment. Most of the BCD South Option would only experience minor groundshaking, with moderate groundshaking located only near the southern end of the alignment. The peak horizontal accelerations for this alignment are presented in Table E.2.13.3.

Seismicity – Liquefaction. Most of this alignment has no potential for liquefaction as it is primarily underlain by igneous and metamorphic bedrock. The BCD South Option route may have moderate potential liquefaction in areas where the alignment crosses and is within active washes and flood plains of La Posta Creek and its associated tributaries, where local pockets of saturated and loose sandy soils may be located. These local pockets of loose sandy soils could potentially liquefy in the event of a large earthquake.

Table E.2.13-3. Approximate Peak Ground Accelerations – BCD South Option

Approximate Option (BCDS) Milepost	Total Length of Segments (miles)	Peak Ground Acceleration
0.5-3.4 and 3.9-5.4	4.4	0.1-0.2g
0-0.5	0.5	0.2-0.3g
3.4-3.9	0.5	0.3-0.4g

Source: CGS, 2006; USGS, 2006a.

Earthquake-Induced Landslides. Most accounts of historical earthquakes in this area describe damaging landslides resulting from earthquake groundshaking (SCEC, 2006). Portions of the BCD South Option route crosses moderately sloping hills of the In-Ko-Pah Mountains and Laguna Mountains and may be susceptible to damage from landslides or rock-falls in the event of a large earthquake on nearby faults.

Environmental Impacts and Mitigation Measures

Construction Impacts

No desert pavement is mapped along the BCD South Option and thus Impact G-2 (Unique geologic features would be damaged due to construction activities) is not expected to occur along this route. No impacts associated with this alternative would occur from construction activities interfering with access to known mineral resources (Impact G-9).

Impact G-1: Erosion would be triggered or accelerated due to construction activities. (Class III)

Excavation and grading for tower foundations, work areas, access roads, and spur roads would loosen soil and trigger or accelerate erosion. Soils along the BCD South Option route have an erosion hazard for off-road/off-trail of moderate and for on-road/on-trail of severe. SDG&E's GEO-APMs 1, 2, 5, and 6 (see Table D.13-11) reduce the amount of erosion that would result from construction by: limiting grading of existing roads in areas with sensitive soils, planning construction to minimize new ground disturbance, use of Best Management Practices (BMPs) such as sand bags and road bars, to control water erosion, and limiting construction traffic. In addition, a Stormwater Pollution Prevention Plan (SWPPP) that would limit erosion from the construction site would be required in accordance with the Clean Water Act. This would result in a less than significant impact (Class III).

Impact G-6: Project would expose people or structures to potential substantial adverse effects as a result of slope instability created during excavation and/or grading (Class II)

Destabilization of natural or constructed slopes would potentially occur as a result of construction activities due to excavation and/or grading operations for the BCD South Option. Construction consisting of grading and excavation within the hills of the In-Ko-Pah and Laguna Mountains would potentially cause slope instability, triggering rock-falls or landslides. Slope instability including landslides, rock fall, earth flows, and debris flows has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy project components and could cause damage to the environment, to project or other nearby structures, and could cause injury or death to workers and/or the public, a significant impact. SDG&E's GEO APMs 4 and 8 (see Table D.13-11) would partially reduce impacts related to slope instability by avoiding placing structures in unstable areas and removing or stabilizing boulders upslope of structures thus reducing the threat of possible slope failures or rockfalls. However, the Proposed Project would still result in significant impacts if unidentified unstable slopes or areas of potentially unstable slopes were disturbed or undercut by construction activities resulting in slope failures. Slope failures would potentially cause damage to the environment, to project or other nearby structures, and could cause injury or death to workers and/or the public, a significant impact. To ensure that slope instability impacts would be reduced to less than significant (Class II), implementation of Mitigation Measure G-6a is required west of milepost BCD-11.5 to delineate potential areas of unstable slopes near and within work areas and minimize the potential from construction triggered slope failures by avoidance or implementation of slope stabilizing design measures.

Mitigation Measure for Impact G-6: Project would expose people or structures to potential substantial adverse effects as a result of slope instability created during excavation and/or grading

G-6a Conduct geotechnical surveys for landslides and protect against slope instability.

Operational Impacts

There would be no impacts associated with this alternative on project structures due to fault rupture (Impact G-5) as the alignment does not cross any active faults.

Impact G-3: Project would expose people or structures to potential substantial adverse effects as a result of problematic soils (Class II)

Soils along the BCD South Option route have moderate potential for corrosion to both uncoated steel and concrete. Expansion potential for the soils varies from low to moderate. Corrosive and expansive sub-surface soils may exist in places along the proposed route which would potentially damage project structures. Application of standard design and construction practices and implementation of GEO-APM-3 (see Table D.13-11) would partially reduce the adverse affects of problematic soils by avoiding placement of structures in areas of high shrink/swell potential, to the extent feasible. However, actual locations of high shrink/swell (expansive) soils and the presence, absence, and location of corrosive soils needs to be determined to fully reduce the potential for adverse affects of problematic soils to less than significant. Unidentified expansive and corrosive soils would potentially damage project structures and facilities potentially resulting in collapse. Collapse of project structures could result in power outages, damage to nearby roads or structures, and injury or death to nearby people, a significant impact. Accordingly, implementation of Mitigation Measure G-3a (Conduct geotechnical studies for soils to assess characteristics and aid in appropriate foundation design) would ensure that impacts associated with problematic soils are reduced to less than significant levels (Class II).

Mitigation Measure for Impact G-3: Project structures could be damaged by problematic soils exposing people or structures to substantial adverse effects

G-3a Conduct geotechnical studies for soils to assess characteristics and aid in appropriate foundation design.

Impact G-4: Project would expose people or structures to potential substantial adverse effects as a result of seismically induced groundshaking and/or ground failure (Class II)

Moderate groundshaking would potentially result in seismically induced ground failures, including liquefaction related phenomena and slope failures along the BCD South Option. Where the alternative alignment crosses and is within active washes and flood plains of Las Posta Creek and its associated tributaries, local pockets of saturated and loose sandy soils could potentially liquefy in the event of a large earthquake. Seismically induced slope failures such landslides and rockfalls would potentially occur along the alignment where it traverses along and adjacent to moderate to steep slopes of the In-Ko-Pah and Laguna Mountains. This could result in damage to project structures. Collapse of project structures could result in power outages, damage to nearby roads of structures, and injury or death to people, a significant impact. To ensure that impacts associated with seismically induced ground failures from strong groundshaking would be reduced to less than significant levels (Class II), implementation of Mitigation Measures G-4b (Conduct Geotechnical Investigations for Liquefaction) and G-6a (Conduct Geotechnical Surveys for Landslides and Protect Against Slope Instability) is required prior to final project design to ensure that people or structures are not exposed to hazards associated with strong to severe seismic groundshaking.

Mitigation Measure for Impact G-4: Project would expose people or structures to potential substantial adverse effects as a result of seismically induced groundshaking and/or ground failure

G-4b Conduct geotechnical investigations for liquefaction.

G-6a Conduct geotechnical surveys for landslides and protect against slope instability.

Impact G-7: Project would expose people or structures to potential substantial adverse effects as a result of landslides, earthflows, debris flows, and/or rockfall (Class II)

Slope instability including landslides, earth flows, debris flows, and rock fall during project operation has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy project components. The area where landslides would cause damage to project structures is along moderate to steep slopes where the alignment crosses the mountains. SDG&E's GEO APMs 4 and 8 (see Table D.13-11) would partially reduce impacts related to landslide hazards during operations of the project. However unidentified unstable slopes or areas of potentially unstable slopes could fail during the lifetime of the BCD South Option. Slope failures would potentially cause collapse of project structures resulting in power outages, damage to nearby roads or structures, and injury or death to nearby people, a significant impact. To ensure that landslide impacts to project structures would be reduced to less than significant levels (Class II), implementation of Mitigation Measure G-6a (Conduct Geotechnical Surveys for Landslides and Protect Against Slope Instability) is required.

Mitigation Measure for Impact G-7: Project would expose people or structures to potential substantial adverse effects as a result of landslides, earthflows, debris flows, and/or rockfall

G-6a Conduct geotechnical surveys for landslides and protect against slope instability.