APPENDIX
10.9 Geotechnical and Geologic Hazard Evaluation

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Converse Consultants

Geotechnical Engineering, Environmental and Groundwater Science, Inspection and Testing Services

April 13, 2012

Mr. Ryan Fowler
RBF Consulting
3300 East Gausti Road, Suite 100
Ontario, CA 91761

Subject: **GEOTECHNICAL/GEOLOGIC HAZARD EVALUATION REPORT**
San Bernardino Clean Water Factory
City of San Bernardino, California
Converse Project No. 11-81-139-01

Dear Mr. Fowler:

Converse Consultants (Converse) has prepared this report presenting the results of our geotechnical/geologic hazard evaluation for the San Bernardino Municipal Water District's Clean Water Factory project located within the City of San Bernardino, San Bernardino County, California. This report was prepared in accordance with our proposal dated February 10, 2011 and your Agreement dated February 17, 2012.

Based on our evaluation, the proposed Clean Water Factory project appears to be generally feasible from a geotechnical and geological standpoint.

We appreciate the opportunity to be of continued service to RBF Consulting. If you have any questions, please do not hesitate to contact us at (909) 796-0544.

CONVERSE CONSULTANTS

Hashmi S. E. Quazi, Ph.D., G. E.
Regional Manager/Principal Engineer

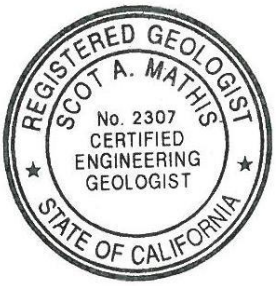
Dist.: 4/Addressee

SM//HSQ/BG

PROFESSIONAL CERTIFICATION

This report has been prepared by the staff of Converse Consultants under the professional supervision of the following professionals whose seals and signatures appear hereon.

The findings and professional opinions contained in this report were prepared in accordance with the generally accepted professional engineering and engineering geologic principle and practice in this area of Southern California. We make no other warranty, either expressed or implied.



Scot Mathis, P.G., C.E.G.
Senior Geologist

EXECUTIVE SUMMARY

The following is a summary of our geotechnical and geologic hazard evaluation, as presented in the body of this report. Please refer to the appropriate sections of the report for complete information. In the event of a conflict between this summary and the report, or an omission in the summary, the report shall prevail.

- Our scope of work included review of published literature and project documents, field reconnaissance, geologic mapping, data evaluation, and preparation of this report.
- The Clean Water Factory project includes improvements to the San Bernardino Water Reclamation Plant (SBWRP) and a conveyance system between the plant and the Waterman Basins. Our evaluation included a proposed alignment corridor, which bounds the Clean Water Factory project and several pipe alignment options.
- The alignment corridor is generally underlain by unconsolidated alluvium sand and silty sand with beds of gravel, cobbles, and boulders. Cobbles and boulders are likely more abundant in the northern portion of the corridor.
- Pelona Schist bedrock is present at the surface in and immediately surrounding Perris Hill in the east-central portion of the alignment corridor.
- Significant watercourses within the alignment corridor include the Santa Ana River, Warm Creek, and East Twin Creek.
- Recent groundwater measurements indicate that the depth to groundwater is between approximately 34 and 50 feet bgs in the portion of the alignment corridor south of Mill Street, and deeper to the north of Mill Street.
- Historical groundwater depths within the corridor have been as shallow as 10 feet bgs in the portion of the corridor south of 5th street and in the Waterman Basins.
- The soils within the alignment corridor are anticipated to be generally excavatable with typical heavy-duty trenching equipment. Difficult excavation due to bedrock may be encountered in Alignment Option 1 near Perris Hill.
- Unconsolidated alluvial sediments along the proposed alignment options will require sloping or shoring of open cut trenches, particularly near existing structures.
- The soils within the alignment corridor are anticipated to generally be very low expansive, although localized deposits of expansive soil may be encountered.
- The Waterman Basins, the northernmost portion of the East Twin Creek Spreading Grounds, and the northern portion of the proposed alignments are within the San Andreas Fault Zone. Two faults are mapped across or adjacent to the alignments

within the fault zone. There is a potential for ground surface fault rupture in this area.

- The southern portion of the alignment corridor does not extend into the San Jacinto Fault Zone.
- The project corridor is subject to strong ground shaking, with a 10 percent chance of being subjected to ground accelerations exceeding 0.78g to 0.88g during the next 50 years.
- Approximately the southern half and the northernmost portion of the alignment corridor are considered to be highly susceptible to liquefaction. The potential for liquefaction in the remainder of the corridor is low.
- Steepened slopes, such as channel banks, within portions of the alignment corridor that are susceptible to liquefaction may have a potential for lateral spreading. The flat-lying areas that make up the majority of the site are not susceptible to lateral spreading.
- With the exception of Perris Hill, the alignment corridor is not considered to be at significant risk from seismically induced landslides.
- The deep, unconsolidated alluvial sediments underlying the corridor have the potential for seismic densification, resulting in differential settlement.
- The southern portion of the corridor, including the SBWRP, is within a dam inundation zone associated with the Santa Ana River.
- Due to the inland location, the site is not at risk from tsunamis.
- There is a potential for localized flooding within the corridor due to seiching in reservoirs, ponds, tanks, and channels within the SBWRP, Waterman Basins, East Twin Creek Spreading Grounds, or elsewhere in the vicinity of the proposed alignments.
- Future geotechnical investigation will be necessary for the selected alignment and other structures, and possibly for areas near faults, bedrock outcrops, or existing drainage channels.

Based on our investigation, we believe that the proposed alignment options are generally suitable for the proposed pipelines, and that the proposed improvements are feasible within the project area, subject to the findings and recommendations of site-specific subsurface geotechnical investigations.

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1.0 INTRODUCTION

This report presents the findings of a geotechnical and geologic hazard evaluation performed by Converse Consultants (Converse) for the proposed City of San Bernardino Municipal Water District (SBMWD) Clean Water Factory (CWF) project in the City of San Bernardino, San Bernardino County, California. The project is located within a corridor extending north from the San Bernardino Water Reclamation Plant (SBWRP), near the I-10 and I-215 interchange to the Waterman Basins, located at the foot of the San Bernardino Mountains. The approximate location of the proposed alignment corridor is shown in Figure No. 1, *Site Location Map*.

The purpose of this evaluation was to identify known geologic hazards, as well as geotechnical opportunities and constraints, within the proposed project alignment. This evaluation was conducted in support of the project Environmental Impact Report/Environmental Impact Statement.

This report is prepared for the project described herein and is intended for use solely by RBF Consulting and their authorized agents for design purposes. It should not be used as a bidding document but may be made available to the potential contractors for information on factual data only. For bidding purposes, the contractors should be responsible for making their own interpretation of the data contained in this report.

2.0 PROJECT DESCRIPTION

The proposed Clean Water Factory (CWF) project will treat effluent from the San Bernardino Water Reclamation Plant (SBWRP) and convey the treated effluent to the Waterman Basins and the East Twin Creek Spreading Grounds. Recycled water spread at these facilities will artificially recharge the Bunker Hill Groundwater Basin. The CWF will also treat and convey a side stream of effluent for direct use as a non‑potable water supply.

Construction of the CWF project will include of the following key elements:

- Treatment improvements to the existing SBWRP,
- Addition of tertiary filtration/disinfection facilities to the SBWRP,
- Addition of advanced waste treatment units to the SBWRP, and
- Recycled water conveyance system to the Waterman Basins and the East Twin Creek Spreading Grounds, as well as direct use customers.

The specific structures included in the planned improvements have not yet been determined. We anticipate that the improvements may include tanks, basins, pumping stations, pump houses, equipment buildings, office buildings, and other similar structures

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San Bernardino Clean Water Factory

Site Location Map

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FIGURE
1

typical of water treatment and distribution facilities. We understand that the pipelines in the recycled water conveyance system may range from 12 to 36 inches in diameter and pipes for distribution of recycled water for direct use may range from 8 to 16 inches in diameter. Up to approximately 100,000 linear feet of pipeline are anticipated. (RBF, 2012)

3.0 ALIGNMENT CORRIDOR DESCRIPTION

The CWF improvements, including the SBWRP and proposed conveyance system alignments, will be located within a corridor extending north from the SBWRP, near the I-10 and I-215 interchange to the Waterman Basins, located at the foot of the San Bernardino Mountains. The corridor is approximately 7.5 miles long and varies from approximately 1.0 to 1.4 miles wide. Three pipeline alignment options are currently under consideration. A fourth option combines Alignment Options 1 and 2.

The northern extent of the corridor, north of the Waterman Basins, is at an elevation of approximately 1,550 feet above mean sea level (amsl). The southern extent of the corridor, south of the SBWRP, is at an elevation of approximately 970 feet amsl. The northern half of the corridor, north of approximately Baseline Street, slopes gently to the south, away from the San Bernardino Mountains. In the southern half of the corridor, the slope shifts to the southwest and west, along East Twin Creek and the Santa Ana River. The only significant break in the topography within the corridor is Perris Hill, a relatively small, narrow, steep, east-west oriented ridge located on the east-central boundary of the corridor. Perris Hill extends approximately 150 feet above the surrounding topography, to a height of approximately 1,315 feet amsl.

Three major watercourses are present within the proposed alignment corridor. The Santa Ana River flows west through the far southern portion of the corridor, south of the SBWRP. Warm Creek flows southwest through the southern half of the corridor, passing adjacent to the east side of the SBWRP, and converging with the Santa Ana River near the southwestern corner of the corridor. East Twin Creek flows south through the eastern portion of the alignment from Waterman Canyon, passing through the Waterman Basins and East Twin Creek Spreading Grounds, and converging with Warm Creek in the east-central portion of the corridor, south of Perris Hill. East Twin Creek and Warm Creek north of Central Avenue are concrete lined, while the southern portion of Warm Creek and the Santa Ana River are unlined. Alignment Option 1 follows the East Twin Creek and Warm Creek channels, while Alignment Options 2 and 3 are located to the west of the creeks.

The proposed alignment corridor is in a developed urban area. The corridor contains residential neighborhoods, commercial and retail areas, light industrial areas, and dedicated open space areas such as parks, golf courses, and cemeteries. The streets within the corridor are paved.

4.0 SCOPE OF WORK

The scope of this investigation included the tasks described in the following sections.

4.1 Literature/Document Review

We reviewed pertinent geotechnical and geologic reports and maps for the area, and project documents provided by RBF Consulting. The documents reviewed are listed in Section 13.0, *References*.

4.2 Field Reconnaissance and Geologic Mapping

A Converse geologist conducted a field reconnaissance of the project area to verify information from regional maps and to identify key geologic units and features exposed at the surface that could impact the proposed CWF project.

4.3 Evaluation and Report Preparation

Data obtained from literature review, field reconnaissance and geologic mapping was compiled and evaluated regard to geotechnical and geologic conditions with the potential to impact the proposed project. Our findings and conclusions were incorporated into this geotechnical and geologic hazard evaluation report.

5.0 SITE GEOLOGY

A general description of the conditions of the project site is presented in the following subsections. A generalized map of the geologic units in the vicinity of the project is presented in Figure 2.

7.1 Regional Geology

The project site is located near the northern boundary of the Peninsular Ranges Geomorphic Province of Southern California. The province consists of a series of northwest-trending mountain ranges and valleys bounded on the north by the San Bernardino and San Gabriel Mountains, on the west by the Los Angeles Basin, and on the south by the Pacific Ocean.

Tectonically, the province is a seismically active region characterized by a series of mainly northwest-trending strike-slip faults. The most prominent nearby faults include the San Jacinto, Cucamonga, and San Andreas Fault Zones, all of which have been known to be active during Quaternary time.

Topography within the province is generally characterized by broad alluvial valleys separated by linear mountain ranges. This northwest-trending linear fabric is created by the regional faulting within the granitic basement rock of the Southern California Batholith. Broad, linear, alluvial valleys have been formed by erosion of these principally granitic mountain ranges.

7.2 Site Geology

The CWF project is located in the central portion of San Bernardino Valley, which is bounded by the San Bernardino Mountains and the San Andreas fault to the north, and the San Timoteo Badlands and the San Jacinto fault to the south. The San Bernardino Valley contains alluvial sediments extending to over 800 feet in thickness in the southern portion of the valley near the SBWRP facility (Dutcher and Garrett, 1963).

The northern portion of the proposed alignment corridor is located on a broad alluvial fan extending to the south from Waterman Canyon in the San Bernardino Mountains. The late Holocene alluvial fan deposits underlying this area consist primarily of unconsolidated to slightly consolidated silt, fine- to coarse-grained sand with beds of gravel, cobbles, and boulders. (Morton and Miller, 2006)

The southern portion of the alignment corridor is underlain by middle to late Holocene axial-channel deposits associated with valley fill by the Santa Ana River and its tributaries. These sediments generally range from very fine to coarse sand, with beds of gravel and small cobbles.

The alluvial fan and axial channel deposits are locally overlain by very young late Holocene wash deposits. These deposits are generally located in active and historical channels and washes. They include unconsolidated and mixed sand, gravel, cobble, and boulder deposits.

Perris Hill, located in the east-central portion of the proposed alignment corridor, is a narrow, steep, east-west oriented ridge extending above the relatively flat valley floor. The hill is composed of Cretaceous Pelona Schist bedrock, a muscovite-chlorite-albite-quartz schist with numerous layers of fine-grained quartzite and greenstone. Pelona Schist is considered to be highly susceptible to landsliding. (Miller, et al, 2001)

5.2 Groundwater

Regional groundwater well data (USGS, 2012) from 2007 to 2012 was reviewed to determine the approximate depth of groundwater throughout the proposed alignment corridor. Groundwater in the northern portion of the alignment corridor, in the vicinity of the Waterman Basins and East Twin Creek Spreading Grounds, was reported at depths between 100 and 150 feet below ground surface (bgs). The deepest groundwater

reported was near Perris Hill, at approximately 250 feet bgs. The reported groundwater depths became shallower to the south, reaching 100 feet bgs near West 5th Street and 50 feet bgs near Mill Street. The shallowest groundwater reported was near the Santa Ana River and the southern end of the corridor, at approximately 34 feet bgs.

Historical groundwater data (Carson and Matti, 1986) indicated a similar pattern to the recent data, but at shallower depths. During the period from 1973 through 1983, groundwater was as shallow as 10 feet bgs at the northern end of the Waterman Basins, and deepened to approximately 150 feet near the southern end of the East Twin Creek Spreading Grounds. The groundwater became shallower to the south, reaching a depth of 10 feet bgs by approximately 5th Street.

Based on our review of recent regional data, we do not anticipate that groundwater will be encountered during construction of the proposed improvements. Perched groundwater may be encountered locally, depending on precipitation and irrigation patterns. Regional groundwater levels may vary depending upon seasonal precipitation, irrigation, surface flow in unlined channels, and groundwater pumping activity in the vicinity.

5.3 Excavatability

Based on the regional geology and our experience with sites in the vicinity of the proposed alignment corridor, we anticipate that the subsurface soils throughout the corridor will generally be excavatable with heavy-duty grading and trenching equipment of the types commonly used for similar construction. Deposits of cobbles and boulders will likely be encountered locally and, if encountered, will require special handling.

Alignment Option 1 crosses through a small area of Pelona Schist bedrock in the area immediately adjacent to Perris Hill. Difficult trenching may be encountered in this area, depending on the depth of the trench and weathering of the bedrock. Alignment Options 2 and 3 do not pass through known areas of shallow bedrock.

5.4 Trench Stability

The proposed conveyance and distribution pipelines will generally be constructed in unconsolidated alluvial sediments. Sloping or shoring of trench sidewalls will be necessary to maintain the stability of open cut trenches. Unstable trench conditions, such as dry, loose, cohesionless soils or existing uncompacted trench backfill, may be encountered locally and may require additional stabilization.

The proposed alignment options are located in developed areas and are near numerous existing structures. These existing improvements may include, but are not limited to, buildings, embankments, channels, pavements, and underground utilities. Temporary

shoring will be required if open sloped excavations will not be feasible due to proximity of the alignment to existing structures or improvements.

5.5 Expansive Soils

Some soils expand or shrink in response to changes in moisture content. Significant damage can occur to structures constructed on expansive soils without appropriate mitigation measures.

Data from the National Cooperative Soil Survey (USDA, 2012) indicates that the proposed alignment corridor contains soils from the Graingeville, Hanford, Soboba, and Tujunga series. Each of these soil series is classified by the USDA as nonplastic or slightly plastic. Based on these classifications, the soils within the proposed alignments are anticipated to be very low expansive. The proposed improvements are not expected to generally be at significant risk from soil expansion. Localized deposits of expansive soils may, however, be encountered.

6.0 FAULTING

6.1 Onsite Faults

The proposed alignment corridor is located generally between the active San Andreas Fault Zone on the north to the active San Jacinto Fault Zone on the south (CGS, 1974 and 1977) as depicted in Figure 3. An active fault is defined as one that has had surface displacement with Holocene time (about the last 11,000 years). The alignment corridor does not contain any additional fault zones designated by San Bernardino County (San Bernardino County, 2007b).

The majority of the Waterman Basins, the northernmost portion of the East Twin Creek Spreading Grounds, and the portions of the proposed alignments north of approximately East 40th Street (approximately 0.6 miles) are within the San Andreas Fault Zone. Two potentially active faults are mapped across or immediately adjacent to the northern portion of the proposed alignments.

The SBWRP and the southern end of the alignments are located approximately 1,500 feet northeast of the San Jacinto Fault Zone. None of the faults mapped within the fault zone projects toward the SBWRP or proposed alignments, although a small area in the far southwestern corner of the alignment corridor is within the fault zone.

6.2 Regional Faults

The following table describes known active faults located site within a 50 kilometer radius of approximate center of the project site.

Table No. 1 Summary of Regional Faults

Fault Name and Section	Approximate Distance to Site Center (kilometers)	Max. Moment Magnitude (Mmax)	Slip Rate (mm/yr)
San Jacinto-San Bernardino	6.5	6.7	12.0
San Andreas Southern	6.5	7.4	24.0
San Jacinto-San Jacinto Valley	12.8	6.9	12.0
Cucamonga	15.7	7.0	5.0
North Frontal Fault Zone (West)	15.9	7.0	1.0
Cleghorn	16.5	6.5	3.0
San Andreas - 1857 Rupture	30.9	7.8	34.0
San Jose	38.0	6.5	0.5
Chino-Central Ave. (Elsinore)	41.1	6.7	1.0
Elsinore-Glen Ivy	44.6	6.8	5.0
Elsinore-Whittier	44.9	6.8	2.5
North Frontal Fault Zone (East)	45.3	6.7	0.5
Helendale –S. Lockhardt	46.1	7.1	0.5

6.3 Ground Shaking

The project site is situated in a seismically active region. As is the case for most areas of Southern California, ground shaking resulting from earthquakes associated with nearby and more distant faults may occur at the project site. During the life of the project, seismic activity associated with active faults can be expected to generate moderate to strong ground shaking at the site. Based on a review of the California Geological Survey's online probabilistic seismic hazards map (CGS, 2011), the proposed alignment corridor has a 10 percent probability of being subjected to ground accelerations exceeding 0.78g to 0.88g during the next 50 years.

6.4 Secondary Effects of Seismic Activity

The site will be subjected to dynamic stresses due to ground acceleration during seismic events. In general, a seismic event may affect the proposed structures by causing ground surface fault rupture, soil liquefaction, landslides, lateral spreading, differential settlement due to seismic shaking, earthquake-induced flooding, tsunamis,

and seiches. A discussion on a site-specific evaluation of each of these seismic effects is presented below:

Surface Fault Rupture: The majority of the Waterman Basins, the northernmost portion of the East Twin Creek Spreading Grounds, and the portions of the proposed alignments north of approximately East 40th Street (approximately 0.6 miles) are within the San Andreas Fault Zone (CGS, 1974), as depicted in Figure 3. Two potentially active faults are mapped across or immediately adjacent to the northern portion of the proposed alignments. There is a potential for ground surface fault rupture in this area.

With the exception of a small area in the far southwestern corner of the alignment corridor, the portion of the alignment corridor south of East 40th Street is not located within a fault zone identified by the State of California or San Bernardino County (CGS, 1974 and 1977; San Bernardino County, 2007b). None of the faults mapped within the nearby fault zones projects toward the proposed alignments. The surface fault rupture potential in this area cannot be known with certainty, but is considered low.

Soil Liquefaction: Liquefaction is defined as the phenomenon in which a cohesionless soil mass suffers a substantial reduction in its shear strength due to the development of excess pore pressures. During earthquakes, excess pore pressures may develop in saturated soil deposits as a result of induced cyclic shear stresses, resulting in liquefaction.

Soil liquefaction generally occurs in submerged granular soils and non-plastic silts located within 50 feet of the ground surface during or after strong ground shaking. There are several general requirements for liquefaction to occur. They are as follows:

- Soils must be submerged
- Soils must be primarily granular
- Soils must be loose to medium-dense
- Soils must be relatively near the ground surface
- Ground motion must be intense
- Duration of shaking must be sufficient for the soils to lose shear resistance

Approximately the southern half of the proposed alignment corridor, south of approximately East Gilbert Street, is designated by San Bernardino County as highly susceptible to liquefaction (San Bernardino County, 2007b) as depicted in Figure 4. The Waterman Basins, the northern half of the East Twin Creek Spreading Grounds, and the portion of the proposed alignments north of approximately East Parkdale Drive are also designated as highly susceptible to liquefaction (San Bernardino County, 2007b). Based on the absence of current or historical shallow groundwater, the potential for significant liquefaction induced settlement in the remainder of the alignment corridor is considered to be low.

Landslides: Seismically induced landslides and other slope failures are common occurrences during or soon after earthquakes. The majority of the proposed alignment corridor is topographically relatively flat, and is not considered to be at risk for seismically induced landslides.

Alignment Option 1 passes immediately to the west of Perris Hill, which is identified by San Bernardino County as having a moderate to high susceptibility to landslides (San Bernardino County, 2007b). Perris Hill is a steep, narrow, east-west oriented ridge. Seismically induced landslides would generally be expected to move to the north or south, not west toward the proposed alignments. Furthermore, Alignment Option 1 is located near, but not adjacent to the toe of Perris Hill. The alignment is not considered be at significant risk from seismically induced landslides.

Lateral Spreading: Seismically induced lateral spreading involves lateral movement of earth materials in response to liquefaction resulting from to ground shaking. It differs from a slope failure in that ground failure involving a large movement does not occur due to the flatter slope of the initial ground surface. Lateral spreading is characterized by near-vertical cracks with predominantly horizontal movement of the soil mass involved over liquefied soils. Because the site is flat-lying, the potential for lateral spreading is considered very low with the exception of locally steepened areas, such as channel banks. Steepened slopes within areas subject to liquefaction may have potential for lateral spreading.

A significant portion of Alignment Option 1 is located along the East Twin Creek and Warm Creek channels. Unlined sections of these channels may be subject to lateral spreading. Alignment Options 2 and 3, as well as the SBWRP, may be subject to lateral spreading where located adjacent to channels or slopes within liquefaction hazard zones.

Differential Settlement Due to Seismic Shaking: Unconsolidated, unsaturated, loose, granular soils may undergo densification in response to strong seismic shaking. Such densification may result in settlement at the ground surface. Differential settlement occurs when variable soil conditions result in differing amounts of settlement within an area. The San Bernardino Valley, including the proposed alignment corridor, is underlain by thick deposits of primarily unconsolidated, granular alluvial sediments. These sediments have the potential for seismic densification, resulting in differential settlement.

Earthquake-Induced Flooding: Flooding may occur due to failure of dams or other water-retaining structures as a result of earthquakes. The SBWRP, the portion of Alignment Option 1 south of West Central Avenue (approximately 0.8 miles) , and the portions of all three alignment options south of Orange Show Road (approximately 0.4

miles) are within a dam inundation zone associated with the Santa Ana River channel and the Seven Oaks Dam (San Bernardino County, 2007a).

Tsunamis: Tsunamis are large waves generated by fault displacement or major ground movement. Due to the inland location of the site, tsunamis do not pose a hazard.

Seiches: Seiches are waves generated in enclosed bodies of water in response to ground shaking. During a large earthquake, seiching may occur in reservoirs, ponds, tanks, and channels within the SBWRP, Waterman Basins, East Twin Creek Spreading Grounds, or elsewhere in the vicinity of the proposed alignments. Therefore, there is a potential for localized flooding of the project area due to seiches.

10.0 SUMMARY OF FINDINGS

The following table summarizes our findings with regard to various potential geotechnical constraints and geologic hazards, and whether they are considered a likely concern for the proposed alignment options and the SBWRP. The following table is only a brief summary intended only for convenience. The relevant sections of this report should be reviewed for detailed information regarding each constraint and hazard.

Table No. 2 Summary of Constraints and Hazards

Geotechnical Constraint / Geologic Hazard	Alignment Option 1	Alignment Option 2	Alignment Option 3	SBWRP
Shallow Groundwater	No	No	No	No
Difficult Excavation	Local	No	No	No
Cobbles and Boulders	Yes	Yes	Yes	Yes
Trench Instability	Yes	Yes	Yes	Yes
Shoring of Adjacent Structures	Yes	Yes	Yes	Yes
Expansive Soils	No	No	No	No
Strong Ground Shaking	Yes	Yes	Yes	Yes
Surface Fault Rupture	Yes	Yes	Yes	No
Soil Liquefaction	Yes	Yes	Yes	Yes
Seismically Induced Landslides	Slight	No	No	No
Lateral Spreading	Yes	Yes	Yes	Yes
Seismic Differential Settlement	Yes	Yes	Yes	Yes
Seismically Induced Flooding	Yes	Yes	Yes	Yes
Tsunamis	No	No	No	No
Seiches	Local	Local	Local	Yes

11.0 FUTURE GEOTECHNICAL SERVICES

This report has been prepared to provide an overview of the general geologic conditions within the proposed alignment corridor and the geotechnical issues that should be considered. Our evaluation was based on regional mapping, document review, and surface reconnaissance. The information presented can be used to assist in the preliminary planning and alignment selection.

Site-specific subsurface geotechnical investigation of the selected alignment will be necessary as the project design is developed. Additional detailed investigation may be required for specific areas of the site, such as areas near faults, bedrock outcrops, or existing drainage channels. Appropriate geotechnical parameters and recommendations for project design, earthwork, and construction should be developed by the geotechnical consultant on the basis of future site-specific subsurface geotechnical investigation.

12.0 CLOSURE

The findings and conclusions of this report were prepared in accordance with generally accepted professional engineering and engineering geologic principles and practice within our profession at this time in Southern California. Our findings and conclusions are based our review of regional mapping and documents, and our surface reconnaissance.

This report was prepared for RBF Consulting for the subject project described herein. We are not responsible for technical interpretations made by others of our information. Specific questions or interpretations concerning our findings and conclusions may require a written clarification to avoid future misunderstandings.

13.0 REFERENCES

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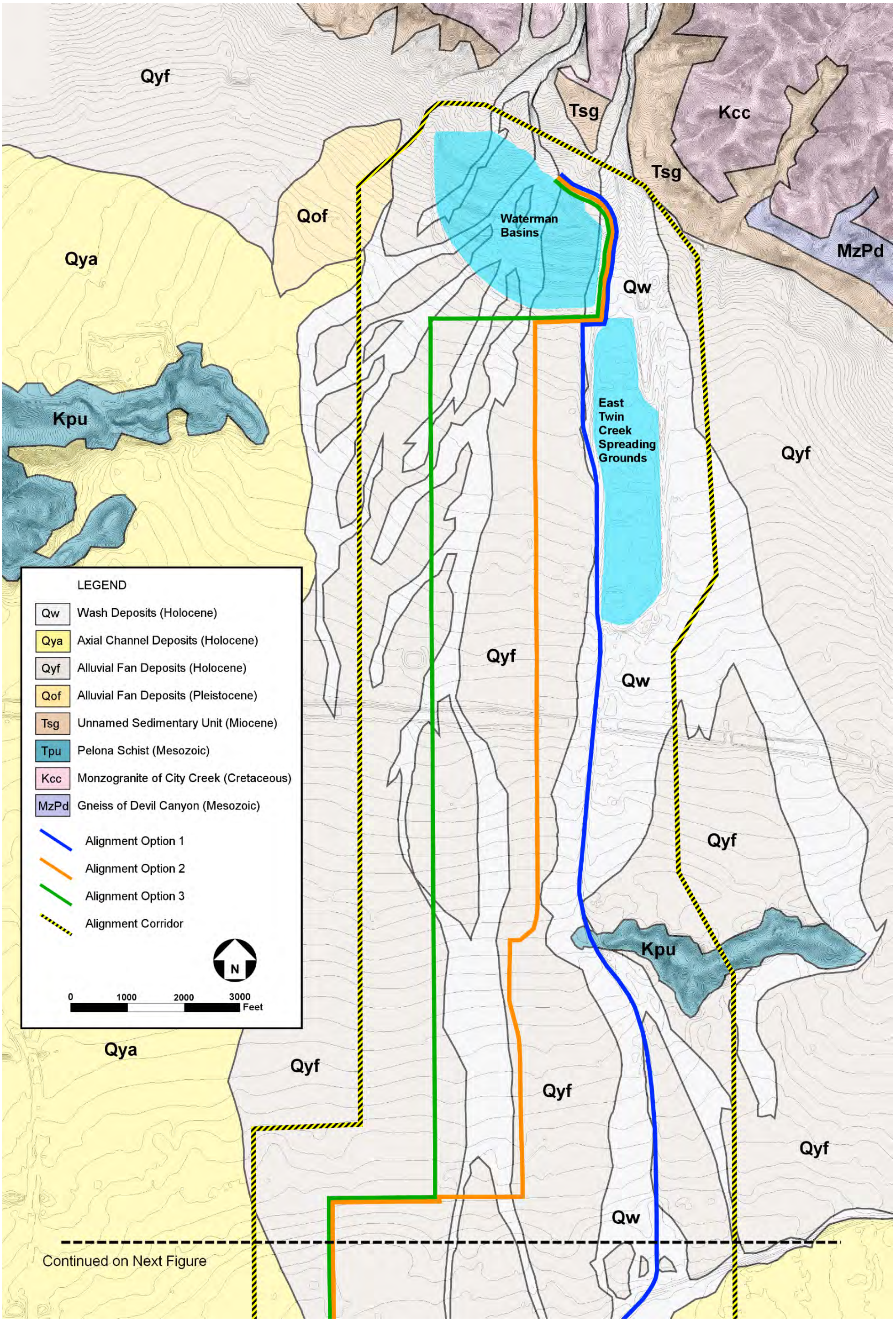

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Geologic Map

Project No
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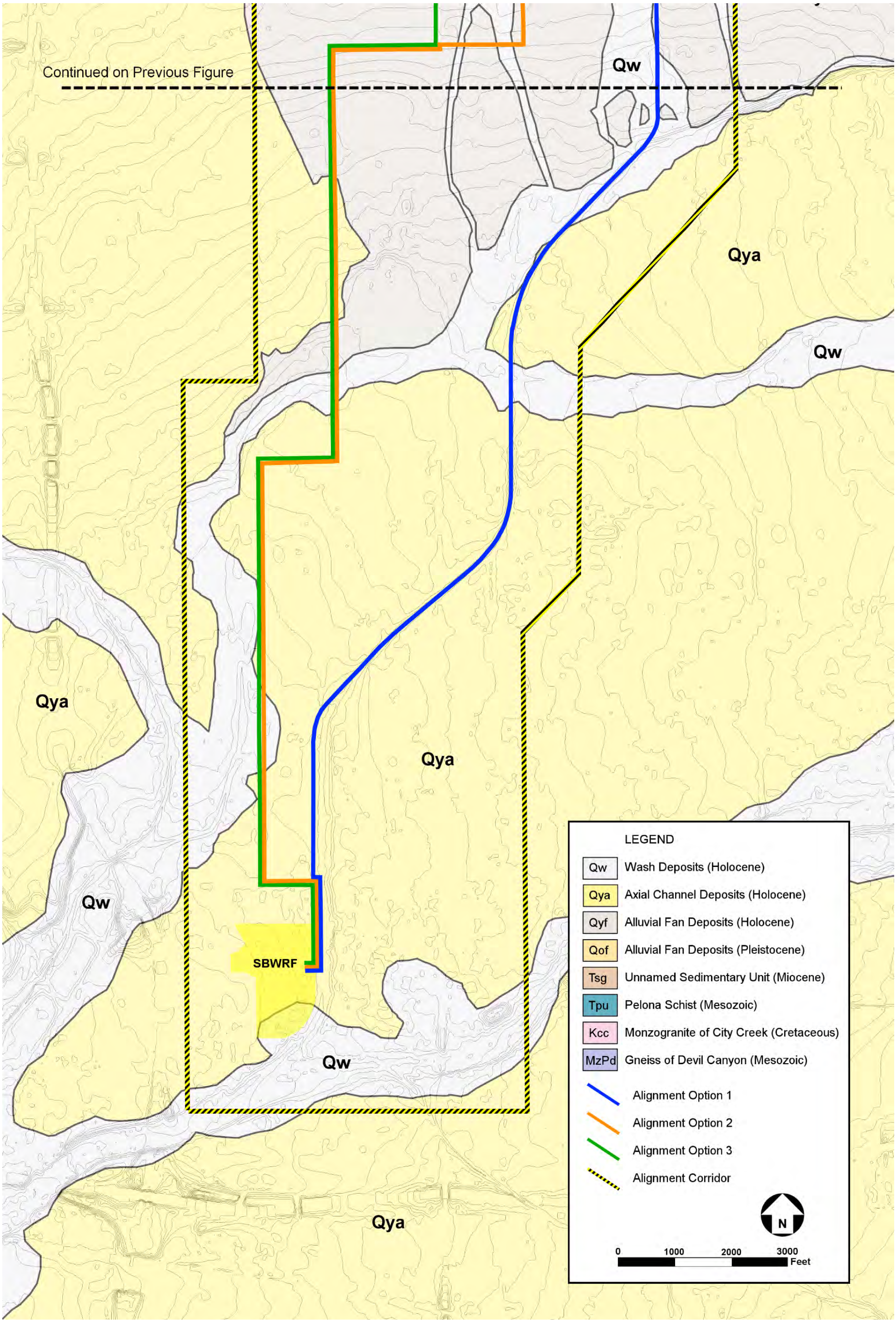
FIGURE
2A



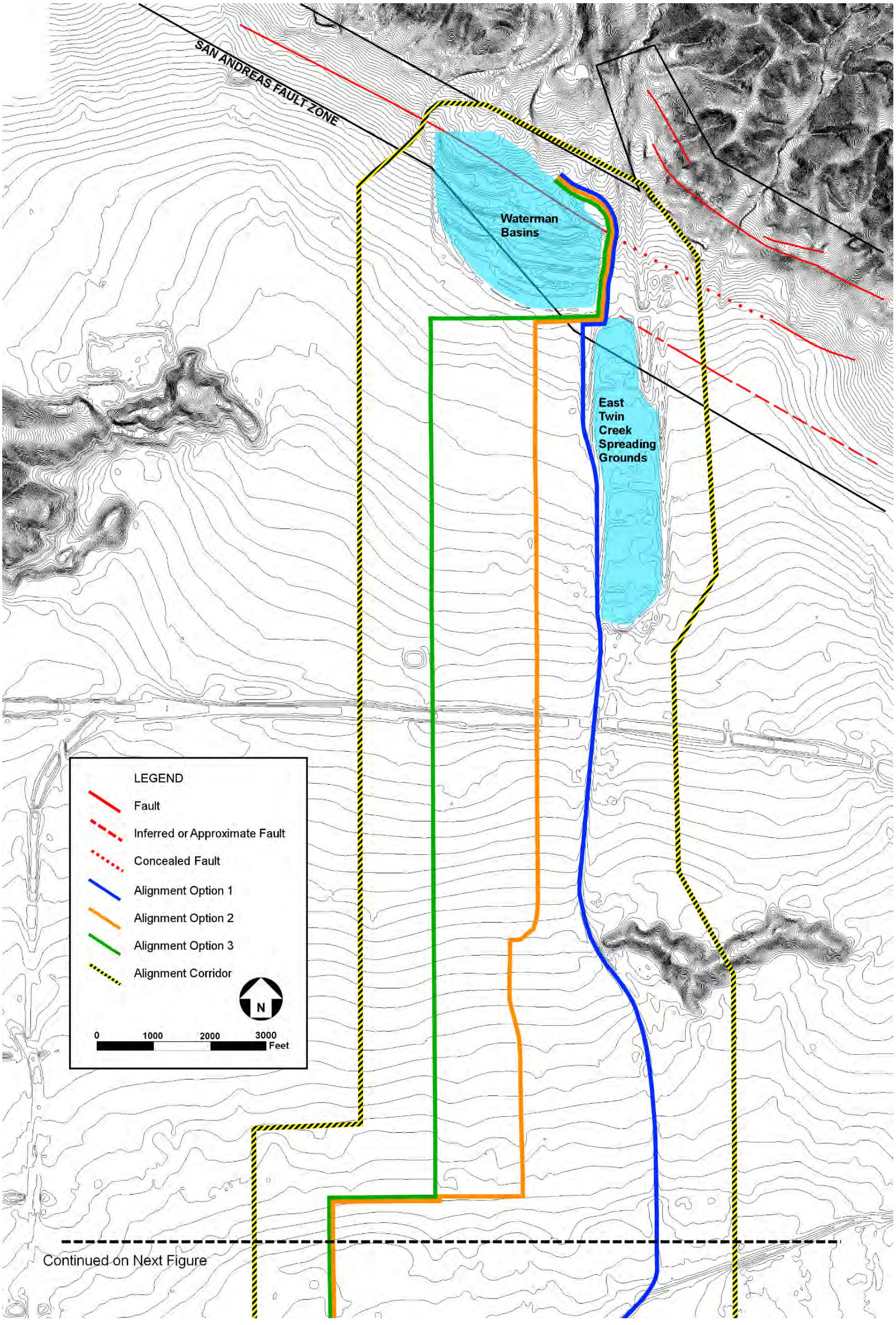
Client: RBF Consulting
San Bernardino Clean Water Factory

Geologic Map

Project No
11-81-139-01

Converse Consultants

FIGURE
2B



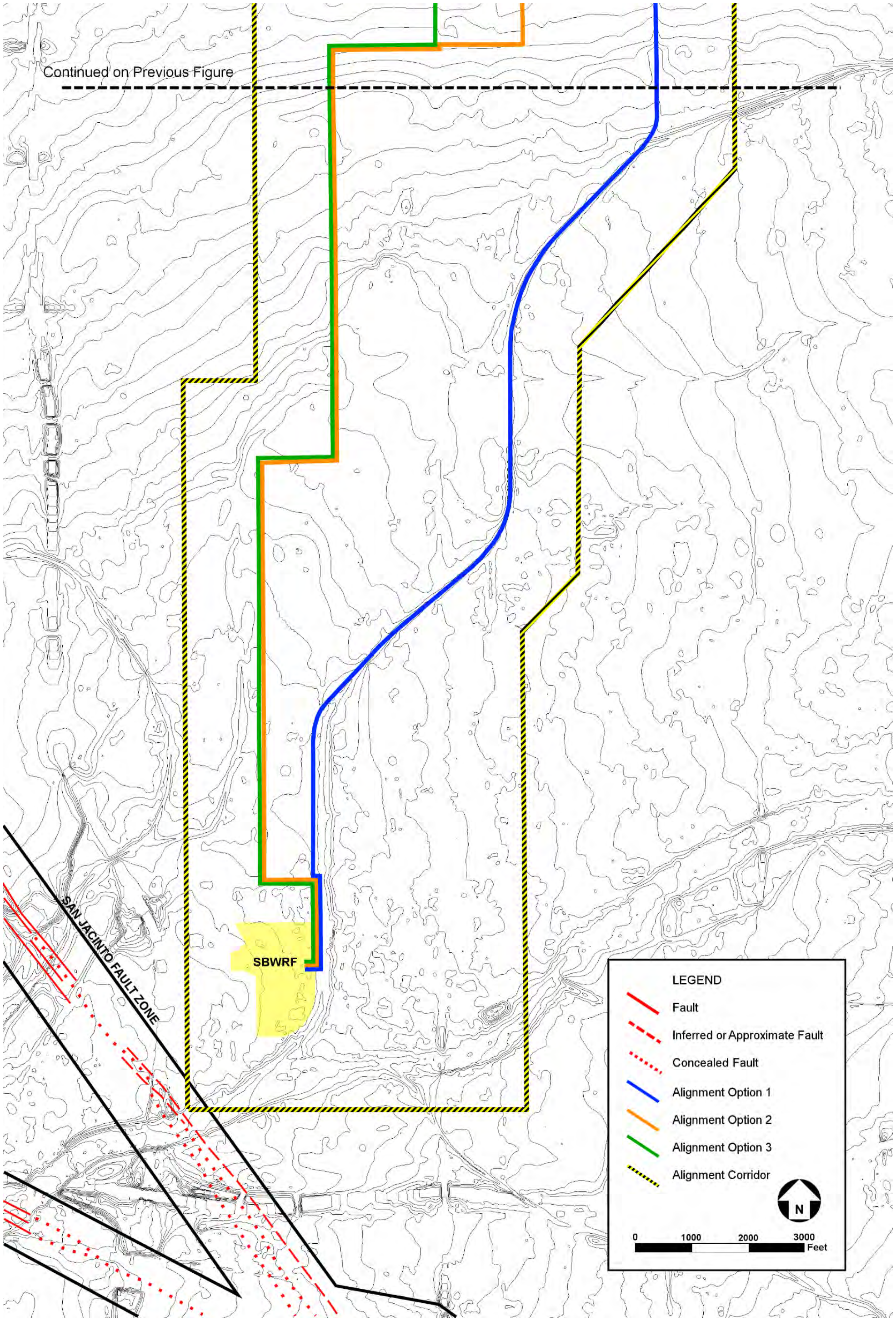
Client: RBF Consulting
San Bernardino Clean Water Factory

Fault Map

Project No
11-81-139-01

Converse Consultants

FIGURE
3A



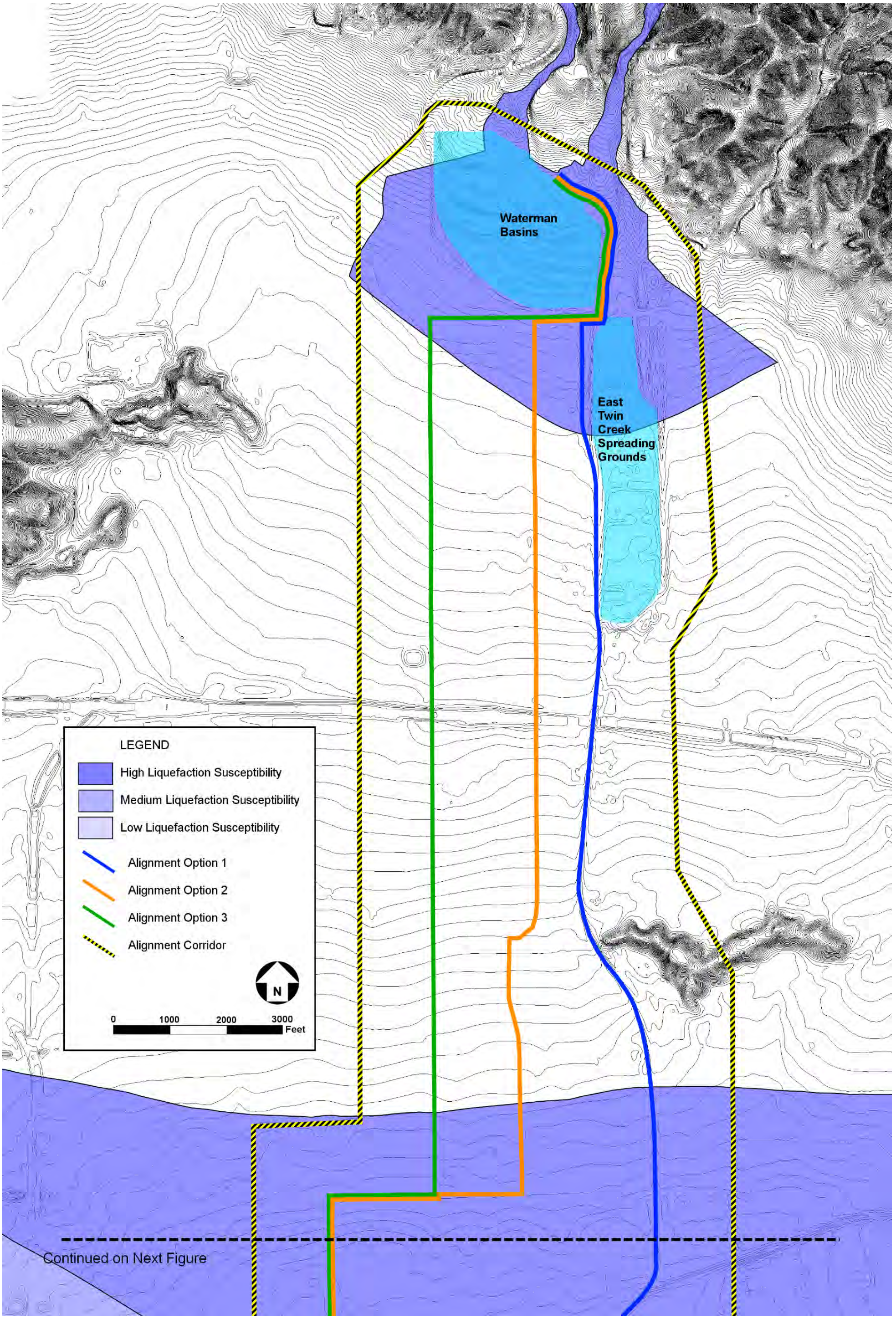
Client: RBF Consulting
San Bernardino Clean Water Factory

Fault Map

Project No
11-81-139-01

Converse Consultants

FIGURE
3B



Client: RBF Consulting
San Bernardino Clean Water Factory

Liquefaction Hazard Map

Project No
11-81-139-01

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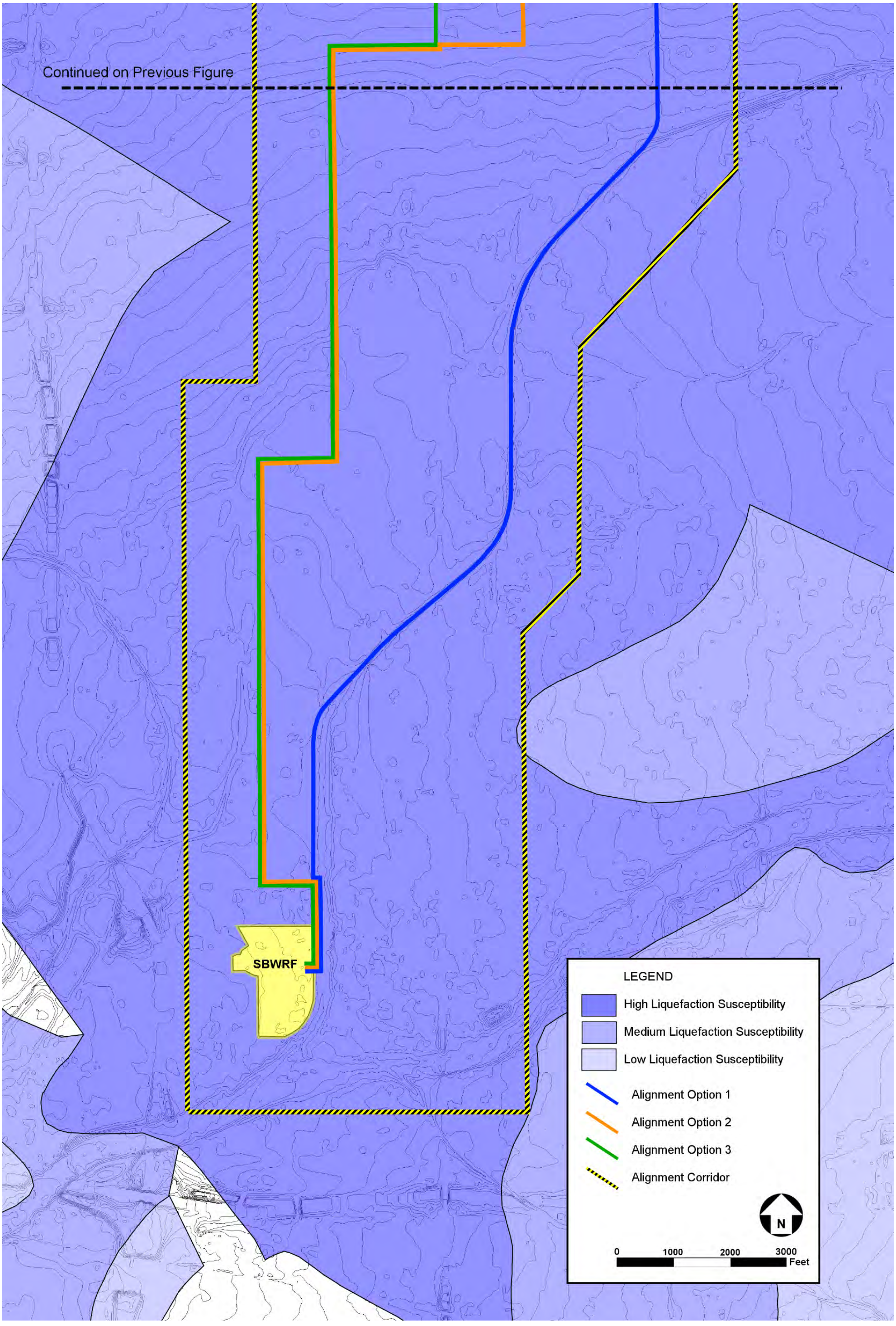
FIGURE
4A



Client: RBF Consulting
San Bernardino Clean Water Factory

Liquefaction Hazard Map

Project No
11-81-139-01

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FIGURE
4B