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Submitted by
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August 17, 2016

Centennial Reservoir Project Conceptual-level Opinion of Probable Construction Cost

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August 17, 2016

Nevada Irrigation District
1036 W. Main Street
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Attention: Mr. Doug Roderick, P.E.

**Subject: Centennial Reservoir Project
Conceptual-level Opinion of Probable Construction Cost**

Dear Mr. Roderick:

We are very pleased to submit this Conceptual-level Opinion of Probable Construction Cost (OPCC) for the potential dam types [roller compacted concrete (RCC) dam and concrete faced rockfill (CFR) dam] and sites (at Axis 2 and Axis 6) currently being considered for the Centennial Reservoir Project. These two dam types and dam site locations were identified in our February 9, 2016, Preliminary Geotechnical Investigation, Phase II Report.

This technical memorandum presents the following:

- Discussion of the RCC and CFR dam alternatives including the dam foundation treatment, and dam, spillway, outlet works and diversion, required construction materials (on-site and import), and conceptual layouts of the site construction plans for both dam types.
- Construction schedules for the RCC dam and the CFR dam.
- Basis for and the results of the OPCC Class 4 estimates, in accordance with the Association for the Advancement of Cost Engineering (AACE), for evaluation and comparison of the RCC and CFR dam concepts.
- Summary and conclusions on the construction schedules and cost estimates for the two dam types at the two dam axis locations.

We are available to discuss this technical memorandum with you. Please contact me at (510) 874-3012 if you have any questions.

Sincerely,
AECOM Technical Services, Inc.

M.P. Forrest

M.P. Forrest, P.E., G.E.
Project Manager

Enclosure:
Centennial Reservoir Project, Conceptual-level Opinion of Probable Construction Cost

Cc: Noel Wong, Ted Feldsher (AECOM)

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List of Acronyms

AACE	Association for the Advancement of Cost Engineering
ADAS	automated data acquisition system
CFR	concrete faced rockfill
cy	cubic yards
G&A	general and administrative
lbs	pounds
lf	lineal feet
NID	Nevada Irrigation District
OPCC	opinion on probable construction cost
RCC	roller compacted concrete
SCADA	supervisory control and data acquisition
sy	square yards
USACE	U.S. Army Corps of Engineers

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1 Introduction

1.1 Background and Purpose

The Nevada Irrigation District (NID) has initiated engineering and planning studies for a proposed reservoir project located on the Bear River at the site location shown in Figure 1-1. The site is between the existing Rollins and Combie Reservoirs, which are also owned and operated by NID. The NID has identified a reservoir storage capacity objective of 110,000 acre-feet for the project, which is known as the Centennial Reservoir.

This technical memorandum presents an opinion on probable construction costs (OPCC) for the project, based on the dam design concepts currently under consideration. Two potential dam types and two potential dam axis alignments are currently being considered. The two dam types are roller compacted concrete (RCC) and concrete faced rockfill (CFR). The two alignments are referred to as Axis 2 and Axis 6. These two dam types and dam axis alignments were identified in the Preliminary Geotechnical Investigation Phase II Report (AECOM, 2016). Figure 1-2 shows the proposed reservoir plan and the locations of Axes 2 and 6. As described in the sections that follow, the scope of work for this technical memorandum included development of OPCC's for each dam type at each axis alignment to compare their relative costs.

A storage capacity of 110,000 acre-feet corresponds to a maximum normal reservoir water surface of approximately elevation 1855 at Axis 2 and elevation 1858 at Axis 6. Retaining a reservoir at either of these two elevations would require a dam height of approximately 275 feet above the Bear River. For the purpose of this technical memorandum, the same 20-foot freeboard was assumed for each dam type. However, depending on the spillway design and freeboard criteria, the final design crest elevations for each of the two dam types are likely to differ.

For estimating purposes, conceptual design layouts were developed based on the geotechnical information presented in the Preliminary Geotechnical Investigation, Phase II Report. The Phase II report described the initial geotechnical investigations performed to assess the site conditions for the proposed dam, and to evaluate the potential dam axis locations and dam types. The report concluded that either an RCC dam or CFR dam could be constructed at either axis for the proposed project.

The work described in this technical memorandum was authorized under the agreement between AECOM and NID dated April 15, 2015, and in accordance with AECOM's proposed scope of work dated January 27, 2016.

1.2 Scope of Work

The scope of work included estimating quantities and developing OPCC's based on assumed foundation surfaces for the conceptual RCC dam and CFR dam layouts at both Axis 2 and Axis 6. The scope of work was divided into the following tasks:

- Development of unit prices for major items of work based on current interpreted site conditions and on costs from similar projects.
- Development of conceptual layouts for the RCC dam and the CFR dam and associated spillway and outlet works based on the geotechnical information presented in the Phase II Report.
- Preparation of conceptual construction schedules for each of the two alternative dam types.
- Preparation of Class 4 OPCCs (as defined by the AACE).
- Preparation of a technical memorandum providing the basis for each OPCC, including conceptual layouts, quantities, and unit costs of the major items.

1.3 Organization of Technical Memorandum

After this introductory section, this technical memorandum is organized into the following sections:

- Section 2 discusses the RCC dam alternative including foundation treatment, spillway, outlet works and diversion facilities, required construction materials, and conceptual site layout.
- Section 3 discusses the CFR dam alternative including foundation treatment, spillway, outlet works and diversion facilities, required construction materials, and conceptual site layout.
- Section 4 describes the construction schedules for each dam type.
- Section 5 presents the basis for and the results of the OPCC's for each dam type.
- Section 6 presents the summary and conclusions.
- Section 7 lists the references.

1.4 Limitations

The estimates presented in this technical memorandum reflect a professional opinion of probable project construction costs, based on conceptual-level design layouts developed using currently available information on the surface and subsurface site conditions.

AECOM represents that its services were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession, within the limits prescribed by our client. No other warranties, either expressed or implied, are included or intended in this technical memorandum.

2 Roller Compacted Concrete Dam

Conceptual-level designs were developed to illustrate the general arrangement and the main features of the RCC dam type. The dam layouts and assumed depths of foundation excavation are based on the results of the Phase II geotechnical investigation (AECOM, 2016). Development of more detailed designs is not warranted at this stage and so was not included in the scope of work. Significant geotechnical engineering and design analyses will be needed in future phases of work to further develop and refine the design layouts, dimensions, and sizes of the various project facilities.

The conceptual plan and section of the RCC dam are shown on Figures 2-1 and 2-2. For a dam crest at approximately elevation 1875 to 1878 feet, the length of Axis 2 would be about 1800 feet. The length of Axis 6 would be about 1600 feet.

2.1 Dam Foundation Treatment

As discussed in the Phase II Report (AECOM, 2016), the foundation for an RCC dam would require slightly weathered to fresh, hard rock. Excavation depths up 100 feet are expected in portions of both potential axis locations. The excavation depths in the abutment areas are expected to average about 60 to 70 feet. Shallower excavation depths are anticipated in the river channel areas based on outcrop observations. Additional geotechnical investigations are needed in all areas to better define the necessary excavation depths.

Grouting would be needed to control seepage through the foundation rock. Based on a maximum reservoir depth of about 255 feet, the hydraulic conductivity data presented in the Phase II Report suggests that the grout curtain depths could range from about 100 to 200 feet below the foundation level. The conceptual design layout includes two grout curtains, each 150 feet deep. The grout holes in each curtain would be angled in opposing directions to more effectively intersect the near-vertical rock discontinuities that are common at the site.

The foundation for an RCC dam at either axis could also require consolidation grouting of fractured rock areas within the footprint. The purpose of this is to strengthen the rock mass and increase the stiffness of the foundation. The conceptual design layout includes consolidation grouting over 30% of the dam foundation footprint area, with 30-foot deep grout holes spaced on a 10 x 10-foot pattern.

Drain holes to control uplift pressures beneath the RCC dam would also be required. The conceptual design includes drain holes drilled from a gallery within the dam, spaced on 10-foot centers and extending to an average depth of 80 feet.

The construction costs for an RCC dam would also include foundation cleaning for geologic mapping, final foundation cleaning prior to RCC placement, surface preparation (i.e., dental excavation of joints and shear zones and replacement with concrete), and leveling concrete placed on the foundation to provide a platform to commence RCC placement. An allowance was included in the OPCC for these items.

2.2 Conceptual Layout of Dam and Appurtenant Structures

The conceptual plan and section of the RCC dam are shown on Figures 2-1 and 2-2. The conceptual cross section has a vertical upstream face, a 0.8H:1V stepped downstream face, and a 30-foot wide crest. The dam would be constructed with one-foot thick lifts of RCC. For the purpose of this OPCC, conventional concrete facings on the upstream and downstream sides were assumed.

The conceptual RCC dam layout includes a spillway integral with the body of the dam, aligned to discharge flows directly into the Bear River channel. The 240-foot-wide spillway bay (at both axes) was selected to maximize the available discharge width and approximately match the river channel width immediately downstream. This layout would help to optimize the dam crest elevation by minimizing the required unit discharge per foot of spillway width. A stilling basin would be located at the toe of the spillway. Reinforced concrete training walls would be constructed on each side of the spillway bay and stilling basin to contain the discharge flows and dissipate energy prior to releasing flows back to the river channel.

The conceptual design also includes a combined low level outlet and diversion conduit. The layout includes an 8-foot diameter steel outlet pipe, which would be cast into the body of the dam. Per direction from NID, the conceptual layout includes only a single low-level intake, located near the base of the dam. The outlet conduit would be fitted with a bifurcation and a blind flange for potential future addition of a power plant at the downstream toe of the dam.

For the purpose of this OPCC, temporary river diversion during construction was assumed to be accomplished in the following manner:

- Complete foundation excavation and preparation of the lower right abutment.
- Construct lower right abutment leveling concrete and RCC block with diversion conduit cast in place.
- Temporarily close off the river with a cofferdam to divert the river through the diversion conduit.
- Complete foundation excavation and preparation in the river channel area.
- Construct the lower left abutment RCC block across the river channel to join with the lower right abutment block.
- Construct dam across its entire width once the diversion conduit is covered, up to the dam crest.

2.3 Construction Materials

For the purposes of this OPCC, rock for RCC aggregate was assumed to be obtained from an on-site rock borrow area. The rock borrow area would first need to be stripped of overburden and weathered rock. The underlying fresh rock would be drilled, blasted, crushed and screened to produce the RCC aggregate. Waste material would be placed in a nearby on-site disposal area as discussed in Section 2.4. An alternative source of material is available at the existing Teichert quarry located south of Axis 2 (Figure 2-3). This material would also require quarrying and processing to produce suitable aggregate.

For the conceptual RCC dam layout, approximately 75,000 tons of cement and 75,000 tons of fly ash would be needed to produce the required volume of RCC. The cement and fly ash would be imported and trucked to the RCC batch plant. Over an estimated 12-month RCC placement period (see Section 4.2), this would necessitate importing a combined total amount of about 570 tons per day of cement and fly ash. This hauling could potentially be limited to Monday through Friday during daylight hours if necessary. In that case, about eight truck loads per day would be required, at about 80 tons per load.

The RCC would be mixed in an on-site batch plant, transported to the dam with a conveyor system, placed in 12-inch-thick lifts, and compacted with 10-ton smooth drum vibratory rollers. For estimating purposes, the cement and fly ash content was assumed to be 150 lbs/cy each, for 300 lbs/cy total. It was assumed that the RCC would be faced with conventional concrete zones placed at the same time as the RCC placement. Grout enriched RCC and other alternative facing methods should be considered further during final design.

RCC would not be placed during rainy weather. During hot weather, RCC placement may be limited to night-time placements or the aggregates may need to be cooled for mixing to stay below maximum allowable temperature requirements. This can be achieved by shading, water spraying, and/or by liquid nitrogen injection.

2.4 Conceptual Layout of Site Construction Plan

A conceptual site layout for RCC dam construction is shown on Figure 2-3. This figure shows the assumed rock borrow area, RCC and conventional concrete batch plant areas, disposal area, and staging areas. For the RCC dam alternative, approximately 1.4 million cubic yards of excavated materials would need to be wasted in the disposal area (based on bulked volume in-place in the disposal area).

Figure 2-3 shows conceptual locations for the main construction site features, including approximate areas in acres for each. These include the rock borrow area, aggregate crushing and screening plant, disposal area, RCC batch plant, conventional concrete batch plant, and the staging area. The staging area would contain the contractor and construction management offices, site geotechnical and RCC/concrete laboratory, fuel depot, and equipment laydown and storage areas. The conceptual locations of the site features were developed based on access and proximity to the dam sites and utilization of relatively flat topographical areas.

Conceptual layouts of the main on-site access routes are also shown on Figure 2-3. Two-lane all-weather road access will be needed from the aggregate crushing and screening plant area to the RCC batch plant site on the right abutment of the dam. This would consist of a haul road along the north rim of the river canyon. Access from the rock borrow area to the disposal area would necessitate a temporary bridge or culvert crossing over the Bear River to the disposal area, similar to the existing crossing providing access to the Teichert quarry downstream. Additional construction routes and permanent access routes are not shown on Figure 2-3.

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3 Concrete Faced Rockfill Dam

Conceptual-level designs were developed to illustrate the general arrangement and the main features of the CFR dam type. The dam layouts and assumed depths of foundation excavation are based on the results of the Phase II geotechnical investigation (AECOM, 2016). Development of more detailed designs is not warranted at this stage and so was not included in the scope of work. Significant geotechnical engineering and design analyses will be needed in future phases of work to develop and refine the design layouts, dimensions, and sizes of the various project facilities.

The conceptual plan and section of the CFR dam are shown on Figure 3-1 and Figure 3-2. The spillway profile is shown on Figure 3-3. For a dam crest at approximately elevation 1875 to 1878 feet, the length of Axis 2 would be about 1800 feet. The length of Axis 6 would be about 1600 feet.

3.1 Dam Foundation Treatment

Foundation treatment for a CFR dam would be divided into two areas, the plinth and the rockfill shell. The plinth connects the concrete facing to the foundation, and includes a non-structural water-stopped joint, referred to as the perimeter joint, between the plinth and the facing. The perimeter joint location is shown on Figure 3-2. The plinth would also serve as the platform and cap for the foundation curtain grouting and would be anchored into rock with grouted steel dowels to resist uplift pressures. The approximate width of the plinth would about 25 to 30 feet (equivalent to about 8 to 10% of the hydraulic head). The plinth would need to be founded on slightly weathered to fresh, hard, groutable rock.

Based on the available investigation data, the foundation excavation depths for the plinth could be up to about 100 feet in the abutment areas of both dam axis locations. The average excavation depth is estimated to be about 60 to 70 feet. Shallower excavation depths are anticipated in the river channel areas based on outcrop observations. Additional geotechnical investigations are needed in all areas to better define the necessary excavation depths.

For the area of the plinth foundation and a distance of about 50 to 100 feet downstream of the plinth, foundation treatment would be required including cleaning for geologic mapping, final foundation cleaning prior to plinth construction, surface preparation (i.e., dental excavation of joints and shear zones and concrete), and backfill concrete.

The foundation for the rockfill zones would generally require moderately weathered or better rock conditions. Based on the Phase II Report (AECOM, 2016), the rockfill foundation excavation depths in the abutments would be up to about 75 feet at Axis 2 (averaging about 30 feet) and up to 30 feet at Axis 6 (averaging about 15 feet). River channel excavation depths are expected to be less than the abutments, on average.

Grouting would be needed to control seepage through the foundation rock. Considering the maximum reservoir depth of about 255 feet and the hydraulic conductivity data presented in the Phase II Report, the necessary grout curtain depths could range from about 100 to 200 feet below the plinth level. For estimating purposes, the average depth was assumed to be 150 feet, with two curtains composed of holes angled in opposing directions to more effectively intersect the near-vertical rock discontinuities prevalent at the site. In addition to the main curtain, the conceptual design layout includes two additional rows of 50-foot-deep grout holes, one on each side the main curtain, to treat a wider zone of fractured rock. These exterior grout holes would also be drilled from the plinth.

3.2 Conceptual Layout of Dam and Appurtenant Structures

The conceptual plan and section of the CFR dam are shown on Figures 3-1 and 3-2. The conceptual cross section includes upstream and downstream slopes of 1.5H:1V and a 30-foot wide crest with a parapet wall. For estimating purposes, it was assumed that the dam would be constructed in two stages. The first stage would be constructed to an elevation that can be constructed in one year, and would be protected by a temporary cofferdam and diversion conduit. Once completed to a sufficient height, the first stage dam would replace the temporary cofferdam to provide a greater level of flood-holding and diversion capacity through the outlet tunnel.

To provide for a well-compacted upstream slope, concrete slip-formed curbs would be placed at the upstream edge of Zone 2 (see Figure 3-2). The Zone 2 bedding material would be placed and compacted up to the concrete curbs. The concrete face would range from 1-foot thick at the top to about 1.5 feet thick at the bottom. The face would be slip formed in vertical panels, 40 to 60 feet wide. Details to be developed during design include facing reinforcement and waterstop details at the joints between the facing panels and along the perimeter joint with the plinth.

For both axis locations, the most efficient spillway location for a CFR dam appears to be the right abutment, because this site offers a shorter overall chute length than the left abutment location. A conceptual layout of the spillway is shown in plan view on Figure 3-2 and in profile on Figure 3-3. The total length of the spillway including the approach channel, chute and stilling basin would be about 1900 feet long for Axis 6. For Axis 2, the spillway would be about 1600 feet long and could include a side channel crest control structure.

The spillway excavation is expected to yield usable quantities of rockfill materials suitable for Zones 4A and 4B. The spillway would include a reinforced concrete slab and walls anchored into the rock foundation to resist hydrostatic uplift forces. Drains behind the walls and under the slab would also be included to control uplift pressures.

The outlet conduit for a CFR dam would be located in a tunnel, which would most likely be driven through the right abutment (Figure 3-2). At either dam axis location, it is assumed that the tunnel would be excavated by drilling and blasting through the basalt bedrock. The conceptual layout for the outlet tunnel at Axis 2 is about 1700 feet long and at Axis 6 it is about 1500 feet long. For estimating purposes, the excavated tunnel diameter was assumed to be about 24 feet to provide sufficient capacity for diversion during construction. The initial ground support for the tunnel would most likely include shotcrete and rock bolts.

The conceptual layout for the permanent reservoir outlet includes a single low-level intake, located at the upstream end of the tunnel. A single 8-foot diameter steel outlet pipe would be located within the tunnel for control of release flows. The design would need to include a control gate (or gates) at the upstream end of the tunnel as well as an energy-dissipating release valve at the downstream end of the outlet conduit. The outlet conduit would be fitted with a bifurcation and a blind flange for potential future addition of a power plant at the downstream toe of the dam.

3.3 Construction Materials

Rockfill is expected to be available from an on-site rock borrow area. For estimating purposes, it was assumed that the on-site rock borrow area would provide materials as indicated in Table 3-1. Rockfill (Zones 4A and 4B in Figure 3-2) is typically placed in 3-foot-thick loose lifts and compacted by heavy (12-ton) vibratory rollers. Lesser quality (weathered) rock can also be utilized in the dam, in a separate downstream shell zone as shown on Figure 3-2. A processed sand and gravel layer (Zone 2) is required to provide a smooth surface on which to construct the concrete facing and to help control any seepage through the joints in the facing. A zone of finer rockfill (Zone 3) is included to separate the sand and gravel transition zone from the coarser rockfill zone. Zones 2 and 3 would also be placed on the foundation upstream of the dam axis to provide for filtering of weathered rock materials. Special filter zones could also be required to prevent piping/erosion of weathered rock foundation materials and joint fillings into the overlying rockfill.

Table 3-1. Rock Materials for CFR Dam Zones

Zone No.*	Description	Material	Lift Thickness (in.)
2	Bedding Layer under Concrete Face	Crushed and screened to sand and gravel sizes	12-18
3	Fine Rockfill	Grizzlied fine rockfill	12-18
4A	Rockfill	Pit-run rockfill	24-36
4B	Weathered Rockfill	Pit-run rockfill	24 - 36

*Refer to Figure 3-2 for zoning.

In order to produce the necessary quality of rockfill materials, the rock borrow area would need to be stripped of overburden and highly weathered rock. The wasted material would be placed in the on-site disposal area as described below. The underlying moderately weathered to fresh rock would be drilled and blasted to produce rockfill for Zones 4A and 4B. Slightly weathered to fresh rock would be crushed and screened to produce Zone 2 material. Zone 3 material would be produced by running the pit-run rock through a grizzly screen or similar device to separate out oversize material and produce the required maximum size material. An alternative source of material is available at the existing Teichert quarry located south of Axis 2 (Figure 3-4). This material would also require quarrying and some processing to produce the needed gradations of rockfill.

Cement and fly ash would need to be imported for the concrete structures and concrete facing. For the CFR dam alternative, approximately 20,000 tons of cement and fly ash would be required. Most of the cement and fly ash would be needed for the construction of the concrete facing and the spillway. These are expected to take a combined duration of about 24 months to construct (see Section 4.3). Over this 24-month duration, roughly 17,000 tons of cement and fly ash would need to be hauled to the site. This equates to about 700 tons or about nine loads per month (assuming 80-ton haul units). An average of about two loads per week would be sufficient to meet the need.

3.4 Conceptual Layout of Site Construction Plan

A conceptual site layout for a CFR dam construction operation is shown on Figure 3-4. This figure shows the assumed rock borrow area, disposal area, concrete batch plant and staging areas. For the CFR dam alternative, approximately 2.8 million cubic yards of excavated materials would need to be wasted in the disposal area (based on bulked volume in-place in the disposal area). This volume is about double the estimated disposal volume for the RCC dam due to greater expected excavation volume for the CFR dam.

Figure 3-4 shows conceptual locations for the main construction site features, including approximate areas in acres for each. These include the rock borrow area, aggregate crushing and screening plant, disposal area, conventional concrete batch plant, and staging area. The staging area would contain the contractor and construction management offices, site geotechnical and concrete laboratory, fuel depot, and equipment laydown and storage areas. The conceptual locations of the site features were developed based on access and proximity to the dam sites and utilization of relatively flat topographical areas.

Conceptual layouts of the main on-site access routes are also shown on Figure 3-4. Two-lane all-weather road access will be needed from the aggregate crushing and screening plant area to the concrete batch plant site on the right abutment of the dam. This would consist of a haul road along the north rim of the river canyon. Access from the rock borrow area to the disposal area would necessitate a temporary bridge or culvert crossing over the Bear River to the disposal area, similar to the existing crossing providing access to the Teichert quarry downstream. Additional construction routes and permanent access routes are not shown on Figure 3-4.

4 Construction Schedules

4.1 General

Figures 4-1 and 4-2 present simplified conceptual construction schedules for the RCC and CFR dam types, respectively. The schedules provide a means to comparatively assess the relative logistics and construction durations of the activities for each dam type.

Many variables were considered in preparation of the construction schedules including productivities (which depend on crew sizes, equipment spreads, access conditions, etc.), approaches to sequencing of activities, number of shifts per day and days per work week, and other factors. The resulting construction schedules are approximate, consistent with the conceptual level of the corresponding OPCC's for each dam type.

The schedules were based on the assumption that construction would start in the spring of Year 1 for each dam type. The schedules focus on the major activities most likely to influence the total construction durations. Development of more detailed schedules is not justified at the current level of project design development.

For this conceptual level estimate, durations of construction were estimated for the major work activities based on the work quantities and typical productivity rates. Productivity rates were estimated based on experience on other projects of similar type and magnitude. The overall estimated durations also consider the logical sequence of work activities, accounting for concurrency of activities where appropriate. The following paragraphs summarize general assumptions and average productivity rates used to develop the estimated construction activity durations:

General Assumptions

- No unusual weather delays
- Work performed six days per week, up to two shifts per day
- No overly restrictive constraints on trucking materials to the site

RCC Dam

- Dam foundation excavation: 13,000 cy per week
- Foundation grouting: 3,000 sf per week
- RCC construction: 18,000 cy per week

CFR Dam

- Dam Foundation excavation: 20,000 cy per week
- Foundation grouting: 3,000 sf per week
- Tunnel driving: 60 lf per week
- Rockfill embankment construction: 30,000 cy per week
- Concrete facing: 1,000 sy per week (2 shifts per day)

4.2 RCC Dam

The conceptual construction schedule for the RCC dam alternative is presented in Figure 4-1. The critical path is expected to go through excavation of the right abutment in preparation for diversion. RCC would then be placed in the lower right abutment along with the diversion conduit (see Section 2.2). After the river has been diverted through the conduit in the lower right abutment RCC block, the critical path will continue through excavation in the lower left abutment and river channel area. RCC would then be placed in the lower left abutment and channel area. Once up to the top of the diversion, RCC placement would continue to the top of the dam.

For estimating purposes, key elements of the schedule were assumed to include the following:

Mobilization would begin early in Year 1. Construction work would begin in Year 1 primarily on the right side of the river channel in preparation for diversion by mid-April of Year 2. Critical work includes site preparation including rock borrow area development for aggregate production, setting up the plant for RCC aggregate production, beginning foundation excavation in the right abutment, placing levelling concrete, and installing the diversion pipe in the lower right abutment. The excavation in the right abutment would need to be completed prior to placing levelling concrete and installing the diversion pipe at the end of Year 1.

In Year 2, the river diversion facilities would need to be in place by about April. This would allow excavation of the lower left abutment and center portion of the channel to be completed in preparation for RCC placement. Once the RCC placement reaches the same elevation as the diversion pipe, RCC and facing concrete construction would then proceed across the full width of the dam in continuous lifts all the way up to the crest. The total estimated duration for RCC and concrete facing construction is estimated at 12 months, based on an average RCC placement rate of about 3000 cy per day, working 6 days per week. Concrete for the spillway and stilling basin walls and the outlet structure would be placed in Year 3 after the RCC is placed.

Foundation grouting for the RCC dam will be designed so that it can be completed off of the critical path for construction. Grouting on the abutments would be conducted following excavation but prior to final foundation cleaning and preparation. Grouting beneath the central portion of the dam in the river channel area would be performed from inside the gallery within the dam.

Allowing for 3 months of float to account for adverse weather during the winter months, it is estimated that the RCC dam could be constructed in about 2½ years.

4.3 CFR Dam

The conceptual construction schedule for the CFR dam alternative is presented in Figure 4-2. The critical path is expected to go through the tunnel excavation for river diversion. After river diversion, the critical path will be through the excavation in the valley bottom followed by rockfill placement in two stages, and completion of the concrete facing and crest of the dam.

For estimating purposes, key elements of the schedule were assumed to include the following:

Mobilization would begin early in Year 1. Construction work would begin in Year 1 with the diversion tunnel excavation driven from the downstream end, with a single heading. Allowing for portal development and stabilization, and assuming initial ground support primarily consisting of shotcrete and rock bolts, the tunnel construction work is estimated to take about 30 weeks. This work is on the critical path to have river diversion facilities in place by April of Year 2. Construction of the upstream cofferdam and intake to the diversion tunnel also must be complete by that time. Embankment and plinth foundation excavation would start at both abutments in Year 1.

Rock borrow development and stockpiling of processed Zones 2 and 3 materials would also need to start in Year 1, to meet the material demand for embankment construction in Year 2. Once the river diversion facilities are in place early in Year 2, the valley bottom foundation excavation would be completed and the Stage 1 embankment construction would start. Plinth construction would start soon thereafter. Stage 2 embankment construction would start at the end of Year 2. Spillway chute excavation and concrete construction would start in Year 2. Suitable rock from the spillway excavation would be routed to the fill placement for use in Zones 4A and 4B. Unsuitable rock from the dam foundation excavation and the spillway excavation would be hauled to the disposal area. Since rockfill construction is relatively insensitive to adverse weather conditions, placement could continue through most of the winter season.

Foundation grouting would follow after plinth construction starting at the beginning of Year 3. The plinth construction would lead the grouting by about 3 months. Construction of the concrete facing would begin around the middle of Year 3, once the Stage 2 embankment is roughly half complete.

When the embankment and concrete facing construction is completed, the crest would be completed in Year 4 with construction of the parapet wall and the dam crest embankment fill.

In total, the estimated duration for CFR dam construction is about 4 years.

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5 Construction Cost Estimates

5.1 General

This section describes the cost estimating methodology and basis for development of comparative conceptual-level opinions of probable construction cost (OPCC) for both the RCC and CFR dam types, at both Axes 2 and 6.

5.2 Project Features

The OPCC's were developed by dividing the project into the following major features or cost categories for each dam type:

RCC Dam:

- Mobilization and site development
- River diversion and outlet conduit
- Foundation excavation and preparation
- RCC and facing concrete
- Spillway
- Outlet and intake structures
- Instrumentation and SCADA

CFR Dam:

- Mobilization and site development
- River diversion and outlet tunnel
- Foundation excavation and preparation
- Rockfill embankment
- Concrete face, plinth and parapet
- Spillway
- Outlet and intake structures
- Instrumentation and SCADA

The following sections describe the major cost components and estimating assumptions applicable to each of the above features and construction activities.

5.2.1 Mobilization and Site Development

Mobilization expenses include contract administration, temporary facilities (e.g. site offices and materials laboratory), transporting equipment to the site, and contract execution costs. Expenses associated with contract administration include preparation of submittals, coordination and meetings, insurance, taxes, and bonds. Expenses associated with temporary facilities include costs to furnish and set up temporary facilities, utilities, and roads at the site preparatory to undertaking construction work. Also included are costs for transporting construction equipment to site, unloading and assembly of the equipment, and breakdown and load out at the end of construction. Expenses associated with contract execution include layout and survey and contract closeout. For estimating purposes, the cost of mobilization was assumed to be 10% of the total of the construction line items.

Site development includes construction and improvement of existing access roads, layout and construction of new haul roads, environmental protection, erosion and sediment control, stripping of surface soils prior to excavation, and borrow area development.

5.2.2 River Diversion and Outlet Conduit

The diversion conduit for the RCC dam is embedded within the body of the dam at the right abutment. The CFR dam requires a diversion tunnel drilled and blasted through the abutment, supported with shotcrete and rock bolts. The cost for an 8-foot diameter steel outlet pipe and control valves is included for both the CFR and RCC dam alternatives.

5.2.3 Dam Foundation Excavation and Preparation

The dam foundation work will include excavating, loading and hauling the materials that are removed from the foundation and abutments to the disposal area shown on Figures 2-3 and 3-4. This will be followed by foundation clean-up; preparation; leveling concrete for the RCC foundation; dewatering and groundwater control; and setting up, mixing and injecting grout for the grout curtain. Construction pricing assumptions for the dam foundation excavation and preparation work include the following:

- Foundation excavation rates were priced per cubic yard assuming large haul trucks and loader/excavator equipment spreads. The developed unit prices were compared with historical and database unit prices for consistency.
- The RCC dam foundation excavation was assumed to require 50% drill and blast and 50% mechanical excavation. For the CFR dam, the foundation areas for the rockfill zones were assumed to require 75% mechanical excavation and 25% drill and blast. The plinth excavation areas were assumed to require 50% mechanical excavation and 50% drill and blast.
- Cleaning and preparation of the foundation surfaces were estimated per square yard using historical and database unit prices.
- Costs for the grout curtain construction were estimated based on the lineal feet of 150-foot-deep grout holes, the number of water tests, and the estimated volume of grout injected into the drill holes (by dry weight of cement).

5.2.4 CFR Dam Embankment

The rockfill embankment construction cost includes materials, labor, and equipment components. The estimated costs for Zone 4A and 4B rockfill materials include drill and blast excavation, loading, hauling, placing, and compaction of rockfill material obtained from the on-site rock borrow area and the spillway/stilling basin excavations. Estimated costs for excavation in the rock borrow area and the spillway/stilling basin are based on production drilling and blasting in basalt. Crushing and screening costs are included for the Zone 2 bedding material beneath the concrete facing. Costs for the Zone 3 transition materials include grizzly screening of the rockfill to remove larger sized rocks. Estimated costs for Zones 2 and 3 include transporting and stockpiling the materials, loading from the stockpiles, hauling, placing, and compacting in the dam. The assumed placement lift thicknesses for each material zone are indicated in Table 3-1. Compaction would be performed with heavy smooth drum vibratory rollers.

5.2.5 CFR Dam Concrete Facing, Plinth and Parapet

The concrete facing for the CFR dam includes slip-formed concrete in 50-foot wide strips, with reinforcement and waterstops. The concrete would be mixed and batched at an on-site plant and conveyed to the dam with cranes and/or conveyor systems.

5.2.6 RCC Dam and Concrete Facing

The estimated cost for RCC construction assumes that the concrete aggregate will be obtained from the on-site rock borrow area shown on Figure 2-3. The aggregate cost includes drill and blast excavation at the quarry, crushing and screening, transporting and placing in stockpiles, loading from stockpiles, and hauling to the RCC batch plant at the top of the right abutment of the dam. The RCC cost also includes mixing the aggregate, cement and fly ash, transporting the RCC mix to the dam by conveyor, spreading and leveling the RCC to 12-inch thick lifts, compacting with heavy smooth drum vibratory rollers. The estimate assumes the conventional concrete facing/grout enriched RCC zones will be formed and placed simultaneously with the RCC placement and compaction.

5.2.7 Spillway

The spillway construction costs include rock excavation (with both drill and blast and mechanical methods), anchors, subdrainage facilities, and structural concrete placement for the base slab and sidewalls. Historical database unit prices were used to estimate the cost of the spillway structural concrete walls and slab.

5.2.8 Outlet and Intake Structures

The outlet works cost components include facilities to provide diversion flows during construction as well as in-stream flow releases during future operation. In addition to the steel conduit, major components were assumed to include the intake trashrack, control gates and valves, and associated electrical and mechanical systems. Detailed conceptual design layouts were not developed for the outlet works structure, so costs were estimated from experience on other similar projects.

5.2.9 Instrumentation and SCADA

Both dam types would include instrumentation to monitor dam performance such as piezometers, survey monuments, inclinometers, and accelerographs. An automated data acquisition system (ADAS) is also assumed, to transmit the data to a central receiving location. Both dam types are also assumed to include supervisory control and data acquisition (SCADA) systems to operate the outlet works gates and valves. The estimates include cost allowances for these systems based on experience on other similar projects.

5.3 Use of Local Quarry Materials

As mentioned in Sections 2.3 and 3.3, the existing commercial quarry located south of the dam site could serve as an alternate source for RCC aggregate, concrete aggregate, or rockfill material. Preliminary inquiries indicate that this quarry could potentially produce the quantities of rock that would be required by the project (Teichert, personal communication, 2016). This material source could be cost-competitive with materials obtained from the on-site rock borrow area. Similar to the on-site rock borrow area, extensive additional quarry development (including stripping and access road construction) and stockpiling would be needed to meet the material demand within the contract schedule. Further consideration and comparison of the costs of using the commercial quarry versus on-site rock borrow sources is recommended as part of subsequent project studies. The comparison should include evaluation of relative risk, cost, permitting, and environmental considerations.

5.4 Quantity Estimates

The major project features were identified and broken down into separate work items for which quantities were then estimated for construction costing. The quantity estimates are dependent on the level of conceptual design detail as discussed in Sections 2 and 3. At the conceptual design level, the focus is on major features and related items of work. For development of the OPCC, the earthwork quantities (foundation excavation, rockfill embankment and RCC) were calculated from the estimated conceptual design cross sections using average end area methods for sections cut on 200 foot spacings. The quantities represent in-place volumes, either in-situ or in-dam, as appropriate. Quantities for hydraulic structures were estimated based on the layouts shown in the conceptual design figures presented in Sections 2 and 3.

5.5 Pricing

The conceptual level OPCC's presented in this technical memorandum are generally consistent with Class 4 estimates, which are described by the Association for the Advancement of Cost Engineering (AACE, 2005) as follows:

> *"Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 15% complete."*
>
> *"Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side."*

Accordingly, the conceptual level Class 4 OPCC's presented in this technical memorandum are expected to fall within a range from 30% below to 30% above the actual construction cost for a given alternative.

Quantities were estimated for major activities and items based on conceptual layouts, and costs were estimated based on historical and database unit prices. Other elements not detailed in the conceptual designs were priced as lump sum allowances in the estimated construction cost based on experience on similar projects.

Construction costs from similar projects were considered in developing the estimates, including both projects under construction and already completed. Some preliminary contacts with material suppliers and contractors were also utilized to develop the OPCC. Conceptual pricing for project features is based on the quantity estimates for each item identified in each feature. An experienced cost estimator with construction and hard dollar contract bid experience prepared the OPCC, using logic, methods, and procedures that are typical for the heavy civil construction industry.

The OPCC is presented in current (2016) dollars and is based on the assumption that the project will be bid in an open, competitive procurement process utilizing industry standard specifications.

Construction costs for the features and items were estimated by developing unit costs and multiplying these by the estimated quantities. Unit prices in the OPCC were based on recently completed similar work and checked using the labor and equipment rates from the U.S. Army Corps of Engineers (USACE) Region VII Construction Equipment Ownership and Operation Expense Schedule (USACE, 2014). Vendor quotes were used for materials obtained off-site. Concrete costs were based on the use of an on-site concrete batch plant.

Direct and indirect costs were estimated for each of the features and items under the major categories of the project. Cost breakdowns are presented in Appendix A for the RCC dam and Appendix B for the CFR dam. The direct costs include the quantity of work, labor, equipment, material and other costs estimated for each item. The general requirements of the contract (supervision and office staff, offices, utilities, etc.) are estimated to be about 15% of the direct cost. The general requirements are divided into mobilization and an indirect cost distributed among the items of each feature of the project. Mobilization was assumed to be approximately 10% and the indirect cost at 15%. The contractor's markup includes general and administrative costs (G&A) and profit. G&A covers home office overhead cost and typically is in the range of 3 to 5% of the total direct construction cost. G&A costs were assumed to comprise 5% of the total estimated direct construction cost and profit was assumed to be 10% of the total estimated direct construction cost. Prevailing wage (Davis-Bacon) rates were used to estimate labor costs. The direct, indirect, and markup costs were added together to arrive at total and unit costs.

All pricing assumes that the contractor is qualified and experienced in the construction of large engineered concrete or rockfill embankment dams. The estimates also assume that the contractor will calculate and offer construction pricing from an open and competitive approach to equipment production and material pricing.

5.6 Design Contingency

The OPCC's presented in this technical memorandum include items, quantities, requirements and constraints that have not been fully identified, or else are not fully investigated or designed. In later stages of design, the scope of the project also tends to expand as more detail is developed and as regulatory agencies undertake more detailed reviews. To account for the items that have not yet been fully developed, a design contingency allowance has been included in each OPCC.

The amount of design contingency reflects the degree of risk associated with uncertainties, particularly with respect to geotechnical conditions, as well as the completeness of the design detail for the major categories. The design contingency is based on, and added to, the subtotal of construction costs because it represents an unknown portion of the total estimated construction cost. The recommended design contingency normally decreases as the project design advances, more information becomes available, project requirements become better defined, and more design detail is captured in the subtotal of construction costs.

The OPCC's presented in this technical memorandum each include a 30% design contingency, incorporated as an integral part of the estimated construction cost to accommodate those features and items of the work that cannot yet be fully assessed due to the conceptual level of the current design alternatives. This level of contingency is consistent with the range indicated for an AACE Class 4 cost estimate (AACE, 2005). In the OPCC's presented in Appendices A and B, the 30% overall contingency is distributed to the various line items to reflect uncertainty in each item.

5.7 Allowances and Exclusions

In order to evaluate potential project costs, allowances for design engineering, construction management, and engineering services during construction should be considered. These can be approximated as percentages of the total construction cost, based on recent experience with similar large infrastructure projects in California. Typical ranges for these costs are as follows, depending in large part on the specific project details and total costs:

- Design engineering: 5 to 8%
- Construction management and engineering services during construction: 8 to 10%

Other potential project costs not directly related to the dam construction are also excluded from the OPCC's presented in this technical memorandum. These include NID's project management and administration costs, reservoir clearing, land acquisition, legal, permitting, environmental review and documentation, and mitigation.

In addition, potential construction cost growth due to change orders is not included in this OPCC. Typical budgetary allowances for such costs can amount to 10% to 15% of the total construction cost, particularly for projects that involve relatively large amounts of geotechnical uncertainty.

5.8 Opinion of Probable Construction Cost

The conceptual design level OPCC's for the RCC and CFR dam alternatives are summarized in Tables 5-1 and 5-2, respectively. The OPCC details are presented in Appendix A for the RCC dam alternatives and in Appendix B for the CFR dam alternatives. Breakdowns are presented for each of the categories and features described in Section 5.2. The recommended design contingency is distributed to each line item of the OPCC.

Although the project construction is anticipated to occur a number of years in the future, the OPCC's presented in this technical memorandum were prepared in 2016 dollars. No attempt was made to predict future escalation of construction costs. Potential issues that could impact future construction costs include changes in the construction industry bidding climate at the time the work is actually bid, increases in prevailing wage rates, and unpredictable fluctuations in material, equipment, and/or fuel prices.

Table 5-1. Opinion of Probable Construction Cost Summary - Roller Compacted Concrete Dam

Category	Description	Axis 2		Axis 6	
		Category Total	Category % of Total	Category Total	Category % of Total
A	Mobilization & Site Development	$23,473,000	9.1%	$25,368,000	8.9%
B	Diversion & Outlet	$ 3,607,000	1.4%	$ 3,607,000	1.3%
C	Dam Foundation	$58,787,000	22.7%	$53,379,000	18.8%
D	RCC & Facing Concrete	$153,552,000	59.2%	$182,234,000	64.1%
E	Spillway	$10,884,000	4.2%	$10,723,000	3.8%
F	Outlet & Intake Structures	$ 7,775,000	3.0%	$ 7,775,000	2.7%
G	Instrumentation & SCADA	$ 1,125,000	0.4%	$ 1,125,000	0.4%
	Total OPCC	**$259,203,000**	**100.0%**	**$284,210,000**	**100.0%**

Based on the approximate percentages indicated in Section 5.7, the total costs for design engineering, construction management, and engineering services during construction for the RCC dam alternative are estimated to be roughly $30 to $50 million.

Table 5-2. Opinion of Probable Construction Cost Summary - Concrete-Faced Rockfill Dam

Category	Description	Axis 2		Axis 6	
		Category Total	Category % of Total	Category Total	Category % of Total
A	Mobilization & Site Development	$32,075,000	9.5%	$31,019,000	9.5%
B	Diversion & Outlet	$59,190,000	17.4%	$53,070,000	16.3%
C	Dam Foundation	$51,579,000	15.2%	$44,094,000	13.6%
D	Embankment	$44,802,000	13.2%	$47,363,000	14.6%
E	Concrete Face, Plinth & Parapet	$46,331,000	13.7%	$40,752,000	12.5%
F	Spillway	$96,144,000	28.3%	$99,672,000	30.6%
G	Outlet & Intake Structures	$ 7,775,000	2.3%	$ 7,775,000	2.4%
H	Instrumentation & SCADA	$ 1,500,000	0.4%	$ 1,500,000	0.5%
	Total OPCC	**$339,396,000**	**100.0%**	**$325,245,000**	**100.0%**

Based on the approximate percentages indicated in Section 5.7, the total costs for design engineering, construction management, and engineering services during construction for the CFR dam alternative are estimated to be roughly $40 to $60 million.

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6 Summary and Conclusions

This technical memorandum presents an opinion of the probable construction costs (OPCC) for each of the two potential dam types and two site locations currently being considered for the Centennial Reservoir Project. OPCC's were developed for roller compacted concrete (RCC) dam and concrete faced rockfill dam (CFR) alternatives, at each of the two site locations currently being considered, designated as Axis 2 and Axis 6. The OPCC's and conceptual-level design layouts were developed based on the available geotechnical information presented in the Preliminary Geotechnical Investigation, Phase II Report (AECOM, 2016).

This technical memorandum includes the conceptual plans and sections developed for the RCC and CFR dam alternatives, along with conceptual construction site layouts for each of these two dam types. The construction site layouts show the assumed rock borrow area, the RCC and conventional concrete batch plant areas, a disposal area for surplus materials, staging and laydown areas, and potential access road alignments. The OPCC's assume that the on-site rock borrow area contains a sufficient amount of suitable material to produce the needed quantities of rockfill and RCC aggregate.

As part of preparing the OPCC's, conceptual level construction schedules were prepared for each dam type, to provide a comparative assessment of the relative construction durations of the RCC and CFR alternatives. The schedules focus on the major construction activities and provide estimates of the total construction durations based on the current level of project development. The schedules indicate that the RCC dam could potentially be constructed in about 2½ years, and the CFR dam would take about 4 years to construct.

The conceptual-level opinions of probable construction cost presented in this technical memorandum are consistent with Class 4 estimates as described by the Association for the Advancement of Cost Engineering (AACE, 2005). The estimated accuracy range of the OPCC's is from 30% below to 30% above the actual construction cost for a given alternative.

The OPCC's include a 30% design contingency, to accommodate those features and items of the work that have not been defined at the current conceptual level of design development. This level of contingency is consistent with the typical range for an AACE Class 4 cost estimate.

Allowances are suggested for non-construction project costs including design engineering, construction management, and engineering services during construction. Other expected project costs, which are excluded from this OPCC, but should be considered by NID include NID project administration and management, reservoir clearing, land acquisition, legal, permitting, environmental review studies, and mitigation. Potential cost growth during construction due to unexpected changes and unforeseen conditions is also excluded from this OPCC but should be considered in NID's future budget planning for the project.

The relative OPCC's for the RCC and CFR dams, in 2016 dollars, are summarized below in Table 6-1. As indicated, the RCC dam at either axis has a lower OPCC than the CFR dam. The RCC dam at Axis 2 has the lowest OPCC of the alternatives considered. The CFR dam at Axis 2 has the highest OPCC.

The estimated costs for each alternative should be reviewed and updated as needed based on additional data gathered during the upcoming Phase III geotechnical investigation. Further design and engineering work should be carried out to select a preferred dam type and site and refine the conceptual layout. The OPCC's presented in this technical memorandum are expected to change once the dam foundation and rock borrow conditions are further defined.

Table 6-1. Summary of Comparative Construction Costs

Dam/Axis	OPCC	Relative Cost
RCC Dam (Axis 2)	$259M	1.00
RCC Dam (Axis 6)	$284M	1.10
CFR Dam (Axis 2)	$339M	1.31
CFR Dam (Axis 6)	$325M	1.25

In addition to further development of the dam and foundation designs, other important design elements will need to be considered and further developed as the project is advanced. These design elements, which each significantly affect the overall project cost and schedule, include the following:

- The spillway and outlet works hydraulic designs and reservoir operational requirements.
- Diversion and cofferdam design requirements, including expected operations of Rollins Reservoir during construction. Diversion requirements will depend heavily on the dam type, since an RCC dam can normally withstand overtopping during construction but a CFR dam usually cannot.
- Construction material balance will need to be analyzed and confirmed. Material balance diagrams will need to be prepared for all material sources (on-site and off-site) and destinations within the dam and disposal areas. These analyses will assist in determining required volumes of borrow excavation, material disposal, and stockpile storage, and borrow area yield. The results will support development of a more detailed construction schedule estimate and OPCC.

7 References

AECOM, 2016, Centennial Reservoir Project, Preliminary Geotechnical Investigation, Phase II Report – Final, February 9.

American Associated of Civil Engineers International (AACE), 2005, AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. TCM Framework: 7.3 – Cost Estimating and Budgeting, February 2.

Teichert, personal communication, 2016, Telephone conversation, M. Forrest (AECOM) to E. Hernberger (Teichert), April 26.

U.S. Army Corps of Engineers (USACE), 2014, Construction Equipment Ownership and Operation Expense Schedule, Region VII, EP-1110-1-8, Volume 7, April.

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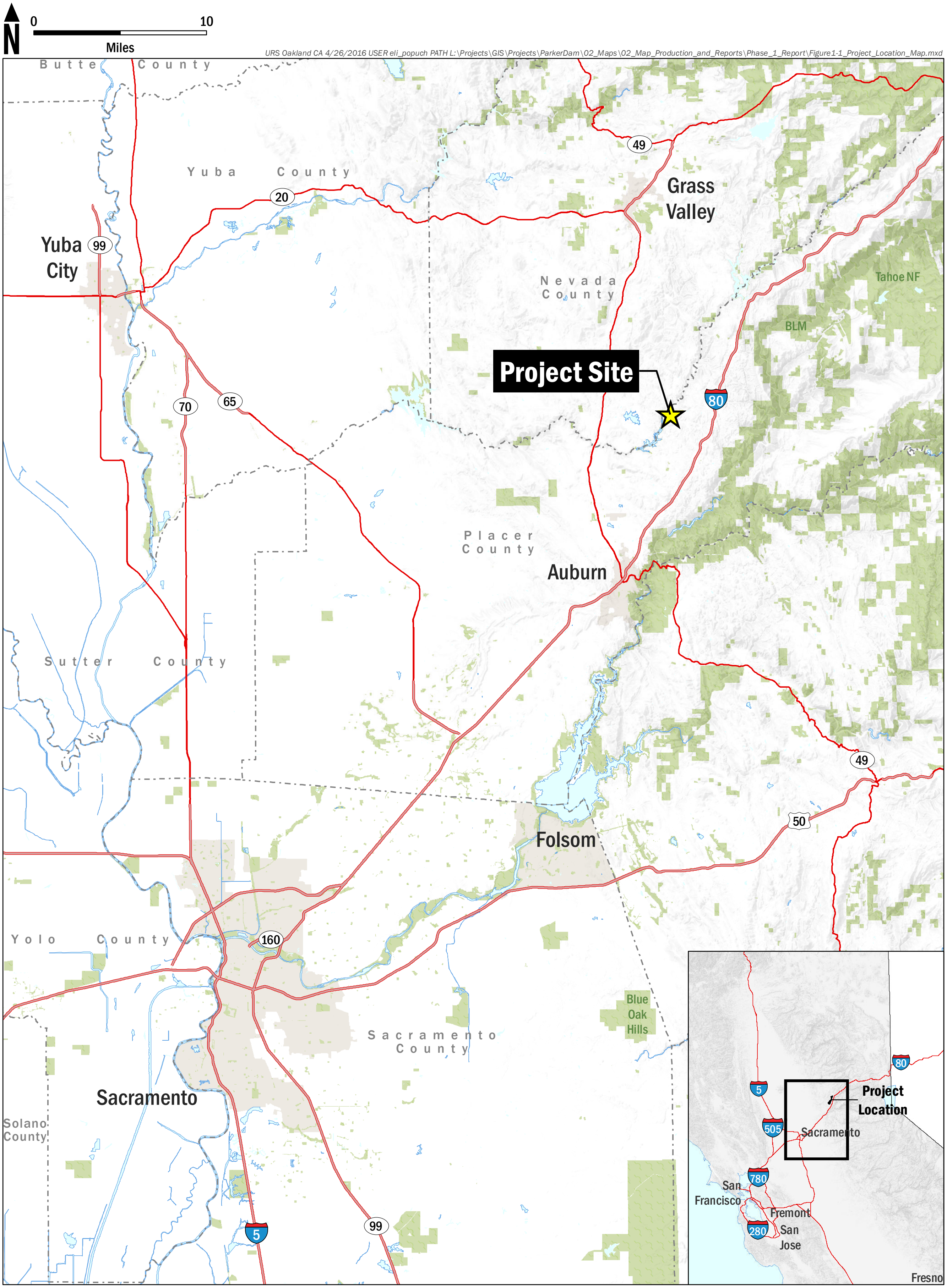
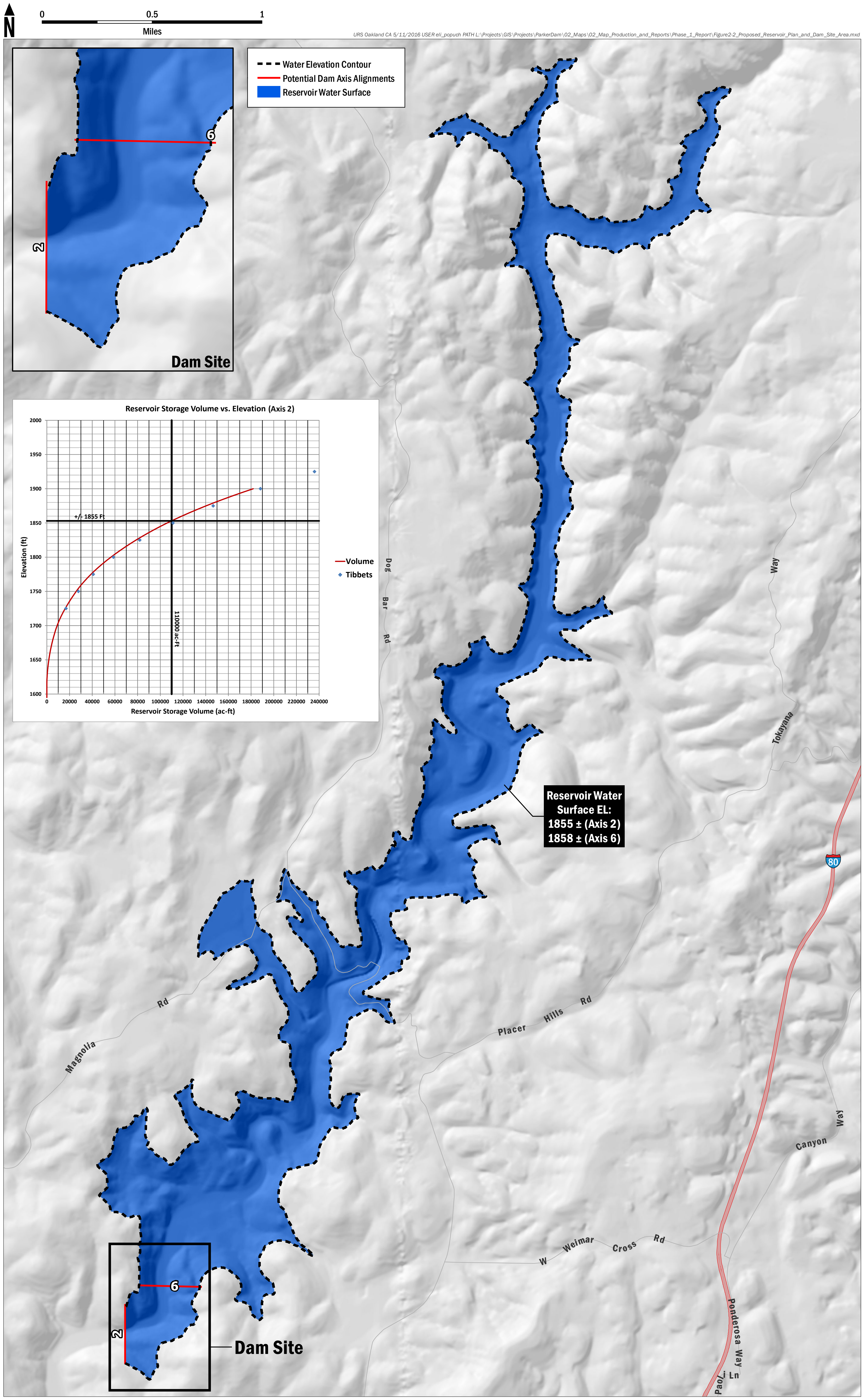


AECOM
Nevada Irrigation District
Centennial Reservoir Project
60488086

FIGURE 1-1
Project Location Map



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Nevada Irrigation Districtt
Centennial Reservoir Project
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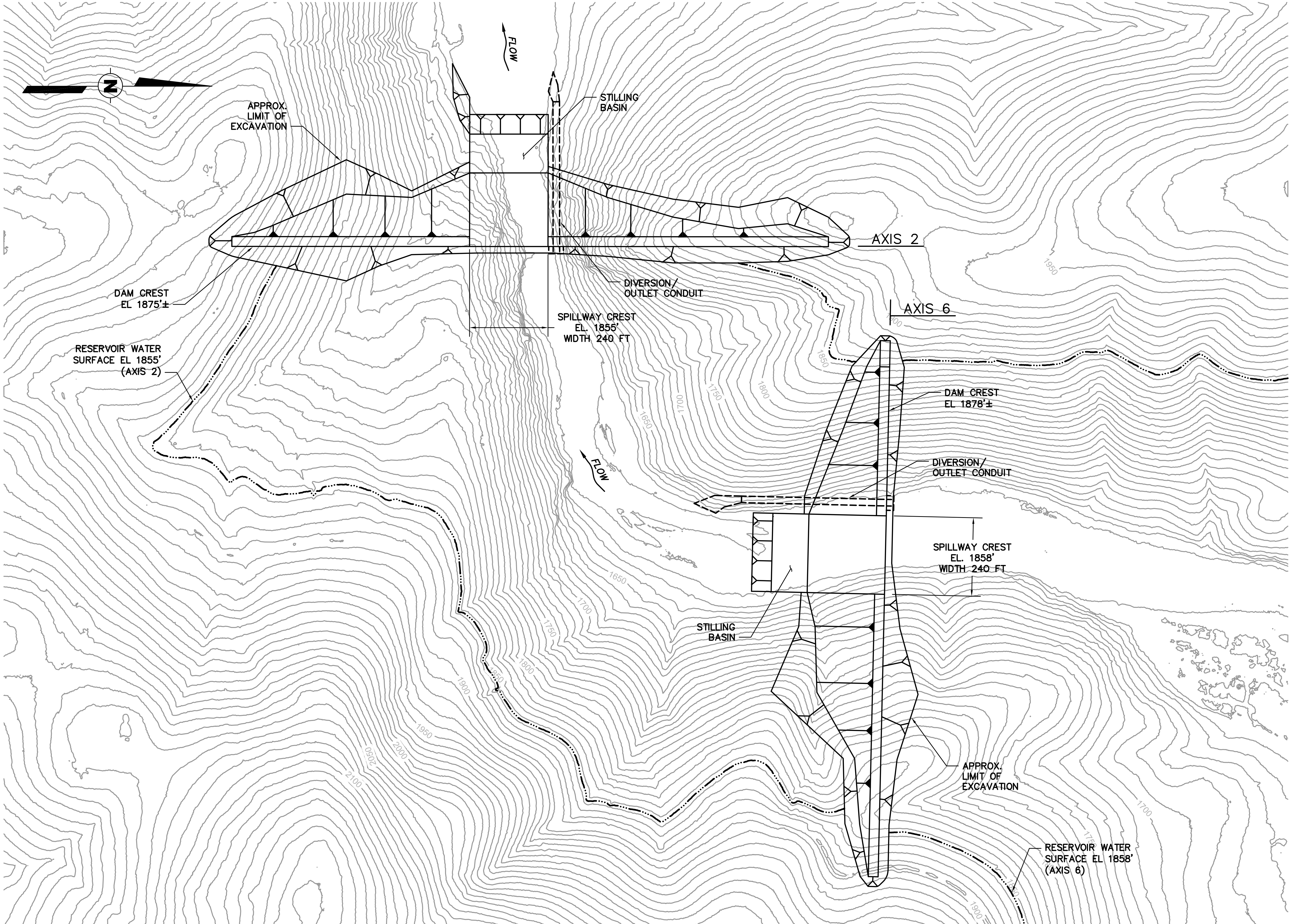
FIGURE 1-2
Proposed Reservoir Plan and Dam Site Area
110,000 Acre Ft Reservoir



0 300 600 Feet

AECOM

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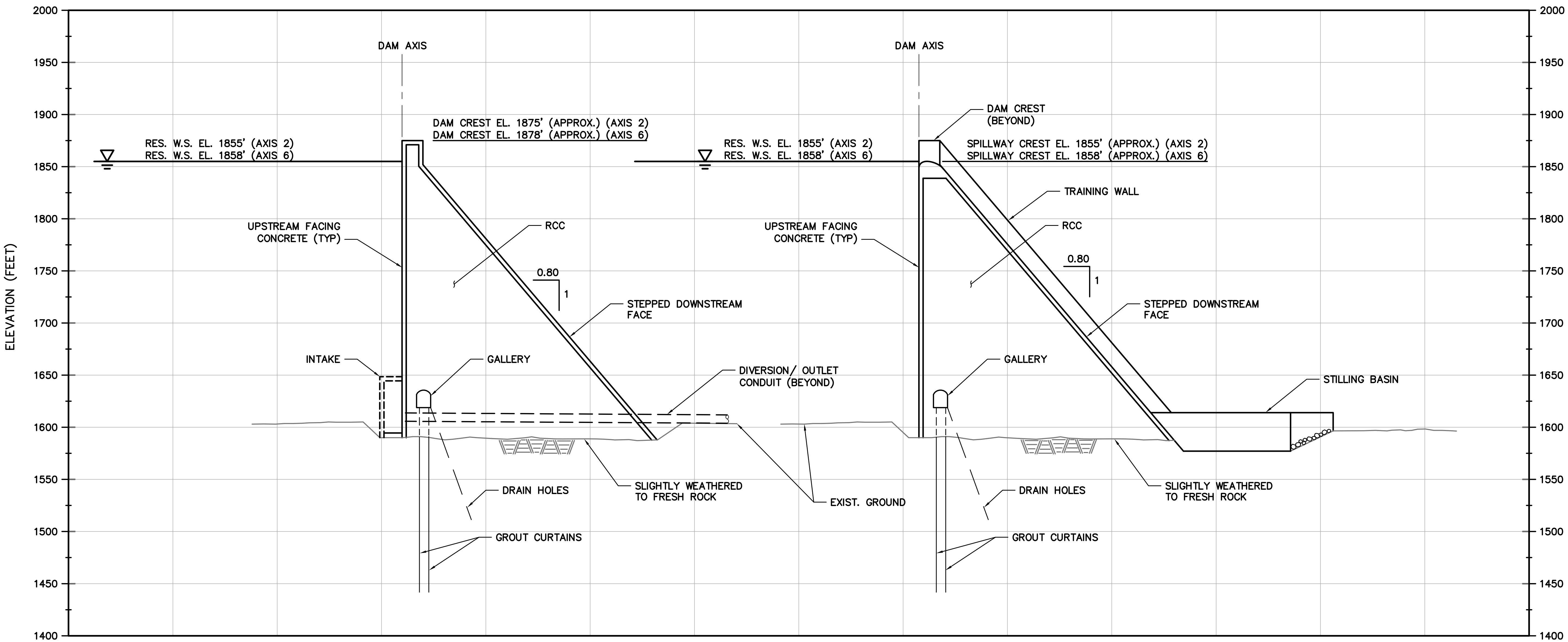
NEVADA IRRIGATION DISTRICT
CENTENNIAL RESERVOIR PROJECT

Roller Compacted Concrete Dam Concept Plan

FIGURE
2-1

Apr 22, 2016 - 3:15pm
L:\Projects\Legacy\IE_Xdrive\x_water\NID Parker Dam\11_Concept Layouts_Proposal Level\CAD\Working\TUFFY\Figure 2-1 (RCC PLAN).dwg

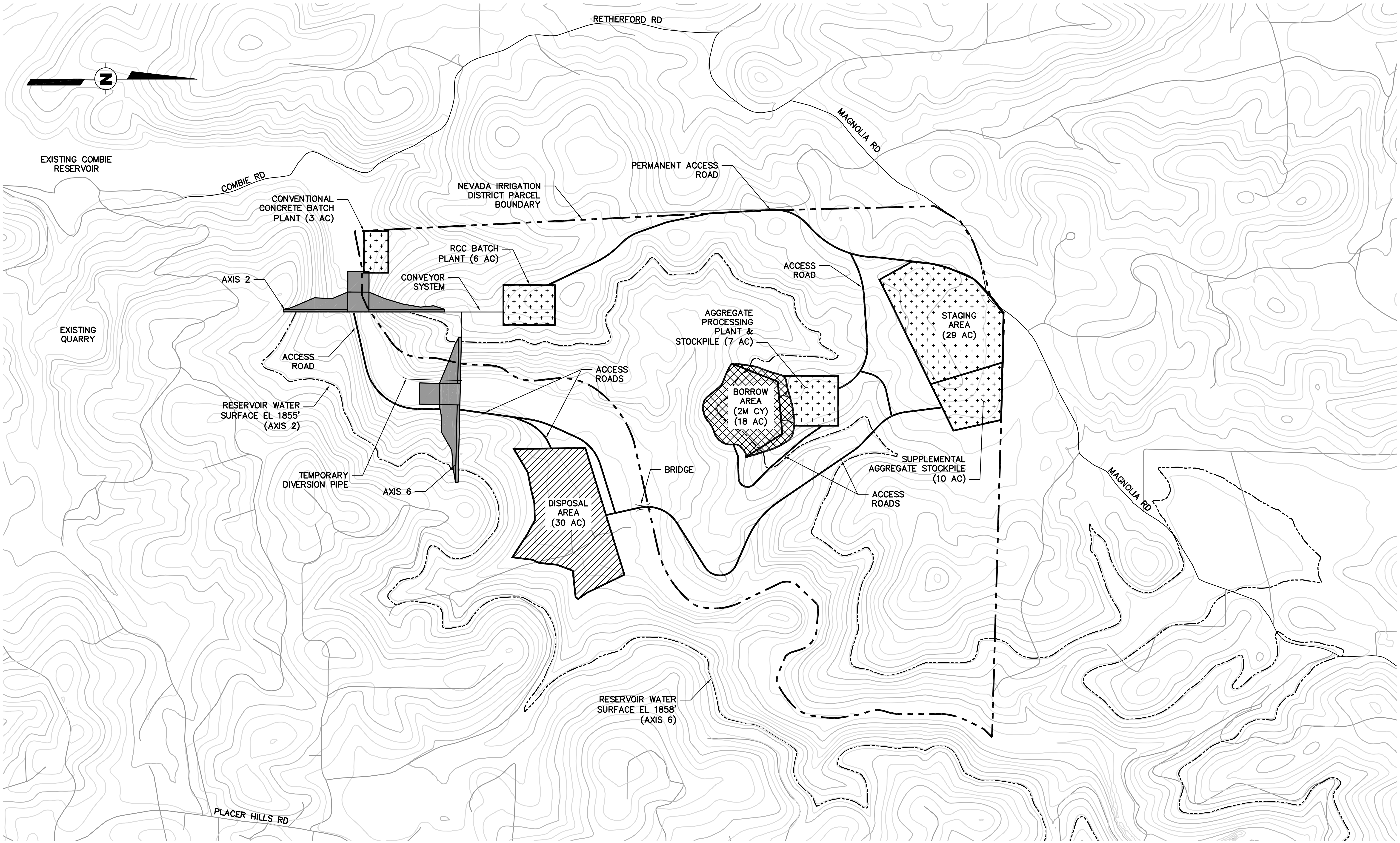


NON–OVERFLOW SECTION
NOT TO SCALE

SPILLWAY SECTION
NOT TO SCALE

Apr 22, 2016 - 2:51pm
L:\Projects\Legacy\IE_Xdrive\x_water\NID Parker Dam\11_Concept Layouts_Proposal Level\CAD\Working\TUFFY\Figure 8-2 and 8-4.dwg

AECOM | 60488086 NEVADA IRRIGATION DISTRICT CENTENNIAL RESERVOIR PROJECT | Roller Compacted Concrete Dam Concept Maximum Sections | FIGURE 2-2



LEGEND:

- STAGING AND PLANT AREAS
- BORROW AREA
- DISPOSAL AREA
- DAM AREA

NOTES:

1. THIS CONCEPT PLAN SHOWS MAIN SITE ACCESS ROADS; OTHERS MAY BE NEEDED.
2. AREAS INDICATED ARE APPROXIMATE.

0 1000 2000 Feet

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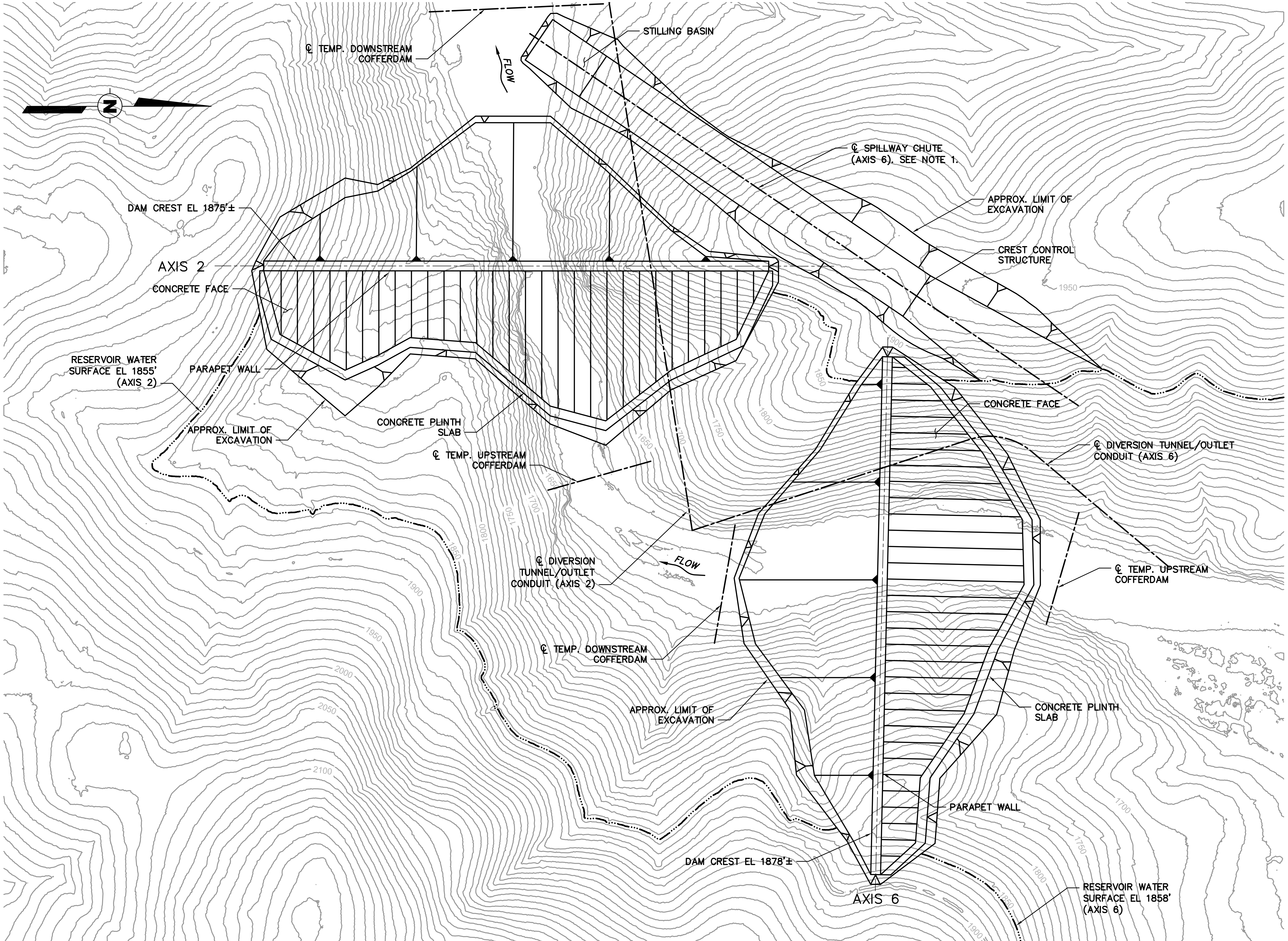
NEVADA IRRIGATION DISTRICT
CENTENNIAL RESERVOIR PROJECT

ROLLER COMPACTED CONCRETE DAM CONSTRUCTION SITE LAYOUT CONCEPT PLAN

FIGURE 2-3



NOTE:

1. SPILLWAY SIMILAR FOR AXIS 2.

0 300 600 Feet

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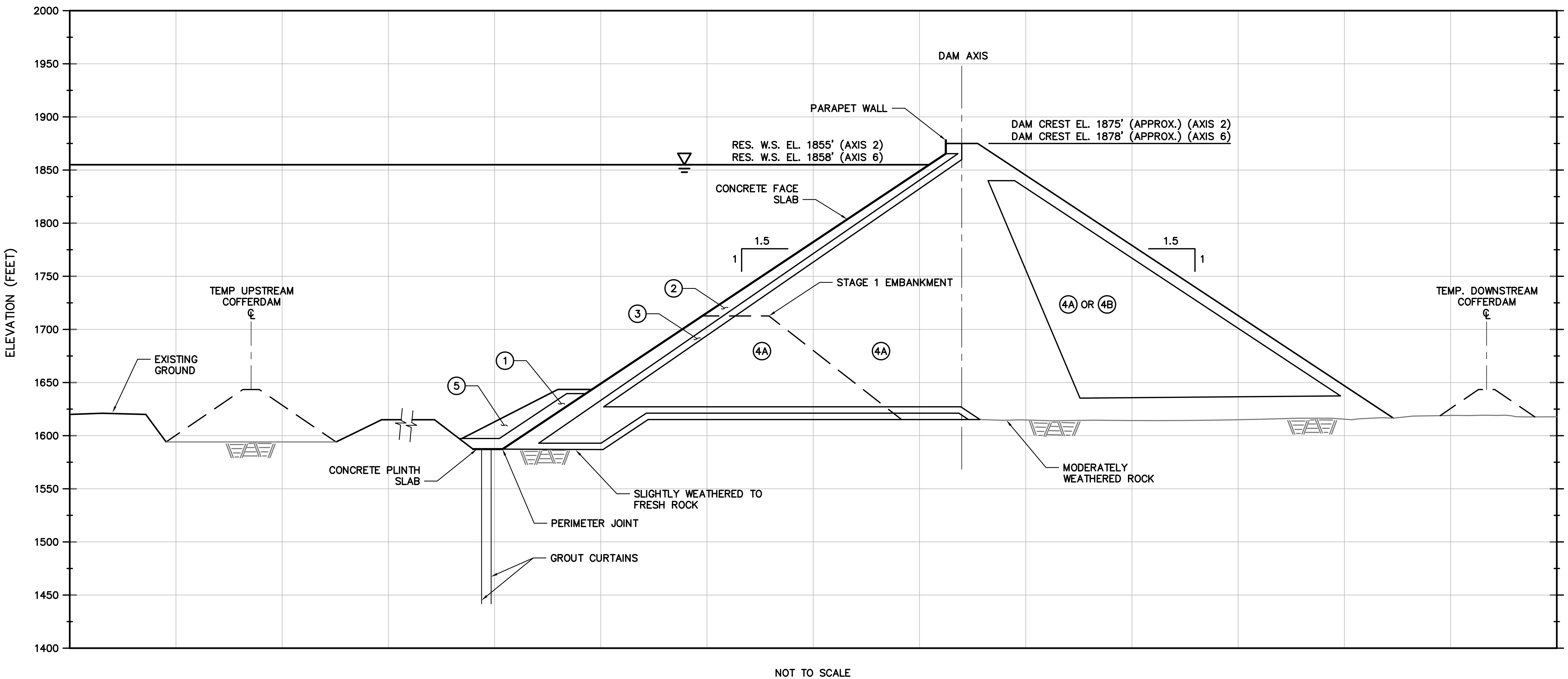
NEVADA IRRIGATION DISTRICT
CENTENNIAL RESERVOIR PROJECT

Concrete-Faced Rockfill Dam Concept Plan

FIGURE 3-1

May 11, 2016 - 2:55pm
L:\Projects\Legacy\E_Xdrive\x_water\NID Parker Dam\11_Concept Layouts_Proposal Level\CAD\Working\TUFFY\Figure 3-1 (CFRD PLAN).dwg



NOT TO SCALE

ZONE DESCRIPTIONS:

- (1) Clayey Soil
- (2) Bedding Layer (Processed Sand & Gravel)
- (3) Fine Rockfill
- (4A) Rockfill
- (4B) Rockfill (Weathered Rock)
- (5) Random Soil/Rock

AECOM	60488086 NEVADA IRRIGATION DISTRICT CENTENNIAL RESERVOIR PROJECT	Concrete Faced Rockfill Dam Concept Maximum Section	FIGURE 3-2

May 11, 2016 - 10:41am
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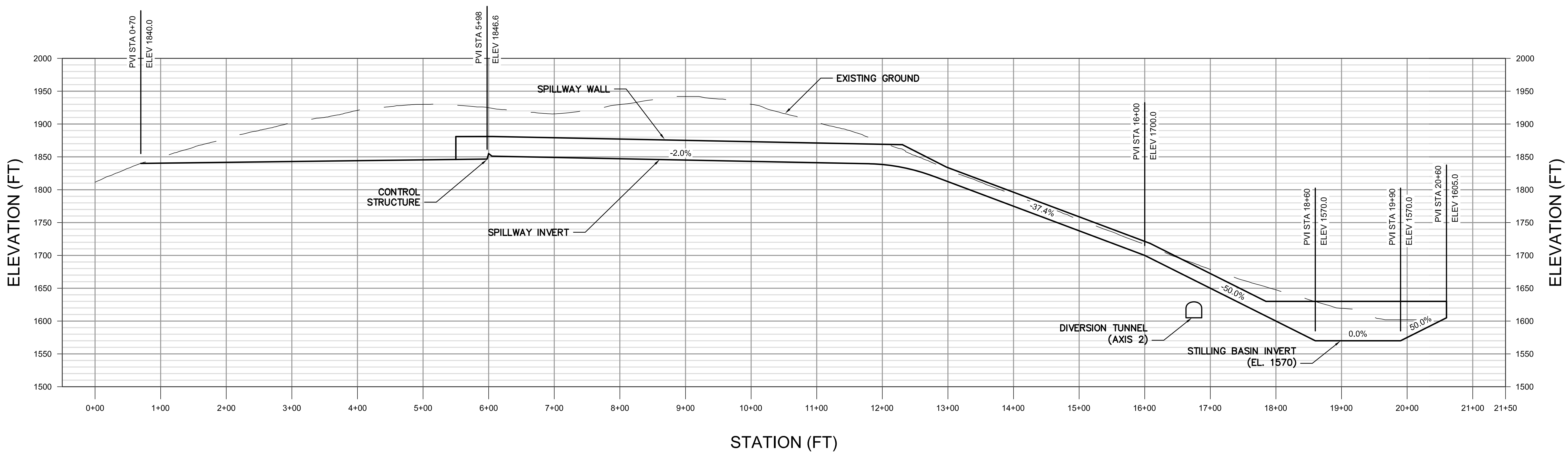

SPILLWAY PROFILE

SCALE 1"=150'

0 150 300 Feet

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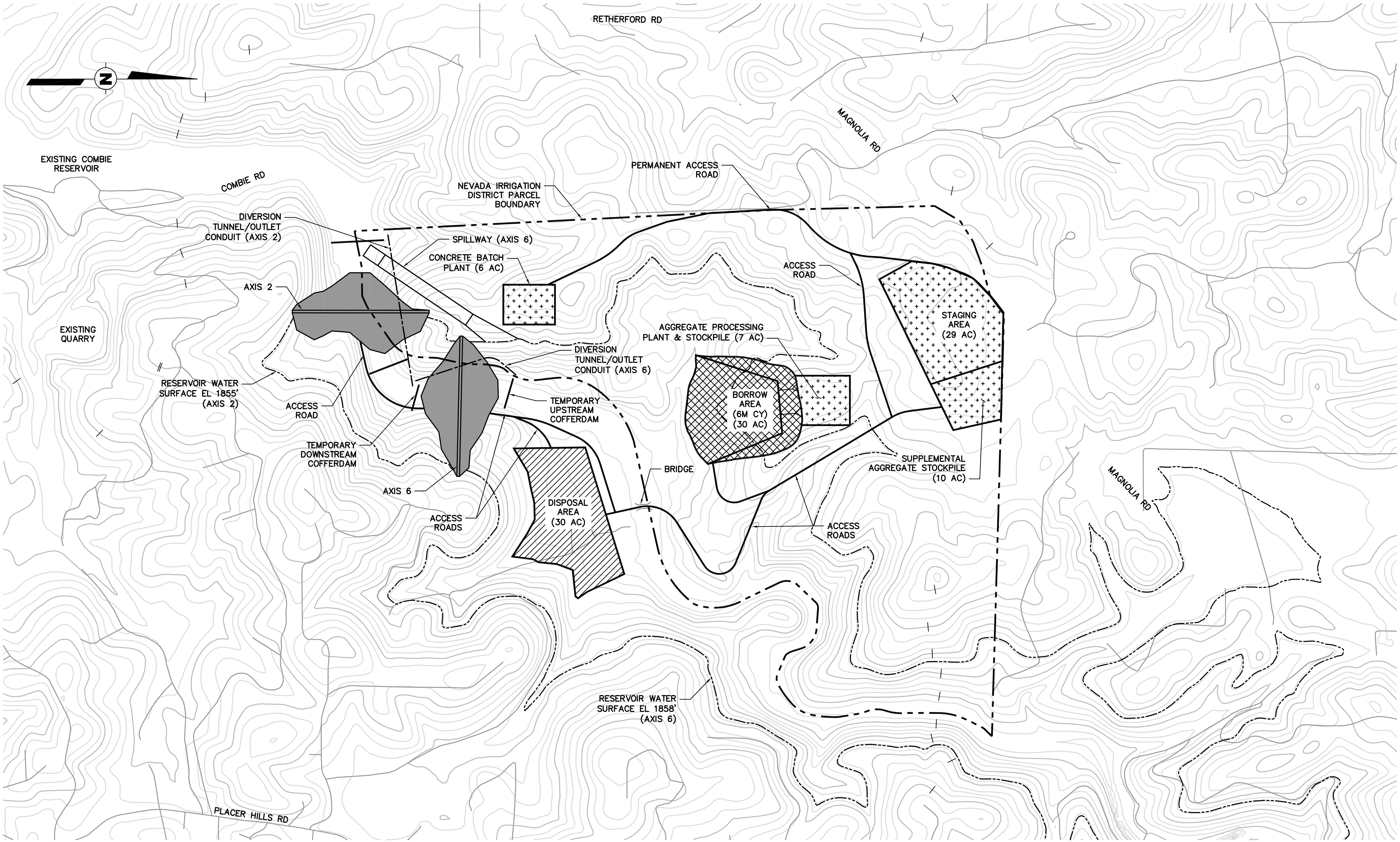
NEVADA IRRIGATION DISTRICT
CENTENNIAL RESERVOIR PROJECT

CONCRETE FACED ROCKFILL DAM
CONCEPT - SPILLWAY PROFILE

FIGURE
3-3

May 12, 2016 - 2:17pm
L:\Projects\Legacy\IE_Xdrive\x_water\NID Parker Dam\11_Concept Layouts_Proposal Level\CAD\Working\TUFFY\Figure 3-3 (Spillway).dwg



LEGEND:

- STAGING AND PLANT AREAS
- BORROW AREA
- DISPOSAL AREA
- DAM AREA

NOTES:

1. THIS CONCEPT PLAN SHOWS MAIN SITE ACCESS ROADS; OTHERS MAY BE NEEDED.
2. AREAS INDICATED ARE APPROXIMATE.

0 1000 2000 Feet

AECOM

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NEVADA IRRIGATION DISTRICT
CENTENNIAL RESERVOIR PROJECT

CONCRETE-FACED ROCKFILL DAM
CONSTRUCTION SITE LAYOUT
CONCEPT PLAN

FIGURE
3-4

May 11, 2016 - 2:54pm
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ID	Task Name	Duration
1	NTP	0 days
2	Mobilization	5 wks
3	Site Preparation	16 wks
4	Quarry Development and Aggregate Production	60 wks
5	Excavation of Right Abutment	18 wks
6	Levelling Concrete and Diversion Pipe Installation	6 wks
7	RCC/Facing Conc. on Right Abutment	24 wks
8	Excavation of Upper Left Abutment	25 wks
9	Cofferdam and Reroute River flow	2 wks
10	River Diversion Complete	0 days
11	Excavation of Lower Left Abutment and Channel Area	6 wks
12	Levelling Concrete	2 wks
13	RCC/Facing Conc. on Left Abutment and Channel Area	12 wks
14	RCC/Facing Conc. on both Abutments to Top (includes 12 weeks for weather delays)	27 wks
15	Concrete Spillway Walls, Intake, Outlet	20 wks
16	Grout Right Abutment	30 wks
17	Grout Left Abutment	30 wks
18	Grout Valley from Gallery	30 wks

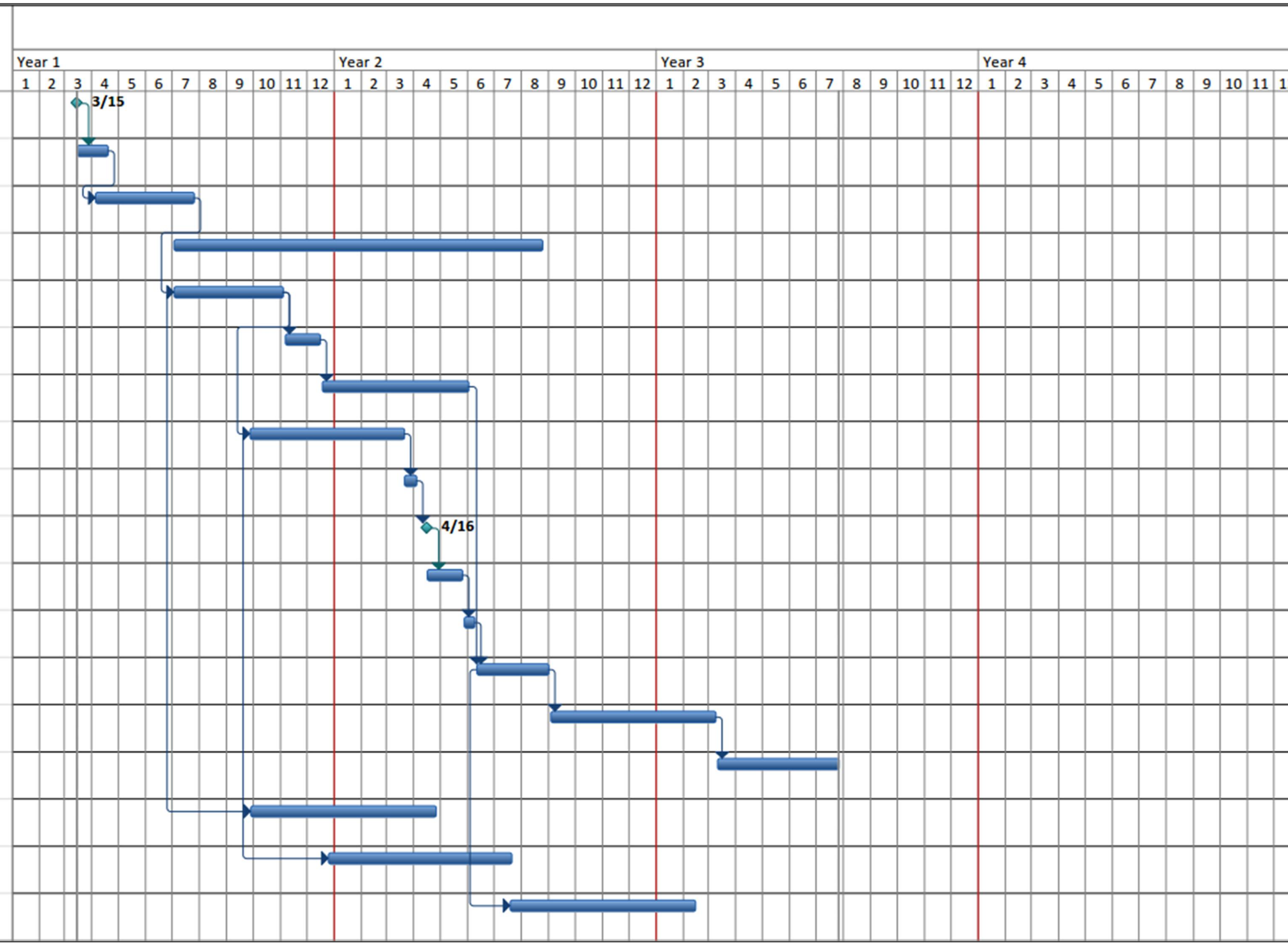

Figure 4-1 Construction Schedule for Roller Compacted Concrete Dam

ID	Task Name	Duration
1	NTP	0 days
2	Mobilization	5 wks
3	Site Preparation	16 wks
4	Tunnel Excavation and Portals	30 wks
5	Foundation and Plinth Excavation (Abutments)	40 wks
6	Cofferdam and Reroute River flow	4 wks
7	River Diversion Complete	0 days
8	Foundation and Plinth Excavation (Valley)	15 wks
9	Rockfill Placement Stage 1	15 wks
10	Rockfill Placement Stage 2	85 wks
11	Plinth Construction	95 wks
12	Grouting	100 wks
13	Facing Construction	55 wks
14	Crest and Parapet Wall	13 wks
15	Quarry Development	150 wks
16	Zones 2 and 3 Production and Stockpile	140 wks
17	Spillway Excavation	30 wks
18	Spillway Concrete Construction	50 wks

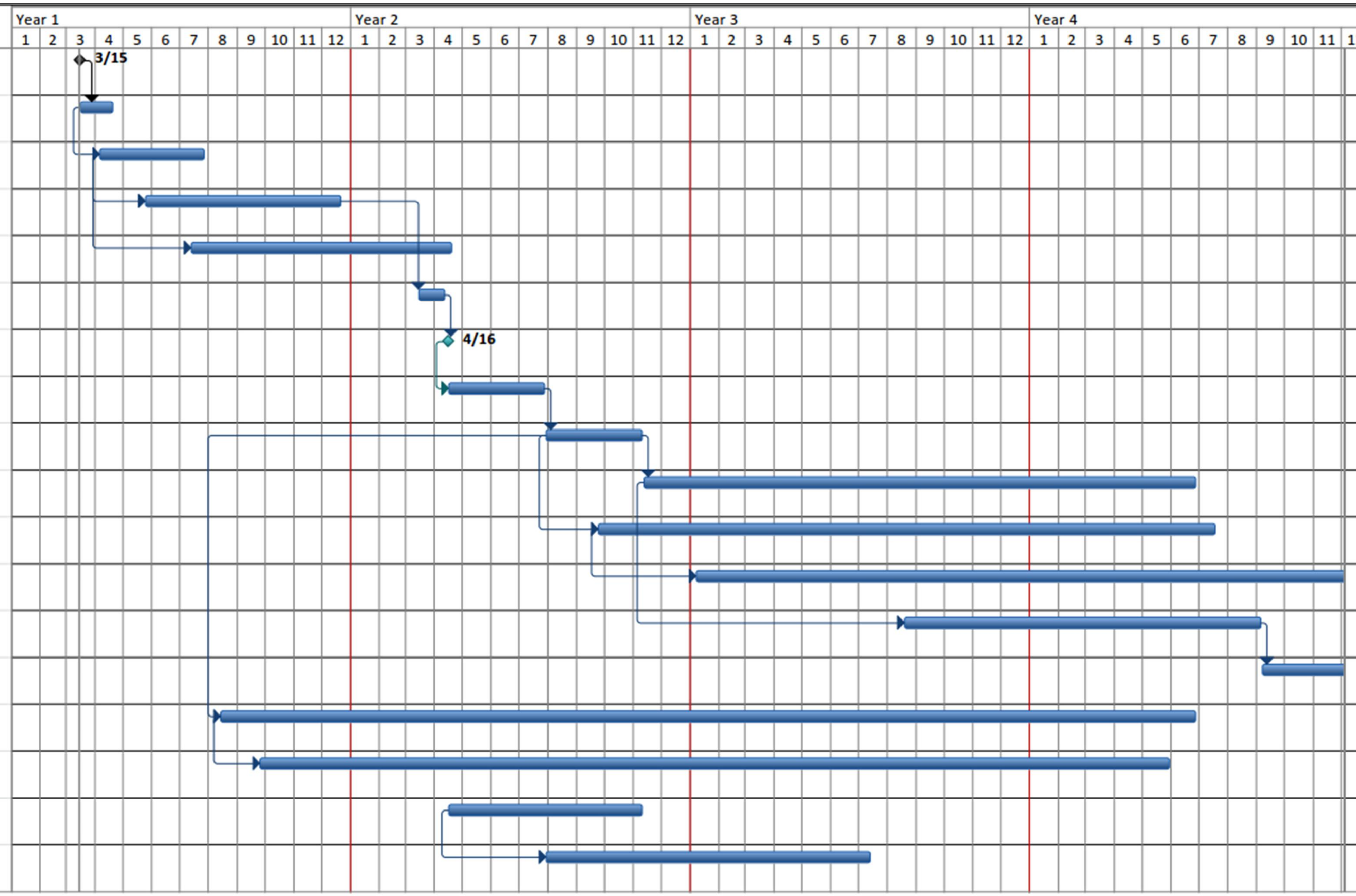

Figure 4-2 Construction Schedule for Concrete-Faced Rockfill Dam

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Appendix A.
Cost Estimate - Roller Compacted Concrete Dam

NID CENTENNIAL RESERVOIR PROJECT

Opinion of Probable Construction Cost (AACE Class 4), May 2016

Axis: **2**

Dam Type: **RCC**

Category/ Item No.	Description	Approx. Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	**Mobilization & Site Development**									**$ 23,473,459**	**9.1%**
1	Mobilization	1	LS	$ 18,117,580.00	$ 18,117,580	5.0%	$ 905,879	$ 19,023,459	7.3%		
2	Site Preparation/restoration	1	LS	$ 1,000,000.00	$ 1,000,000	30.0%	$ 300,000	$ 1,300,000	0.5%		
3	Borrow Area Development	300,000	cy	$ 7.00	$ 2,100,000	50.0%	$ 1,050,000	$ 3,150,000	1.2%		
B	**Diversion & Outlet**									**$ 3,607,000**	**1.4%**
4	Diversion during construction	1	LS	$ 500,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
5	Outlet conduit/steel pipe	460	lf	$ 3,500.00	$ 1,610,000	20.0%	$ 322,000	$ 1,932,000	0.7%		
6	Cofferdams - upstream & downstream	1	LS	$ 500,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
7	Dewatering	1	LS	$ 300,000.00	$ 300,000	25.0%	$ 75,000	$ 375,000	0.1%		
C	**Dam Foundation**									**$ 58,787,330**	**22.7%**
8	Foundation excavation - unclassified	674,000	cy	$ 19.50	$ 13,143,000	40.0%	$ 5,257,200	$ 18,400,200	7.1%		
9	Initial cleaning	26,600	sy	$ 15.00	$ 399,000	10.0%	$ 39,900	$ 438,900	0.2%		
10	Final cleaning	26,600	sy	$ 8.00	$ 212,800	10.0%	$ 21,280	$ 234,080	0.1%		
11	Surface preparation	26,600	sy	$ 25.00	$ 665,000	25.0%	$ 166,250	$ 831,250	0.3%		
12	Levelling concrete	16,000	cy	$ 300.00	$ 4,800,000	30.0%	$ 1,440,000	$ 6,240,000	2.4%		
13	Grout curtains	54,000	lf	$ 304.00	$ 16,416,000	40.0%	$ 6,566,400	$ 22,982,400	8.9%		
14	Consolidation grouting	21,500	lf	$ 230.00	$ 4,945,000	40.0%	$ 1,978,000	$ 6,923,000	2.7%		
15	Drain holes	14,600	lf	$ 150.00	$ 2,190,000	25.0%	$ 547,500	$ 2,737,500	1.1%		
D	**RCC & Facing Concrete**									**$ 153,552,000**	**59.2%**
16	RCC (aggregate, cement, fly ash)	807,000	cy	$ 125.00	$ 100,875,000	30.0%	$ 30,262,500	$ 131,137,500	50.6%		
17	Facing concrete	33,000	cy	$ 430.00	$ 14,190,000	35.0%	$ 4,966,500	$ 19,156,500	7.4%		
18	Gallery	1,800	lf	$ 1,200.00	$ 2,160,000	40.0%	$ 864,000	$ 3,024,000	1.2%		
19	Heavy riprap	3,000	cy	$ 60.00	$ 180,000	30.0%	$ 54,000	$ 234,000	0.1%		
E	**Spillway**									**$ 10,883,500**	**4.2%**
20	Structural concrete	6,000	cy	$ 1,000.00	$ 6,000,000	25.0%	$ 1,500,000	$ 7,500,000	2.9%		
21	Structural concrete - crest slab	1,700	cy	$ 700.00	$ 1,190,000	15.0%	$ 178,500	$ 1,368,500	0.5%		
22	Structural concrete - misc.	500	cy	$ 1,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
23	Stilling basin anchors	7,000	lf	$ 150.00	$ 1,050,000	30.0%	$ 315,000	$ 1,365,000	0.5%		
F	**Outlet & Intake Structures**									**$ 7,775,000**	**3.0%**
24	Outlet Structure	1	LS	$ 2,000,000.00	$ 2,000,000	40.0%	$ 800,000	$ 2,800,000	1.1%		
25	Intake/trashrack	1	LS	$ 500,000.00	$ 500,000	40.0%	$ 200,000	$ 700,000	0.3%		
26	Mechanical (gates/valves)	1	LS	$ 1,500,000.00	$ 1,500,000	35.0%	$ 525,000	$ 2,025,000	0.8%		
27	Electrical	1	LS	$ 1,500,000.00	$ 1,500,000	50.0%	$ 750,000	$ 2,250,000	0.9%		
G	**Instrumentation & SCADA**									**$ 1,125,000**	**0.4%**
28	Instrumentation	1	LS	$ 250,000.00	$ 250,000	50.0%	$ 125,000	$ 375,000	0.1%		
29	SCADA	1	LS	$ 500,000.00	$ 500,000	50.0%	$ 250,000	$ 750,000	0.3%		
Total Estimated Construction Cost					**$ 199,293,380**		**$ 59,909,909**	**$ 259,203,289**	**100.0%**	**$ 259,203,289**	**100.0%**
Design Contingency						30.1%					
Note: See Tech Memo, Section 5, for cost exclusions.											
								Opinion of Probable Construction Cost		**$ 259,200,000**	

NID CENTENNIAL RESERVOIR PROJECT

Opinion of Probable Construction Cost (AACE Class 4), May 2016

Axis: 6

Dam Type: RCC

Category/ Item No.	Description	Approx. Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	**Mobilization & Site Development**									**$ 25,367,733**	**8.9%**
1	Mobilization	1	LS	$ 19,921,650.00	$ 19,921,650	5.0%	$ 996,083	$ 20,917,733	7.4%		
2	Site Preparation/restoration	1	LS	$ 1,000,000.00	$ 1,000,000	30.0%	$ 300,000	$ 1,300,000	0.5%		
3	Borrow Area Development	300,000	cy	$ 7.00	$ 2,100,000	50.0%	$ 1,050,000	$ 3,150,000	1.1%		
B	**Diversion & Outlet**									**$ 3,607,000**	**1.3%**
4	Diversion during construction	1	LS	$ 500,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.2%		
5	Outlet conduit/steel pipe	460	lf	$ 3,500.00	$ 1,610,000	20.0%	$ 322,000	$ 1,932,000	0.7%		
6	Cofferdams - upstream & downstream	1	LS	$ 500,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.2%		
7	Dewatering	1	LS	$ 300,000.00	$ 300,000	25.0%	$ 75,000	$ 375,000	0.1%		
C	**Foundation**									**$ 53,378,800**	**18.8%**
8	Foundation excavation - unclassified	573,000	cy	$ 19.50	$ 11,173,500	40.0%	$ 4,469,400	$ 15,642,900	5.5%		
9	Initial cleaning	27,000	sy	$ 15.00	$ 405,000	10.0%	$ 40,500	$ 445,500	0.2%		
10	Final cleaning	27,000	sy	$ 8.00	$ 216,000	10.0%	$ 21,600	$ 237,600	0.1%		
11	Surface preparation	27,000	sy	$ 25.00	$ 675,000	25.0%	$ 168,750	$ 843,750	0.3%		
12	Levelling concrete	16,000	cy	$ 300.00	$ 4,800,000	30.0%	$ 1,440,000	$ 6,240,000	2.2%		
13	Grout curtains	48,000	lf	$ 304.00	$ 14,592,000	40.0%	$ 5,836,800	$ 20,428,800	7.2%		
14	Consolidation grouting	22,000	lf	$ 230.00	$ 5,060,000	40.0%	$ 2,024,000	$ 7,084,000	2.5%		
15	Drain holes	13,100	lf	$ 150.00	$ 1,965,000	25.0%	$ 491,250	$ 2,456,250	0.9%		
D	**RCC & Facing Concrete**									**$ 182,234,000**	**64.1%**
16	RCC (aggregate, cement, fly ash)	982,000	cy	$ 125.00	$ 122,750,000	30.0%	$ 36,825,000	$ 159,575,000	56.1%		
17	Facing concrete	34,000	cy	$ 430.00	$ 14,620,000	35.0%	$ 5,117,000	$ 19,737,000	6.9%		
18	Gallery	1,600	lf	$ 1,200.00	$ 1,920,000	40.0%	$ 768,000	$ 2,688,000	0.9%		
19	Heavy riprap	3,000	cy	$ 60.00	$ 180,000	30.0%	$ 54,000	$ 234,000	0.1%		
E	**Spillway**									**$ 10,722,500**	**3.8%**
20	Structural concrete	6,000	cy	$ 1,000.00	$ 6,000,000	25.0%	$ 1,500,000	$ 7,500,000	2.6%		
21	Structural concrete - crest slab	1,500	cy	$ 700.00	$ 1,050,000	15.0%	$ 157,500	$ 1,207,500	0.4%		
22	Structural concrete - misc.	500	cy	$ 1,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.2%		
23	Stilling basin anchors	7,000	lf	$ 150.00	$ 1,050,000	30.0%	$ 315,000	$ 1,365,000	0.5%		
F	**Outlet & Intake Structures**									**$ 7,775,000**	**2.7%**
24	Outlet Structure	1	LS	$ 2,000,000.00	$ 2,000,000	40.0%	$ 800,000	$ 2,800,000	1.0%		
25	Intake/trashrack	1	LS	$ 500,000.00	$ 500,000	40.0%	$ 200,000	$ 700,000	0.2%		
26	Mechanical (gates/valves)	1	LS	$ 1,500,000.00	$ 1,500,000	35.0%	$ 525,000	$ 2,025,000	0.7%		
27	Electrical	1	LS	$ 1,500,000.00	$ 1,500,000	50.0%	$ 750,000	$ 2,250,000	0.8%		
G	**Instrumentation & SCADA**									**$ 1,125,000**	**0.4%**
28	Instrumentation	1	LS	$ 250,000.00	$ 250,000	50.0%	$ 125,000	$ 375,000	0.1%		
29	SCADA	1	LS	$ 500,000.00	$ 500,000	50.0%	$ 250,000	$ 750,000	0.3%		
Total Estimated Construction Cost					**$ 219,138,150**		**$ 65,071,883**	**$ 284,210,033**	**100.0%**	**$ 284,210,033**	**100.0%**
Design Contingency						29.7%					
Note: See Tech Memo, Section 5, for cost exclusions.											
								Opinion of Probable Construction Cost		**$ 284,200,000**	

RCC Foundation Excavation - 2
674,000 cubic yard
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill and Blast Rock	cubic yard	404,000	5.10	2,060,400
2	Excavate, Load, Haul Rock	cubic yard	404,000	8.50	3,434,000
3	Excavate, Load, Haul Unclassified Excavation	cubic yard	371,000	7.50	2,782,500
4	Excavate and Grade Side Slope	cubic yard	84,000	5.00	420,000
5	Grade and Level Stockpiles	square foot	125,000	9.60	1,200,000
6					
7					
8	Subtotal:				9,896,900
9	General Requirements: 15%				1,484,535
10	Subtotal:				11,381,435
11	Overhead and Profit: 15%				1,707,215
12	Total:				13,088,650
	Foundation Excavation:	**cubic yard**	**674,000**	**19.42**	**13,088,650**

Assumptions:

- Assume 50% Rock and 50% Unclassified
- Assume hauled to waste stockpile on site, approx. 5,000 haul
- Assume 20% drill blast yield and swell
- Assume 10% swell for unclassified excavation
- Assume 2,100' of side slope @ 40 cubic yards per lineal foot
- Assume maximum height of stockpiles 16' approx. 25 acre

RCC Grout Curtain - 2
54,000 lineal foot
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill Rock	lineal foot	54,000	75.00	4,050,000
2	Drill Grout: (.10) (54,000)	lineal foot	5,400	65.00	351,000
3	Water Pressure Test: (6) (360)	each	2,160	210.00	453,600
4	Process, Mix, Inject Grout: (3) (54,000)	cubic foot	162,000	41.00	6,642,000
5	Cement: (.5) (54,000)	sack	27,000	28.00	756,000
6	Plasticizer: (4.5) (54,000)	ounce	243,000	.30	72,900
7	Connections: (54,000 / 150')	each	360	285.00	102,600
8	Subtotal:				12,428,100
9	General Requirements: 15%				1,864,215
10	Subtotal:				14,292,315
11	Overhead and Profit: 15%				2,143,847
12	Total:				16,436,162
	Grout Curtain:	**lineal foot**	**54,000**	**304.37**	**16,436,162**

Assumptions:

- 2 row grout curtain, primary, secondary on 10' center each row
- Assume axis #2 1,800'
- Assume drill depth 150'
- Assume redrill grout 10%
- Assume 6 water pressure test per drilled hole
- Assume 1/2 cubic foot cement per lineal foot drilled hole

RCC Consolidation Grout - 2
21,500 Lineal foot
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill Rock	lineal foot	21,500	55.00	1,182,500
2	Drill Grout: (.10) (21,500)	lineal foot	2,150	50.00	107,500
3	Water Pressure Test: (1) (1,197)	each	720	210.00	151,200
4	Process, Mix, Inject Grout: (2) (21,500)	cubic foot	43,000	41.00	1,763,000
5	Cement: (.5) (21,500)	sack	10,750	28.00	301,000
6	Plasticizer: (4.5) (21,500)	ounce	96,750	.30	29,025
7	Connections: (21,500 / 30')	each	720	285.00	205,200
8	Subtotal:				3,739,425
9	General Requirements: 15%				560,914
10	Subtotal:				4,300,339
11	Overhead and Profit: 15%				645,051
12	Total:				4,945,390
	Grout Curtain:	**lineal foot**	**21,500**	**230.02**	**4,945,390**

Assumptions:

- 2 row grout curtain, primary, secondary on 10' center each row
- Assume axis 1,030'
- Assume drill depth 150'
- Assume redrill grout .10
- Assume 6 water pressure test per drilled hole
- Assume .5 cubic foot cement per lineal foot drilled hole

Roller Compacted Concrete - 2
807,000 cubic yard
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Cement RCC: 150# per cubic yard	ton	60,525	145.00	8,776,125
2	Cement Grout Enrich: (.13) (807,000)	sack	104,900	31.00	3,251,900
3	Pozzolan: 150# per cubic yard	ton	60,525	98.00	5,931,450
4	Retard Add. Mix: (.47) (807,000)	gallon	379,300	16.00	6,068,800
5	Contraction Joint: (.378) (807,000)	square foot	305,000	11.00	3,355,000
6	Aggregate: (2.0) (807,000)	ton	1,614,000	8.50	13,719,000
7	Mix, Convey, Place, Compact	cubic yard	807,000	45.00	36,315,000
8	Subtotal:				77,417,275
9	General Requirements: 15%				11,612,591
10	Subtotal:				89,029,866
11	Overhead and Profit: 15%				13,354,480
12	Total:				102,384,346
	Roller Compacted Concrete:	**cubic yard**	**807,000**	**126.87**	**102,384,346**

Appendix B.
Cost Estimate - Concrete-Faced Rockfill Dam

NID CENTENNIAL RESERVOIR PROJECT

Opinion of Probable Construction Cost (AACE Class 4), May 2016

Axis: 2

Dam Type: CFRD

Category/ Item No.	Description	Approx. Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	**Mobilization & Site Development**									$ 32,075,327	9.5%
1	Mobilization	1	LS	$23,690,787.50	$ 23,690,788	5.0%	$ 1,184,539	$ 24,875,327	7.3%		
2	Site preparation/restoration	1	LS	$1,500,000.00	$ 1,500,000	30.0%	$ 450,000	$ 1,950,000	0.6%		
3	Borrow area development	500,000	cy	$7.00	$ 3,500,000	50.0%	$ 1,750,000	$ 5,250,000	1.5%		
B	**Diversion & Outlet**									$ 59,190,000	17.4%
4	Outlet tunnel	1,700	lf	$20,000.00	$ 34,000,000	35.0%	$ 11,900,000	$ 45,900,000	13.5%		
5	Outlet plug	1,300	cy	$1,500.00	$ 1,950,000	10.0%	$ 195,000	$ 2,145,000	0.6%		
6	Steel Pipe	1,700	lf	$3,000.00	$ 5,100,000	20.0%	$ 1,020,000	$ 6,120,000	1.8%		
7	Tunnel portals	1	LS	$2,000,000.00	$ 2,000,000	50.0%	$ 1,000,000	$ 3,000,000	0.9%		
8	Cofferdams - upstream & downstream	1	LS	$1,000,000.00	$ 1,000,000	40.0%	$ 400,000	$ 1,400,000	0.4%		
9	Unwatering	1	LS	$500,000.00	$ 500,000	25.0%	$ 125,000	$ 625,000	0.2%		
C	**Dam Foundation**									$ 51,578,990	15.2%
10	Foundation excavation - embankment	970,000	cy	$10.00	$ 9,700,000	20.0%	$ 1,940,000	$ 11,640,000	3.4%		
11	Foundation excavation - plinth	201,000	cy	$19.50	$ 3,919,500	35.0%	$ 1,371,825	$ 5,291,325	1.6%		
12	Initial cleaning	22,200	sy	$15.00	$ 333,000	10.0%	$ 33,300	$ 366,300	0.1%		
13	Final cleaning	22,200	sy	$8.00	$ 177,600	10.0%	$ 17,760	$ 195,360	0.1%		
14	Clean for shell foundation	75,800	sy	$8.00	$ 606,400	10.0%	$ 60,640	$ 667,040	0.2%		
15	Grout curtains	63,700	lf	$305.00	$ 19,428,500	35.0%	$ 6,799,975	$ 26,228,475	7.7%		
16	Consolidation grouting	21,200	lf	$227.00	$ 4,812,400	35.0%	$ 1,684,340	$ 6,496,740	1.9%		
17	Surface preparation	22,200	sy	$25.00	$ 555,000	25.0%	$ 138,750	$ 693,750	0.2%		
D	**Embankment**									$ 44,801,704	13.2%
18	Zone 1	15,000	cy	$6.00	$ 90,000	20.0%	$ 18,000	$ 108,000	0.0%		
19	Zone 2	345,500	cy	$16.70	$ 5,769,850	35.0%	$ 2,019,448	$ 7,789,298	2.3%		
20	Zone 3	286,800	cy	$12.50	$ 3,585,000	35.0%	$ 1,254,750	$ 4,839,750	1.4%		
21	Zone 4A/4B Rockfill	2,246,500	cy	$11.25	$ 25,273,125	25.0%	$ 6,318,281	$ 31,591,406	9.3%		
22	Zone 5	15,000	cy	$6.00	$ 90,000	20.0%	$ 18,000	$ 108,000	0.0%		
23	Heavy riprap	3,000	cy	$60.00	$ 180,000	30.0%	$ 54,000	$ 234,000	0.1%		
24	Crest & DS face roading	3,500	lf	$30.00	$ 105,000	25.0%	$ 26,250	$ 131,250	0.0%		
E	**Concrete Face, Plinth & Parapet**									$ 46,330,750	13.7%
25	Slip-formed curbs on upstream face	16,000	cy	$450.00	$ 7,200,000	25.0%	$ 1,800,000	$ 9,000,000	2.7%		
26	Facing concrete	29,500	cy	$560.00	$ 16,520,000	30.0%	$ 4,956,000	$ 21,476,000	6.3%		
27	Plinth	7,100	cy	$1,000.00	$ 7,100,000	30.0%	$ 2,130,000	$ 9,230,000	2.7%		
28	Plinth anchors	12,750	lf	$190.00	$ 2,422,500	10.0%	$ 242,250	$ 2,664,750	0.8%		
29	Parapet Wall	3,600	cy	$1,000.00	$ 3,600,000	10.0%	$ 360,000	$ 3,960,000	1.2%		
F	**Spillway**									$ 96,144,000	28.3%
30	Spillway excavation	630,000	cy	$21.00	$ 13,230,000	40.0%	$ 5,292,000	$ 18,522,000	5.5%		
31	Spillway structure	50,000	cy	$1,000.00	$ 50,000,000	40.0%	$ 20,000,000	$ 70,000,000	20.6%		
32	Spillway crest control	2,000	cy	$600.00	$ 1,200,000	35.0%	$ 420,000	$ 1,620,000	0.5%		
33	Structural concrete - misc.	500	cy	$1,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.2%		
34	Spillway slab anchors	26,000	lf	$150.00	$ 3,900,000	20.0%	$ 780,000	$ 4,680,000	1.4%		
35	Wall backfill & drains	56,000	cy	$10.00	$ 560,000	20.0%	$ 112,000	$ 672,000	0.2%		
G	**Outlet & Intake Structures**									$ 7,775,000	2.3%
36	Outlet Structure	1	LS	$2,000,000.00	$ 2,000,000	40.0%	$ 800,000	$ 2,800,000	0.8%		
37	Intake/trashrack	1	LS	$500,000.00	$ 500,000	40.0%	$ 200,000	$ 700,000	0.2%		
38	Mechanical (gates/valves/HPU/Gen Set)	1	LS	$1,500,000.00	$ 1,500,000	35.0%	$ 525,000	$ 2,025,000	0.6%		
39	Electrical	1	LS	$1,500,000.00	$ 1,500,000	50.0%	$ 750,000	$ 2,250,000	0.7%		
H	**Instrumentation & SCADA**									$ 1,500,000	0.4%
40	Geotechnical Instrumentation	1	LS	$500,000.00	$ 500,000	50.0%	$ 250,000	$ 750,000	0.2%		
41	SCADA	1	LS	$500,000.00	$ 500,000	50.0%	$ 250,000	$ 750,000	0.2%		
Total Estimated Construction Cost					**$ 260,598,663**		**$ 78,797,108**	**$ 339,395,771**	**100.0%**	**$ 339,395,771**	**100.0%**
Design Contingency						30.2%					
Note: See Tech Memo, Section 5, for cost exclusions.											
								Opinion of Probable Construction Cost		**$ 339,400,000**	

NID CENTENNIAL RESERVOIR PROJECT

Opinion of Probable Construction Cost (AACE Class 4), May 2016

Axis: 6

Dam Type: CFRD

Category/ Item No.	Description	Approx. Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	**Mobilization & Site Development**									**$ 31,019,448**	**9.5%**
1	Mobilization	1	LS	$22,685,188.50	$ 22,685,189	5.0%	$ 1,134,259	$ 23,819,448	7.3%		
2	Site preparation/restoration	1	LS	$1,500,000.00	$ 1,500,000	30.0%	$ 450,000	$ 1,950,000	0.6%		
3	Borrow area development	500,000	cy	$7.00	$ 3,500,000	50.0%	$ 1,750,000	$ 5,250,000	1.6%		
B	**Diversion & Outlet**									**$ 53,070,000**	**16.3%**
4	Outlet tunnel	1,500	lf	$20,000.00	$ 30,000,000	35.0%	$ 10,500,000	$ 40,500,000	12.5%		
5	Outlet plug	1,300	cy	$1,500.00	$ 1,950,000	10.0%	$ 195,000	$ 2,145,000	0.7%		
6	Steel Pipe	1,500	lf	$3,000.00	$ 4,500,000	20.0%	$ 900,000	$ 5,400,000	1.7%		
7	Tunnel portals	1	LS	$2,000,000.00	$ 2,000,000	50.0%	$ 1,000,000	$ 3,000,000	0.9%		
8	Cofferdams - upstream & downstream	1	LS	$1,000,000.00	$ 1,000,000	40.0%	$ 400,000	$ 1,400,000	0.4%		
9	Dewatering	1	LS	$500,000.00	$ 500,000	25.0%	$ 125,000	$ 625,000	0.2%		
C	**Foundation**									**$ 44,093,995**	**13.6%**
10	Foundation excavation - embankment	769,000	cy	$10.00	$ 7,690,000	20.0%	$ 1,538,000	$ 9,228,000	2.8%		
11	Foundation excavation - plinth	143,000	cy	$19.50	$ 2,788,500	35.0%	$ 975,975	$ 3,764,475	1.2%		
12	Initial cleaning	20,400	sy	$15.00	$ 306,000	10.0%	$ 30,600	$ 336,600	0.1%		
13	Final cleaning	20,400	sy	$8.00	$ 163,200	10.0%	$ 16,320	$ 179,520	0.1%		
14	Clean for shell foundation	74,500	sy	$8.00	$ 596,000	10.0%	$ 59,600	$ 655,600	0.2%		
15	Grout curtains	57,000	lf	$305.00	$ 17,385,000	35.0%	$ 6,084,750	$ 23,469,750	7.2%		
16	Consolidation grouting	19,000	lf	$227.00	$ 4,313,000	35.0%	$ 1,509,550	$ 5,822,550	1.8%		
17	Surface preparation	20,400	sy	$25.00	$ 510,000	25.0%	$ 127,500	$ 637,500	0.2%		
D	**Embankment**									**$ 47,362,937**	**14.6%**
18	Zone 1	18,000	cy	$6.00	$ 108,000	20.0%	$ 21,600	$ 129,600	0.0%		
19	Zone 2	264,300	cy	$16.70	$ 4,413,810	35.0%	$ 1,544,834	$ 5,958,644	1.8%		
20	Zone 3	244,500	cy	$12.50	$ 3,056,250	35.0%	$ 1,069,688	$ 4,125,938	1.3%		
21	Zone 4A/4B Rockfill	2,606,500	cy	$11.25	$ 29,323,125	25.0%	$ 7,330,781	$ 36,653,906	11.3%		
22	Zone 5	18,000	cy	$6.00	$ 108,000	20.0%	$ 21,600	$ 129,600	0.0%		
23	Heavy riprap	3,000	cy	$60.00	$ 180,000	30.0%	$ 54,000	$ 234,000	0.1%		
24	Crest & DS face roading	3,500	lf	$30.00	$ 105,000	25.0%	$ 26,250	$ 131,250	0.0%		
E	**Concrete Face, Plinth & Parapet**									**$ 40,751,600**	**12.5%**
25	Slip-formed curbs on upstream face	14,000	cy	$450.00	$ 6,300,000	25.0%	$ 1,575,000	$ 7,875,000	2.4%		
26	Facing concrete	25,500	cy	$560.00	$ 14,280,000	30.0%	$ 4,284,000	$ 18,564,000	5.7%		
27	Plinth	6,300	cy	$1,000.00	$ 6,300,000	30.0%	$ 1,890,000	$ 8,190,000	2.5%		
28	Plinth anchors	11,400	lf	$190.00	$ 2,166,000	10.0%	$ 216,600	$ 2,382,600	0.7%		
29	Parapet Wall	3,400	cy	$1,000.00	$ 3,400,000	10.0%	$ 340,000	$ 3,740,000	1.1%		
F	**Spillway**									**$ 99,672,000**	**30.6%**
30	Spillway excavation	750,000	cy	$21.00	$ 15,750,000	40.0%	$ 6,300,000	$ 22,050,000	6.8%		
31	Spillway structure	50,000	cy	$1,000.00	$ 50,000,000	40.0%	$ 20,000,000	$ 70,000,000	21.5%		
32	Spillway crest control	2,000	cy	$600.00	$ 1,200,000	35.0%	$ 420,000	$ 1,620,000	0.5%		
33	Structural concrete - misc.	500	cy	$1,000.00	$ 500,000	30.0%	$ 150,000	$ 650,000	0.2%		
34	Spillway slab anchors	26,000	lf	$150.00	$ 3,900,000	20.0%	$ 780,000	$ 4,680,000	1.4%		
35	Wall backfill & drains	56,000	cy	$10.00	$ 560,000	20.0%	$ 112,000	$ 672,000	0.2%		
G	**Outlet & Intake Structures**									**$ 7,775,000**	**2.4%**
36	Outlet Structure	1	LS	$2,000,000.00	$ 2,000,000	40.0%	$ 800,000	$ 2,800,000	0.9%		
37	Intake/trashrack	1	LS	$500,000.00	$ 500,000	40.0%	$ 200,000	$ 700,000	0.2%		
38	Mechanical (gates/valves)	1	LS	$1,500,000.00	$ 1,500,000	35.0%	$ 525,000	$ 2,025,000	0.6%		
39	Electrical	1	LS	$1,500,000.00	$ 1,500,000	50.0%	$ 750,000	$ 2,250,000	0.7%		
H	**Instrumentation & SCADA**									**$ 1,500,000**	**0.5%**
40	Geotechnical Instrumentation	1	LS	$500,000.00	$ 500,000	50.0%	$ 250,000	$ 750,000	0.2%		
41	SCADA	1	LS	$500,000.00	$ 500,000	50.0%	$ 250,000	$ 750,000	0.2%		
Total Estimated Construction Cost					**$ 249,537,074**		**$ 75,707,907**	**$ 325,244,980**	**100.0%**	**$ 325,244,980**	**100.0%**
Design Contingency						30.3%					
Note: See Tech Memo, Section 5, for cost exclusions.											
								Opinion of Probable Construction Cost		**$ 325,200,000**	

Axis 2 - Zone 2
345,500 cubic yard
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill and Blast Rock	cubic yard	456,000	3.00	1,368,000
2	Excavate, Separate, Screen	cubic yard	456,000	1.30	592,800
3	Load, Haul, Place	cubic yard	456,000	4.00	1,824,000
4	Control Moisture, Compact	cubic yard	456,000	1.25	570,000
5					
6					
7					
8	Subtotal:				4,354,800
9	General Requirements: 15%				653,220
10	Subtotal:				5,008,020
11	Overhead and Profit: 15%				751,203
12	Total:				5,759,223
	Axis 2 - Zone 2	**cubic yard**	**345,500**	**16.67**	**5,759,223**

Assumptions:

Assume over drill and blast 20% for yield

Assume over screen 10% for yield

Assume 20% waste place and compact

Assume approx. 4,500 haul

Axis 2 - Zone 3
286,800 cubic yard
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill and Blast Rock	cubic yard	315,500	3.00	946,500
2	Excavate, Separate, Screen	cubic yard	315,500	1.30	410,150
3	Load, Haul, Place	cubic yard	315,500	3.20	1,009,600
4	Control Moisture, Compact	cubic yard	315,500	1.10	347,050
5					
6					
7					
8	Subtotal:				2,713,300
9	General Requirements: 15%				406,995
10	Subtotal:				3,120,295
11	Overhead and Profit: 15%				468,044
12	Total:				3,588,339
	Axis 2 - Zone 3	**cubic yard**	**286,800**	**12.51**	**3,588,339**

Assumptions:

Assume over drill and blast 10% for yield

Assume over screen 10% for yield

Assume approx. 4,500 haul

Axis 2 - Zone 4A, 4B
2,246,500 cubic yard
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill and Blast Rock	cubic yard	2,359,000	3.20	7,548,800
2	Excavate, Separate, Screen	cubic yard	2,359,000	.90	2,123,100
3	Load, Haul, Place	cubic yard	2,359,000	3.00	7,077,000
4	Control Moisture, Compact	cubic yard	2,359,000	1.00	2,359,000
5					
6					
7					
8	Subtotal:				19,107,900
9	General Requirements: 15%				2,866,185
10	Subtotal:				21,974,085
11	Overhead and Profit: 15%				3,296,113
12	Total:				25,270,198
	Axis 2 - Zone 4A, 4B	**cubic yard**	**2,246,500**	**11.25**	**25,270,198**

Assumptions:

Assume over drill and blast 5% for yield

Assume over screen 5% for yield

Assume approx. 4,500 haul

CFRD Grout Curtain - Axis 2
63,720 lineal foot
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill Rock	lineal foot	63,720	75.00	4,779,000
2	Drill Grout: (.10) (63,720)	lineal foot	6,400	65.00	416,000
3	Water Pressure Test: (6) (425)	each	2,550	210.00	535,500
4	Process, Mix, Inject Grout: (3) (63,720)	cubic foot	191,200	41.00	7,839,200
5	Cement: (.5) (63,720)	sack	32,000	28.00	896,000
6	Plasticizer: (4.5) (63,720)	ounce	287,000	.30	86,100
7	Connections: (63,720 / 150')	each	425	285.00	121,125
8	Subtotal:				14,672,925
9	General Requirements: 15%				2,200,939
10	Subtotal:				16,873,864
11	Overhead and Profit: 15%				2,531,080
12	Total:				19,404,943
	Grout Curtain:	**lineal foot**	**63,720**	**304.53**	**19,404,943**

Assumptions:

- 2 row grout curtain, primary, secondary on 10' center each row
- Assume axis #2 2,124'
- Assume drill depth 150'
- Assume redrill grout 10%
- Assume 6 water pressure test per drilled hole
- Assume 1/2 cubic foot cement per lineal foot drilled hole

CFRD Consolidation Grout - Axis 2
21,200 lineal foot
Direct and Indirect Cost

Effective Date: 3/16

Item No.	Description	UOM	Quantity	Price ($)	Amount ($)
1	Drill Rock	lineal foot	21,200	55.00	1,166,000
2	Drill Grout: (.10) (21,200)	lineal foot	2,100	50.00	105,000
3	Water Pressure Test: (2) (424)	each	848	210.00	178,080
4	Process, Mix, Inject Grout: (2) (21,200)	cubic foot	42,400	41.00	1,738,400
5	Cement: (.5) (21,200)	sack	10,600	28.00	296,800
6	Plasticizer: (4.5) (21,200)	ounce	94,500	.30	28,350
7	Connections: (21,200 / 50')	each	424	285.00	120,840
8	Subtotal:				3,633,470
9	General Requirements: 15%				545,021
10	Subtotal:				4,178,491
11	Overhead and Profit: 15%				626,774
12	Total:				4,805,264
	Grout Curtain:	**lineal foot**	**21,200**	**226.66**	**4,805,264**

Assumptions:

- 2 row grout curtain, primary, secondary on 10' center each row
- Assume axis 1,030'
- Assume drill depth 150'
- Assume redrill grout .10
- Assume 6 water pressure test per drilled hole
- Assume .5 cubic foot cement per lineal foot drilled hole

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