MEMORANDUM

Updated Information for Final EIR/EIS

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The purpose of this memorandum is to summarize updated information and results as related to construction and operational assumptions for the groundwater impact analysis presented in the *Bay Delta Conservation Plan Draft Environmental Impact Report/Environmental Impact Statement* (DEIR/DEIS) and the *Bay Delta Conservation Plan/California Water Fix Partially Recirculated Draft Environmental Impact Report/Supplemental Draft Environmental Impact Statement* (RDEIR/SDEIS). This updated information is related to: a) use of slurry cutoff walls to reduce the potential impacts from dewatering activities during construction of conveyance facilities, and b) use of a combination of toe drains, interceptor wells, and soil grouting to reduce the potential for seepage onto lands adjacent to the forebays during operations of the conveyance facilities.

This updated project description information has been considered by the EIR/EIS team that prepared the groundwater resources impact analysis presented in Chapter 7, Groundwater, of the DEIR/DEIS and the RDEIR/SDEIS. As a result of this updated project description, the potential adverse effects to groundwater conditions identified in the DEIR/DEIS and the RDEIR/SDEIS have been reduced to a level of less than significant and not potentially adverse, for CEQA and NEPA respectively. The updated impact conclusions contained in this memorandum will be included in the Final EIR/EIS.

1.0 Groundwater Analysis in the DEIR/DEIS and RDEIR/SDEIS

The existing groundwater analysis in Chapter 7 of the DEIR/DEIS and the RDEIR/SDEIS included an evaluation of potential groundwater impacts during construction and operations of the conveyance facilities, as summarized below.

1.1 Groundwater Impact Analysis of Construction Effects in the DEIR/DEIS and RDEIR/SDEIS

The potential effects on groundwater during construction were analyzed as described under Impact GW-1.

> **Impact GW-1:** *During Construction, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells*.

The DEIR/DEIS groundwater impact analysis identified potentially significant adverse impacts on groundwater elevations due to dewatering actions. The DEIR/DEIS analysis assumed the following dewatering methods during construction of the conveyance facilities that included tunnels:

- Intakes: Construction at the intakes would occur within an open excavated area with dewatering wells placed every 50 to 75 feet apart along the construction perimeter, as needed. Based upon information presented in the 2010 *Technical Memorandum: Analysis of Dewatering Requirements for Potential Excavations*, DHCCP, it was assumed that the dewatering rate at each intake would range from 34 to 2,720 gallons/minute (gpm) depending upon the presence of sand and clay layers.

- Tunnel Shafts: Dewatering wells would be placed at each tunnel shaft. Based upon information presented in the 2010 *Technical Memorandum: Analysis of Dewatering Requirements for Potential Excavations*, DHCCP, it was assumed that the dewatering rate at each tunnel shaft would range from 34 to 2,720 gallons/minute (gpm) depending upon the presence of sand and clay layers.
- Forebay Embankments: Construction at the Intermediate and Clifton Court/Byron Tract forebays would occur within an open excavated area with dewatering wells placed every 50 to 75 feet apart along the construction perimeter. Based upon information presented in the 2010 *Technical Memorandum: Analysis of Dewatering Requirements for Potential Excavations*, DHCCP, it was assumed that the dewatering rate at the forebays would range from 34 to 2,720 gallons/minute (gpm) depending upon the presence of sand and clay layers.

Based upon the 2010 *Technical Memorandum: Analysis of Dewatering Requirements for Potential Excavations*, DHCCP, it was assumed that the total dewatering actions could result in a range from approximately 240 to 10,500 gpm for construction of the intakes, pipelines, tunnel shafts, and forebays. Dewatering would occur 24 hours per day and 7 days per week and would be initiated 1 to 4 weeks prior to excavation at each location. Dewatering would continue until excavation was completed and the structures to be constructed were protected from higher groundwater levels. The dewatering wells would reduce groundwater elevations within a zone of influence that was projected using the Central Valley Hydrologic Model for the Delta (CVHM-D) model to extend approximately 2,600 feet from the intake and forebay excavations. The groundwater elevation decline was projected to be 0 to 10 feet below pre-construction conditions at the intakes and up to 20 or 30 feet below pre-construction conditions near the forebays. Once dewatering is stopped groundwater elevations are projected to return to within 5 feet of pre-construction conditions after two months and to pre-construction elevations over the course of several months.

It also should be recognized that the estimate of the size of the zone of influence from the dewatering wells was based upon the geological conditions included in the U.S. Geological Survey (USGS) CVHM-D model that was used for the DEIR/DEIS and RDEIR/SDEIS impact analysis. The geological conditions were developed by USGS based upon broad regional hydrogeological conditions. Actual conditions may vary. During design of the conveyance facilities, site-specific geotechnical borings will provide localized information about geological characteristics that could influence the rate of groundwater flow through the soils (e.g. the presence of sands, gravels, clays, and other soil materials). The site-specific information would be used to determine the extent of the zone of influence, the potential for changes in groundwater elevation and for design and implementation of the groundwater impact reduction measures described in this memorandum.

Mitigation Measure GW-1 in the DEIR/DEIS described a monitoring program with potential actions to offset impacts, such as: (a) installation of sheet piles at the construction site to depths below groundwater elevations to reduce groundwater dewatering actions, (b) deepening or modifying affected water supply wells to maintain water supplies at preconstruction levels, or (c) securing potable water supplies from offsite sources for homes and businesses with affected potable water supply wells. This mitigation measure will be retained in the Final EIR/EIS.

Although the project description in the RDEIR/RDEIS was revised to include the use of slurry walls and other measures that would reduce groundwater impacts, the analysis of groundwater impacts of the proposed project in the RDEIR/SDEIS continued to be based upon the construction methods at the intakes and forebays as described in the DEIR/DEIS. Therefore the conclusions in the RDEIR/RDEIRS remained similar to the conclusions in the DEIR/DEIRS.

1.2 Groundwater Impact Analysis of Operations Effects in the DEIR/DEIS and RDEIR/SDEIS

The potential effects on groundwater during operations were analyzed as described under Impact GW-5.

Impact GW-5: *During Operations of New Facilities Interfere with Agricultural Drainage in the Delta*.

The groundwater impact analyses presented in the DEIR/DEIS and the RDEIR/SDEIS identified potentially significant adverse impacts on agricultural drainage on adjacent fields near the forebays when the surface water elevation in the forebays occur at a higher elevation than the surrounding ground surfaces. The analysis assumed that the embankments of the Intermediate Forebay and the Clifton Court/Byron Tract Forebay would be designed to avoid water flow through or under the embankments in accordance with the California Department of Water Resources (DWR) Division of Safety of Dams requirements. As described in the DEIR/DEIS, the forebays would include a seepage cutoff wall within the embankment around each forebay to prevent water from moving through the embankment. It was assumed that the seepage cutoff wall would be constructed to a depth that would allow the wall to be sealed to an impermeable layer of clay or bedrock to avoid water from flowing under the seepage cutoff wall. A toe drain would be constructed on the land-side of the embankment to collect water that collected on the land-side of the embankment due to either runoff or any residual seepage that did occur. Water collected in the toe drain would be pumped into the adjacent forebay.

The DEIR/DEIS and RDEIR/SDEIS impact analyses determined that these measures would generally reduce seepage, or the occurrence of increased groundwater elevations. However, no soil borings were available at that time of the preparation of the DEIR/DEIS for review by the groundwater analysis team. If the local geologic conditions did not include the presence of an impermeable layer around the entire forebay, during periods when the surface water elevation in the forebays were near or at the maximum elevations, it could be possible that water could flow under the embankment at depths below the seepage cutoff walls and increase the surrounding groundwater elevations. Although increased groundwater elevations would generally be beneficial for groundwater supply wells, high groundwater elevations that occur within 0 to 10 feet of the ground surface could interfere with agricultural practices near the forebays. Many of the agricultural areas in the Delta currently use drains to reduce the groundwater elevations near the ground surface. The additional flows under the embankments and deep seepage cutoff walls could create more flows than the current drain capacities. To reduce these impacts to a level of less than significant and not potentially adverse, Mitigation Measure GW-5 identified implementation of a monitoring program with potential actions to offset impacts, such as: (a) installation/improvement of subsurface agricultural drainage or an equivalent drainage measure, and (b) interceptor wells to reduce groundwater elevations to pre-construction conditions.

The DEIR/EIS and the RDEIR/EIS project descriptions currently state that in some instances construction of improved drainage systems and/or installation of French drains and/or interceptor wells may result in costs that would be imprudent to bear in light of the fair market value of the affected lands. However, if the seepage mitigation measures described herein are implemented for any lands where the seepage potential may occur and which are not acquired by DWR, the residual impact that would be less than significant and not potentially adverse to drainage facilities on lands near the forebays.

2.0 Updated Information for the Groundwater Analysis in the EIR/EIS

Following publication of the RDEIR/SDEIS, additional information was compiled by DWR and reviewed by the EIR/EIS groundwater analysis team. This information and the proposed changes to the impact analysis to be included in the Final EIR/EIS are summarized in this section of this memorandum. The updated information is related to the use of deep slurry cutoff walls at the intakes, tunnel shafts, and forebays during construction; and use of seepage control methods near the forebays during operations.

2.1 Use of Slurry Cutoff Walls to Reduce Adverse Effects on Groundwater Elevations during Construction

Slurry walls are a method to control groundwater at a site using a low-permeability, sub-surface, cutoff wall[1]. The slurry walls can be constructed in areas with high groundwater, such as the intake locations adjacent to the Sacramento River. Slurry walls are constructed by excavating a trench through relatively permeable soils where the groundwater occurs (e.g., sands and gravels) to a layer of impervious materials (e.g., clays or bedrock). The trench is then filled with a slurry of a clay-like material (e.g., bentonite or bentonite-cement). The water moves from the slurry into the adjacent soil, and the clay-like material forms a low-permeable coating on the sides of the trench that minimizes groundwater from filling the trench. The bottom of the trench is generally located within a naturally impermeable soil layer or constructed with an impermeable or low-permeable material.

In the early 1900s, slurry trench methods were initially used to stabilize deep oil wells.[2] The use of bentonite clays in the slurry methods began in 1929 to stabilize unconsolidated materials at excavated sites. By the late 1930s, slurry methods were used to construct continuous diaphragm walls in Milan, Italy. In the 1940s, the U.S. Army Corps of Engineers used slurry walls at Terminal Island, California to control salt water intrusion and along the Mississippi River to control water flowing through and under the levees. The use of slurry walls was improved after 1969 when a combination of bentonite and cement (or similar materials) were combined with water to allow the slurry to more rapidly harden in the excavated trench. The slurry walls can be constructed for temporary groundwater and seepage control, or combined with other diaphragm wall components or panels to become part of the permanent structure.

Installation of permanent hydraulic barriers using slurry cutoff walls (as included in the proposed project description) are frequently used in areas with high groundwater elevations to form a permanent hydraulic barrier between the groundwater aquifer and the excavated area required for construction of buildings or water storage basins. Slurry cutoff walls can be installed in areas with high groundwater with no dewatering or with only minimal localized dewatering actions, through the use of continuous trenching/slurry placement or the use of panels that can be driven to depths below the groundwater to form a trench with the slurry placed within portions of the panels. The depth of the slurry cutoff wall generally extends to an impermeable soil layer (e.g., clay soils) at a depth lower than the invert elevation of the excavation (or bottom floor of the structure to be constructed [e.g., intake or tunnel shaft]). If the impermeable layer is not continuous along length of the slurry cutoff wall, grout is frequently injected along the base of the slurry cutoff wall to more fully connect the wall to the impermeable layer. Groundwater that previously moved horizontally through the soil toward the excavation location would then be redirected by the slurry cutoff wall to move around the wall and construction site.

The slurry cutoff wall could be lined with hard panels to provide structural support during construction, or the slurry cutoff wall could be formed using a concurrent and continuous excavation/slurry placement method depending upon the local geological conditions and the width of the wall. The slurry cutoff wall could extend to depths of more than 150 feet. Following placement of the slurry cutoff wall around a construction site and installation of any additional structures that would be needed to support

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[1] U.S. Department of the Interior, Bureau of Reclamation, 2014, *Design Standards No. 13, Embankment Dams, Chapter 16: Cutoff Walls, Phase 4 Final*, July.

[2] U.S. Environmental Protection Agency, 1984, *Slurry Trench Construction for Pollution Migration Control, EPA-540/2-84-001*, February.

the walls of the excavated area, excavation of the site could begin. The initial activity would include dewatering within the slurry cutoff walls. Dewatering within the slurry cutoff walls would either not affect, or have only a minimal effect on, adjacent groundwater wells and elevations depending upon the geological conditions because the slurry cutoff wall would isolate the groundwater within the construction site from the remaining portions of the aquifer.

2.1.1 Use of Slurry Cutoff Walls for the Conveyance Facilities

Groundwater conditions are generally within 5 to 10 feet of the ground surface near the intake locations along the Sacramento River, the Intermediate Forebay near tributaries of the Sacramento River, or tunnel shafts and Clifton Court/Byron Tract Forebay near the Delta sloughs. Near the intakes and the Intermediate Forebay, groundwater generally flows from the east towards the Sacramento River. However, at the intake locations, water from the river also flows from the river towards the land if the groundwater under the land is at a lower elevation than the surface water elevation in the river. The bottom elevation (or invert) of the intake structures, tunnel shafts, and forebays will be below the groundwater elevation prior to construction. Therefore, a method needs to be used during construction to remove the groundwater prior to excavation and construction of the structures.

As described above in Section 1.0 of this memorandum, the method considered in the DEIR/DEIS to remove the groundwater involved construction of a series of dewatering wells to remove the groundwater from the site at a higher rate than the groundwater moves towards the excavation location. The use of dewatering wells would result in the decline of groundwater over a greater area than just the construction site due to the manner that groundwater moves through the surrounding soils. The extent of the groundwater elevation decline (zone of influence) both in horizontal and vertical distances is dependent upon the local geological conditions and the rate of groundwater recharge from adjacent areas. In general, the zone of influence appears in a circular pattern and the reduction in groundwater elevation is reduced as the distance increases from the dewatering wells (see Figure 1 at the end of this memorandum). As described in Section 1.0, the extent of the zone of influence near the construction sites considered in the DEIR/DEIS and RDEIR/SDEIS would be up to 2,600 feet from the dewatering well locations.

For the proposed project to reduce the potential for changes in groundwater elevations or wells in areas near the construction sites, the revised proposed project description includes use of slurry cutoff walls in the following manner:

- Intakes: Deep slurry cutoff walls at the intakes would be installed to reduce or avoid levee under-seepage in accordance with USACE requirements and to reduce the groundwater inflow into deep excavations within the intake construction sites. The deep slurry cutoff walls would be installed around the structures to reduce the need to use dewatering wells and the related effects on groundwater conditions near the construction locations. The structures at the intake locations to be constructed below the ground surface would be constructed using impermeable structural material (e.g., concrete). Along the Sacramento River, cutoff walls would be extended into the levees in accordance with USACE requirements and a sheet pile cofferdam would be constructed prior to dewatering and excavation of the site.
- Tunnel Shafts: Slurry diaphragm walls would be installed prior to construction of the tunnel shafts to minimize the need for dewatering. The tunnel shafts and the bottom of the tunnel shafts would be constructed of impermeable material to prevent groundwater from entering the tunnel.
- Forebays: Deep slurry cutoff walls at the forebays would be installed to reduce or avoid levee under-seepage in accordance with Division of Safety of Dams requirements for water storage facilities. The

deep slurry cutoff walls around the forebays would reduce the need to use dewatering wells and the related effects on groundwater conditions near the construction locations. At Clifton Court Forebay, new embankments around the construction site would include installation of a sheet pile cofferdam prior to dewatering and excavation of the site.

Construction of slurry cutoff walls along the water bodies at the intake locations and the forebays would extend to the levees where the slurry cutoff wall would connect to a diaphragm wall installed along the levee. The diaphragm wall would serve as a structural wall for the intake. The combination of the diaphragm wall and the slurry cutoff wall would force water from adjacent water bodies to remain in the water bodies (e.g., Sacramento River and sloughs). The conceptual design currently envisions that a second slurry cutoff wall would be constructed along the backside of the intake structure sites. This slurry cutoff wall would be tied into the proposed slurry cutoff wall that parallels the river or sloughs. In this arrangement, the entire ground area within the slurry cutoff wall perimeter could be dewatered without impacting surrounding groundwater levels. On the land-side of the intake locations and the forebays, the slurry cutoff wall would force groundwater moving from the land-side towards the water bodies to flow around or under the wall towards the river or slough (see Figure 1). This method was used during construction of the intake on the Sacramento River near Freeport by the Freeport Regional Water Authority. Construction at the Freeport intake only included slurry cutoff walls along the Sacramento River levee because high groundwater conditions were not prevalent on the land-side of the intake.[3]

The slurry cutoff wall would extend to a depth below the invert elevation of the excavation to allow for removal of groundwater below the excavation and formation of a structurally-sound foundation for the intake, levee, or other structure. The depths of the slurry cutoff wall would be dependent upon the local geology and could change even at the same intake location or along the forebay levee. The design objective would be to extend the slurry cutoff wall to a clay layer that would be allow the wall to form a relatively good seal that would force the groundwater to move around or under the slurry cutoff walls.

Information from recent geotechnical borings was recently provided to the EIR/EIS groundwater impact analysis team. This information indicated the presence of 10 to 20 foot thick clay layers located at depths of 50 to 140 feet below the ground surface near the intakes and Intermediate Forebay, and at depths of 0 to over 140 feet below the ground surface near Clifton Court/Byron Tract Forebay. The clay layers are interwoven with silty clay and sandy soils throughout the geotechnical borings. The borings are located near the actual construction sites, but not necessarily within the construction sites. The results of these borings are indicative of the geotechnical conditions. However, during design additional geotechnical borings will be completed to develop specific design criteria for slurry cutoff walls and seepage control methods at each location. It is anticipated that the design criteria will not only be different for each site, but will change along the extent of the slurry cutoff wall at each site as the geologic conditions can change within 50 to 100 feet in many locations in the Delta. It should be noted that some of the information from these initial borings indicate different geological conditions than the U.S. Geological Survey assumed in the CVHM model that was used in the EIR/EIS analysis including an increased presence of clay layers. This type of information would result in different groundwater flow and recharge rates, groundwater dewatering rates, horizontal extents of the zone of influence, and depths of groundwater elevation changes.

[3] 2006, Freeport Regional Water Authority, *Contract No. FIP510, Freeport Regional Water Project, Intake Facilities, Bid Documents, Drawings*, December.

2.1.2 Modification of the Groundwater Impact Analysis for the Final EIR/EIS

Based upon this additional information provided to the EIR/EIS groundwater impact analysis team related to the use of slurry cutoff walls to be installed around the intake locations, tunnel shafts, and forebays, the revised impact analysis results indicate that the extent of changes in groundwater elevations near these construction sites would be substantially reduced from those described in the DEIR/DEIS and RDEIR/SDEIS. Based upon the use of slurry cutoff walls at the intake locations, tunnel shafts, and forebays, it is anticipated that potential adverse impacts identified in the DEIR/DEIS and RDEIR/SDEIS would be reduced to a level of less than significant. It is assumed that the mitigation measures would continue to include a monitoring program and commitments included in Mitigation Measure GW-1 to extend the depth of groundwater wells if groundwater elevations declined below the pump inlets as compared to pre-construction conditions.

2.2 Use of Seepage Control Methods to Reduce Adverse Effects on Groundwater Elevations during Operations

The intake structures, tunnel shafts, and tunnels would be constructed with impermeable materials (e.g., concrete) to prevent groundwater from entering these structures. Therefore, water also would not be able to move from within these structures to the adjacent groundwater.

The forebays would be constructed with slurry cutoff walls and seepage cutoff walls around the embankments. These walls would avoid or minimize water from flowing through the embankments in accordance with the DWR Division of Safety of Dams requirements. The impermeable or low-permeability slurry cutoff walls and seepage cutoff walls would extend to an impermeable soil layer. As described in Section 2.1 of this memorandum, the impermeable layers could be discontinuous around the perimeter of the forebays. In those areas, the potential for groundwater flow at depths under the embankments could be minimized through the placement of grout along the bottom of the slurry cutoff walls and seepage cutoff walls.

The material along the bottom of the forebays could range from impermeable to low-permeability soils. When the surface water elevations in the forebays rise towards the maximum design surface water elevation, the weight of the water has the potential to result in deep groundwater flow under the slurry cutoff walls and seepage cutoff walls. This condition could increase groundwater elevations adjacent to the forebays. If this were to occur, the results could be beneficial to nearby groundwater supply wells and create adverse impacts to nearby agricultural fields if the groundwater causes ponding or cause the groundwater to rise within the root zone of plants. The use of toe drains, as described in the proposed project description, and implementation of a groundwater monitoring program with improved drainage systems and/or installation of French drains and/or interceptor wells (as described in Mitigation Measure GW-5 in the DEIR/DEIS and the RDEIR/SDEIS) would mitigate this potential and result in an impact that would be less than significant and not potentially adverse to drainage facilities on lands near the forebays, as described in the DEIR/DEIS and the RDEIR/SDEIS. This portion of the groundwater impact analysis would continue to be included in the Final EIR/EIS.

The DEIR/EIS and the RDEIR/EIS project descriptions currently state that in some instances construction of improved drainage systems and/or installation of French drains and/or interceptor wells may result in costs that would be imprudent to bear in light of the fair market value of the affected lands. However, if the seepage mitigation measures described herein are implemented for any lands where the seepage potential may occur and which are not acquired by DWR, the residual impact that would be less than significant and not potentially adverse to drainage facilities on lands near the forebays.

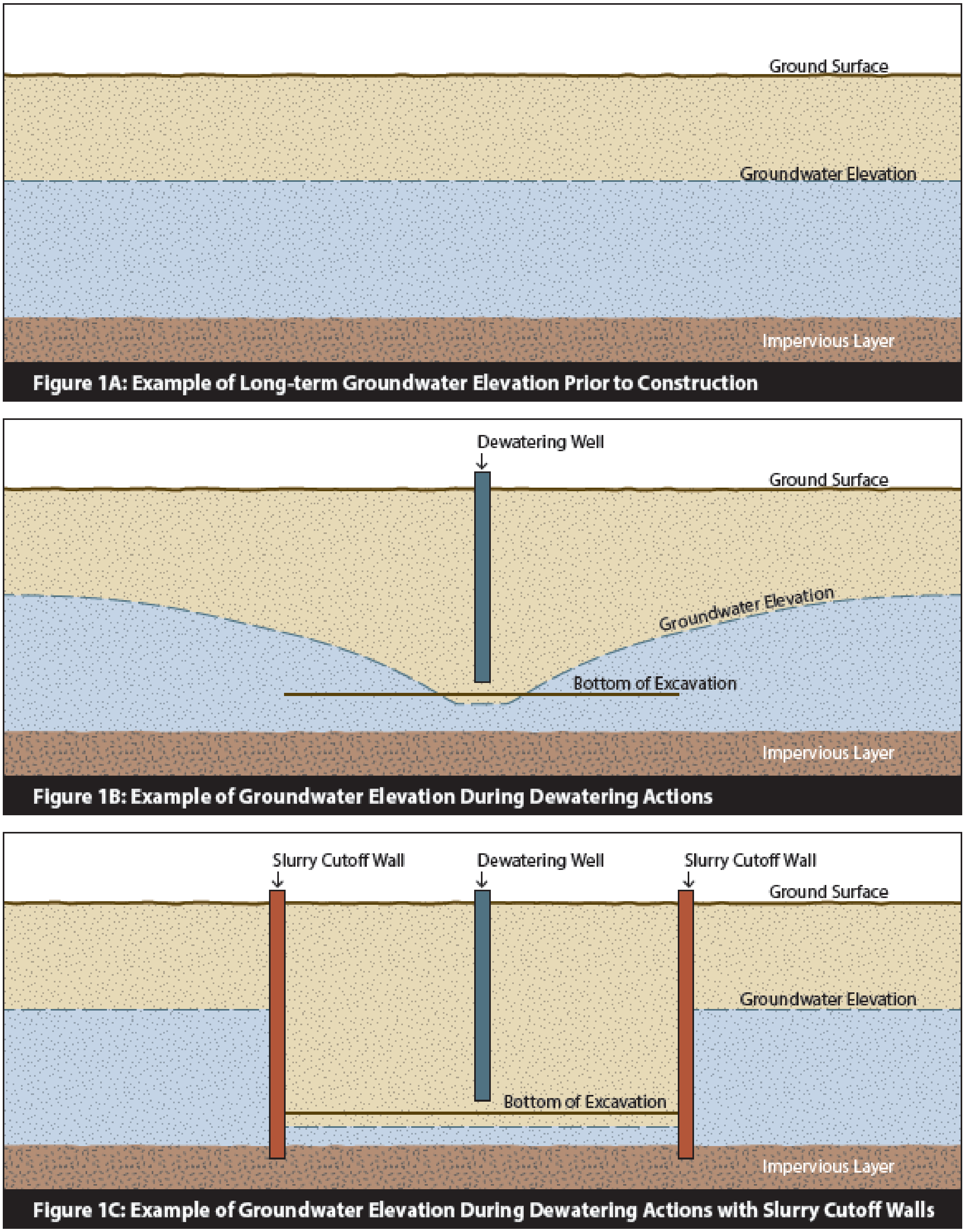

Figure 1A: Example of Long-term Groundwater Elevation Prior to Construction

Figure 1B: Example of Groundwater Elevation During Dewatering Actions

Figure 1C: Example of Groundwater Elevation During Dewatering Actions with Slurry Cutoff Walls

Figure 1
Changes to Groundwater Elevations due to Dewatering Actions with and without Slurry Cutoff Walls