Groundwater Technical Report

for the

Halligan Water Supply Project Environmental Impact Statement

Prepared for

U.S. Army Corps of Engineers

Omaha District

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<tr>
<td>3PC</td>
<td>third party contractor</td>
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<tr>
<td>AF</td>
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<td>C-BT</td>
<td>Colorado-Big Thompson</td>
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<td>Colorado Department of Public Health and Environment</td>
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<tr>
<td>mg/L</td>
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<td>North Fork Cache La Poudre River</td>
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<td>NPIC</td>
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1 Introduction

A technical consulting team prepared this groundwater technical report for the Halligan Water Supply Project (Halligan Project). The Halligan Project Environmental Impact Statement (EIS) will summarize the information in this report. This report presents descriptions of potential environmental effects to groundwater associated with the City of Fort Collins' (Fort Collins) Proposed Action, three alternatives to Fort Collins' Proposed Action, and the No-Action Alternative.

1.1 Description of Alternatives

The U.S. Army Corps of Engineers conducted a screening process to identify alternatives to Fort Collins' Proposed Action that met the future water demands for Fort Collins as stated in the "Purpose and Need Report" (WEST et al. 2016). "The Alternatives Screening Report" (DiNatale Water Consultants and CDM Smith 2016) presents the screening process and the three alternatives identified along with the No-Action Alternative. As part of the screening process, Fort Collins provided details regarding the construction, water conveyance, technical aspects and assumptions for the Fort Collins' Proposed Action, three alternatives, and the No-Action Alternative that are discussed in the "Final Alternatives Description Report" (MWH 2015). The hydrologic models utilized and the associated outputs are described in the "Hydrologic Modeling Technical Report" (CDM Smith and DiNatale Water Consultants 2016). For this report, we present a brief overview of the Fort Collins' Proposed Action, three alternatives, and the No-Action Alternative for a general understanding.

All of the alternatives include water storage with the exception of the No-Action Alternative. Under Fort Collins' Proposed Action and each alternative, Fort Collins proposed to store the same existing water rights including converted Southside Ditch rights, reusable Water Supply and Storage Company rights, the conditional Grey Mountain right, and the conditional water right associated with the enlarged Halligan Reservoir with a priority date of 2014, if approved.

1.1.1 Fort Collins' Proposed Action

Fort Collins' Proposed Action is to enlarge the Halligan Reservoir, which is located on the North Fork Cache La Poudre River (North Fork) about 25 miles northwest of Fort Collins. Currently, the North Poudre Irrigation Company (NPIC) owns the entire water storage capacity of 6,400 acre-feet (AF) at the Halligan Reservoir. Fort Collins would increase the capacity by 8,125 AF for a total water storage capacity of 14,525 AF. The current maximum surface area of the Halligan Reservoir is 253 acres, while the maximum surface area of the enlarged reservoir would be approximately 386 acres. Fort Collins has applied for a conditional water right for the storage of water in the enlarged Halligan Reservoir with a priority date of 2014. To enlarge the existing reservoir, Fort Collins would raise the existing dam an estimated 25 feet. In general, Fort Collins would enlarge the reservoir by expanding the foundation on the downstream face of the
dam approximately 8 to 12 feet and make the dam thicker and taller while maintaining a geometry similar to the existing dam. Preparation for the foundation would require rock excavation along the abutments and valley bottom outside of the existing footprint. During construction, the North Fork would bypass the construction via a temporary cofferdam and outlet pipes.

Fort Collins cannot directly divert water released from Halligan Reservoir into its existing intake facilities that convey water to the Fort Collins water treatment facility. Under its Proposed Action, Fort Collins would release water from Halligan Reservoir into the North Fork and allow that water to flow down the North Fork into and through the Seaman Reservoir until it reaches the Cache La Poudre River (Poudre River). Fort Collins would divert a similar amount of water at its intakes located on the Poudre River above the confluence with the North Fork. This process is referred to as an exchange and must be authorized by a court issued exchange decree. Fort Collins has two separate intakes on the main stem of the Poudre River: 1) the existing City of Fort Collins Pipeline via its diversion structure located at Gateway Park, and 2) the Pleasant Valley Pipeline via the existing Munroe Canal (a.k.a. North Poudre Supply Canal or Munroe Gravity Ditch) diversion structure.

Fort Collins would develop the following infrastructure and construction areas in association with this alternative (Figure 1-1): the raised Halligan dam, new outlet works, a cofferdam and temporary outlet pipes, a temporary bridge below the existing dam to access both sides of the North Fork during construction, staging areas, a batch plant, burrow pits, and access roads.
Figure 1-1. Fort Collins' Proposed Action.
1.1.2 Expanded Glade Alternative

The Expanded Glade Alternative would provide Fort Collins with 6,075 AF of water storage through the expansion of the proposed Glade Reservoir. The Expanded Glade Alternative is contingent on the Corps permitting the Glade Reservoir. Glade Reservoir is a 170,000 AF reservoir that is part of Northern Colorado Water Conservancy District’s (Northern Water) proposed action analyzed in the Northern Integrated Supply Project Supplemental Draft EIS (NISP SDEIS 2015). Under this alternative Fort Collins would operate its storage in the enlarged Glade Reservoir independently, enlarging and using several components of the proposed Glade Reservoir infrastructure to store and release water from the reservoir. Fort Collins would require some additional infrastructure. The expansion would require raising the dam approximately 4 feet higher than the NISP design. The maximum surface area of the expanded Glade Reservoir is expected to be approximately 1,693 acres which is 57 acres more than the maximum surface area of the Glade Reservoir proposed by NISP.

Fort Collins would deliver water through the Poudre Valley Canal to the NISP proposed diversion point into Glade Reservoir. This diversion point and the Poudre Valley Canal would need to be enlarged to accommodate both NISP and Fort Collins water inflows simultaneously. Fort Collins would temporarily retain the diverted water in the Glade Forebay and then pump it into the reservoir. Fort Collins would release water through the Glade Dam infrastructure and either route the water to the Poudre River for use in an exchange or send it directly into Fort Collins existing raw water supply lines. Fort Collins would construct a new pipeline that would connect the Glade Reservoir outlet pipeline to Fort Collins' existing pipelines and the Pleasant Valley Pipeline. Fort Collins could release water into Fort Collins' new pipeline and then into the Poudre River at a river turnout in exchange for water diverted by Fort Collins upstream of the confluence with the North Fork. Alternatively, Fort Collins could direct water to a new pretreatment facility co-located with the Glade Pump Station at the foot of the dam and then convey the water through its new pipeline to its existing raw water supply lines.

Fort Collins would develop the following infrastructure in association with this alternative (Figure 1-2): the raised Glade dam, increased depth to the NISP proposed forebay, larger or additional pumps located at the NISP pump station, a pretreatment facility, a pipeline from the pretreatment facility to the raw water supply lines, and a river turnout on the new pipeline.
Figure 1-2. Expanded Glade Alternative.
1.1.3 Gravel Pits Alternative

The Gravel Pits and Joe Wright Reservoir Reoperation Alternative (hereafter Gravel Pits Alternative) would involve using a complex of gravel pits on the north side of the Poudre River near Taft Hill Road for water storage. The eight interconnected cells at the gravel pit complex would provide approximately 3,875 AF of combined water storage. After the gravel pits are completed, Fort Collins would excavate additional storage within the area of the permitted gravel pit, if needed, to achieve the desired water storage. Two of the existing pits outside the floodplain would likely require above-grade storage achieved by the construction of 20-foot tall berms around the perimeter of the pit. Twenty-foot-high berms are classified as jurisdictional dams under the Colorado Division of Safety of Dam criteria (Colorado Division of Water Resources 2016) and would require specific design standards provided by the Colorado State Engineer. The final design would require the approval of the Colorado State Engineer prior to construction.

Generally, Fort Collins would convey water from the Poudre River to the gravel pits and then release the water from the gravel pits back to the Poudre River for exchange or into the existing Fort Collins raw water pipelines. To move water to the gravel pits, Fort Collins would divert water from the Larimer County No. 2 Canal diversion structure south of the Poudre River. Fort Collins would install a 42-inch pipeline beneath the riverbed to carry water north to the gravel pits. Water would enter the gravel pit complex at the Stenger pit or Home Office pit, and would flow to other pits by gravity, or in some cases, by pumping into the North Shores No. 1 pit, depending on the difference in water levels between the Stenger and North Shore pits.

For an exchange, Fort Collins would release water from the gravel pits into new pipelines and then into the Poudre River at a turnout located on the north bank in exchange for water diverted into its intakes higher up on the Poudre River. The other option would be for Fort Collins to pump water to a pretreatment facility. The pretreatment facility would improve the water quality to levels similar to the water diverted at Fort Collins' intakes, and would deliver this pretreated water directly into the Fort Collins raw water supply lines.

As part of this alternative, Fort Collins would store more water over the winter at Joe Wright Reservoir by authorizing fewer single use water trades with the NPIC. No physical changes are required for this operational change.

Fort Collins would develop the following infrastructure in association with this alternative (Figure 1-3): new pipelines, three pump stations, a pretreatment facility, diversion structure, staging areas, and access roads.
Figure 1-3. Gravel Pits Alternative.
1.1.4 **Agricultural Reservoirs Alternative**

For the Agricultural Reservoirs Alternative, Fort Collins would achieve additional water storage by procuring dedicated space in two existing reservoirs: NPIC Reservoir No. 5 and Reservoir No. 6. These reservoirs are interconnected and can be operated as a single element. The reservoirs are located approximately 9 miles northeast of the Fort Collins water treatment facility. The feasibility of this alternative depends on Fort Collins and NPIC being able to manage its storage capacity independently. The combined reservoirs have a capacity of 17,830 AF, so Fort Collins would need to acquire 6,475 AF that would constitute approximately 36 percent of the available combined capacity of the two reservoirs. Fort Collins would acquire the storage in the reservoirs through a purchase and operating agreement with NPIC. Fort Collins would need to independently own, operate, and otherwise control the water storage for it to count towards its safety factor. If an acquisition were to be possible, Fort Collins would need to compensate NPIC for loss of water capacity, loss of water rights, and any detrimental consequences inflicted to NPIC's system or shareholders.

Fort Collins would divert water from the Poudre River at the Munroe Canal diversion structure and convey the water by gravity into the Pleasant Valley Pipeline and through a new bi-directional 48-inch diameter pipe ending at the control valve by the Reservoir No. 6 outlet. From Reservoir No. 6, a new dedicated pipeline would convey the water to Reservoir No. 5 using a pressurized conveyance system eliminating the need for a pump.

Similar to the Gravel Pits Alternative, Fort Collins would have two options for water released from Reservoirs Nos. 5 and 6: either to use the water in an exchange or direct the water into Fort Collins existing raw water supply lines. For an exchange, Fort Collins would release water from the reservoirs into the bi-directional pipeline and then into the Poudre River at a turnout located on the north bank in exchange for water diverted into its intakes on the Poudre River above the confluence with the North Fork. The other option would be for Fort Collins to pump water to a pretreatment facility and then into the Fort Collins' raw water supply lines. The pretreatment facility would improve the water quality to levels similar to the water diverted at Fort Collins' raw water intakes. Fort Collins would release water for exchanges when possible to reduce the amount of pumping required.

Fort Collins would develop the following infrastructure in association with this alternative (Figure 1-4) new pipelines, a valve house, a pump station, a pretreatment facility, diversion structure, staging areas, and access roads.
Figure 1-4. Agricultural Reservoir Alternative.
1.1.5 No-Action Alternative

The No-Action Alternative, unlike the action alternatives, does not involve structural changes to existing infrastructure or development of new structures associated with the Fort Collins water supply system. The No-Action Alternative is an administrative approach to try to meet as much of the city's purpose and need as possible with the three following measures.

- Fort Collins would change its operational procedures at its existing Joe Wright Reservoir to store more water over the winter.
- Fort Collins would acquire additional NPIC shares either through direct purchase of shares or by requiring residential and commercial development to provide dedicated shares.
- Fort Collins would implement mandatory water use restrictions during drought periods and system failures.

All components of the No-Action Alternative are non-structural and require no ground disturbance of any type.

Under the first measure of its No-Action Alternative, Fort Collins would conduct fewer single-use water transactions with NPIC to maintain a higher water level at the Joe Wright Reservoir over the winter, similar to the Gravel Pits Alternative. Fort Collins would set the winter carryover capacity for Joe Wright Reservoir at 3,200 AF. To sustain this level, Fort Collins would need to cut the amount of late summer and fall distribution of single-use water for subsequent exchange with NPIC. NPIC has previously accepted these single use exchanges of Joe Wright Reservoir water for NPIC's Colorado-Big Thompson (C-BT) water stored in Horsetooth Reservoir, which has been mutually beneficial for Fort Collins and NPIC. Fort Collins benefitted from the water exchanges by reducing the amount of single use water stored in Joe Wright Reservoir allowing storage space for more reusable use water collected in the spring from Michigan Ditch. For NPIC, the exchanges allowed water diversion at Munroe Canal during times when the exchange potential for moving C-BT water upstream to the Munroe Canal was low. This reoperation option would require no new infrastructure and would provide no new storage capacity for Fort Collins.

Under the second measure of its No-Action Alternative, Fort Collins would either directly purchase NPIC shares or require future developers to dedicate NPIC shares to Fort Collins as a condition of future development. NPIC shares would specifically need to have a C-BT storage component. Acquiring NPIC shares provides Fort Collins additional C-BT water and its associated storage. Northern Water has imposed limitations on the amount of additional C-BT shares Fort Collins can directly purchase. However, it would be permissible for Fort Collins to acquire C-BT units by purchasing NPIC shares or through dedication from developers. Fort Collins has deliberately focused on developing its Poudre River sources to diversify its system as it already owns a large amount of C-BT shares.
The third measure Fort Collins would enact as part of the No-Action Alternative is to impose more frequent and severe mandatory water restrictions. Fort Collins has already implemented a "Water Supply Shortage Response Plan" (2003; revised in 2013) to address drought and emergency water supply situations. The plan provides four response levels to address various levels of supply shortage severity. Since its inception in 2003, Fort Collins has imposed mandatory water restrictions (Response Level 1) twice: in 2003 to respond to the early 2000s drought, and in 2013 in response to a drought and water quality impacts of the High Park Fire. Under the No-Action Alternative, water supply shortages would likely be more frequent and severe and water restrictions would be implemented more frequently, would be more severe, and would last longer. Mandatory water use restrictions would not create additional firm water yield or storage capacity, but the approach would extend available supplies during a drought or interruption in water supply. However, modeling suggests that during the design drought, even with restrictions, Fort Collins would not be able to maintain a reserve of water equal to 15 percent of Fort Collins' average annual demand as a buffer in case of storage or delivery system failure, forest fire, adverse unexpected water court rulings, or other unanticipated stressors on the its water delivery system. This would make Fort Collins vulnerable to water shortages and the possibility of water shutoffs if an unforeseen event disrupted the water supply system.

For further details on this alternative or the other proposed alternatives, please see the "Final Alternatives Description Report" (MWH 2015).

1.2 Regulatory and Management Framework

The Colorado Division of Water Resources (CDWR) oversees groundwater and surface water administration in the State of Colorado. Surface water and groundwater in connection with surface water in Colorado is administered according to the Prior Appropriation Doctrine (often referred to as first in time, first in right). Once these rights are issued a decree date, they are given an administration number which states their priority. Earlier water rights have seniority, meaning they are entitled to their water prior to water rights with a lower priority (junior) to them. Surface water diversions were typically developed before most groundwater (well) water rights.

Groundwater administration and enforcement is one of the primary responsibilities of the CDWR, led by the State Engineer. By law, every new well in the state that diverts groundwater must have a well permit. To obtain a permit, a person must file an application for approval of a permit with the State Engineer.

The discharge of groundwater encountered in excavations that extend below the water table may be required by the various alternatives under review for the project, and must be permitted through a General Permit for Construction Dewatering Activities (COG-070000) from the Colorado Department of Public Health and Environment (CDPHE).
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2 Methods

In this section, we describe the methods we used to qualitatively assess potential impacts to groundwater resources resulting from construction and operation of the alternatives described in Section 1.1. Groundwater resources are subsurface water that is present in aquifers. Groundwater may support beneficial uses such as water supply or maintenance of wetlands or riparian communities. Prior technical reports supporting the NISP DEIS and SDEIS summarized existing information and were used as the principal source of information. Sources of information are included in Section 6, Literature Cited.

Our analysis area included a 0.5-mile radius buffer surrounding all infrastructure associated with each alternative, including reservoir footprints, pipeline and pump station footprints, and construction disturbance areas, staging areas, and material borrow areas identified in the Fort Collins Alternative Descriptions Report (MWH 2015). Propagation of significant impacts beyond this distance is unlikely based on the hydrologic characteristics in each of the areas. Information on sites within the 0.5-mile buffer that had potential releases of contaminants to the environment summarized in Hazardous Site Technical Report was considered in the analysis of potential impacts. We evaluated current use of groundwater by querying the CDWR well permits database within the buffer area.

Analysis of the relationship between changes in stream stage and corresponding changes in groundwater levels on the North Fork was conducted for four well transects at three locations. Each transect consisted of a stream stage gage and two observation wells in adjacent alluvial materials. Weekly changes in stream stage and groundwater levels are available for a 2-year period. Appendix A provides copies of the well completion reports, while Appendix B presents average weekly groundwater and stream stage elevations at each transect. The change in groundwater level as a percentage of the change in stream stage was assessed to allow analysis of potential impacts on riparian areas under operating conditions. This is the same method used in the NISP EIS identified below.

Data and analysis documented in the NISP EIS were also utilized in this qualitative assessment. Specific studies were conducted along the Cache la Poudre from where it exits the foothills to Greeley, which are relevant to the Gravel Pits Alternative. These investigations included installing a series of wells in transects across the alluvial valley, monitoring groundwater levels and stream stage, conducting limited water quality sampling for total dissolved solids and hydraulic testing. (ERO, 2012). The total dissolved solids in the alluvial groundwater ranged from 276 to 2,090 milligrams per liter (mg/L). There are no enforceable standards for total dissolved solids in groundwater. There is a secondary standard of 500 mg/L for drinking water that is based on aesthetics.
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3 Affected Environment

3.1 Fort Collins’ Proposed Action

3.1.1 Hydrogeologic Setting

The existing Halligan Reservoir is on the North Fork, which is in a narrow canyon eroded into Precambrian igneous and metamorphic rocks on the eastern slope of the Rocky Mountain System (U.S. Army Corps of Engineers [the Corps], 1981). These igneous and metamorphic rocks are generally dense with no significant open pore space, other than what is associated with fractures. The groundwater flow within the basin is generally controlled by structural factors such as faulting and shear zones (McCain et al., 1979). As discussed in the Geology Technical Report Section 3.2.2 (CDM Smith 2016a), several significant fault zones are present in the Halligan Reservoir area that are likely to have enhanced fracturing. Limited alluvial deposits are present in some valley bottom areas downstream of the Halligan Reservoir dam, with a thickness of less than 20 feet.

When present, the alluvium generally consists of poorly sorted materials such as sand and gravel with silt and clay and there is a high percentage of boulders and cobbles. Several monitoring wells were installed in alluvium downstream of the existing Halligan Dam that indicate the presence of less than 20 feet of alluvial material overlying the bedrock. There are several permitted wells within the 0.5-mile buffer area of the Halligan Project where potential groundwater related impacts may occur (Figure 3-1). The wells located in alluvium downstream of the dam are monitoring wells installed as part of studies associated with the reservoir. One deep bedrock well is located about 0.5 miles from the reservoir. Water level changes in the deep bedrock aquifers associated with the alternative are not expected to be significant at existing wells due to the low permeability of the bedrock zones and the distance to the reservoir.

Anthropogenic activity minimally affects the groundwater flow pattern in the vicinity of the Halligan Project because the groundwater basin is located in a mountainous terrain in a narrow valley with limited alluvium. Activities such as groundwater well pumping, mining, cattle ranching, and construction activities have the potential to temporarily change the groundwater flow patterns but generally only in a localized area, due to the close connection between the stream and alluvial deposits. Groundwater flow in the fractured bedrock zones is likely a subdued reflection of topography, with flow generally toward valley areas. The North Fork receives diffuse discharge from the bedrock zones. Groundwater flow in the limited extent of alluvial deposits is typically down the valley trend, and locally toward the river channel. Water levels in the alluvial aquifer are expected to respond rapidly to changes in river stage near the channel, with a damped response distant from the channel. Water level impacts in the fractured bedrock will likely be localized due to the relatively low hydraulic conductivity. Water levels adjacent to the reservoir in the fractured bedrock aquifer will track reservoir levels in the area adjacent to the shoreline have a similar gradient away from the reservoir as before the proposed
action. The source of water for the increased storage would be from a new water right that would allow storage of water during high flows when downstream earlier priority demands are being met, as described in Section 1.
Figure 3-1. Fort Collins' Proposed Action Groundwater Wells.
3.1.2 Groundwater Quality

Anthropogenic activity minimally affects the groundwater quality in the vicinity of the Halligan Project due to limited development in the area. Some localized impact is possible due to waste disposal using septic tanks and leach fields, however, no changes in impact are associated with implementation of the preferred alternative would occur. No residential leach fields are located adjacent to the reservoir, and groundwater level changes in downgradient alluvial materials due to operation of the alternative are small and will not changes impacts from existing residential waste disposal.

Groundwater within the vicinity of the Halligan Project is considered generally good quality, since discharge from the igneous and metamorphic bedrock aquifers is relatively low in total dissolved solids. Additionally, there are no known hazardous waste sites, including Leaking Utility Storage Tanks or Reportable Quantity Releases, with potential to adversely impact groundwater quality located within a 0.5-mile radius of the alternative footprint, based on analyses documented in the Hazardous Sites Technical Report (CDM Smith 2016b).

3.2 Expanded Glade Alternative

3.2.1 Hydrogeologic Setting

The proposed Glade Reservoir site is in a dry valley between hogback ridges. No perennial stream is present in this area. As described in the Geology Technical Report Section 3.3.1 (CDM Smith 2016a), the expansion areas associated with this alternative encompass side slopes and the upper portion of the valley area between hogback ridges. No significant alluvium is present within these expansion areas. However, in the lower reach of the reservoir that is part of the Glade Reservoir Alternative in the NISP SDEIS, alluvium of the Poudre River is present.

There are several permitted wells within 0.5-mile of area of the Glade Reservoir where potential groundwater related impacts may occur (Figure 3-2). This alternative will result in a rise in reservoir stage of up to 4 feet, which will not have any significant impact on water levels in adjacent wells. The source of the water for this alternative is described in Section 1. Monitoring wells were installed within the proposed Glade Reservoir footprint and downgradient of the proposed dam.

The steeply dipping sedimentary rocks within the footprint of the expansion area include variable rock types of Lower Permian to Cretaceous age. The sedimentary units strike approximately north-south and dip toward the east. A limited portion of the expansion area extends onto gneiss, which will have very limited permeability and is not considered an aquifer in this limited contact area. Groundwater flows through steeply dipping Paleozoic and Mesozoic sedimentary strata (Hershey and Schneider, 1972). These lithologic units formed as the result of marine and terrestrial sedimentation related to fluctuations in relative sea level and regional tectonic activity (Weimer and Sonnenberg, 1996).
3.2.2 Groundwater Quality

The groundwater basin within the proposed expansion areas, potential borrow areas, and associated conveyance construction disturbance areas is located in relatively flat lands of the Colorado Piedmont section of the Great Plains province. Anthropogenic activity does affect the groundwater quality in this region from the foothills to the confluence of the Poudre River with the South Platte River because of the agricultural practices, ranching, oil production, industry, and urbanization in the region.

The groundwater quality in the alluvial aquifer within the 0.5-mile buffer of the Glade Reservoir Alternative is presented in "Final Groundwater Technical Report for the Main stem of the Cache la Poudre River, Northern Integrated Supply Project, Supplemental Draft, Halligan-Seaman Water Supply Projects, Draft Environmental Impact Statements", prepared for the Corps Omaha District, dated January 2012 (ERO, 2012). This report noted that the groundwater quality downgradient of where the Cache la Poudre exits the foothills was good, with total dissolved solid less than 300 mg/L. A former Air Force site that has contaminated groundwater with low levels of TCE is located near this alternative and is described in the Hazardous Sites Technical Report (CDM Smith 2016b). There is some potential during excavation to encounter groundwater that would exceed groundwater standards and would require treatment prior to discharge. Permitting of excavation dewatering discharge will need to address the potential for encountering TCE above discharge standards.
Figure 3-2. Expanded Glade Alternative Groundwater Wells.
3.3 Gravel Pits Alternative

3.3.1 Hydrogeologic Setting

The proposed storage reservoirs of the Gravel Pits Alternative are located in an area underlain by sand and gravel deposits of the Poudre River. These alluvial deposits comprise the aquifer that could be impacted by this alternative. This alternative would repurpose gravel pits after completion of mining and the alternative would include installation of a boundary barrier to isolate the in-ground reservoir from the alluvial aquifer. The initial mining operations are not part of the alternative, but would be conducted under terms of mining permits. Installation of the barrier would not require dewatering, as a slurry wall is typically installed under ambient groundwater conditions. If additional mining is required within the mine permit boundary in order to obtain the necessary storage, some additional dewatering may be required, however, this would be governed by provisions of the mining permit. The source of water for this alternative is described in Section 1. The pipeline traverses across several Cretaceous formations, after leaving the Poudre River valley, as described in the Geology Technical Report Section 3.4.1 (CDM Smith 2016a). The bedrock aquifers are either very low permeability or have water levels that are below the area that will be disturbed by pipeline construction and will not be considered further in this section.

The alluvium of the Poudre River was investigated as part of a combined field program with NISP for the NISP NEPA evaluation and is summarized here (ERO 2012). These investigations included installation of monitoring well transects upstream and downstream of the Glade Reservoir Alternative. These studies indicated that the Poudre River is a gaining stream (streamflow increases due to discharge of groundwater to the channel) in the area of this alternative.

The Watson Lake transect is a string of five monitoring wells installed into the upper portion of the alluvial aquifer along a transect perpendicular to the trend of the Poudre River channel. The Watson Lake transect is located approximately three miles upstream of the gravel pits that will comprise the storage reservoirs for this alternative. Water levels in the alluvial monitoring wells in the Watson Lake transect responded rapidly to changes in stage in the river channel, with the most rapid response occurring near the channel, indicating a high degree of hydraulic communication between the alluvial aquifer and the river. Water levels in the monitoring wells were impacted by the presence of a more permeable paleo channel that appears to provide a preferential pathway for routing water down the valley, where it likely subsequently discharges to the Cache La Poudre River channel. The wells on the Watson Lake transect were drilled to a depth of about 15 feet and did not encounter the underlying bedrock, indicating the alluvium thickness exceeds 15 feet. Hydraulic characteristics were quantified by testing two of the wells, indicating the alluvial aquifer is moderately permeable at these locations.

The Martinez Park transect is a string of five monitoring wells installed into the upper portion of the alluvial aquifer along a transect perpendicular to the trend of the Poudre River channel. The Martinez Park transect is located about 1.5 miles downstream of the location of the gravel pits. Five wells were installed perpendicular to the channel, with three of the wells on the north
side and the remaining two wells on the south side of the channel. As with the Watson Lake transect, water levels in the alluvial aquifer at the Martinez Park transect respond rapidly to changes in river stage, indicating good hydraulic communication. Water levels in the alluvial wells are higher than the water surface in the channel, confirming the gaining nature of the stream. The monitoring well logs at this transect encountered the shale and clayey sandstone bedrock between 11 and 15 feet below ground surface.

(Figure 3-4) shows the relationship between Poudre river stage and short-term groundwater level response presented in the NISP report (ERO, 2013).

The locations of the proposed pipelines, three pump stations, a pretreatment plant, the potential construction disturbance, borrow and staging areas, and gravel pits for the Gravel Pits Alternative are also shown in (Figure 3-3), along with the location of monitoring transects that are describe above. There are a significant number of water supply wells within the 0.5-mile buffer area producing water from the alluvial aquifer.
Figure 3-3. Gravel Pits Alternative Groundwater Well.
Figure 3-4. Percent of Ground Water Level Change Versus River Stage Change for Various Distances from the River (ERO 2013).
3.3.2 Groundwater Quality

Limited groundwater quality data are available for the South Platte alluvial aquifer in the area of interest. Selected general water quality indicators were monitored at several transect locations in the South Platte alluvium (ERO, 2012). Groundwater quality in the Poudre River alluvium declines from where the river exits the canyon to the confluence with the South Platte River (ERO 20123). In canyon areas within the mountains, bedrock groundwater with relatively low total dissolved solids recharges the alluvial aquifer. After reaching the plains, the alluvium fills a valley primarily eroded in marine shales of the Pierre Shale Formation, which results in an increase in the total dissolved solids concentration. For example, the reported total dissolved solids at the upstream Watson Lake transect is 288 mg/L, while at the downstream Martinez Park transect, total dissolved solids increase to 852 mg/L. The groundwater does not exceed enforceable drinking water standards for total dissolved solids at either of these transects. The dominant anion also changes over this distance from bicarbonate near the mountain front to sulfate in areas downgradient of the mountain front. Irrigation return flow influences water quality in the alluvial aquifer.

The potential hazardous sites identified within the 0.5-mile buffer with documented releases having a potential to impact groundwater quality within the vicinity of the alternative are described in the Hazardous Sites Technical Report (CDM Smith 2016b). None of the identified hazardous sites present an ongoing risk of contamination that is relevant to this alternative as cleanup is complete and no further actions have been required by the State. Residual contamination that may potentially remain is at levels that are considered protective by the State.

3.4 Agricultural Reservoirs Alternative

3.4.1 Hydrogeologic Setting

The Pierre Shale underlies Reservoir #5 and Reservoir #6 associated with the Agricultural Reservoirs Alternative, as shown in the Geology Technical Report. The Pierre Shale is not considered an aquifer due to its low permeability. The majority of the pipeline route also overlies the Pierre Shale. The western extent of the proposed pipeline route traverses the alluvial deposits of the Cache La Poudre River valley, which were described in Section 3.3 above. The source of water to be used for this alternative is described in Section 1 and would consist of water rights on the Poudre river that would be diverted via an existing canal.

The locations of the wells within the vicinity of the Agricultural Reservoirs Alternative are shown in (Figure 3-5). The aquifer that these largely domestic wells produce from is uncertain and may indicate that low production rates are possible from some units in the Pierre shale. The locations of the proposed pipelines, three pump stations, a pretreatment plant, the potential construction disturbance, borrow, and staging areas, and gravel pits for the Gravel Pits Alternative are also shown in (Figure 3-5).
3.4.2 Groundwater Quality

The Pierre Shale, which underlies the majority of the area associated with this alternative, has a very low permeability, so no bedrock aquifers are present. The characteristics of the alluvial aquifer are described in Section Error! Reference source not found.. If groundwater is encountered in the Pierre Shale along the path of the pipeline that requires dewatering, the presence of selenium could be a potential issue. A study assessing contributions of selenium from areas underlain by the Pierre Shale in southern Colorado, near Pueblo concluded that selenium was present in limited groundwater in the Pierre that was degrading surface water quality (Divine 2009).

The potential hazardous sites identified within the 0.5-mile buffer with documented releases having a potential to impact groundwater quality within the vicinity of the alternative are described in the Hazardous Sites Technical Report (CDM Smith 2016b). All sites identified with past releases have been closed, with no further actions required by the State, so no impact to groundwater is expected for this alternative. Residual contamination that may potentially remain is at levels that are considered protective by the State.

3.5 No-Action Alternative

Under the No-Action Alternative no new infrastructure will be developed and no construction will occur. Risk of impact to groundwater resources occurs when contaminated water or soil is disturbed during construction or operation, when groundwater tables are raised or lowered due to new or expanded reservoir footprints, or when storm water runoff poses a risk to new water supply reservoirs. In the No-Action Alternative new supplies would come from additional agricultural transfers. Under Colorado water law, only the portion of water consumptively used on the land can be transferred. Although irrigation would cease in these areas, historic return flows are to be maintained. Because none of these occur under the No-Action Alternative, potential impacts on groundwater resources are not expected.
Figure 3-5. Agricultural Reservoir Alternative Groundwater Wells.
4 Environmental Consequences

The environmental impacts to groundwater levels include both short-term impacts, such as dewatering of excavations during construction, and long-term impacts, such as raising groundwater levels around reservoirs. Groundwater quality may be impacted by releases of contaminants during construction, changing flow directions and gradients or changing recharge to the aquifer systems due to alternative implementation.

4.1 Fort Collins’ Proposed Action

4.1.1 Groundwater Level

The Fort Collins’ Proposed Action will include raising water level above the existing reservoir level by about 26 feet in the Halligan Reservoir. Stream stage in the Poudre channel will also increase during periods when releases from the reservoir occur, however, the stream stage increase due to this alternative is small. The reservoir is in hydraulic communication with adjacent bedrock aquifers, so groundwater levels in the bedrock aquifers will also increase during periods when the reservoir level is higher. This water level change will be most significant in areas adjacent to the reservoir (no data is available in adjacent areas to qualify); however, there is currently no significant groundwater development in areas where bedrock water levels may increase. Higher water levels do not constitute a negative impact in the bedrock aquifers.

The relationship between changes in stream stage and changes in groundwater levels were assessed at three locations, with four well transects in downstream riparian areas along the North Fork. Stream stage and groundwater levels were monitored in the stream channel and two adjacent wells at each transect location over a 2-year period. (Figure 4-1) shows the location of the Halligan Reservoir Area transect. (Figure 4-2) provides the location of the Eagles Nest Open Space Area transect. (Figure 4-3) shows the locations of the upstream and downstream transects at the Gateway Park/Seaman Reservoir Area. (Figure 4-4) presents the relationship between stream stage changes and corresponding groundwater level changes, as a percentage of the stream stage change. These relationships were based on weekly stream stage changes that were one foot or greater, as was done for the NISP EIS on the mainstem. The relationship between stream stage changes and the response in groundwater levels varies and is specific to each transect. Groundwater level changes more closely reflect stream stage changes at locations closer to the stream channel. Operation of this alternative will not impact the main stem of the Cache le Poudre below the confluence with the North Fork, since an equivalent volume of water will be diverted at the existing diversion location upstream of this confluence.
Figure 4-1. Location of the Halligan Reservoir Transect.
Figure 4-2. Location of the Eagles Nest Open Space Area Transect.
Figure 4-3. Location of the Upstream and Downstream Transects at Gateway Park/Seaman Area.
Figure 4-4. Groundwater Response to Steam Stage Change at North Fork Transects.
4.1.2 Groundwater Quality

Because the rise in water level associated with the incremental change in reservoir level will occur within the same rock types, we do not expect there to be any change in water quality in the bedrock aquifer associated with alternative.

4.2 Expanded Glade Alternative

4.2.1 Groundwater Levels

The Expanded Glade Alternative would only raise the elevation of the proposed Glade Reservoir inundation pool 3.6 feet. The incremental rise in groundwater levels for this alternative is not significant, since the additional storage volume is a small percentage of the currently planned reservoir volume. Pipelines that will be part of the NISP system will be used for conveyance, so there will be no additional pipeline related impacts on groundwater from the incremental addition of this alternative.

4.2.2 Groundwater Quality

No significant impact on water quality is anticipated due to the small incremental rise in water level in the reservoir associated with this alternative. The rise in water level associated with the incremental change in reservoir level will occur within the same rock types and will not likely impact the adjacent TCE plume area at the former Air Force site due to the limited incremental change in head.

4.3 Gravel Pits Alternative

4.3.1 Groundwater Level

This alternative utilizes gravel pits for water storage, which will require installation of impermeable clay barrier walls from the surface down to bedrock in order to avoid loss of water to the aquifer. This will result in decreasing the portion of the alluvial aquifer that is currently conveying groundwater toward the river channel and down the valley. This is similar in concept to a subsurface dam blocking part of the alluvium. This blockage will likely result in an increase in water levels on the up gradient side of the gravel pit storage complex, and a corresponding decline in water levels on the downgradient side. The net change in flow in the Poudre due to the composite impact of the gravel pit storage is expected to be minimal, downstream of the gravel pit storage facilities. Wells that are present in the area between individual storage sites will likely no longer be able to produce water, since communication with the surrounding alluvial aquifer will be cut off by the barrier walls. The increased water levels on the up gradient side of the storage reservoirs will also increase the hydraulic gradient toward the river channel, potentially increasing the groundwater discharge to the adjacent Poudre channel. The rise in water levels on the up gradient side of the storage reservoirs could potentially impact structures, particularly basements, if the rise in water level is sufficient. This potential blockage and subsequent
groundwater mounding can be minimized by including features in the design of the gravel pit storage facilities to minimize water level rise in the up gradient areas resulting in negligible impacts to the water levels.

Temporary impacts to water levels may also be associated with dewatering of pipeline trenches, if this is necessary. Details on water levels and depth of trenches will be developed during final design, if this alternative is implemented.

### 4.3.2 Groundwater Quality

No change in water quality is anticipated associated with this alternative. Releases of contaminants during construction has the potential to contaminate groundwater, however, best management practices can minimize this potential. The construction of this alternative will isolate the reservoir from the alluvial aquifer, so stored water will not interact with the alluvial aquifer. If a potential rise in water level occurs in the area up gradient of the reservoir, it will be within strata with the same geochemical characteristics as the remainder of the alluvial aquifer. Flow directions may change but not significant enough to change groundwater quality in the area.

### 4.4 Agricultural Reservoirs Alternative

#### 4.4.1 Groundwater Level

No impact on groundwater levels is anticipated from the reservoirs associated with this alternative, since these reservoirs will not change in size or overall operation. Temporary declines in water levels may be associated with trench dewatering, if this is necessary during construction. Information on dewatering requirements will be developed during the final design, if this alternative is implemented.

#### 4.4.2 Groundwater Quality

No impact on groundwater quality is expected from this alternative. If dewatering is necessary within saturated zones in the Pierre Shale, this dewatering effluent may have elevated total dissolved solids, sulfate and trace metals and metalloids such as selenium.

### 4.5 No-Action Alternative

Under the No-Action Alternative, no new infrastructure will be developed and no construction will occur. Risk of impact to groundwater resources occurs when contaminated water or soil is disturbed during construction or operation, when groundwater tables are raised due to new or expanded reservoir footprints, or when storm water runoff poses a risk to new water supply reservoirs. Because none of these occur under the No-Action Alternative, potential impacts on groundwater resources are not expected.
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5 Summary of Effects

The impacts associated with the Fort Collins’ Proposed Action and alternatives are primarily associated with changes in water levels in the adjacent aquifers. The change in adjacent aquifer water levels as a percentage change in stream stage is presented in Sections 3.3.1 and 4.1.1. Since the water level changes in both alluvial aquifers and bedrock aquifers occur in similar rock types, no change in water quality is anticipated. The construction activities for pipelines associated with alternatives could potentially require temporary dewatering in areas with a shallow water table. A summary of the impacts for the Fort Collins’ Proposed Action and alternatives are summarized below.

- Fort Collins’ Proposed Action. The enlargement of Halligan Reservoir will increase the reservoir level by about 25 feet. This will increase water levels in the adjacent fractured bedrock aquifer. No impact to water resources or water quality is anticipated, since the rise in water levels will occur in the same rock types.

- Expanded Glade Alternative. This alternative includes a small incremental rise in water level in the reservoir to accommodate project storage requirements. This will increase water levels in adjacent aquifers; however, this water level increase will occur in similar rock types, so no impact to water quality is expected.

- Gravel Pits Alternative. This alternative will entail construction of an impermeable clay barrier wall to the shale bedrock to allow storage of groundwater and minimize loss of stored water to the alluvial groundwater system. This can be characterized as a partial subsurface dam that will divert groundwater in the alluvium around the reservoir area. This will result in a rise in water level in areas up gradient of the reservoir and a decline downgradient of the reservoir. Since the alluvial aquifer is highly interconnected with surface water, the alluvial water levels will rapidly recovery to conditions that are in equilibrium with stream channel levels, limiting the areal impact of water level changes. The rock types comprising the aquifer material in the area of rising water levels are the same as the remainder of the aquifer, so no water quality impact is expected. Temporary dewatering during construction of the pipeline may be necessary that will result in a short-term localized water level decline.

- Agricultural Reservoirs Alternative. This alternative utilizes existing reservoirs and will operate similar to the current operations, therefore no significant impact on water levels is expected due to the alternative. Temporary dewatering during construction of the pipeline may be necessary that will result in a short-term localized water level decline. If dewatering is required from saturated Pierre Shale, the dewatering effluent may include elevated total dissolved solids and trace metals and metalloids such as selenium.

- No-Action Alternative. This alternative does not include any new infrastructure, so there is no impact expected to groundwater. The transfer of irrigation rights will decrease recharge although historic return flows from the irrigated areas would be maintained.
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6 Literature Cited


Colorado Department of Natural Resources. 2016. Design Review and Construction Inspection. Colorado Division of Water Resources, Department of Natural Resources. Information Available at: http://water.state.co.us/SurfaceWater/DamSafety/DesignConstruction/Pages/default.aspx


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Appendix A : North Fork Monitoring Well Construction Reports
**WELL CONSTRUCTION AND TEST REPORT**

1. WELL PERMIT NUMBER: M4H-048893
2. WELL OWNER INFORMATION
   - NAME OF WELL OWNER: WESTERN ECOSYSTEMS TECHNOLOGY, INC.
   - MAILING ADDRESS: 2003 CENTRAL AVE.
   - CITY: COTULLA, STATE: WY, ZIP CODE: 82001
   - TELEPHONE NUMBER: (367) 634-1756
3. WELL LOCATION AS DRILLED:
   - NE 1/4, SW 1/4, Sec. 24, Twp. 17, N or S, Range 7, E or W
   - DISTANCES FROM SEC. LINES: 914 ft. from N or S section line and 1756 ft. from E or W section line.
   - SUBDIVISION: LOT ____, BLOCK ____,
   - FILLING UNIT: Owner's Well Designation: WD-4
   - Easting: 467,529.80
   - Northing: 467,529.80
4. GROUND SURFACE ELEVATION: 6294.7 feet
   - DATE COMPLETED: 10/16/09
   - TOTAL DEPTH: 12.5 feet
5. GEOLOGIC LOG:
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6. HOLE DIAM (in.):
   - From (ft): 2.25
   - To (ft): 12.5
7. PLAIN CASING:
   - OD (in): 1
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   - Wall Size (in): 0.133
   - From (ft): 0
   - To (ft): 6.5
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     - Kind: PVC
     - Wall Size (in): 0.133
     - Screen Slot Size (in): 0.010
     - From (ft): 6.5
     - To (ft): 12.5
8. FILTER PACK:
9. PACKER PLACEMENT:
   - Material: SILICA SAND
   - Size: 1½ x 20
   - Interval: 6.5-12.5'
10. GROUTING RECORD
    - Material: GRANITE 6/16
    - Amount: 0-6.5'
    - Density: 140.6 DRY CONVERT
11. DISINFECTION: Type: NA
12. WELL TEST DATA: Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.
   - TESTING METHOD:
     - Static Level: ______ ft.
     - Date/Time measured: ____________
     - Production Rate: ______ gpm.
     - Pumping Level: ______ ft.
     - Date/Time measured: ____________
     - Test Length (hrs): ______
   - Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-61-109(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]
   - Company Name: SITE SERVICES INC.
   - Phone: (303) 873-0009
   - License Number: ____________
   - Mailing Address: 15099 WEST 144TH AVE., SUITE #2, GOLDS, CO 80403
   - Signature: [Sign]
   - Print Name and Title: [Print Name and Title]
   - Date: ________

For Office Use Only
**WELL CONSTRUCTION AND TEST REPORT**

**WELL PERMIT NUMBER:** MH-048893

**NAME OF WELL OWNER:** WEST Ed Ecosystems Technology, Inc.

**Mailing Address:** 2003 Central Ave.

**City:** Colorado Springs

**State:** CO

**Zip Code:** 80901

**Telephone Number:** (303) 839-1756

**Well Location as Drilled:** NE 1/4, SW 1/4, Sec. 34, Twp. 11N or S, Range 71E or W

**Distances from Sec. Lines:** 910 ft. from N or S section line and 1820 ft. from E or W section line.

**Subdivision:**

**Lot:**

**Block:**

**Filing (Unit):**

**Optional GPS Location:** GPS Unit must use the following settings: Format must be UTM, Units must be meters, Datum must be NAD83, Units must be set to true N, Easting: 471491.42, Northing: 4525222.94

**Ground Surface Elevation:** 6288.4 feet

**DATE COMPLETED:** 10/16/09

**Total Depth:** 13.5 feet

**Drilling Method:** Direct Push

**Hole Dia (in.)**

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**Remarks:**

**Company Name:** SITE SERVICES INC.

| Phone: (303) 873-0009 | License Number: |

| Mailing Address: 15017 W. 44TH AVE., SUITE 2, GOLDCO, CO 80403 | Signature: |

| Print Name and Title | Date |

**I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. (The filing of a document that contains false statements is a violation of section 27-11-109 (1)(e), C.R.S., and is punishable by fines up to $35,000 and/or revocation of the contracting license.)**

**Company Name:**

**Phone:** (303) 873-0009

**License Number:**

**Mailing Address:** 15017 W. 44TH AVE., SUITE 2, GOLDCO, CO 80403

**Signature:**

**Print Name and Title:**

**Date:**
WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sharman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3588 http://www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MA-04892

2. WELL OWNER INFORMATION
NAME OF WELL OWNER: WESTERN ECOsystems TECHNOLOGY, Inc.
MAILING ADDRESS: 2803 Central Ave.
CITY: Cheyenne STATE: WY ZIP CODE: 82001
TELEPHONE NUMBER: (307) 634-1786

3. WELL LOCATION AS DRILLED: Sec. 1/4, Sec. 1/4, Sec. 4, Twp. 9 S or S, Range 70 E or W
DISTANCES FROM SEC. LINES: 610 ft. from N or S section line and 380 ft. from E or W section line.
SUBDIVISION: Owner’s Well Designation: E4-1 Easement: 480629-62
STREET ADDRESS AT WELL LOCATION: Nothing: 4513409.67

4. GROUND SURFACE ELEVATION 5639 feet DRILLING METHOD: DIRECT PUSH
DATE COMPLETED: 10/16/09 TOTAL DEPTH: 12.5 feet DEPTH COMPLETED: 12.5 feet

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| 1 | PVC | 0.133 | 3 | 12.5 |

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9. PACKER PLACEMENT:


10. GROUTING RECORD

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TESTING METHOD: N/A

Static Level: ft. Date/Time measured: Production Rate gpm.
Pumping Level: ft. Date/Time measured: Test Length (hrs): 

Remarks: 

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name: SITE SERVICES INC.
Phone: (303) 273-0009 License Number: 

Mailing Address: 16047 West 144th Ave., Suite K, Golden, CO 80403

Signature: Print Name and Title: Date:
WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone: Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589
http://www.water.state.co.us

1. WELL PERMIT NUMBER: MA-048892

2. WELL OWNER INFORMATION
   NAME OF WELL OWNER: WESTERN ECOSYSTEMS TECHNOLOGY, INC.
   Mailing Address: 3003 Central Ave.
   CITY: CHICAGO, STATE: IL ZIP CODE: 60601
   Telephone Number: (312) 684-1756

3. WELL LOCATION AS DRILLED: SE 1/4, SE 1/4, Sec. 4, Twp. 9 N or S, Range 10 E or W
   Distances from Sec. Lines: 750 ft. from N or S section line and 380 ft. from E or W section line.
   Subdivision: __________, Lot ________, Block ________, Filing (Unit) ________.
   Optional GPS Location: GPS Unit must use the following settings: Format must be UTM, Units must be meters, Datum must be NAD83. Unit must be set to true N, Zone 12 or Zone 13

Street Address at Well Location: Nothing: 4513438.82

4. GROUND SURFACE ELEVATION 5641.7 feet
   DRILLING METHOD: DIRECT PUSH
   Date Completed: __________ feet, Depth Completed: 13.0 feet

5. GEOLOGIC LOG:
   Depth | Type   | Grain Size | Color | Water Loc |
   2.25  |        |            |       |           |

6. HOLE DIAM (in.) From (ft) To (ft)
   2.25  0  13

7. PLAIN CASING:
   OD (in) Kind Wall Size (in) From (ft) To (ft)
   1 PVC 0.133 0 5.5

8. PERFORATED CASING:
   Screen Slot Size (in): 0.010
   1 PVC 0.133 5.5 13

9. PACKER PLACEMENT:
   Material: Silica Sand
   Size: 10X20
   Interval: 5.5-13
   Depth: 13

10. GROUTING RECORD:
    Material: Amount, Density, Interval, Placement:
    Sensipane 5.5 lbs.
    (Hydraulic Grout)

11. DISINFECTION: Type: NA
    Amt Used: NA

12. WELL TEST DATA: [ ] Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.
    Testing Method: NA
    Static Level: ft. Date/Time measured: Production Rate: gpm.
    Pumping Level: ft. Date/Time measured: Test Length (hrs):__________

Remarks: NA

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-109(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.

Company Name: SITE SERVICES INC.
Phone: (303) 273-9009 License Number: 80403
Mailing Address: 15097 West 44th Ave., Suite 2, Golden, CO 80403
Signature: Print Name and Title: Date:
WELL CONSTRUCTION AND TEST REPORT

1. WELL PERMIT NUMBER: NH-048891
2. WELL OWNER INFORMATION
   NAME OF WELL OWNER: WESTERN ECOSYSTEMS TECHNOLOGY, INC.
   Mailing Address: 2005 CENTRAL AVE.
   CITY: CHEYENNE
   STATE: WY
   ZIP CODE: 82001
   TELEPHONE NUMBER: (307) 684-1756
3. WELL LOCATION AS DRILLED: NW1/4, SE1/4, Sec. 33, Twp. 9 N, Range 70 E or 8 W
   Distances from Sec. Lines: 1876 ft. from N or S section line and 1125 ft. from E or W section line.
   Subdivision: ___________, LOT __________, BLOCK __________, FILING (UNIT) __________
   Optional GPS Location: GPS Unit must use the following settings: Format must be UTM, Units must be meters, Datum must be NAD83, Unit must be set to true N, 0 Zone 12 or 8 Zone 13
   Owner's Well Designation: SW-1
   Easting: 4802553.81
   Northing: 4605698.39
4. GROUND SURFACE Elevation: 5384.6 feet
   DATE COMPLETED: 10/16/09
   TOTAL DEPTH: 12.5 feet
   DRILLING METHOD: DIRECT PUSH
   Feet: Depth Completed: 12.5 feet
5. GEOLOGIC LOG:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Type</th>
<th>Grain Size</th>
<th>Color</th>
<th>Water Loc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
6. HOLE DIAM (in.) | From (ft) | To (ft) |
| 2.25 |          |         |

<table>
<thead>
<tr>
<th>Depth</th>
<th>Type</th>
<th>Grain Size</th>
<th>Color</th>
<th>Water Loc.</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>
7. PLAIN CASING:

<table>
<thead>
<tr>
<th>OD (in)</th>
<th>Kind</th>
<th>Wall Size (in)</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PVC</td>
<td>0.133</td>
<td>0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OD (in)</th>
<th>Kind</th>
<th>Wall Size (in)</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
</table>

<table>
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<tr>
<th>OD (in)</th>
<th>Kind</th>
<th>Wall Size (in)</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
</table>

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<tr>
<th>OD (in)</th>
<th>Kind</th>
<th>Wall Size (in)</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>OD (in)</th>
<th>Kind</th>
<th>Wall Size (in)</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
</table>

8. FILTER PACK:

<table>
<thead>
<tr>
<th>Material</th>
<th>Size</th>
<th>Interval</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt/Sand</td>
<td>10x20</td>
<td>4.5-12.5</td>
<td></td>
</tr>
</tbody>
</table>

9. PACKER PLACEMENT:

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Density</th>
<th>Interval</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime</td>
<td>4.5&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. GROUTING RECORD:

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Density</th>
<th>Interval</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.5&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. DISINFECTION: Type: 12A
   Amt. Used: __________
12. WELL TEST DATA:
   Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.
   TESTING METHOD:
   Static Level: __________ ft. Date/Time measured: __________ Production Rate: __________ gpm.
   Pumping Level: __________ ft. Date/Time measured: __________ Test Length (hrs): __________
   Remarks: ____________________________
13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-81-106(1)(a), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]
   Company Name: SITE SERVICES, INC.
   Phone: (303) 373-0009
   License Number: __________
   Mailing Address: 1097 WEST 44TH AVE., SUITE #2, GLOVER, CO 80403
   Signature: ________________________________
   Print Name and Title: ________________________________
   Date: __________
WELL CONSTRUCTION AND TEST REPORT
STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 918, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

1. WELL PERMIT NUMBER: 14 - 0418801

2. WELL OWNER INFORMATION
NAME OF WELL OWNER: WESTERN ECOLOGY SERVICES, INC.
MAILING ADDRESS: 9203 CENTRAL AVE
CITY: CARRIHallo STATE: UT ZIP CODE: 82001
TELEPHONE NUMBER: (307) 634 - 1756

3. WELL LOCATION AS DRILLED: NW 1/4, Sec 14, Twp 9 N or S, Range 70 W, Section 32, Subdivision:
DISTANCES FROM SEC. LINES: 1811 ft. from N or S section line and 1484 ft. from E or W section line.

4. GROUND SURFACE ELEVATION: 5392.6 feet
DATE COMPLETED: 10/16/09 TOTAL DEPTH: 14 feet

5. GEOLOGIC LOG:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Type</th>
<th>Grain Size</th>
<th>Color</th>
<th>Water Loc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

6. HOLE DIAM (in.): 2.25 feet DRILLING METHOD: DREDGE DUSK

<table>
<thead>
<tr>
<th>Depth</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14</td>
<td></td>
</tr>
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</table>

7. PLAIN CASING:

<table>
<thead>
<tr>
<th>OD (in)</th>
<th>Kind</th>
<th>Wall Size (in)</th>
<th>From (ft)</th>
<th>To (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.133</td>
<td>PVC</td>
<td>0.133</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

| PERFORATED CASING: Screen Slot Size (in): 0.10 |
| PFC    | 0.133 | 6              | 14        |

8. FILTER PACK:

<table>
<thead>
<tr>
<th>Material</th>
<th>Size</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAND</td>
<td>10x20</td>
<td>Depth</td>
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</tbody>
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9. PACKER PLACEMENT:

<table>
<thead>
<tr>
<th>Material Amount</th>
<th>Density</th>
<th>Interval</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
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</table>

10. GROUTING RECORD

<table>
<thead>
<tr>
<th>Material Amount</th>
<th>Density</th>
<th>Interval</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

11. DISINFECTION: Type

12. WELL TEST DATA: □ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD

Static Level ft. Date/Time measured: Production Rate gpm.
Pumping Level ft. Date/Time measured: Test Length (hrs).

Remarks:

I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 403-2. [The filing of a document that contains false statements is a violation of section 37-91-109(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name: SITE SERVICES INC.
Phone: (303) 213-00009 License Number:

Mailing Address: 15017 WEST 44TH AVE. SUITE #4, GOLDEN, CO 80403
Signature: Print Name and Title Date:
1. WELL PERMIT NUMBER: NY - 0482891
2. WELL OWNER INFORMATION
   NAME OF WELL OWNER: WESTERN ECOSYSTEMS TECHNOLOGY, INC.
   MAILING ADDRESS: 2003 CENTRAL AVE.
   CITY: CHEYENNE STATE: WY ZIP CODE: 82001
   TELEPHONE NUMBER: (307) 634-1756
3. WELL LOCATION AS DRILLED: NW1/4, SE1/4, Sec. 33, Twp. 89 N or 8 S, Range 70 E or W
   DISTANCES FROM SEC. LINES: 1940 ft. from N or S section line and 1736 ft. from E or W section line.
   SUBDIVISION:
   LOT
   BLOCK
   FILING (UNIT)
   Optional GPS Location: GPS Unit must use the following settings: Format must be UTM, Units must be meters, Datum must be NAD83, Unit must be set to true N, Zone 12 or Zone 13
   STREET ADDRESS AT WELL LOCATION:
   Northing: 4505796.69
4. GROUND SURFACE ELEVATION 5381.4 feet
5. GROUNDS SURFACE ELEVATION 5381.4 feet
   DATE COMPLETED: 10/16/09 TOTAL DEPTH: 12 feet
6. HOLE DIAM (in.) FROM (ft) TO (ft)
   2.26
   12
7. PLAIN CASING:
   OD (in) Kind Wall Size (in) From (ft) To (ft)
   1 PVC 0.133 0 3.5
   PERFORATED CASING: Screen Slot Size (in): 0.010
   1 PVC 0.133 3.5 12
8. FILTER PACK:
   MATERIAL SIZE
   9. PACKER PLACEMENT:
   Type
   10. GROUTING RECORD
   Material Amount Density Interval Placement
   BEARATE 3.516, .0-3.5, (ENTERED GRAY-PAINT)
11. DISINFECTION: Type
    Amt. Used
12. WELL TEST DATA: □ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.
   TESTING METHOD
   Static Level ft. Date/Time measured: Production Rate gpm.
   Pumping Level ft. Date/Time measured: Test Length (hrs).
   Remarks:
   13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-61-102(1)(6), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]
   COMPANY NAME: SITE SERVICES I-X.
   PHONE: (303) 873-0009
   LICENSE NUMBER:
   MAILING ADDRESS: 15057 WEST 44TH AVE., SUITE #2, GOLDEN, CO 80403
   SIGNATURE: Print Name and Title
   DATE:
**WELL CONSTRUCTION AND TEST REPORT**

**STATE OF COLORADO, OFFICE OF THE STATE ENGINEER**
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589  http://www.water.state.co.us

---

1. **WELL PERMIT NUMBER:** MA-048891

2. **WELL OWNER INFORMATION**
   - **NAME OF WELL OWNER:** WESTERN ECOSYSTEM TECHNOLOGY, Inc.
   - **MAILING ADDRESS:** 2003 CLEAR CREEK AVE.
   - **CITY:** CRESTED BUTTE
   - **STATE:** WY
   - **ZIP CODE:** 82001
   - **TELEPHONE NUMBER:** (307) 634-1756

3. **WELL LOCATION AS DRILLED:** NW1/4, SE1/4, Sec. 33, Twp. 9 N or R S, Range 10 E or W
   - **DISTANCES FROM SEC. LINES:** 1960 ft. from N or S section line and 1600 ft. from E or W section line.
   - **SUBDIVISION:**
   - **LOT:**
   - **BLOCK:**
   - **FILED (UNIT):**
   - **Optional GPS Location:** GPS Unit must use the following settings: Format must be UTM, Units must be meters, Datum must be NAD83, Unit must be set to true N. Zone 12 or Zone 13
   - **Owner’s Well Designation:** SD-2
   - **Easting:** 4806326
   - **Northing:** 5305981.02

4. **GROUND SURFACE ELEVATION:** 5384.5 feet
   - **DATE COMPLETED:** 10/16/09
   - **TOTAL DEPTH:** 12 feet
   - **DRILLING METHOD:** DIRECT PUSH
   - **HOLE DIAM (in.)**
   - **From (ft):**
   - **To (ft):**
   - **PERFORATED CASING:** Screen Slot Size (in): 0-0.10
   - **PERFORATED CASING:** Screen Slot Size (in): 0-0.10

5. **GEOLOGIC LOG:**
   - **Depth**
   - **Type**
   - **Grain Size**
   - **Color**
   - **Water Loc.**

6. **PLAIN CASING:**
   - **OD (in)**
   - **Kind**
   - **Wall Size (in)**
   - **From (ft):**
   - **To (ft):**

7. **FILTER PACK:**
   - **Material:** SODA ASH
   - **Size:** 10\x20
   - **Interval:** 8-7-12
   - **Depth:**

8. **PACKER PLACEMENT:**
   - **Type:**

9. **GROUTING RECORD:**
   - **Material Amount**
   - **Density**
   - **Interval**
   - **Placement:**

---

11. **DISINFECTION:**
   - **Type:** NA
   - **Amt. Used:**

12. **WELL TEST DATA:**
   - **Testing Method:**
     - **Static Level:** ft
     - **Date/Time measured:**
     - **Production Rate:** gpm
     - **Pumping Level:** ft
     - **Date/Time measured:**
     - **Test Length (hrs):**

**Remarks:**

---

13. **I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2.**

**Company Name:** SITE SERVICES INC.
**Phone:** (303) 713-0009
**License Number:**

**Mailing Address:** 15097 WEST HHB AVE., SUITE 42, GOLDEN, CO 80403
**Signature:**
**Print Name and Title:**
**Date:**
Appendix B: Groundwater and Stream Stage at Transects