

Appendix 3A

Lithologic Logs Used for Geologic Cross Sections

Appendix 3A. Lithologic Logs Used for Geologic Cross Sections

DWR produced a report in 2014 describing the complex geology of the northern Sacramento Valley, focusing on the Late Cenozoic geologic formations and structures that compose or influence the groundwater aquifers (DWR, 2014¹). This report covered the portion of the valley within the Corning Subbasin. DWR conducted an extensive literature review of published and unpublished data and integrated the data to produce a geologic report, map, and cross sections that describe the geology. Geologic cross sections were interpreted in part from the lithologic logs of nearby wells. Only wells within 2 miles of each cross section were considered. Of those wells, three are within Corning Subbasin (Figure 3A-1). California State Well 24N03W29Q001M is 3 miles southwest of the City of Corning, near Cross Section A-A'; its lithologic log is shown on Figure 3A-2. State Well 24N02W29N003 is 5 miles southeast of the City of Corning, near the intersection of Cross Sections A-A' and F-F'; its lithologic log is shown on Figure 3A-3. State Well 22N02W18C001M is 4 miles northeast of Orland, on Cross Section F-F'; its lithologic log is shown on Figure 3A-4. The sand provenance of each well is shown in Table 3A-1.

¹ DWR, 2014. Geology of the Northern Sacramento Valley, California. Northern Region Office Groundwater and Geologic Investigation Section. June. <https://cawaterlibrary.net/wp-content/uploads/2017/05/Geology-of-the-Northern-Sacramento-Valley.pdf>

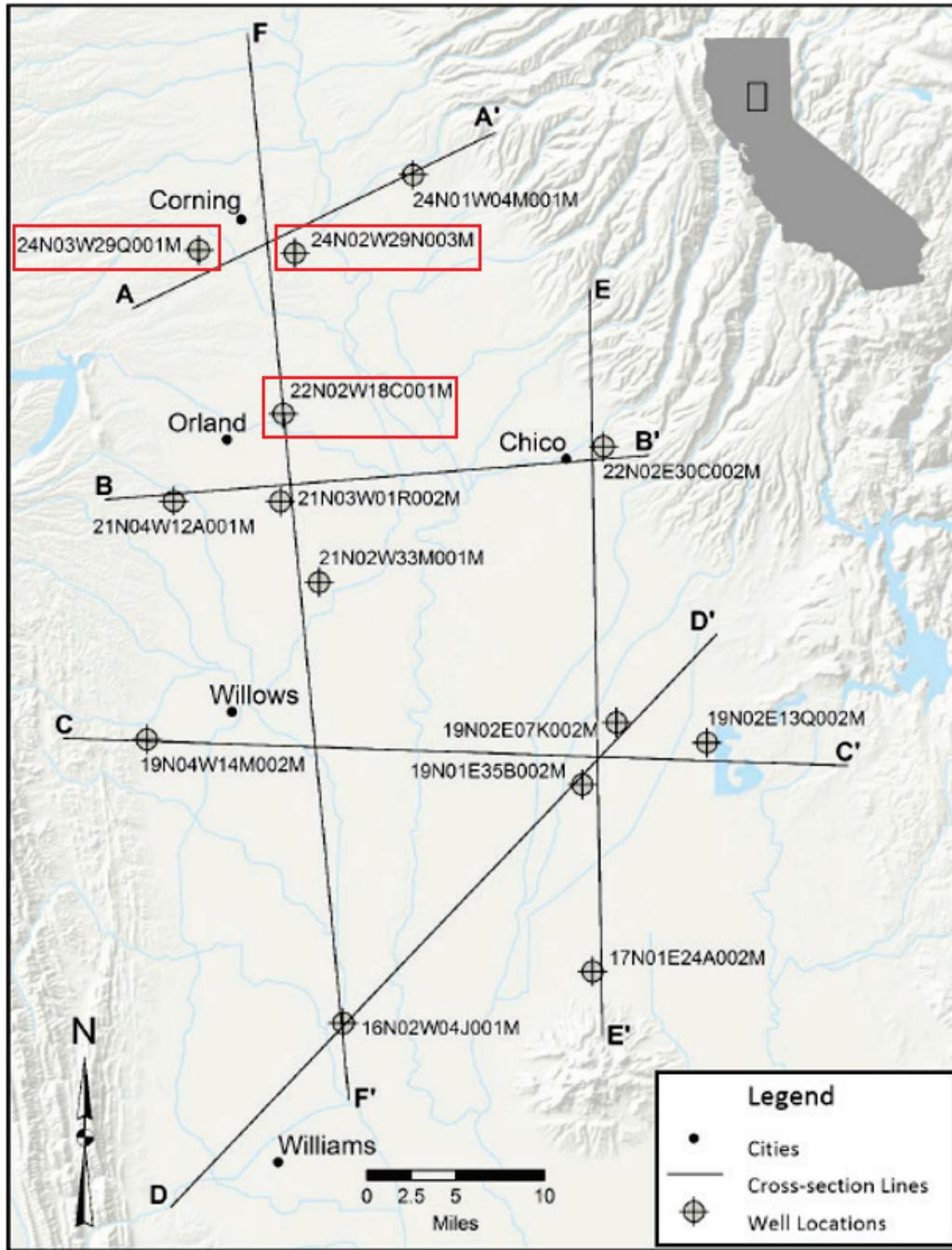


Figure 3A-1. Geologic Cross Sections and Nearby Wells

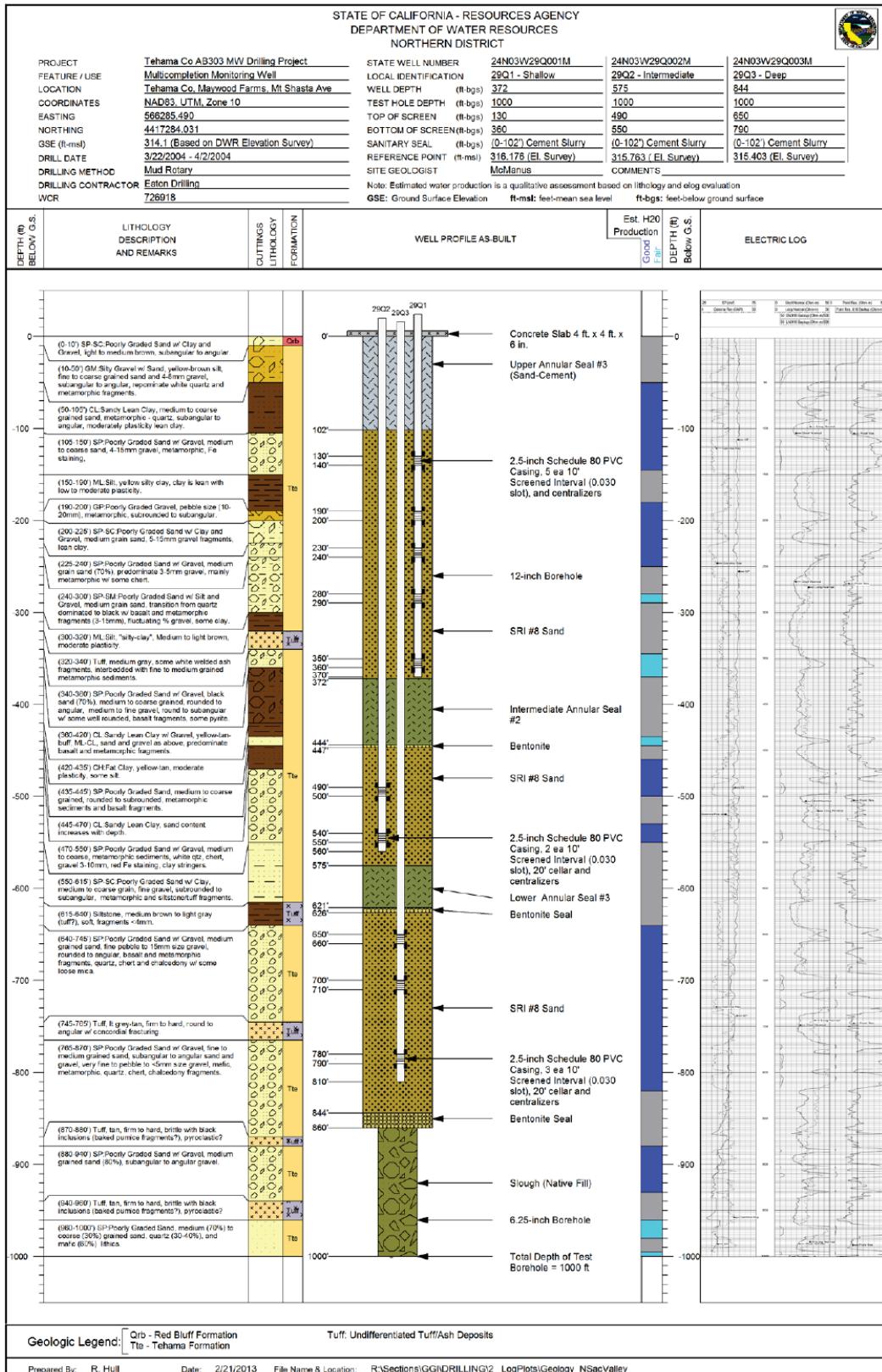


Figure 3A-2. Lithology of California State Well 24N03W29Q001M

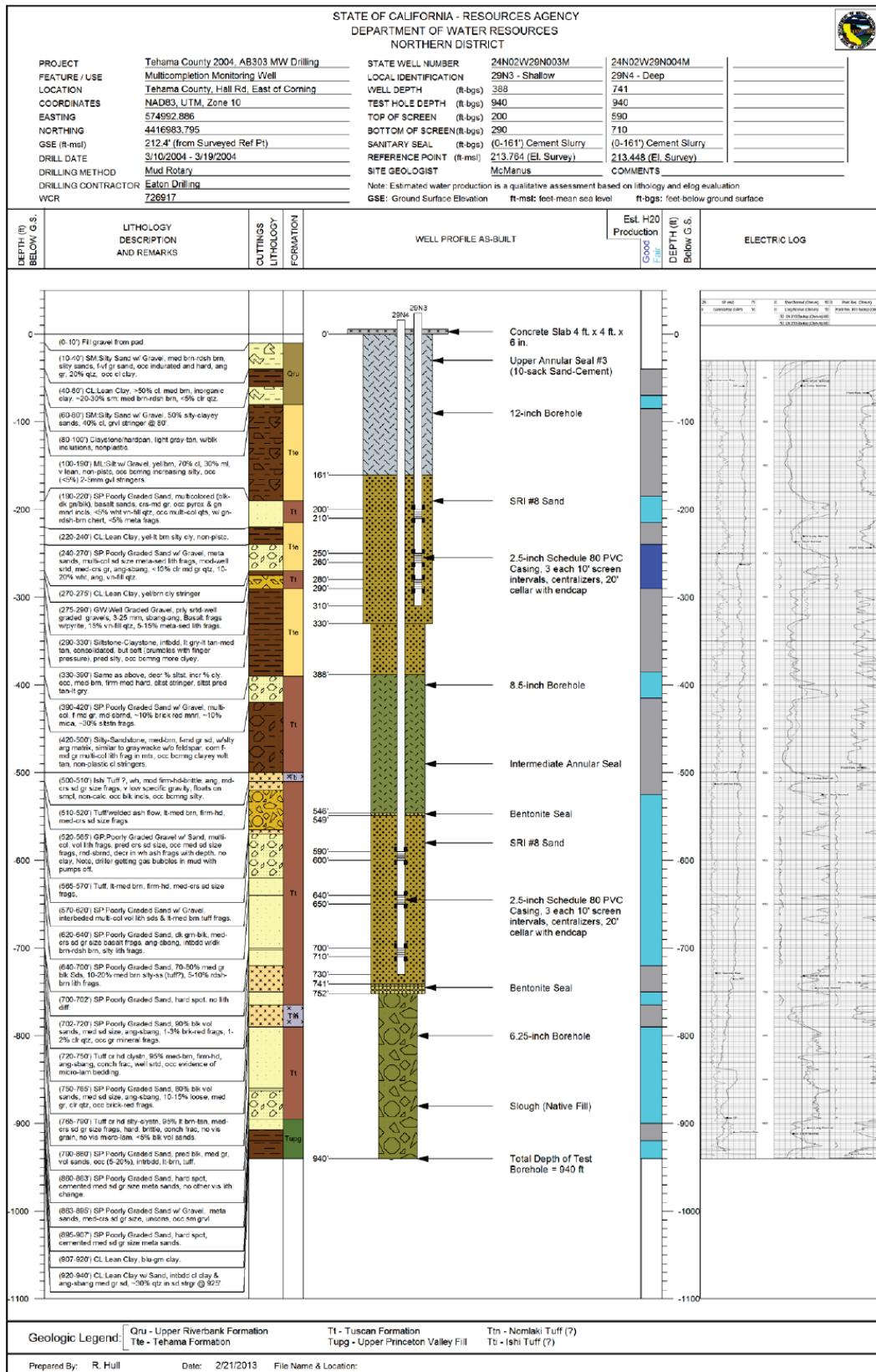


Figure 3A-3. Lithology of California State Well 24N02W29N003M

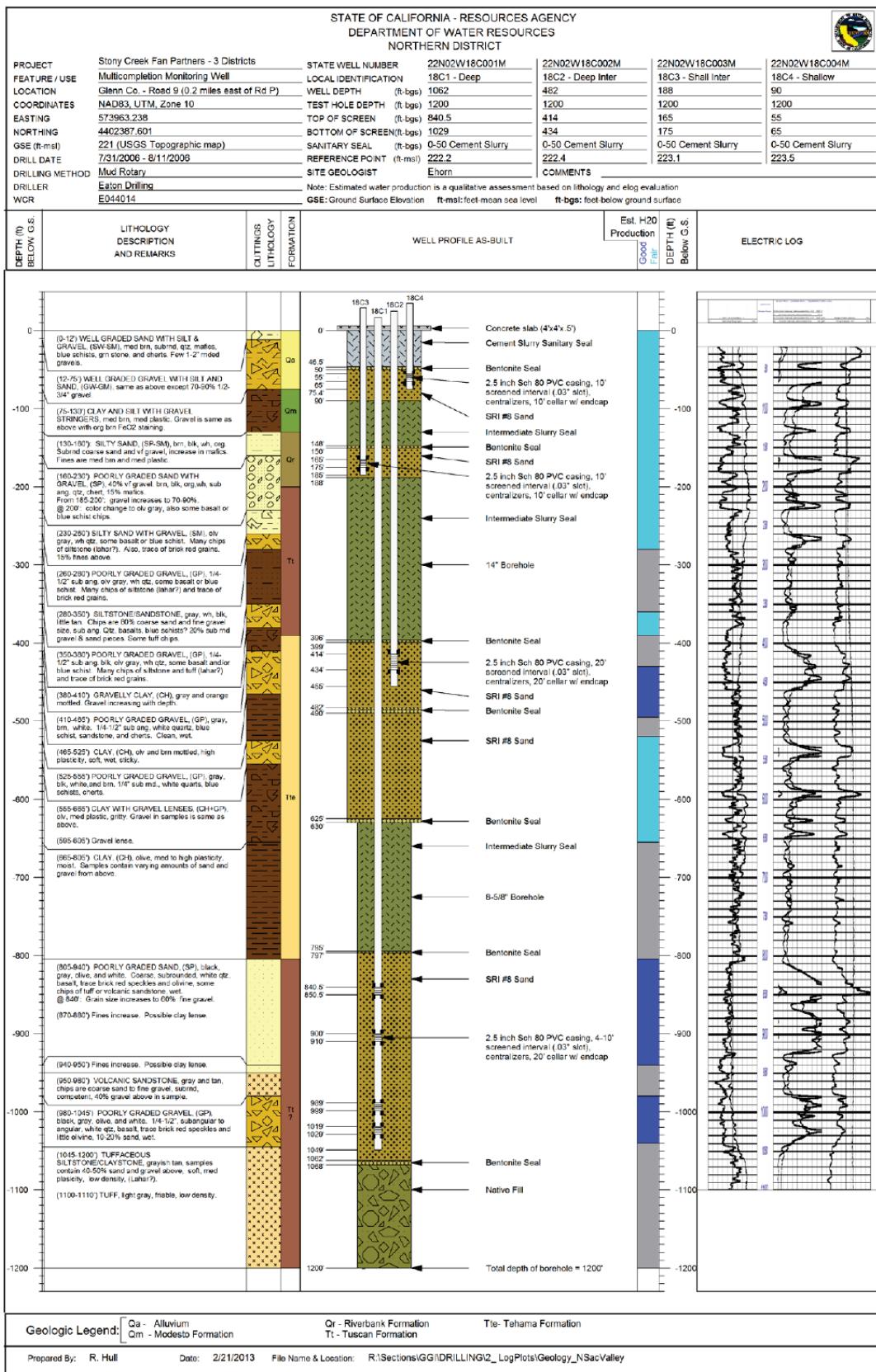


Figure 3A-4. Lithology of California State Well 22N02W18C001M

Table 3A-1. Sand Provenance Analysis

Well	Sample depth range (feet below ground surface)	Percent composition ^a			Predominant source formation
		Lm	Lv	Ls	
24N03W29Q001M	260-270	95	3	2	Tehama
	660-680	58	20	22	Tehama
	980-1,000	85	3	12	Tehama
24N02W29N003M	200-220	29	37	34	Tehama/Tuscan/intermixing
	270-280	46	34	20	Tehama/Tuscan/intermixing
	380-400	76	1	23	Tehama
	640-660	1	97	2	Tuscan
	740-760	0	100	0	Tuscan
	890-900	1	99	0	Tuscan
	920-930	70	15	15	Tehama/upper Princeton Valley fill
22N02W18C001M	540-560	91	4	5	Tehama
	810-820	44	32	24	Tehama/Tuscan Intermixing
	980-990	16	71	13	Tuscan

Notes:

^a Lm = lithic metamorphic; Lv = lithic volcanic; Ls = lithic sedimentary.

Appendix 3B

Methodology for Extension of Cross Section A-A'

Appendix 3B. Methodology for Extension of Cross Section A-A'

The original California Department of Water Resources (DWR) cross section A-A' covered roughly half of the Corning Subbasin as shown on Figure 3B-1 below. This cross section was developed for the 2014 DWR report *Geology of the Northern Sacramento Valley*¹ using 1) lithologic cutting descriptions and geophysical data from groundwater observation well drilling and 2) geophysical data from the California Department of Conservation's Division of Oil, Gas, and Geothermal Resources' natural gas well drilling. While cross section A-A', F-F', and B-B' overlie the major areas of groundwater production, extension of section A-A' was desired to further understanding of stratigraphy in the western portion of the Subbasin. In particular, data regarding the extent and thickness of the Tehama formation were required to evaluate the occurrence of freshwater near the Subbasin's western boundary. The area through which section A-A' was extended is presented on Figure 3B-2.

The two primary data sources utilized for extension of cross section A-A' were well completion reports (WCR) and oil and gas well logs. WCR were acquired from DWR's online WCR map application (<https://data.cnra.ca.gov/showcase/well-completion-report-map-app>). Oil and gas well logs were downloaded from the California Department of Conservation Geologic Energy Management Division's (CALGEM) online well finder (<https://www.conservations.ca.gov/calgem/Pages/WellFinder.aspx>).

To extend cross section A-A', the line was first digitized and extended to the Subbasin boundary in ArcGIS. To enable drawing of land surface, a digital elevation model (DEM) was used to draw an elevation profile along the extension. Well completion reports and oil and gas well logs along the extended line were then downloaded and spatially grouped by overlying Public Land Survey System (PLSS) sections. Purple PLSS sections on Figure 3B-2 contained at least one associated WCR.

With all relevant information compiled, WCR and oil and gas logs were then systematically analyzed along the cross-section extension to characterize the occurrence of formations. Where present, oil and gas logs were given preferential weight due to their high-quality geologic logging and accompanying resistivity logs. Once hand-drawn, the cross section extension was brought into AutoCAD and added to the original A-A' cross section. Figure 3B-3 displays the draft hand-drawn extension of section A-A', including sketches of example wells used for section development and PLSS sections. In this figure, sections that had at least one associated WCR are presented with a representative well sketch. Sections without a well sketch did not contain any WCR. Figure 3B-4 displays the final section A-A' as drawn in AutoCAD.

¹ <https://cawaterlibrary.net/wp-content/uploads/2017/05/Geology-of-the-Northern-Sacramento-Valley.pdf>

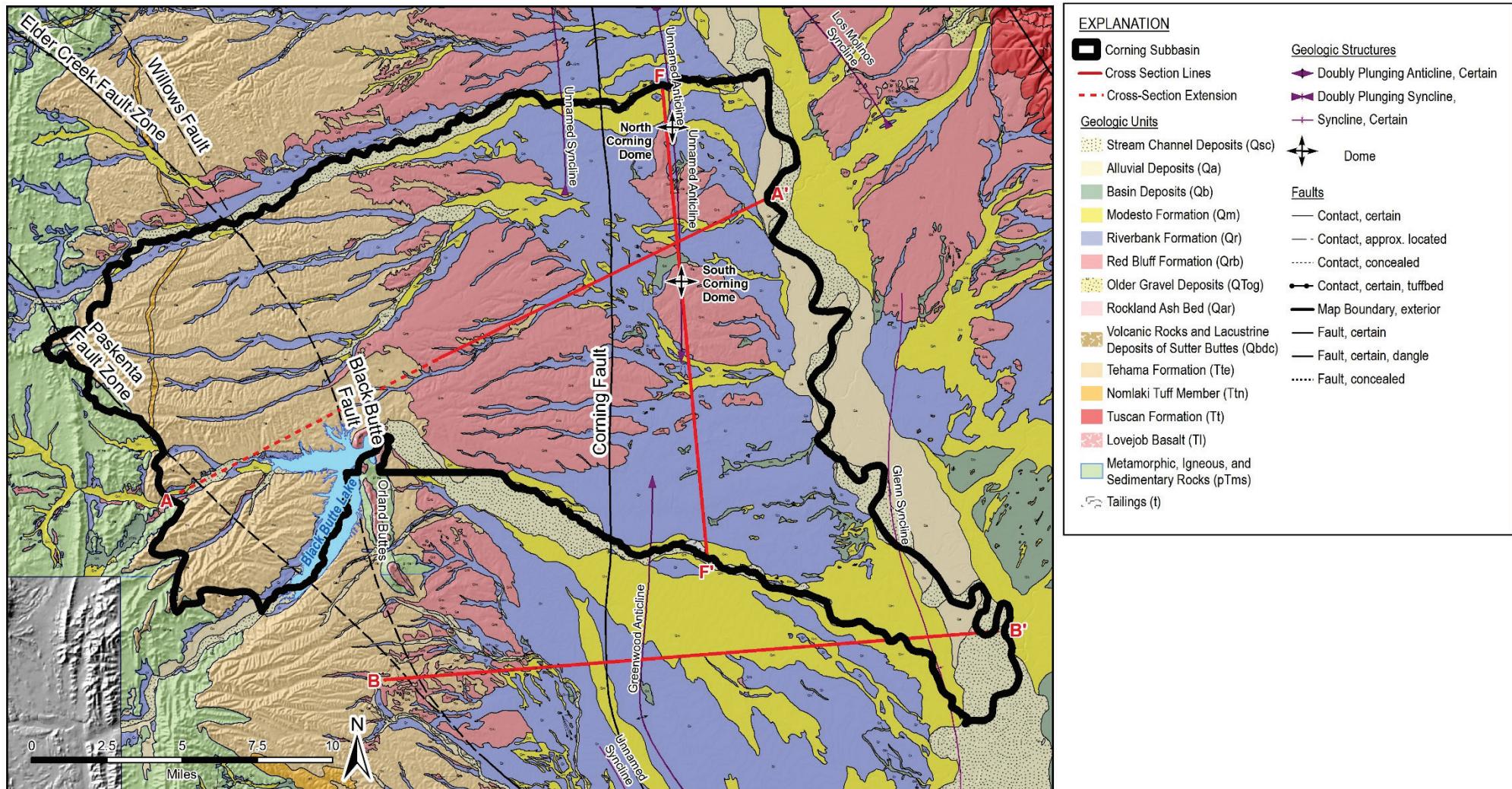


Figure 3B-1. Surficial Geology and Extent of Cross Section A-A'

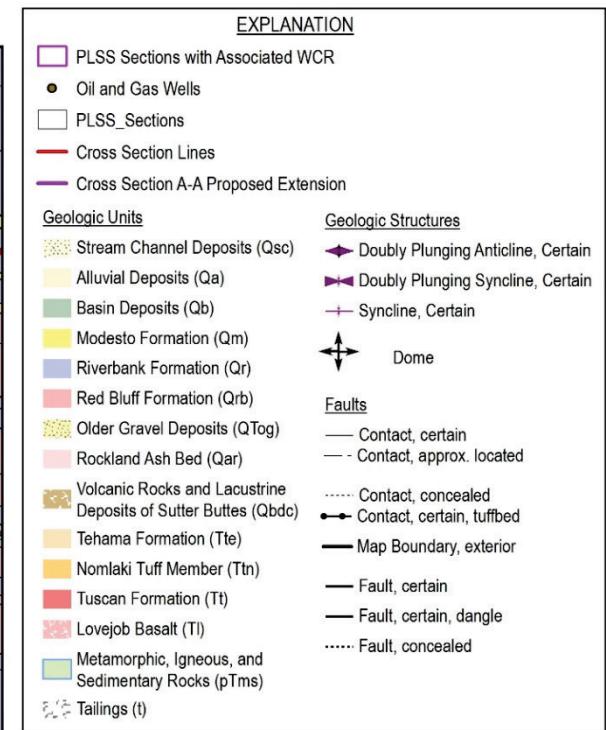
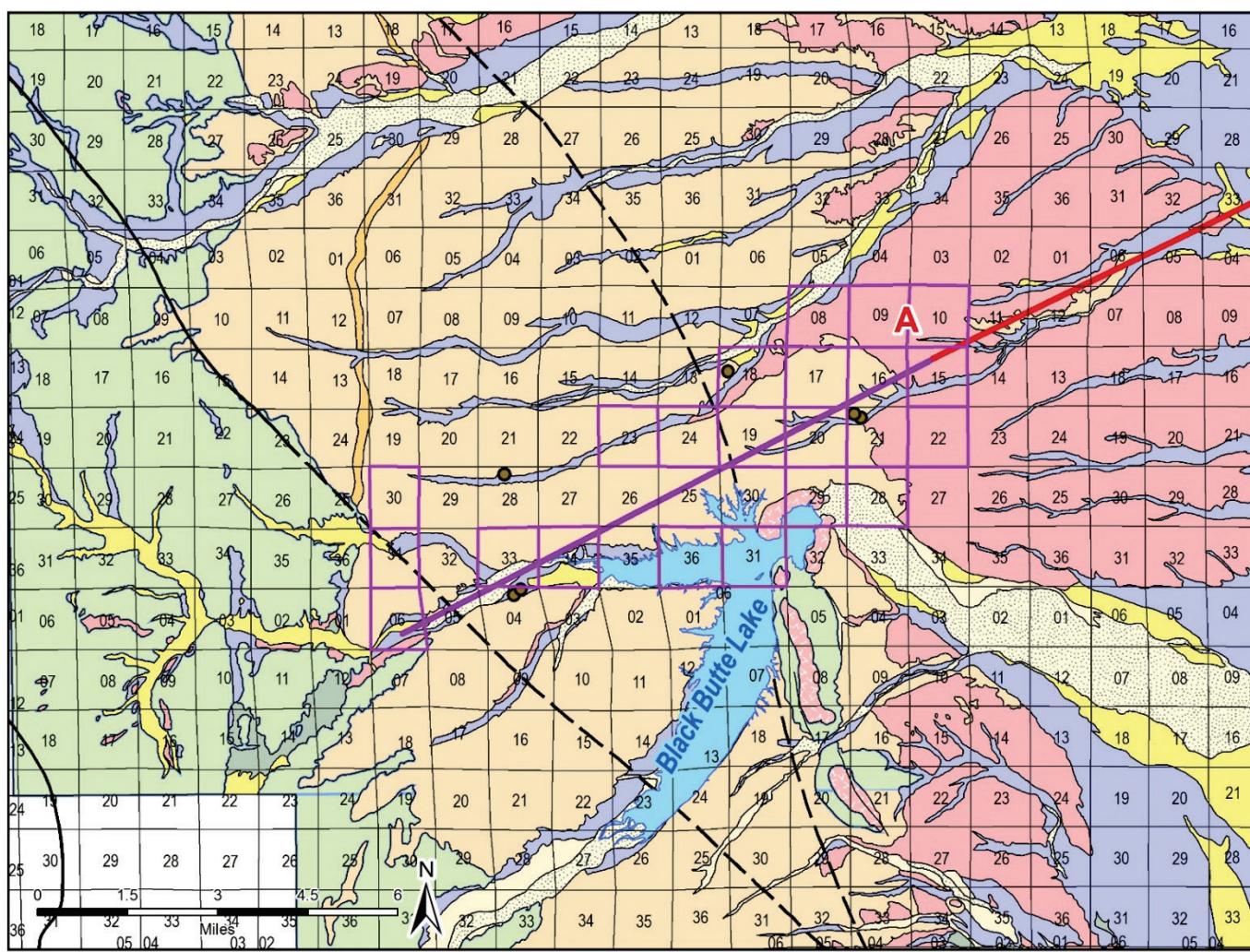


Figure 3B-2. Area of Cross Section A-A' Extension with PLSS Sections

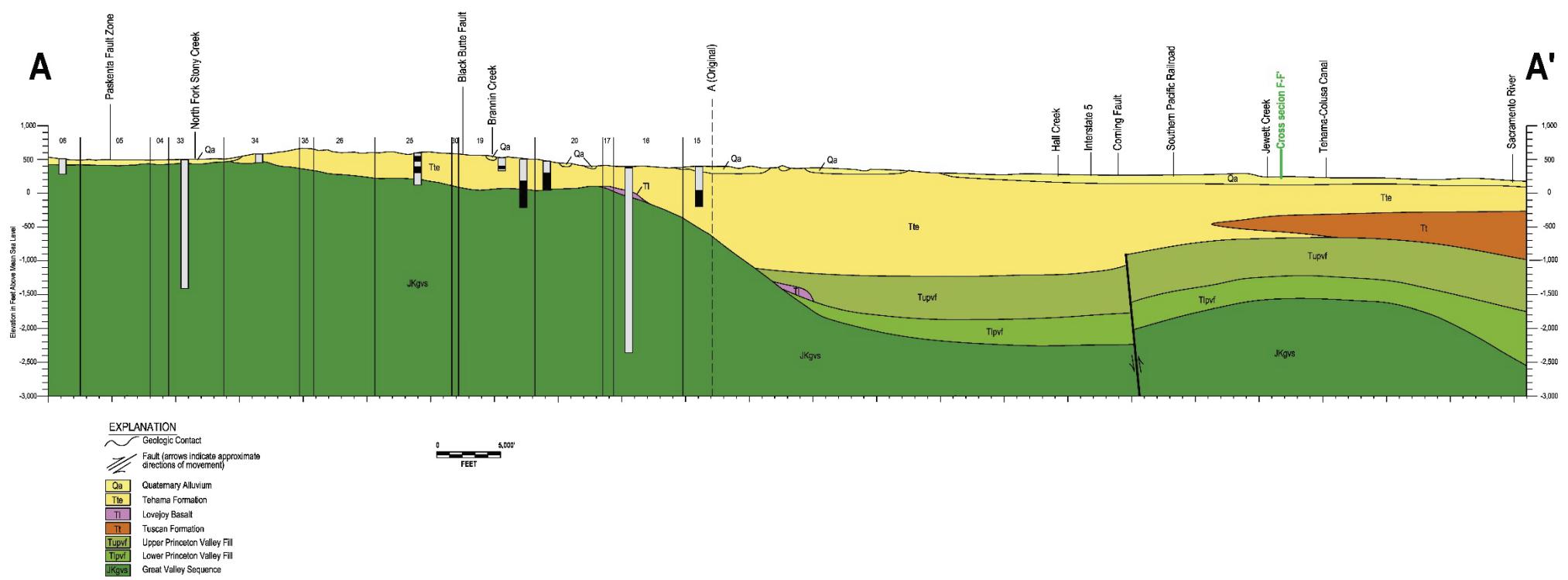


Figure 3B-3. Draft Cross Section A-A' Extension

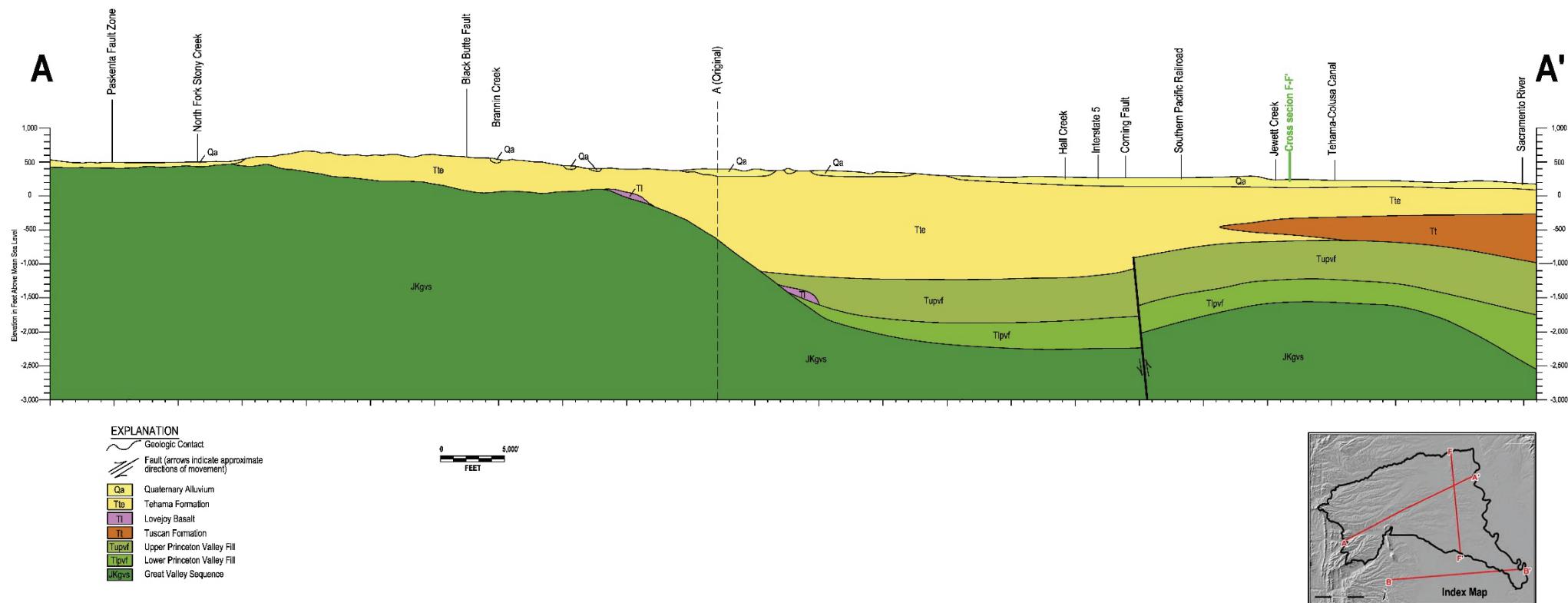
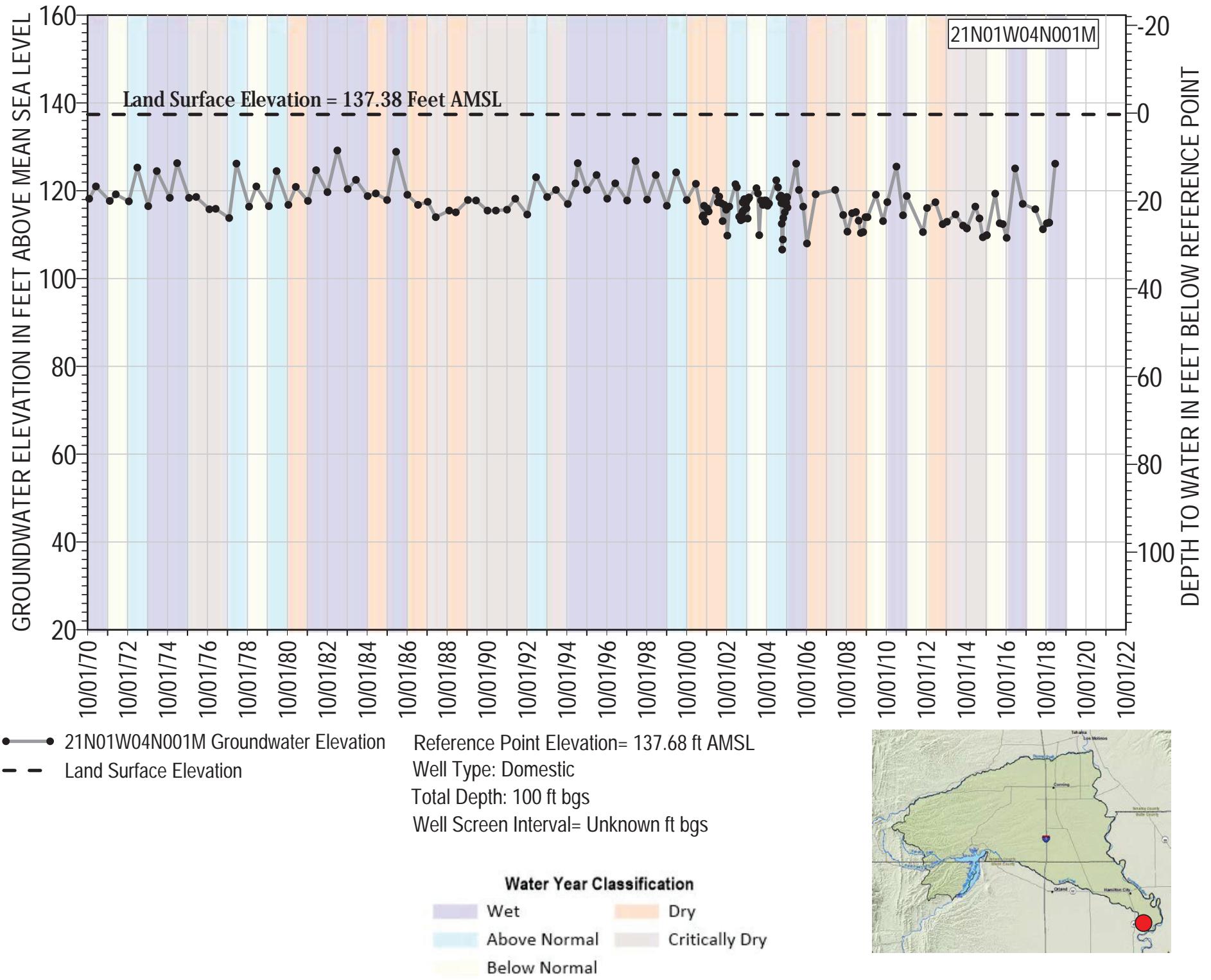
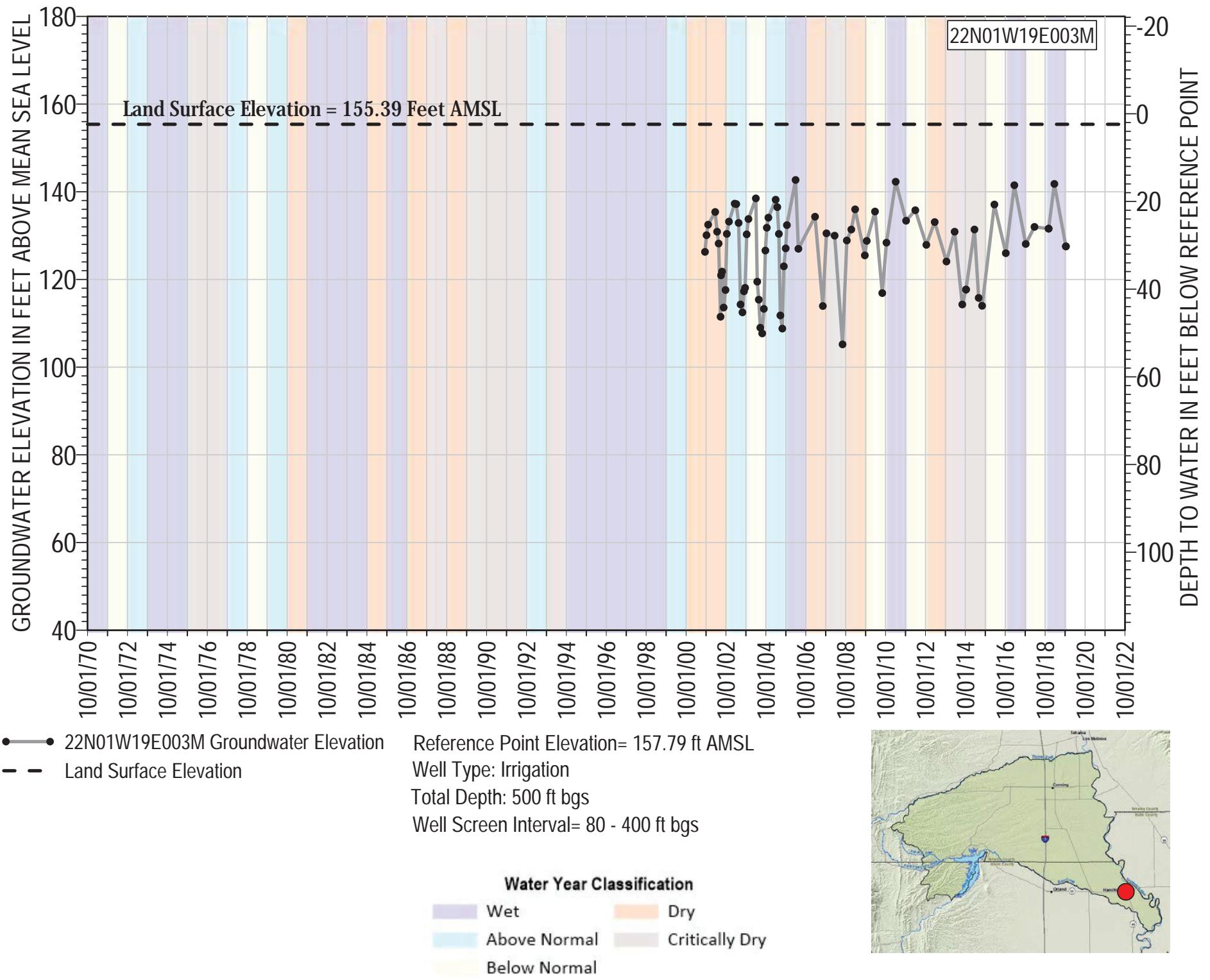


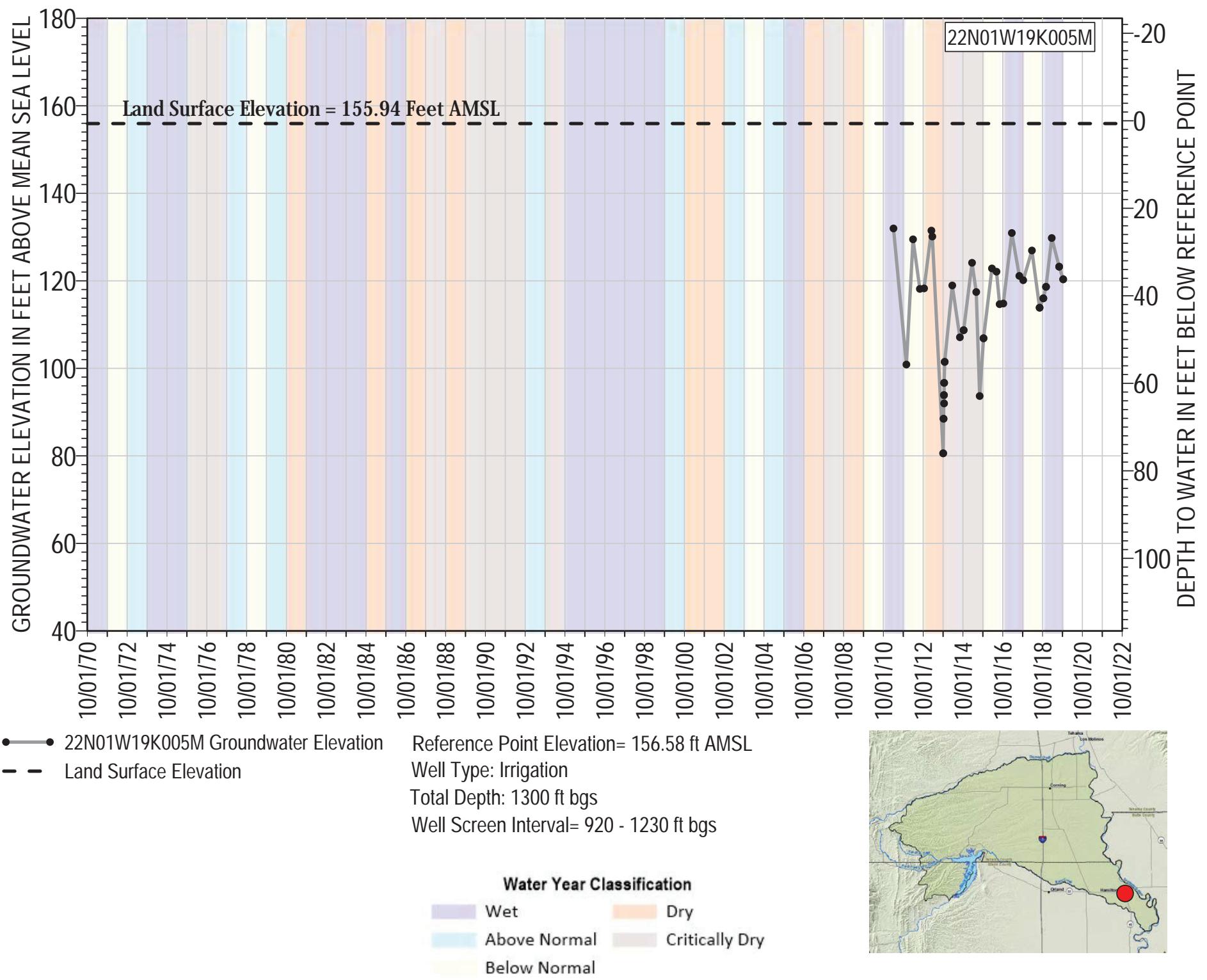
Figure 3B-4. Final Cross Section A-A' Extension

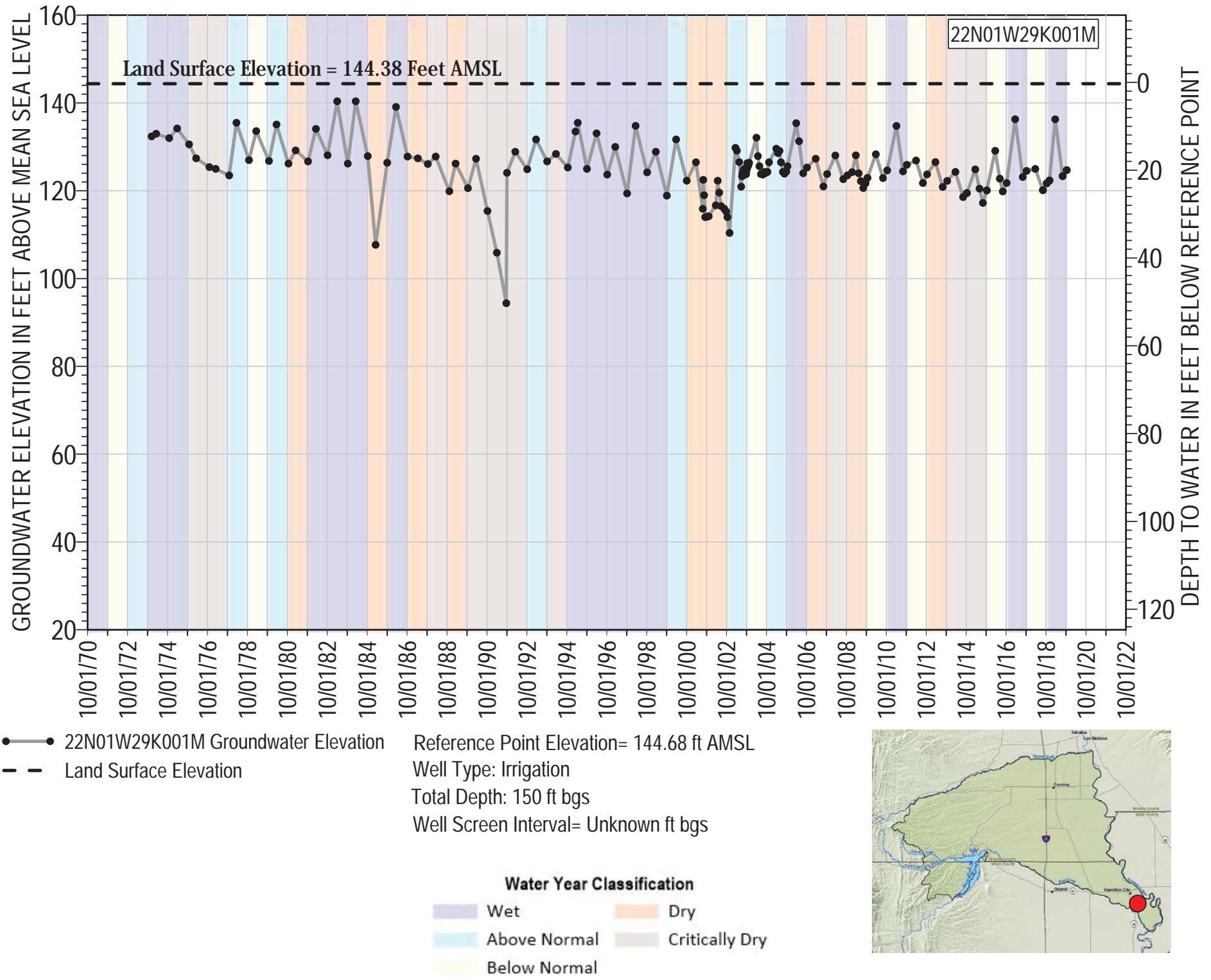
Appendix 3C

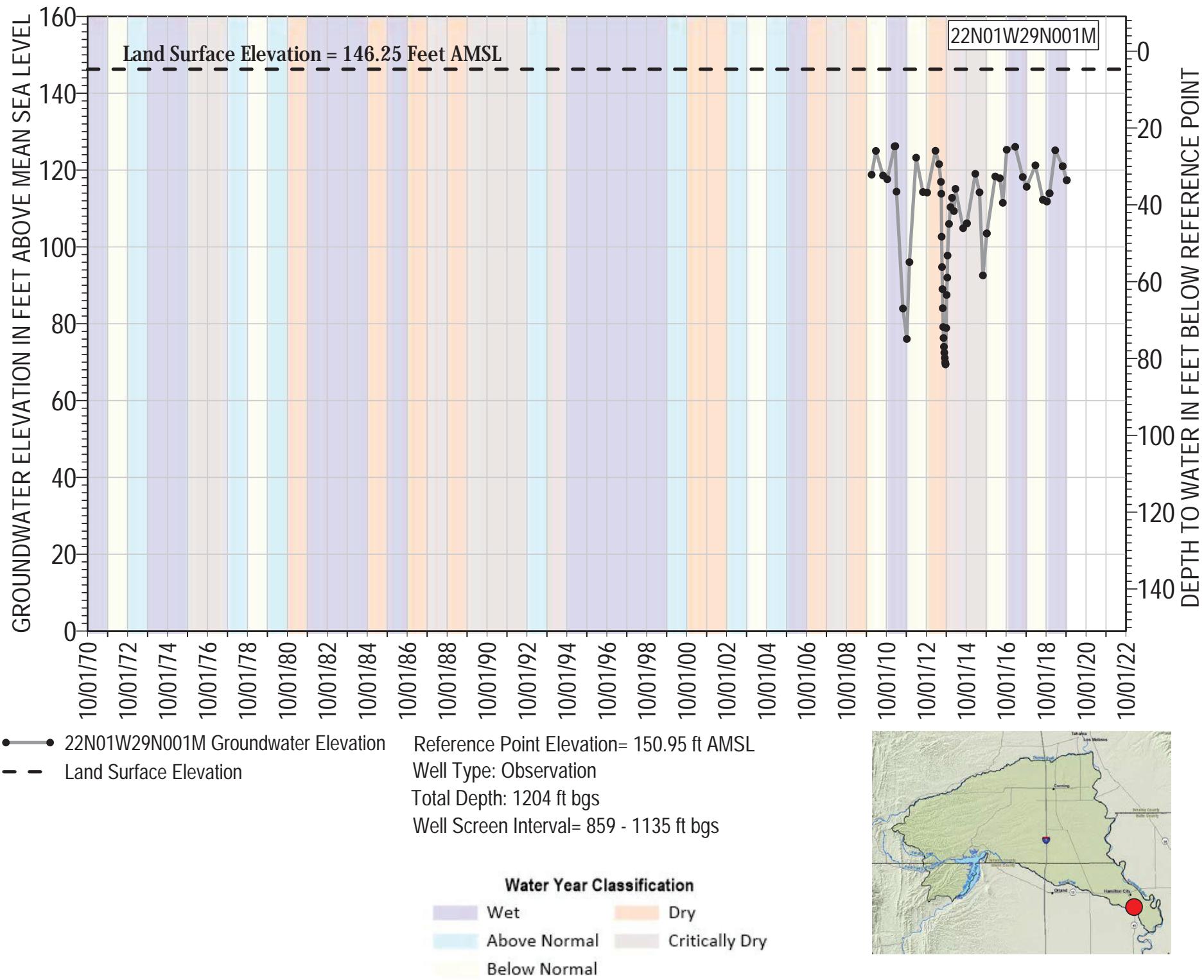
Groundwater Level Hydrographs

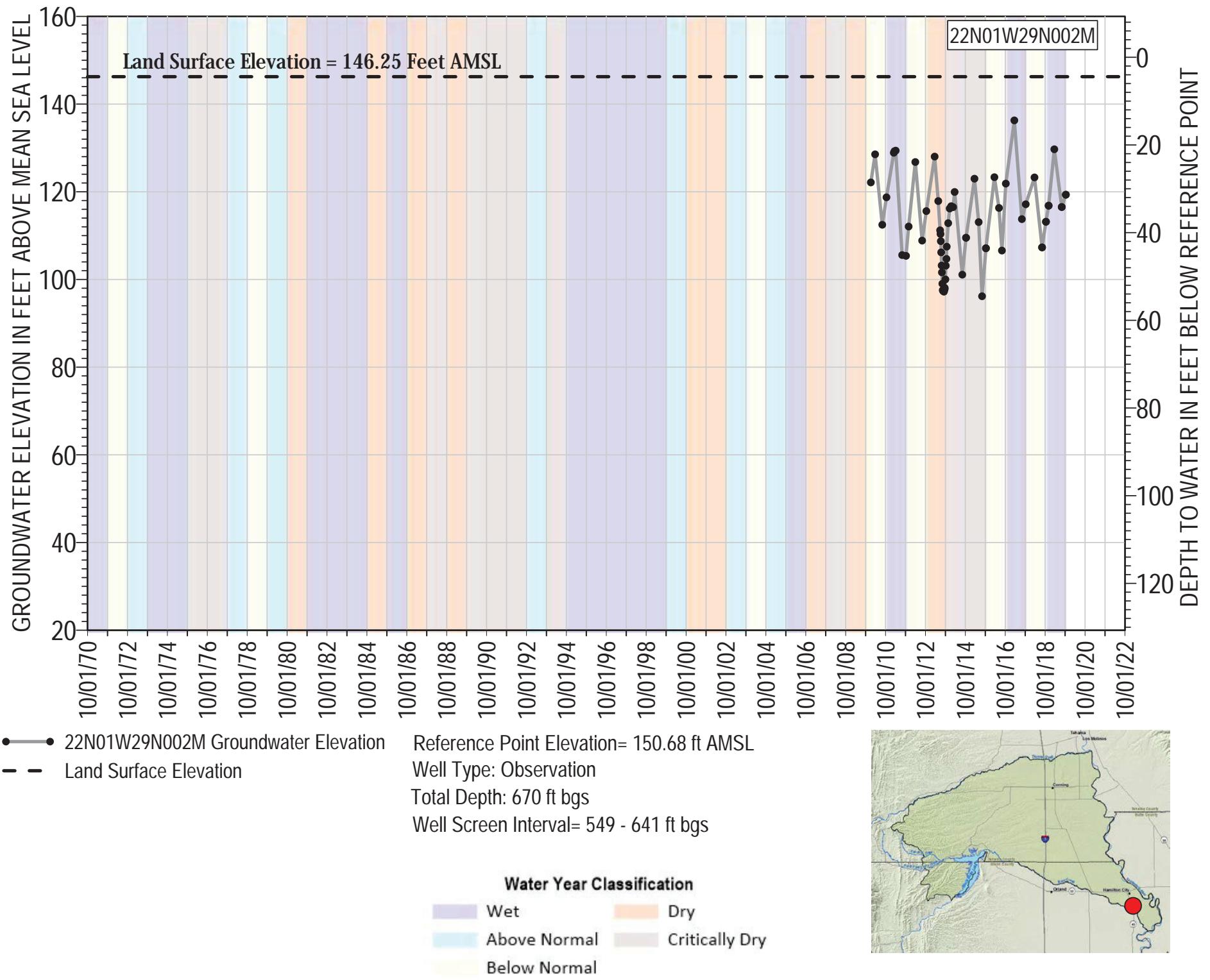


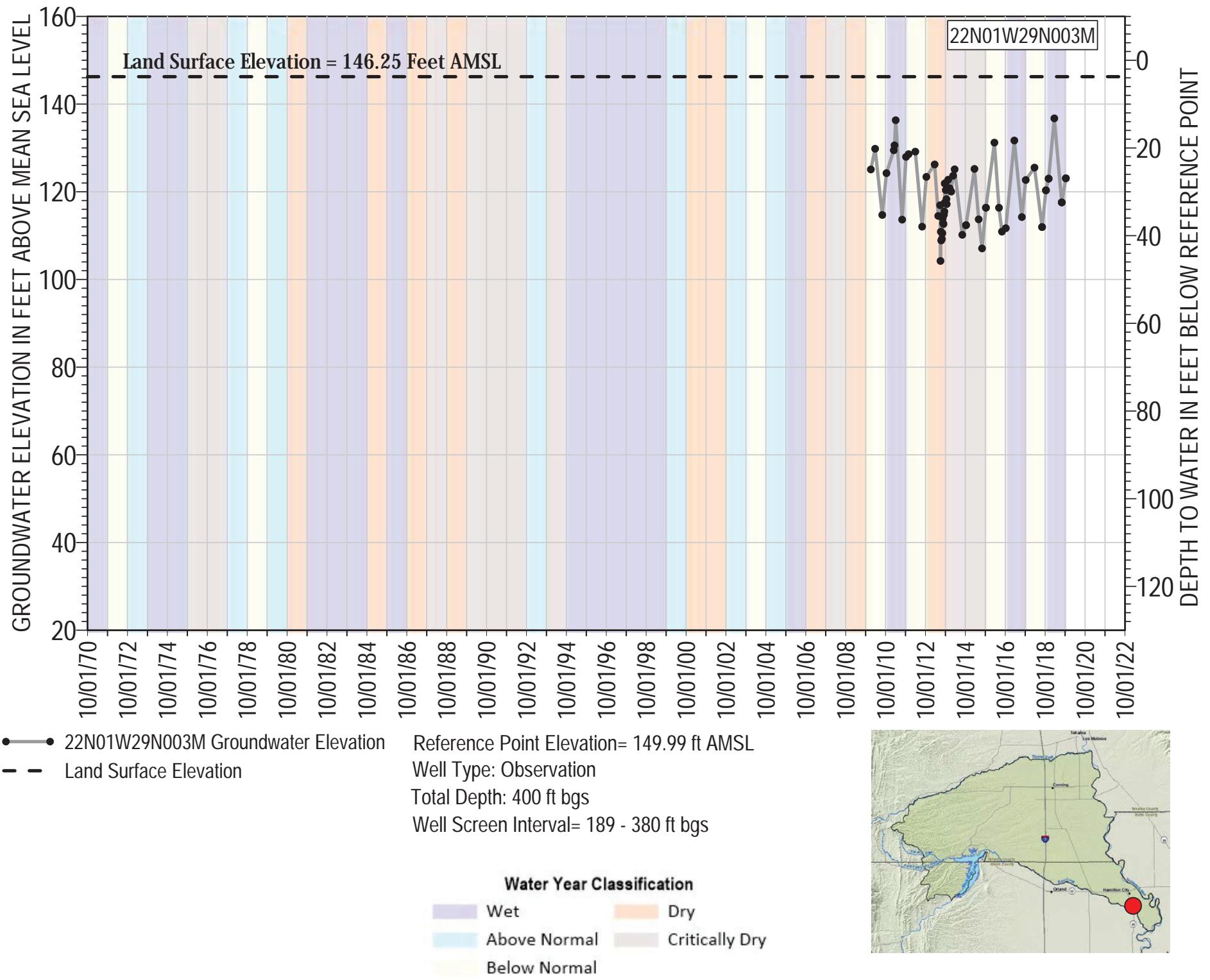


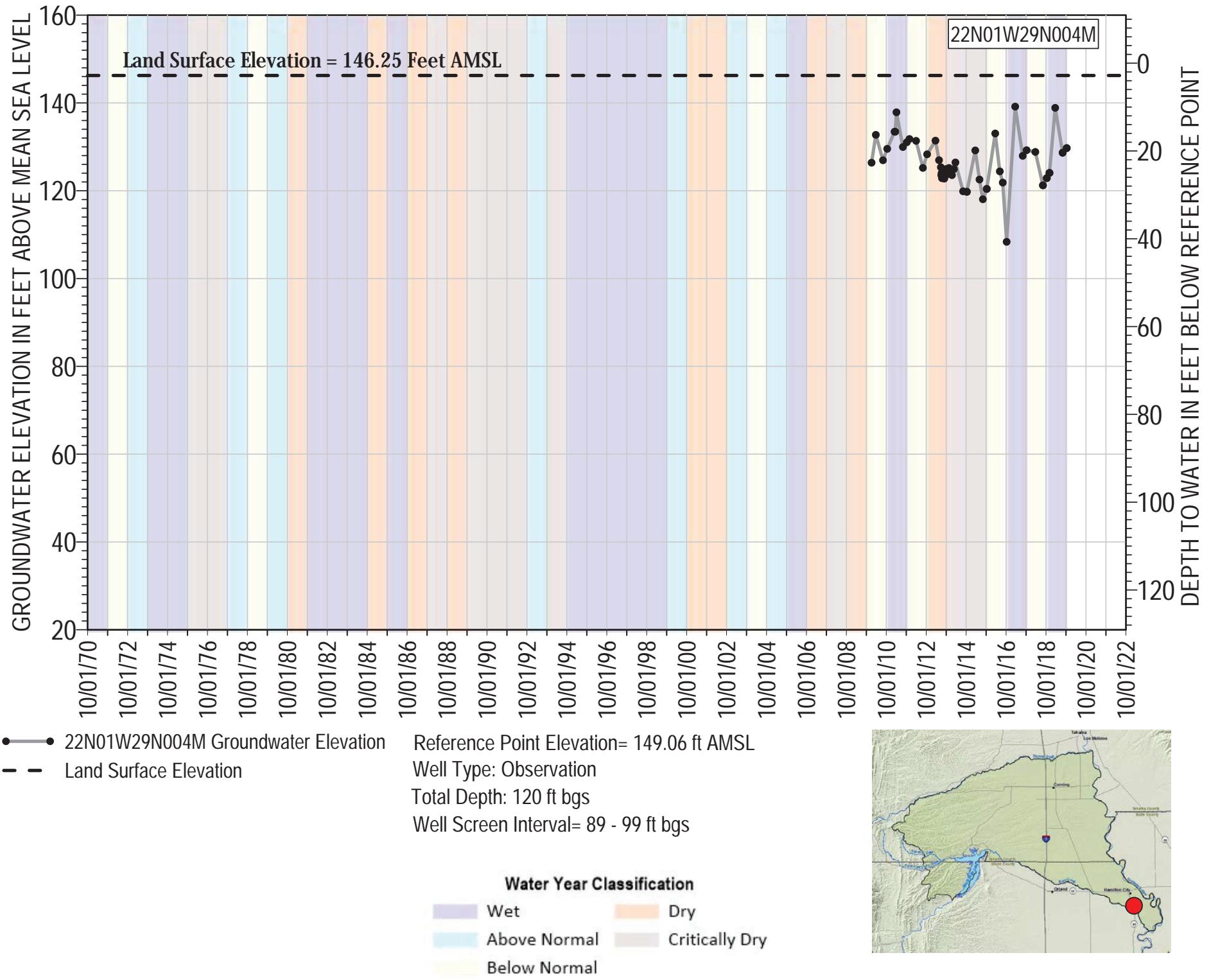


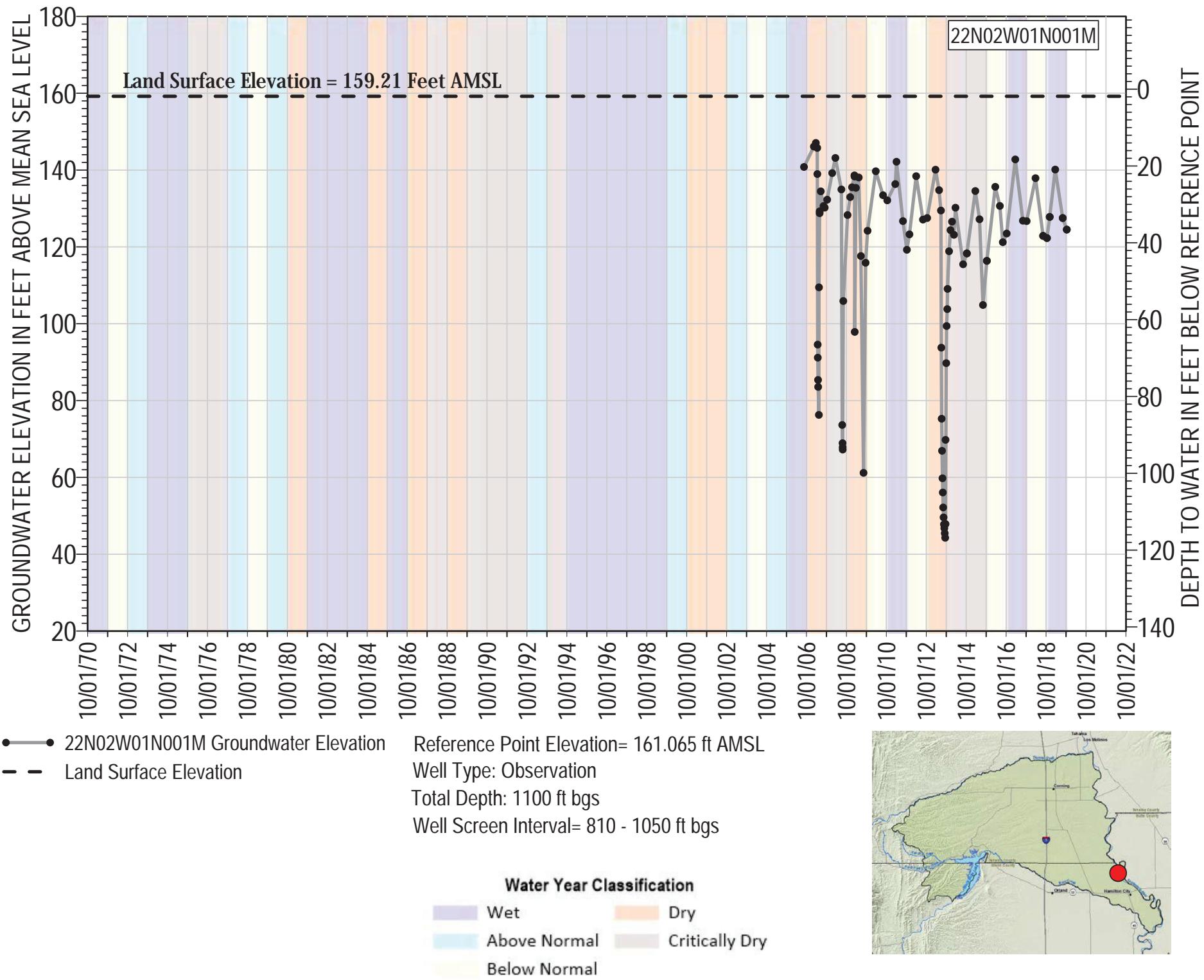


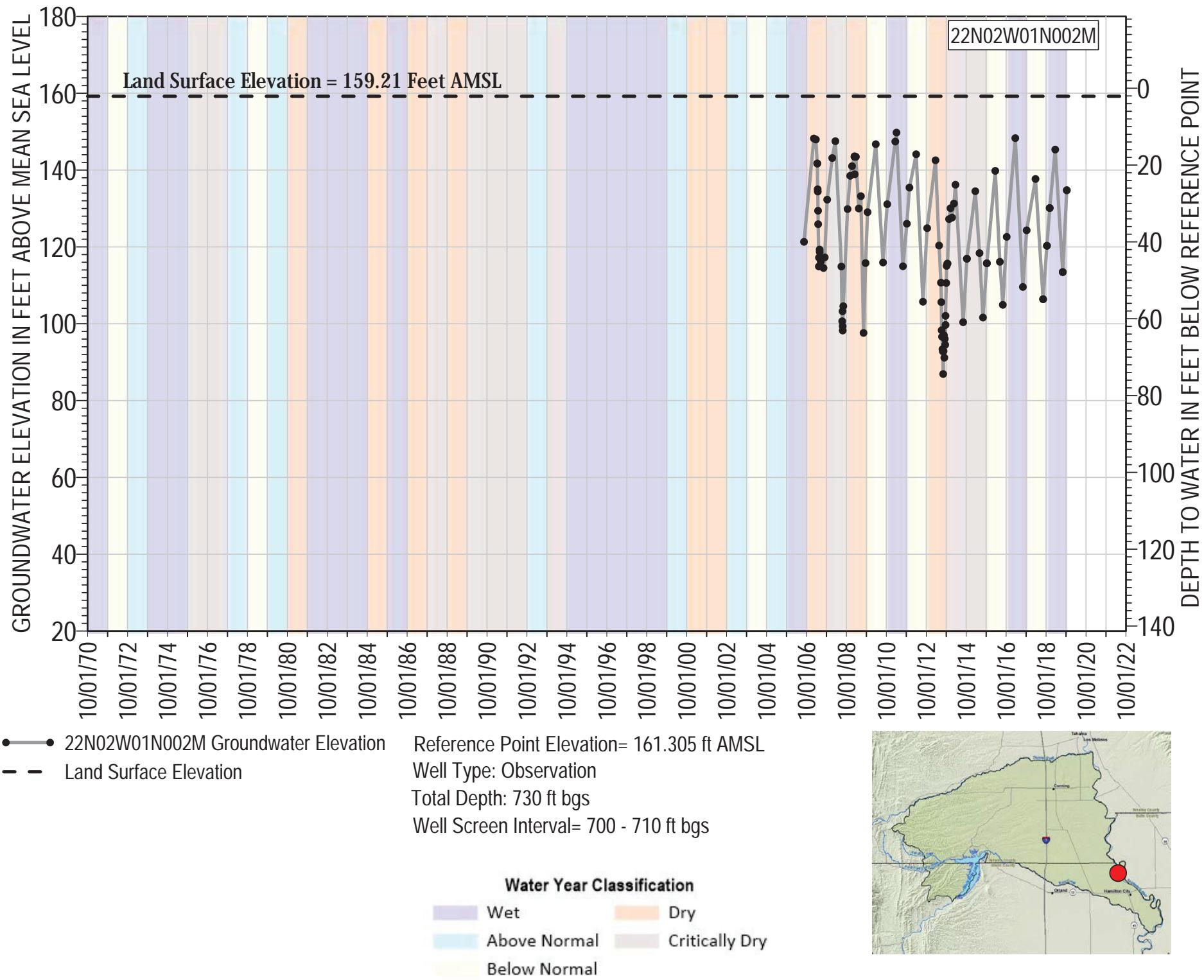


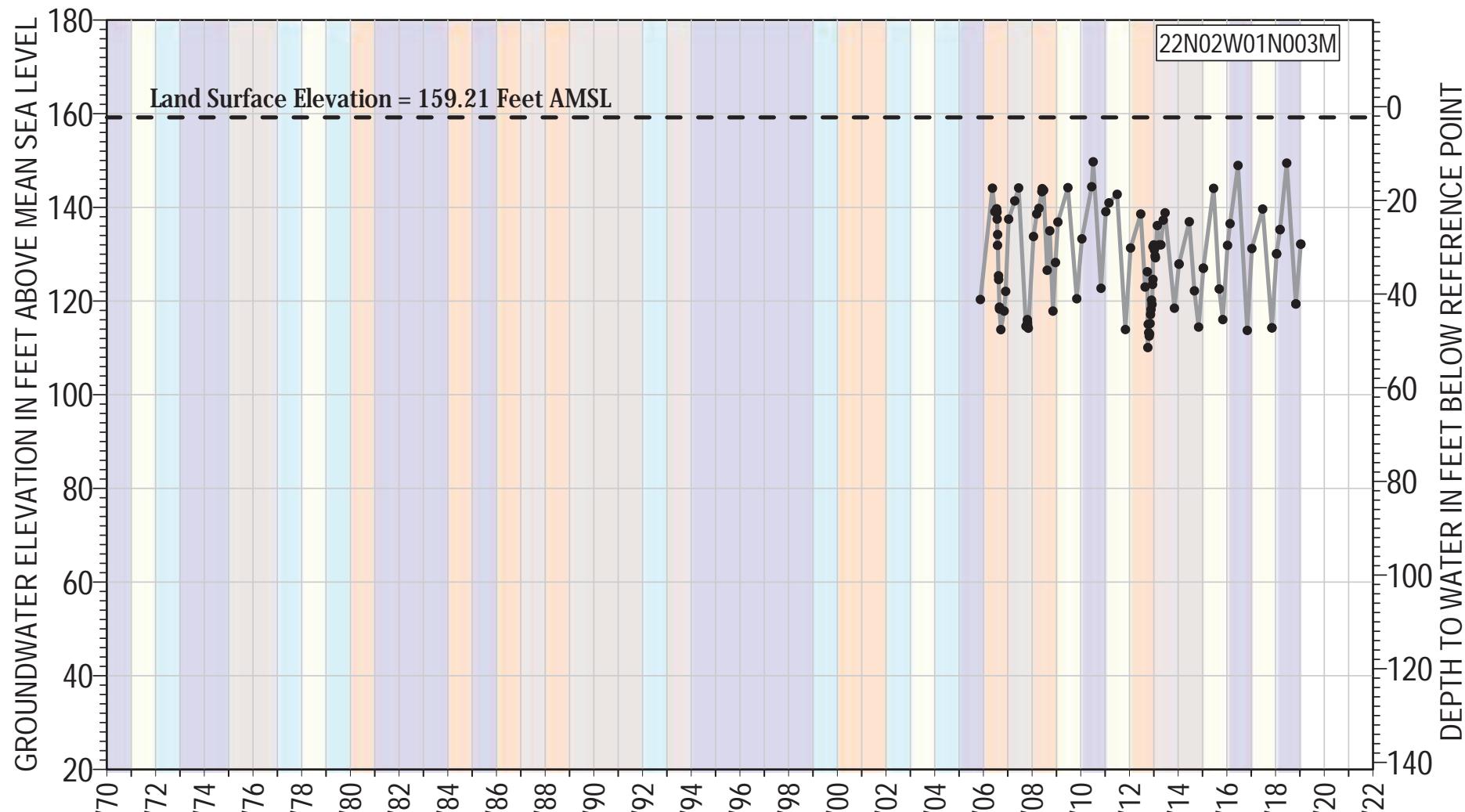






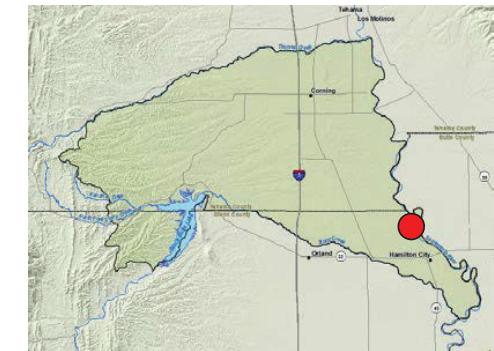


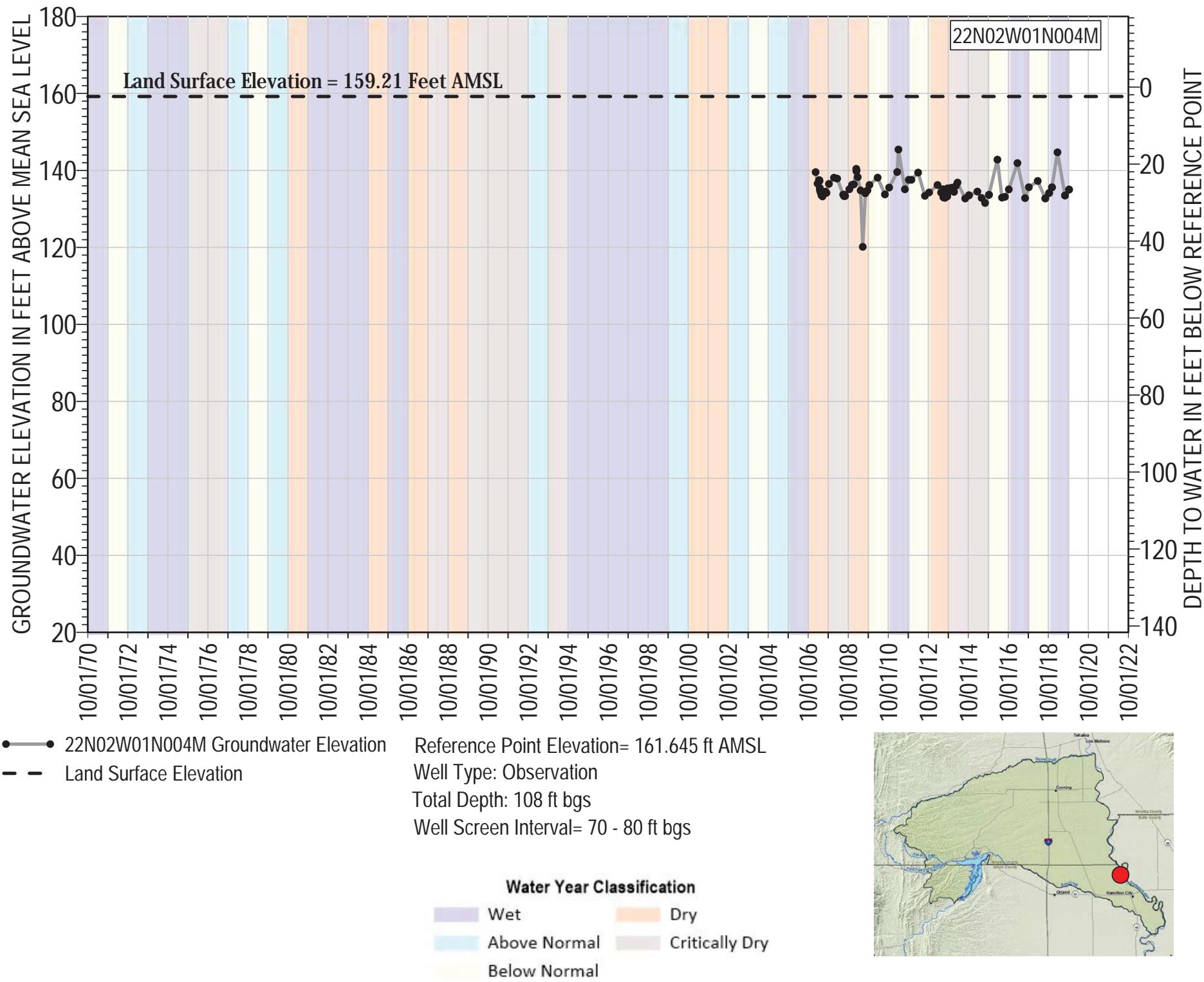


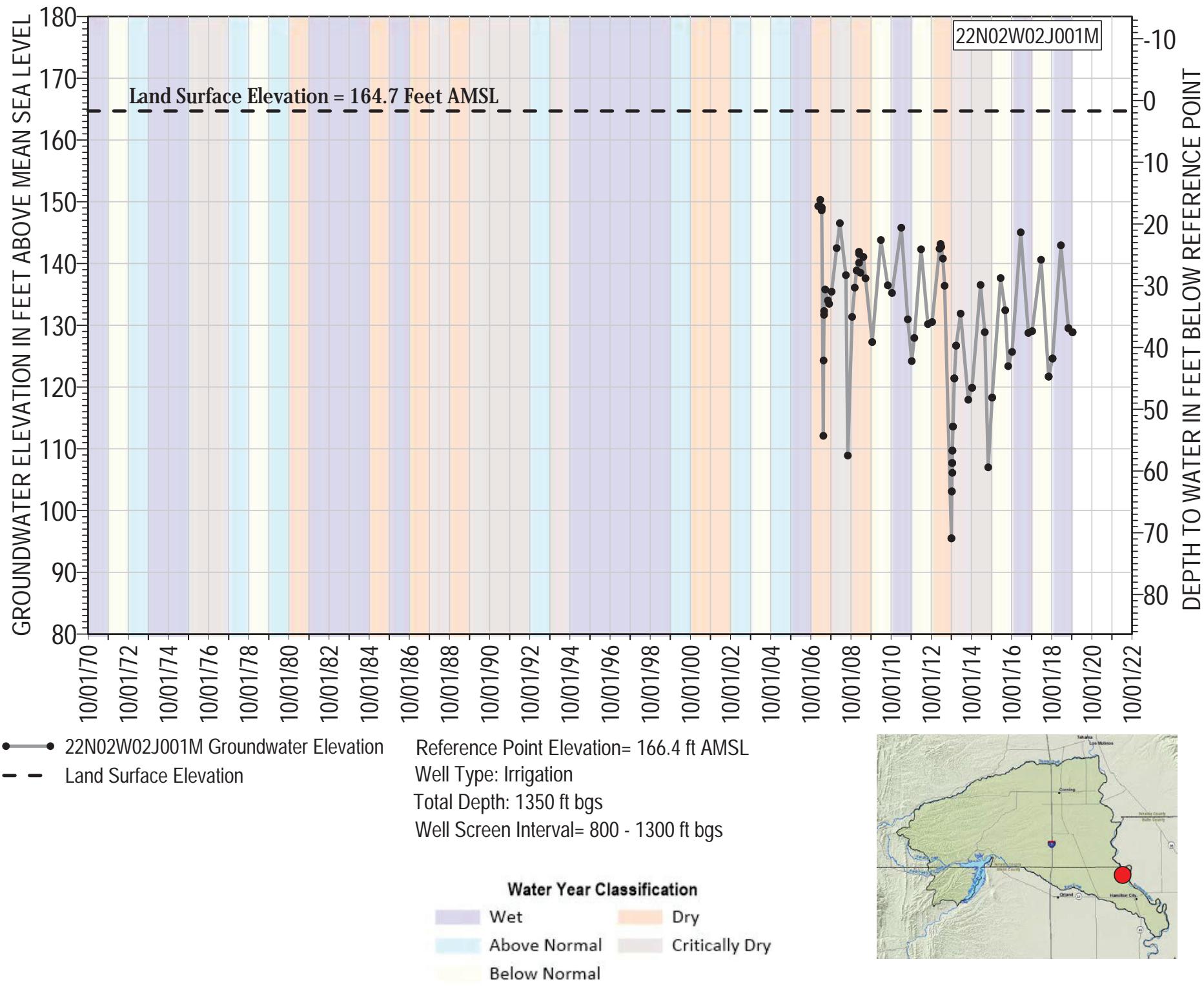


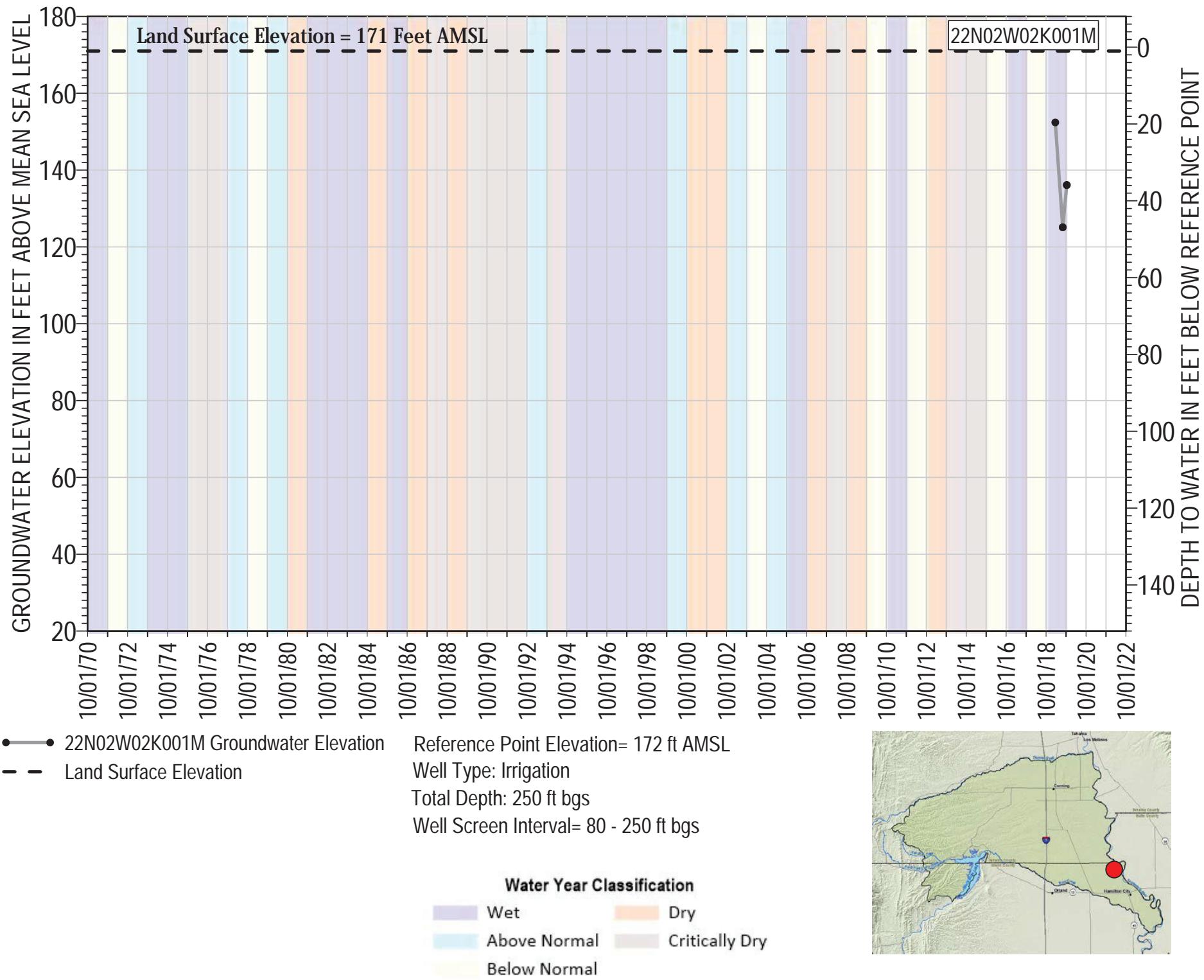
● 22N02W01N003M Groundwater Elevation
 - - Land Surface Elevation

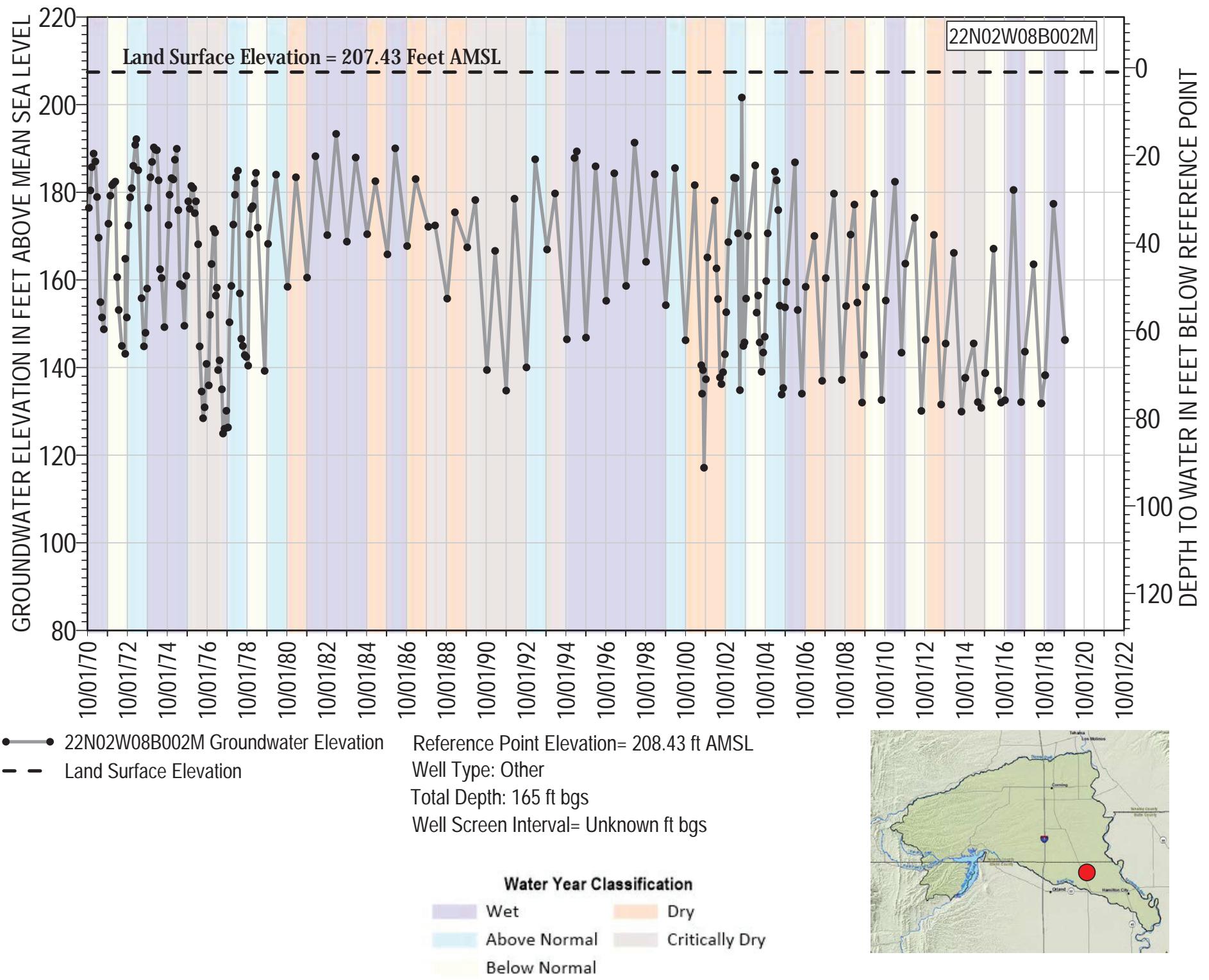
Reference Point Elevation= 161.495 ft AMSL
 Well Type: Observation
 Total Depth: 440 ft bgs
 Well Screen Interval= 210 - 370 ft bgs

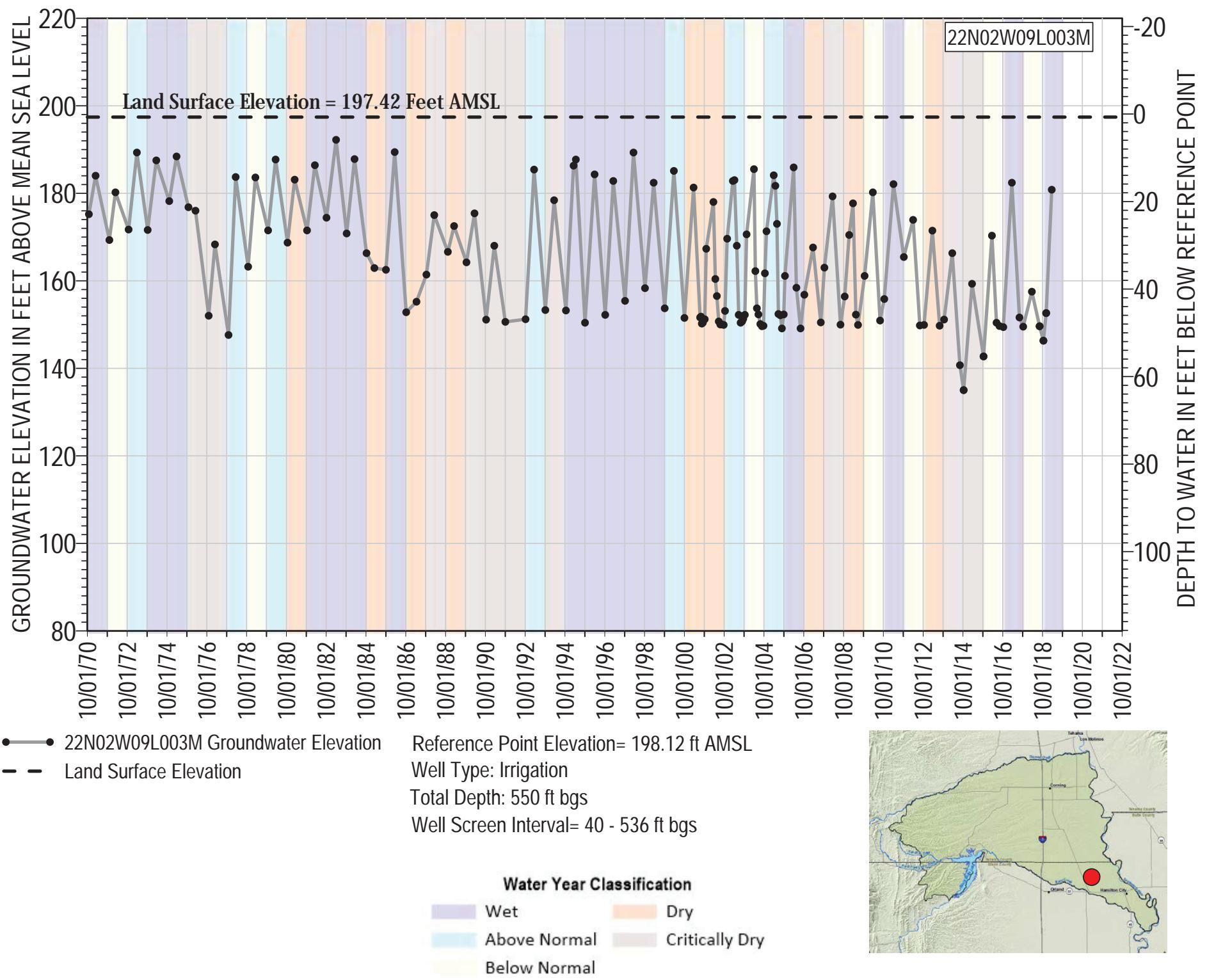


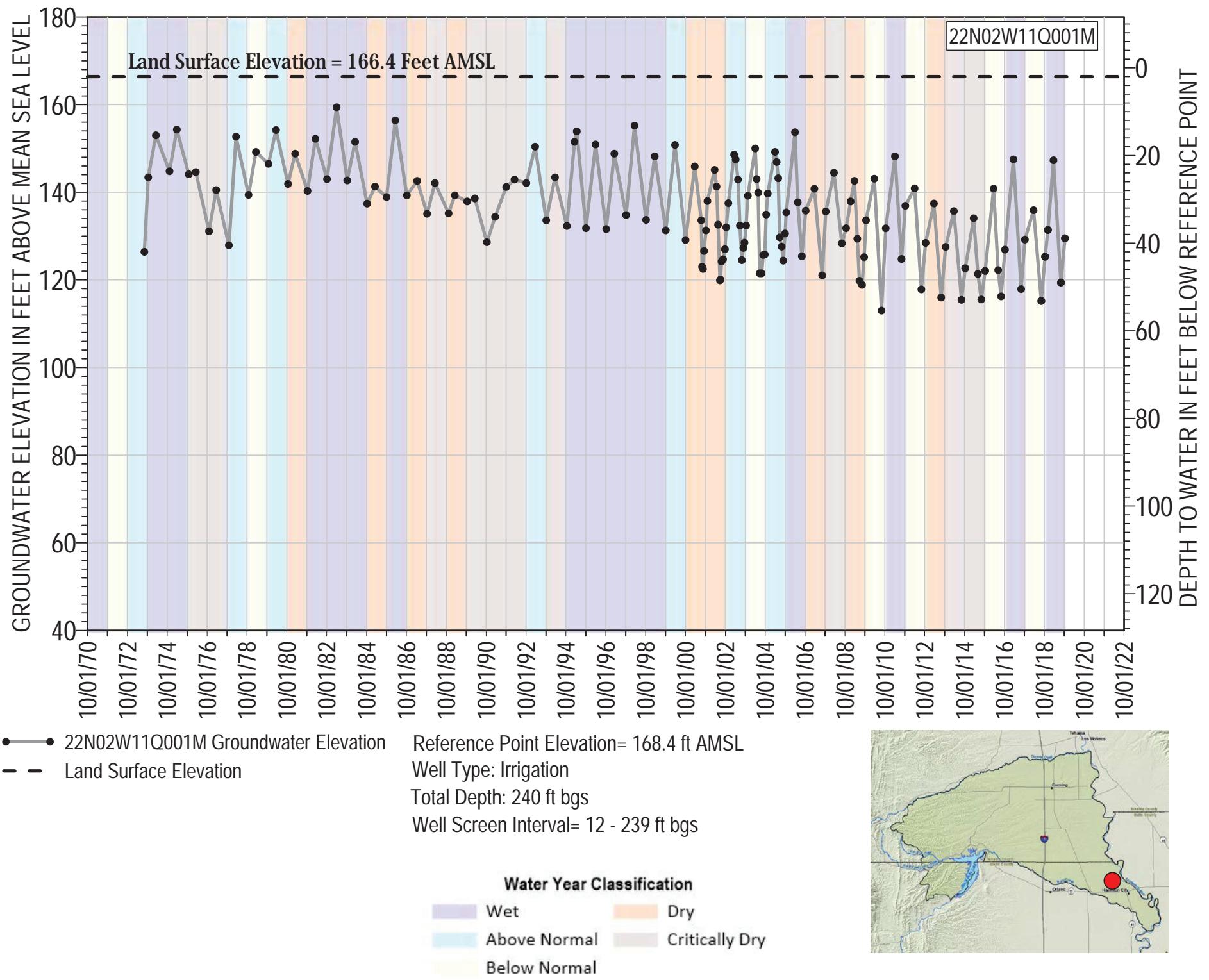


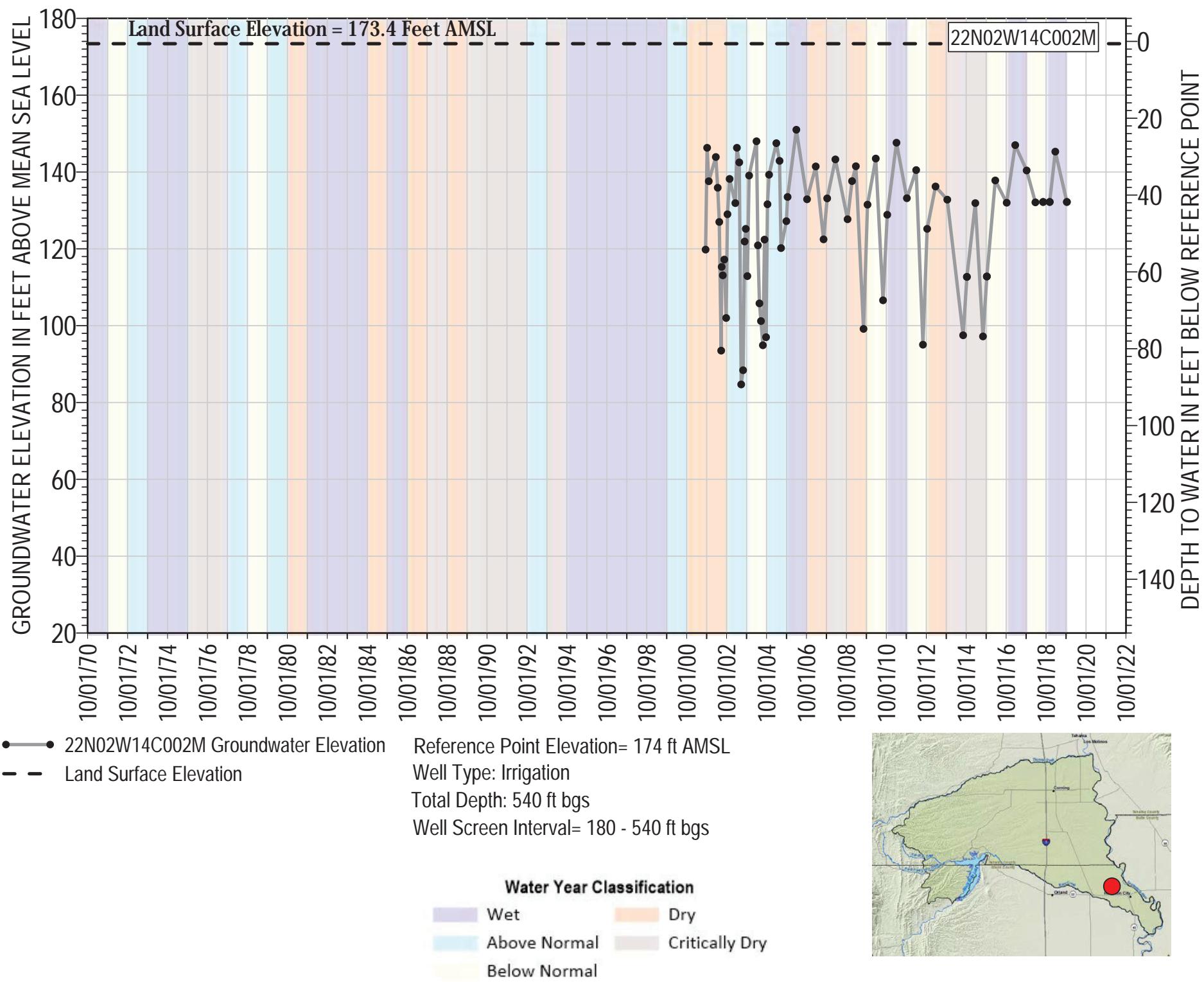


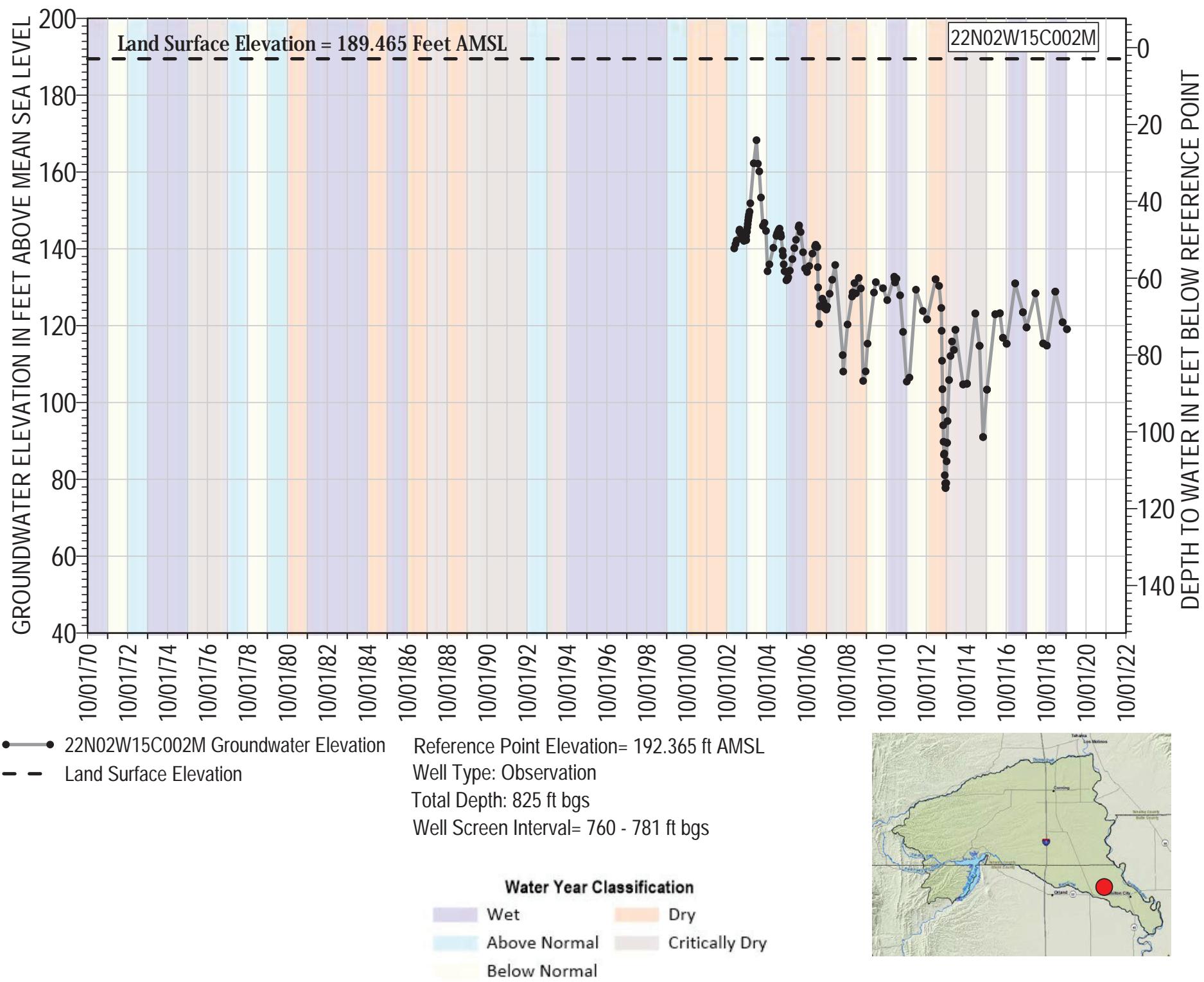


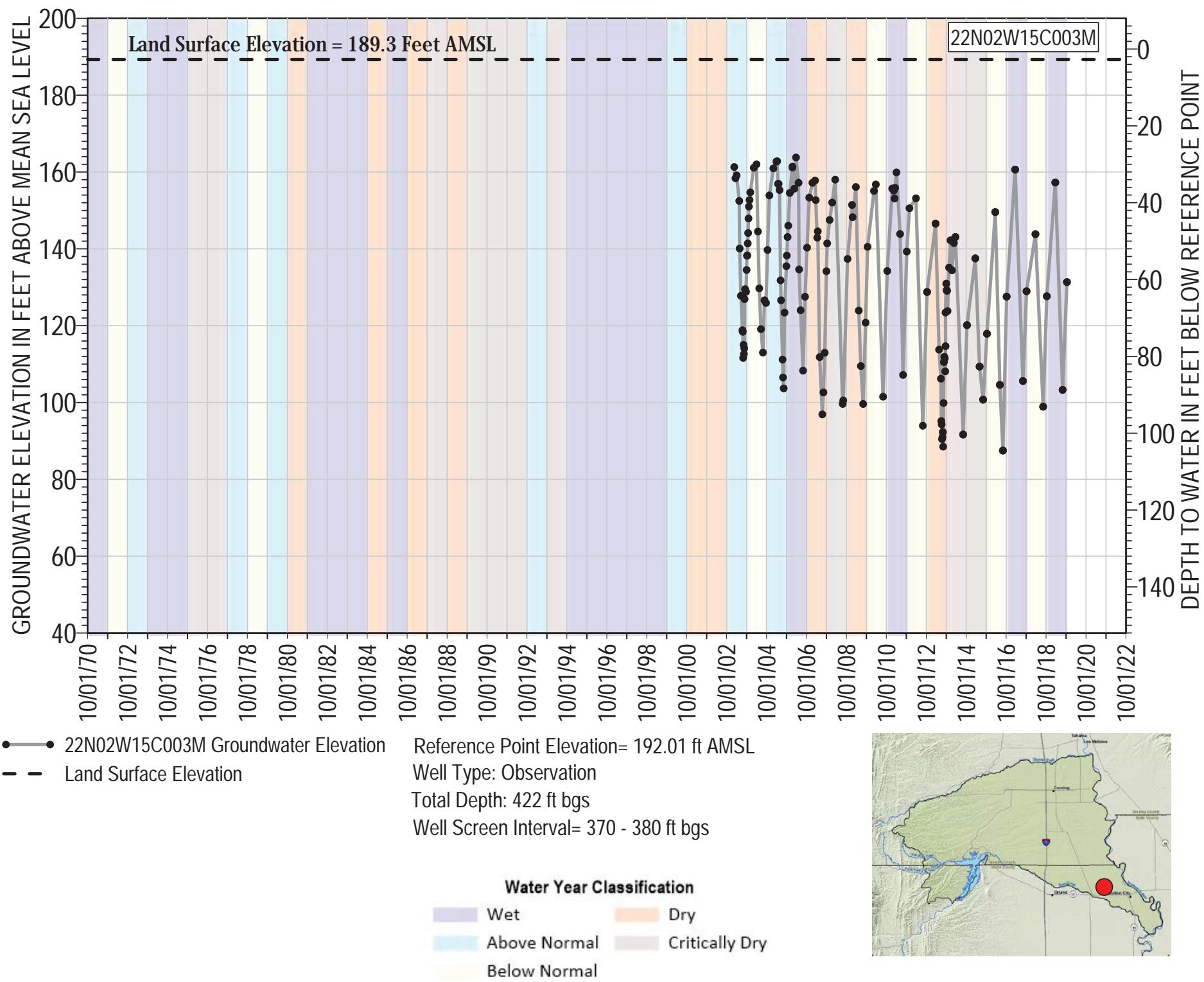


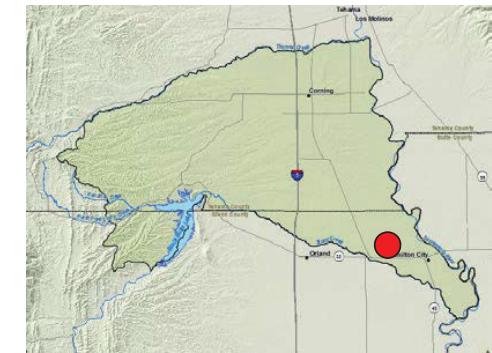
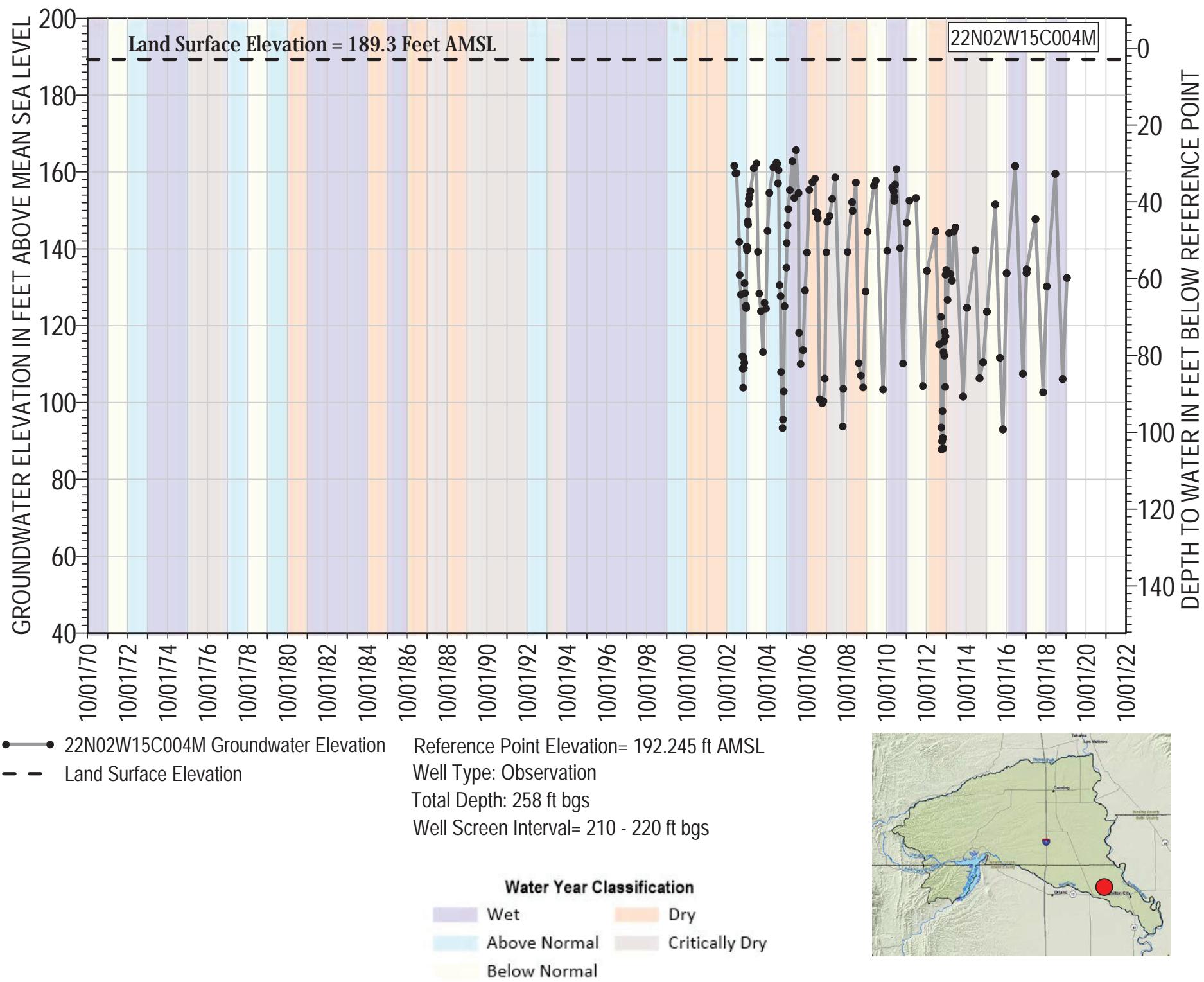


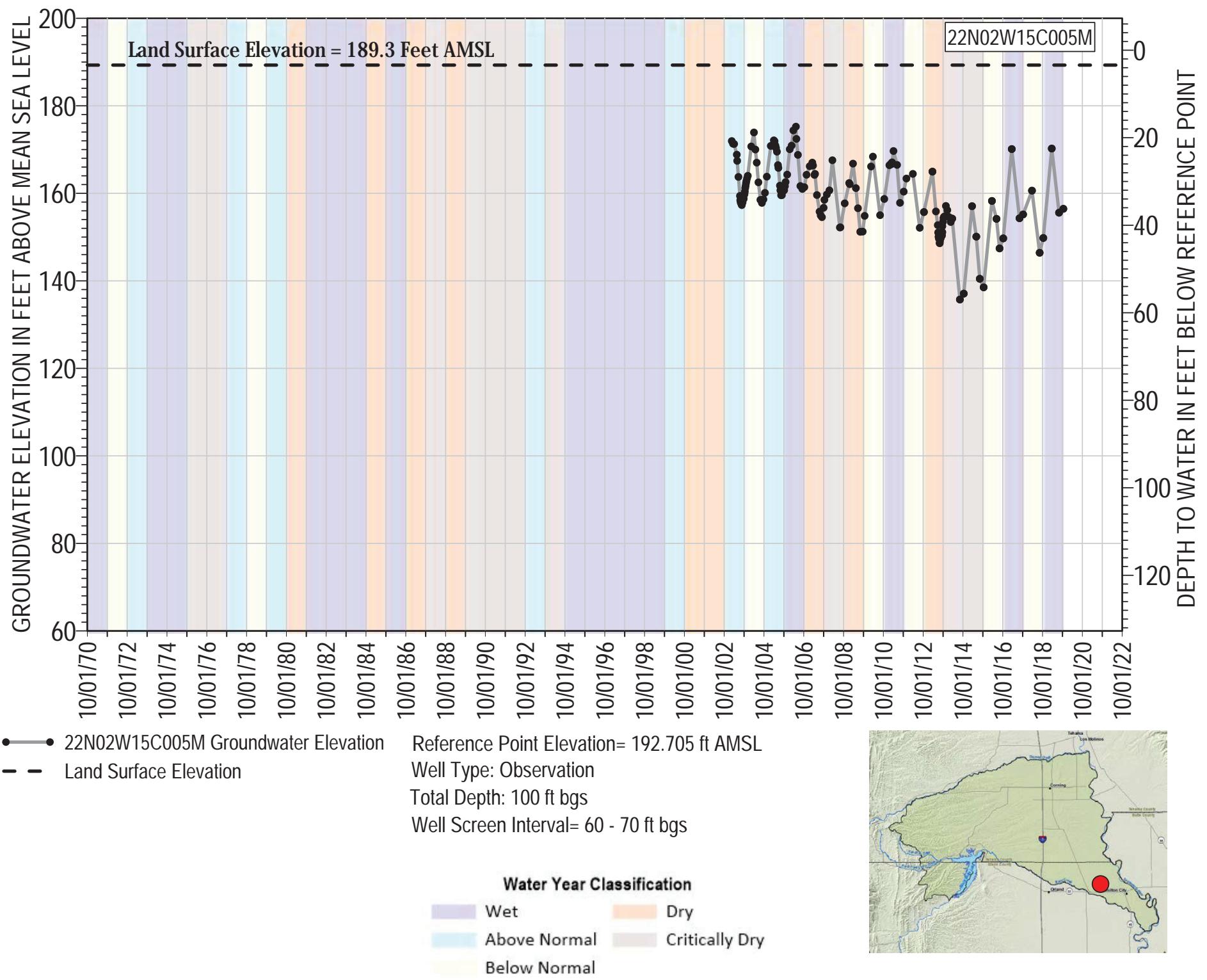


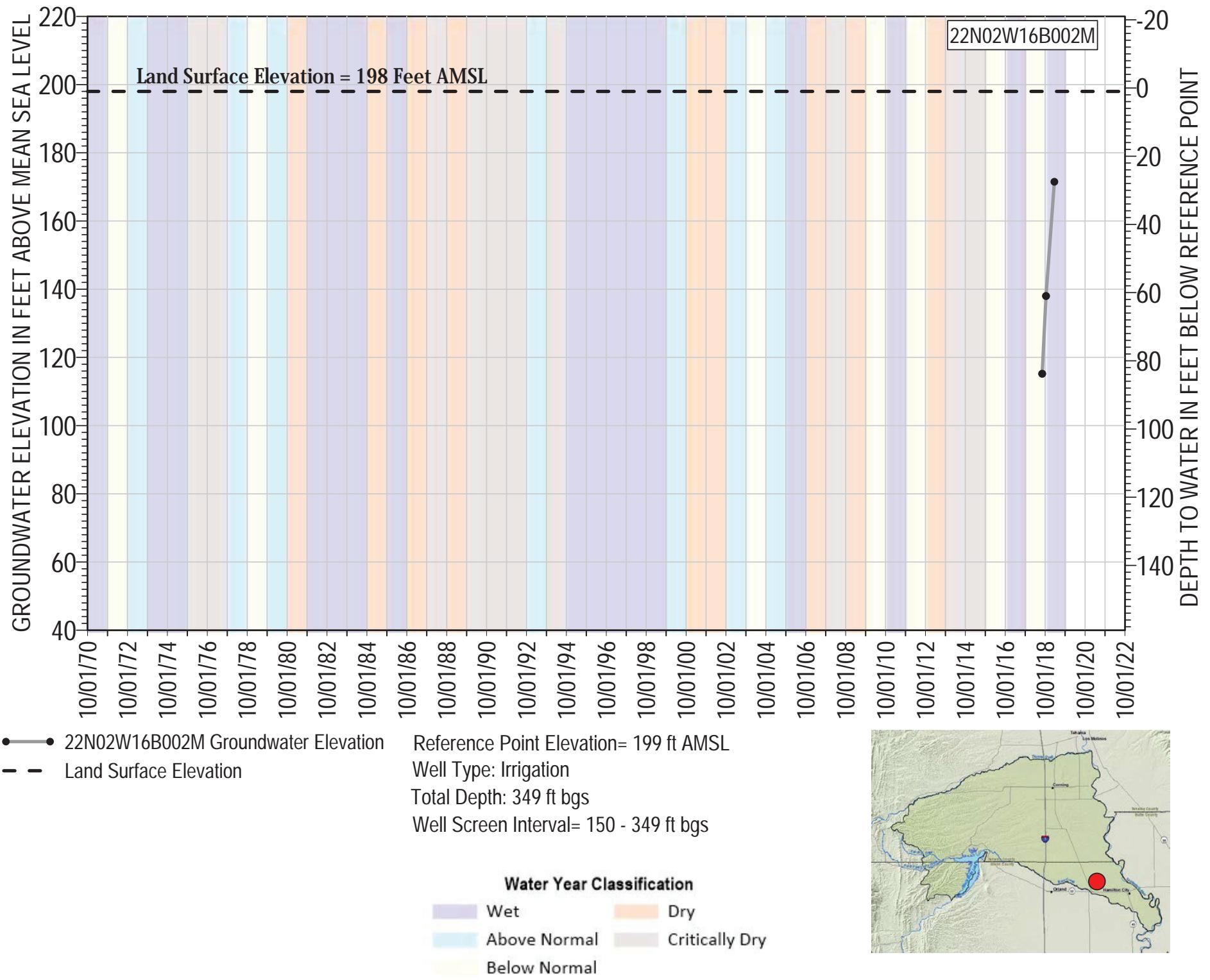


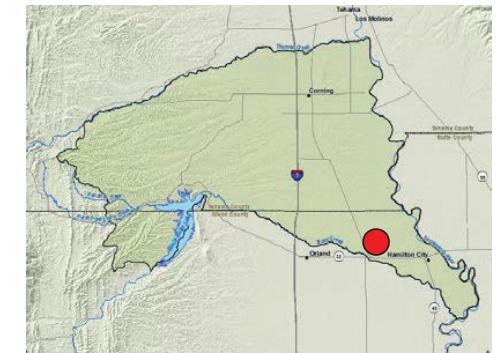
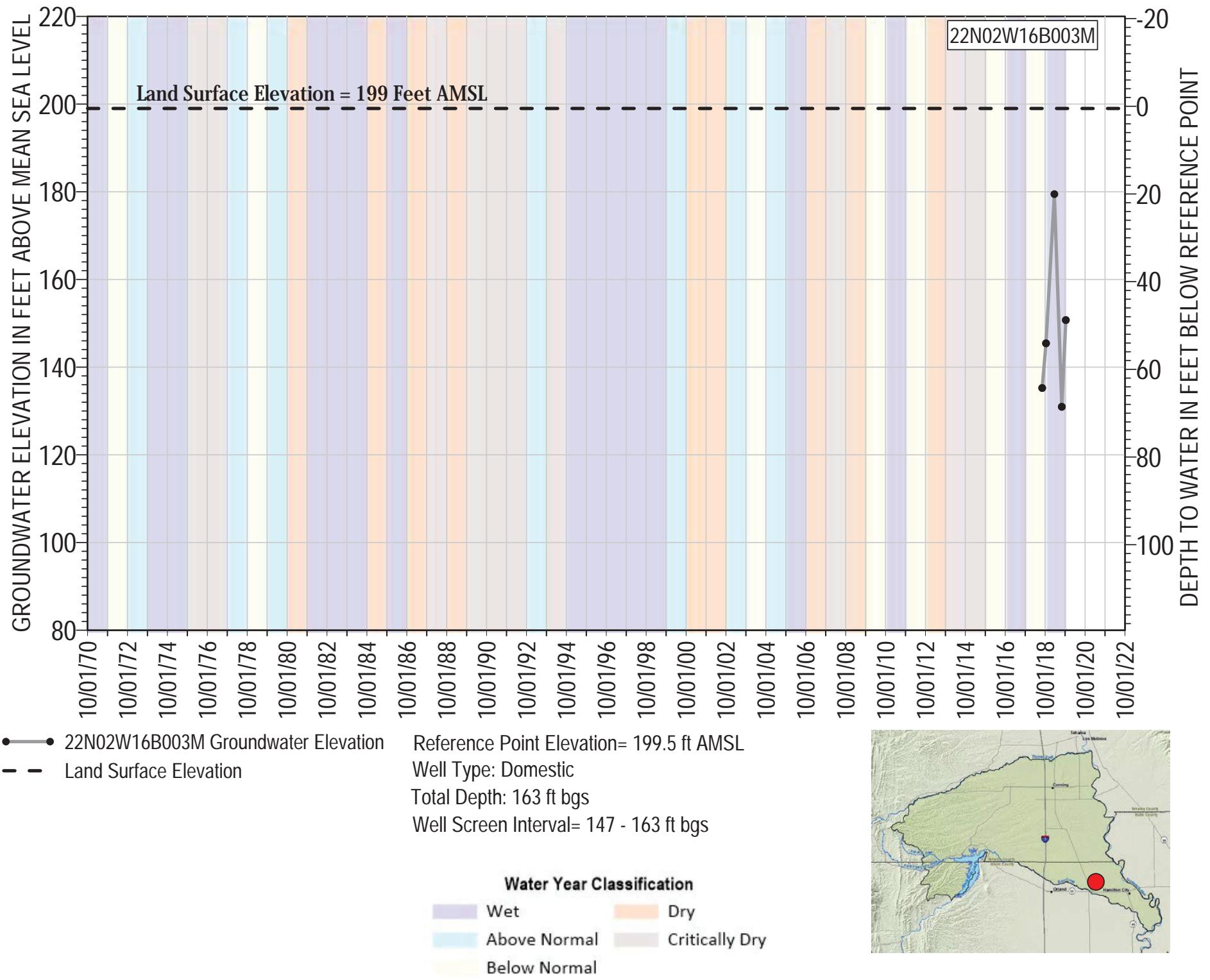


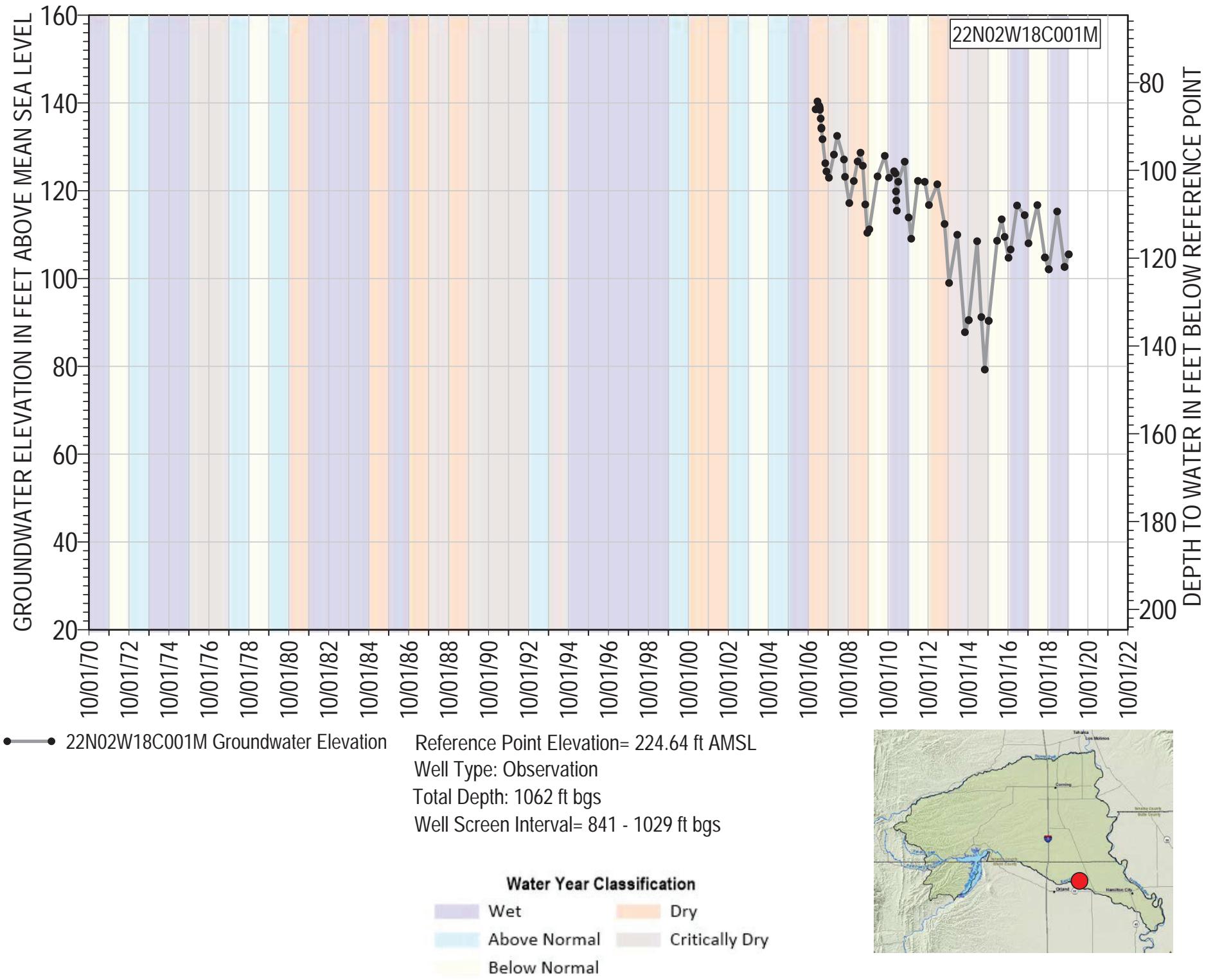


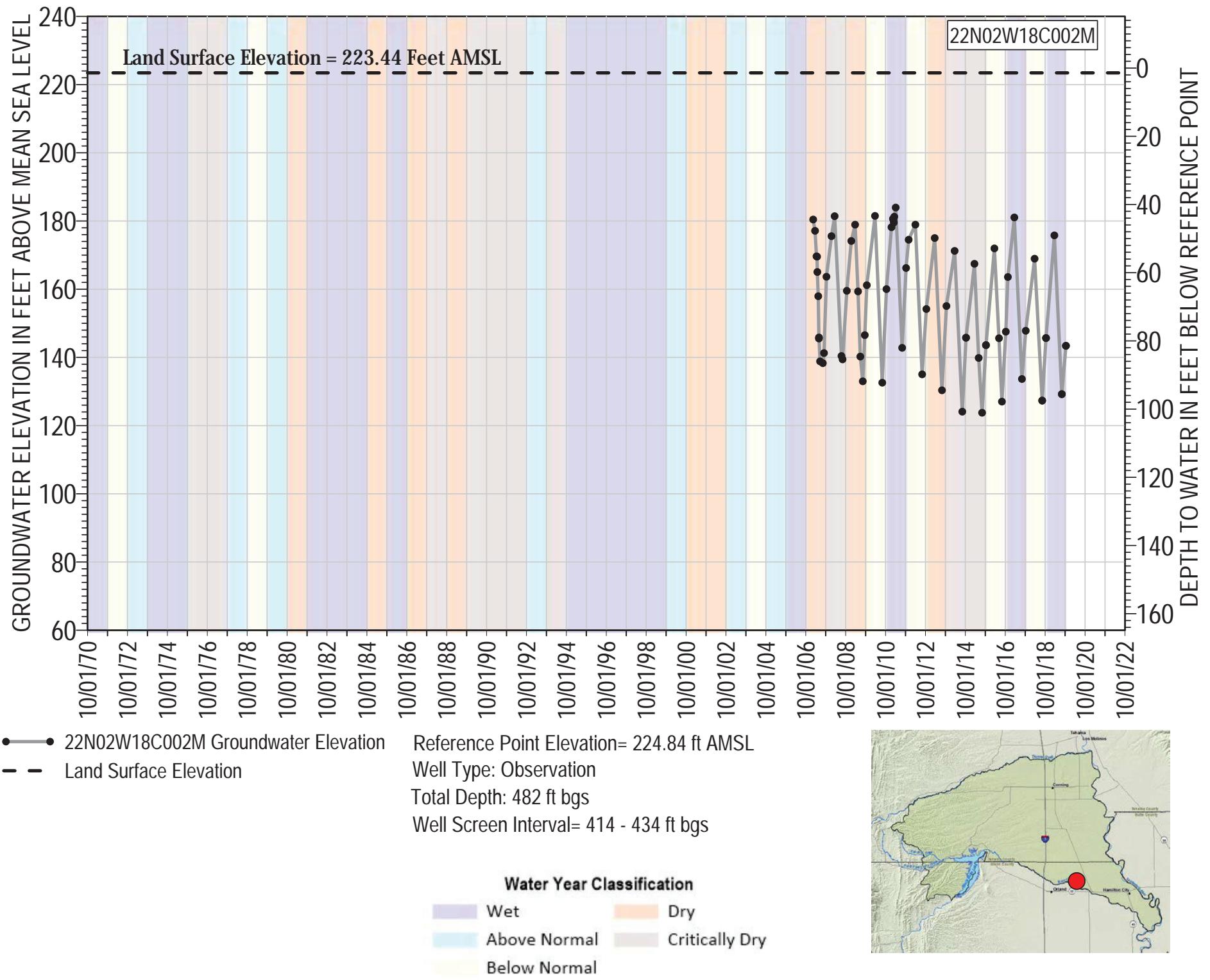


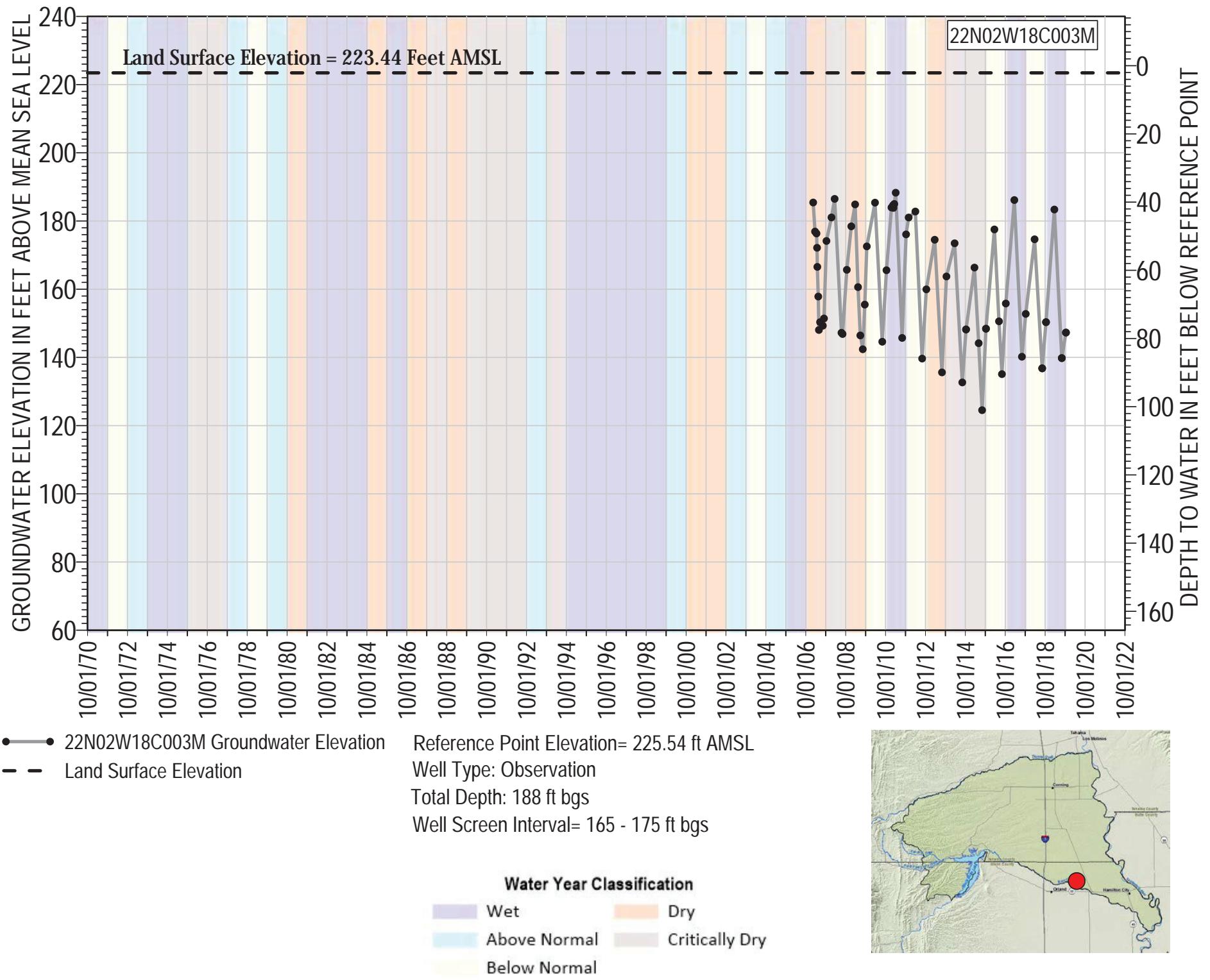


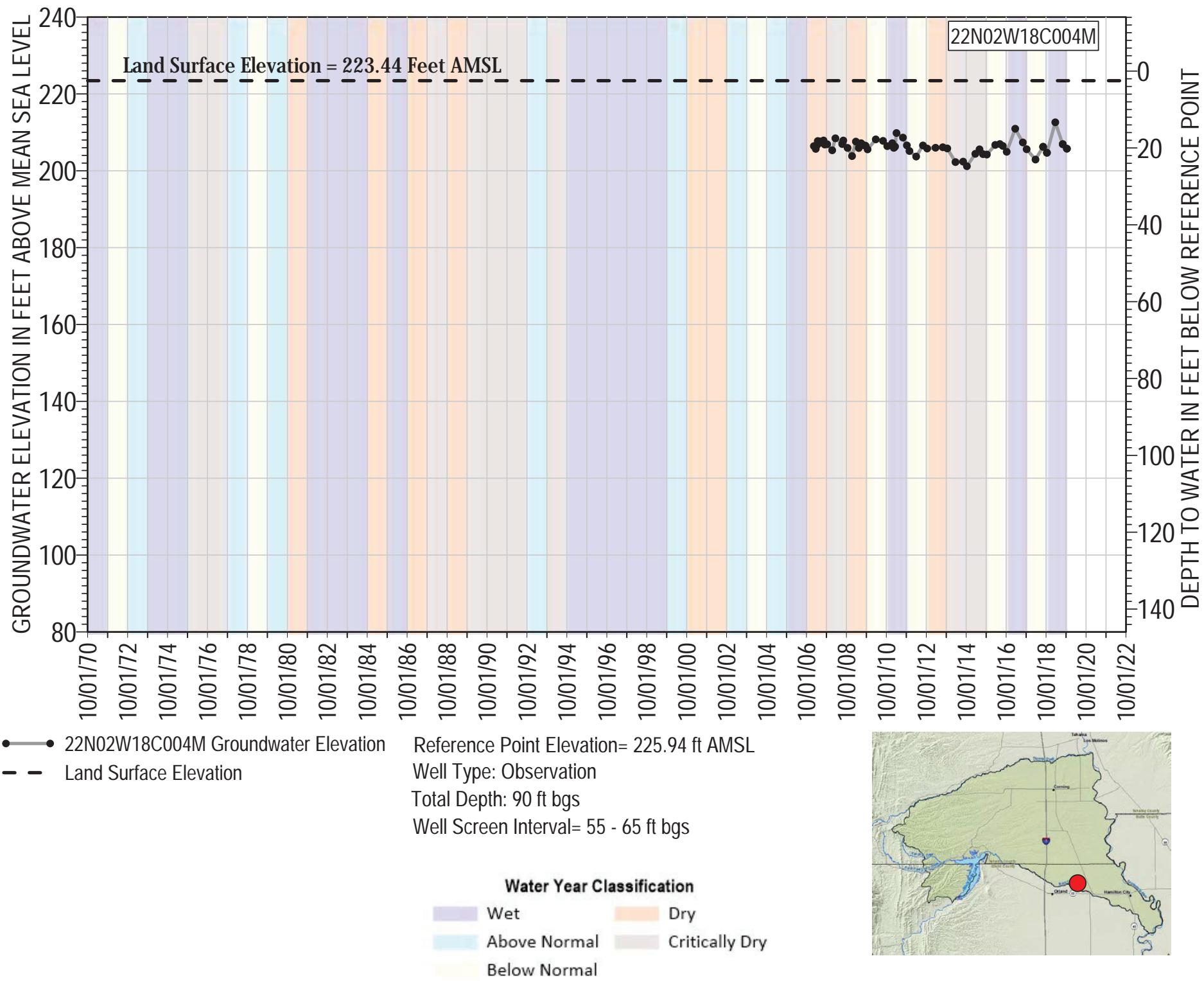


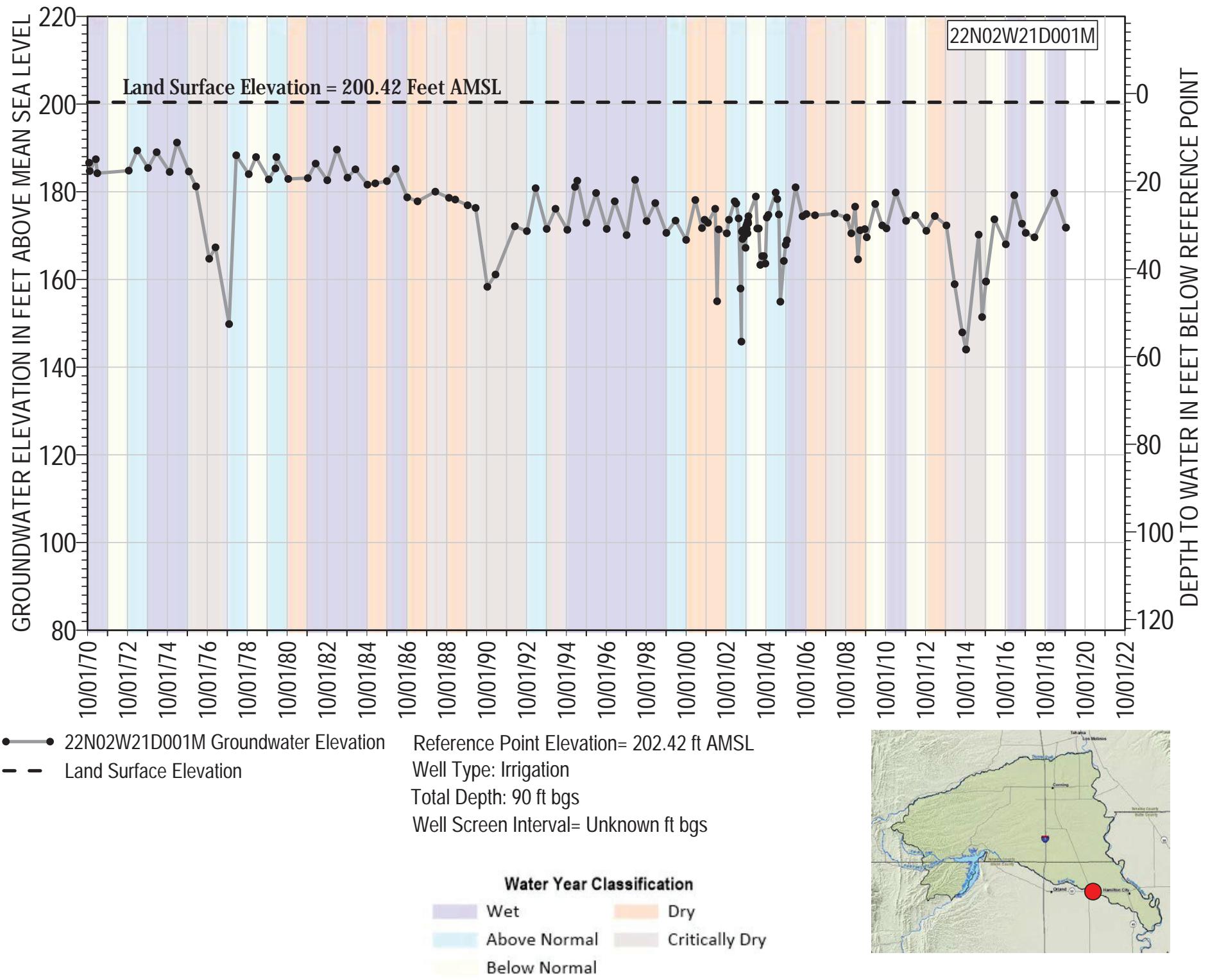


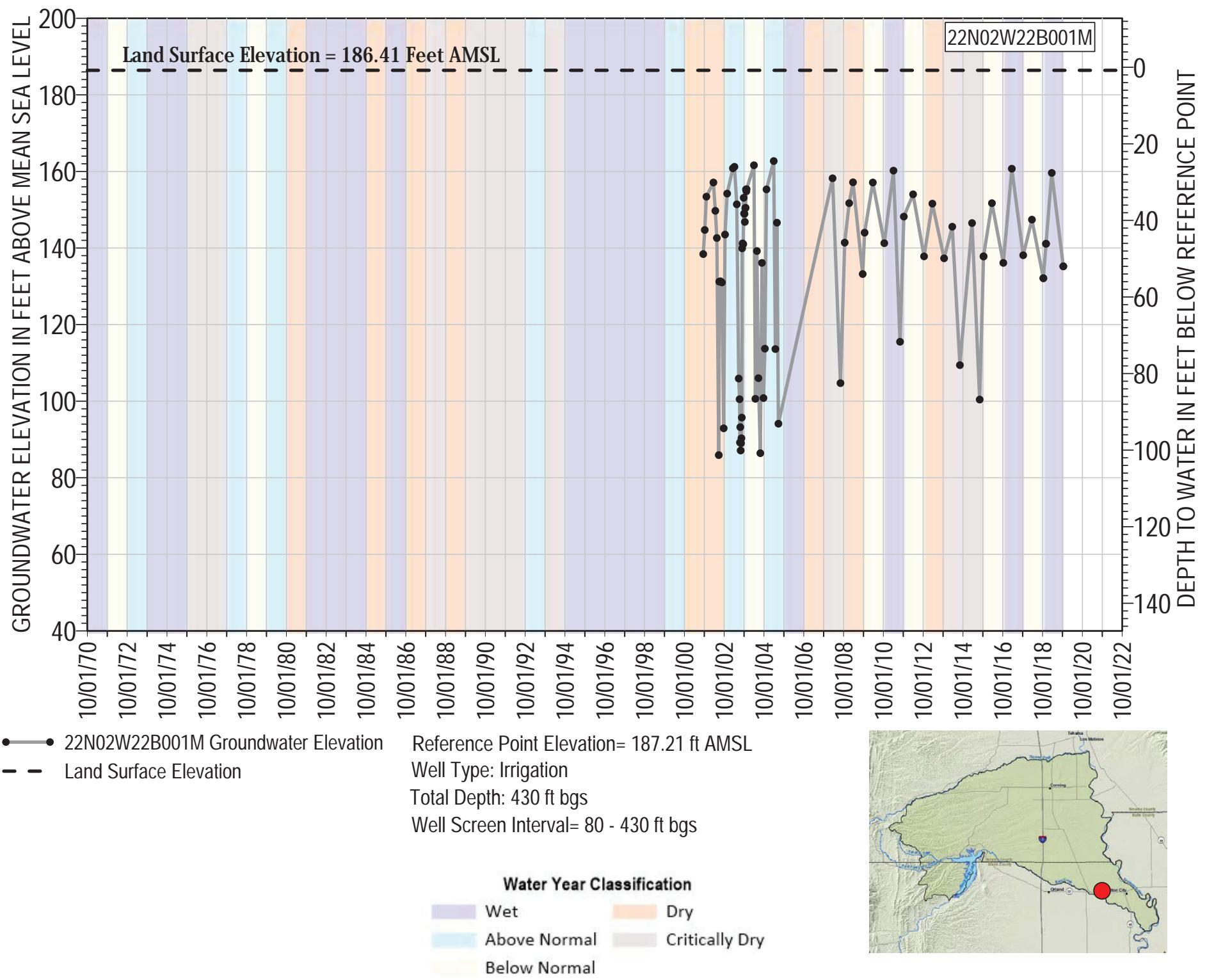


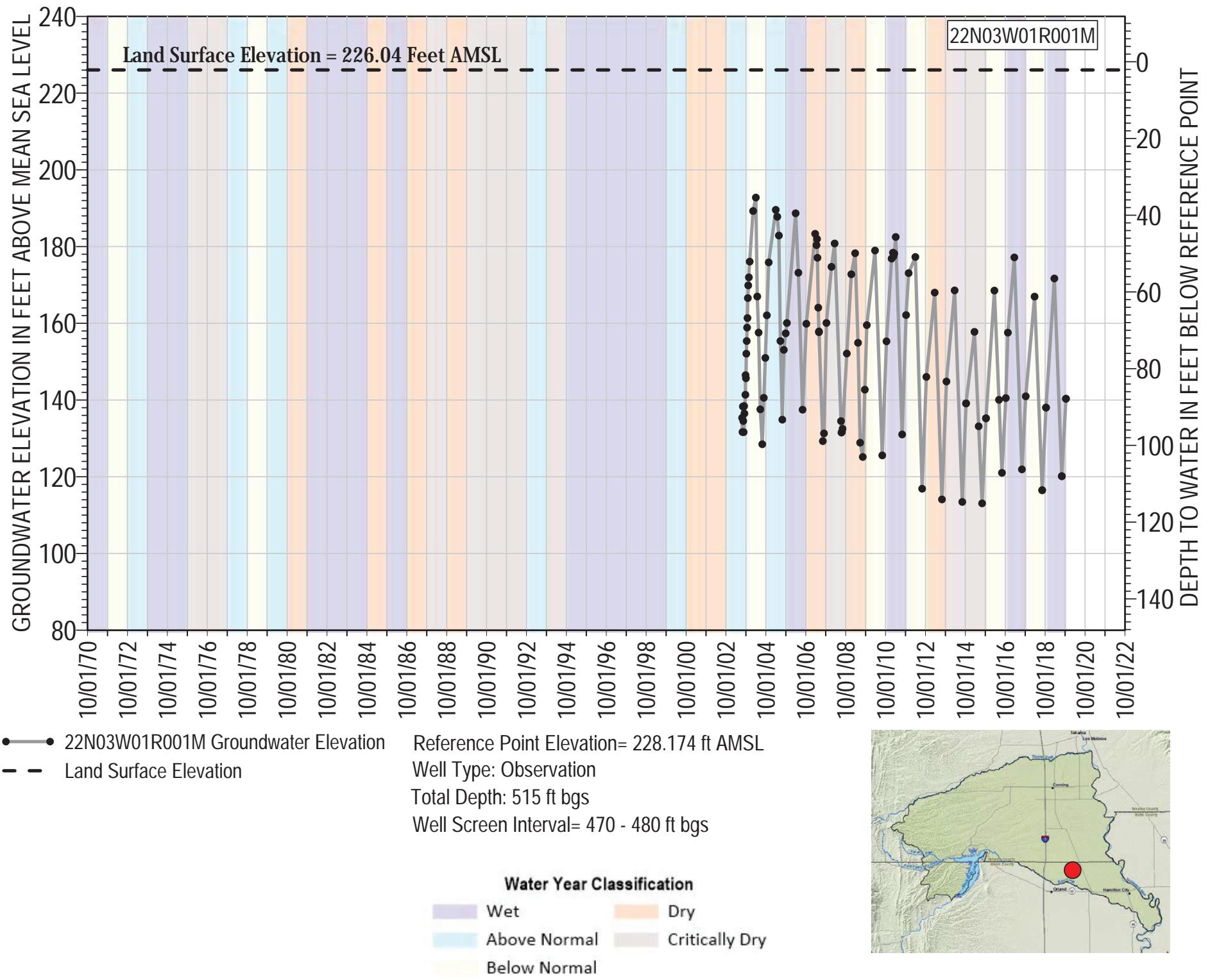


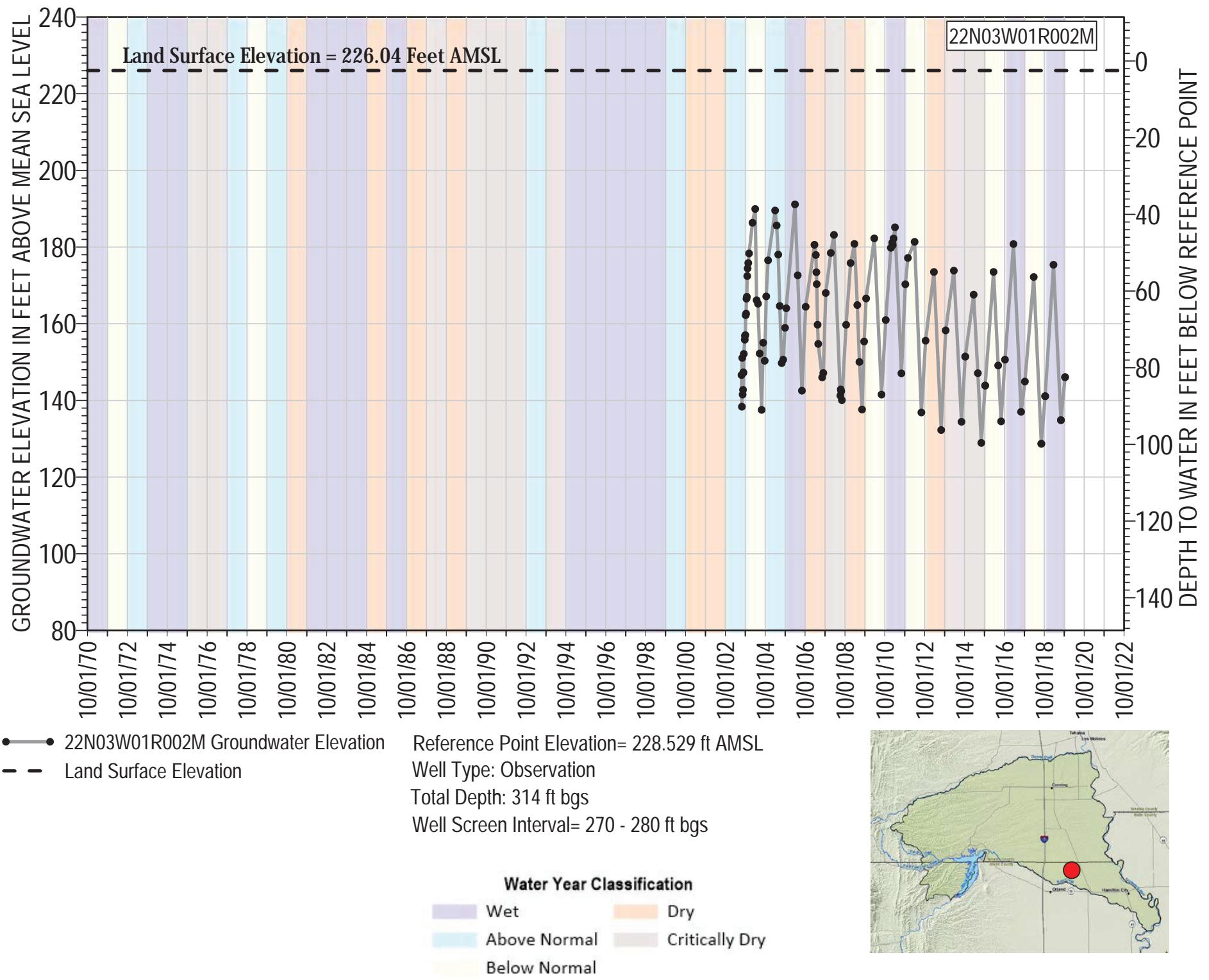


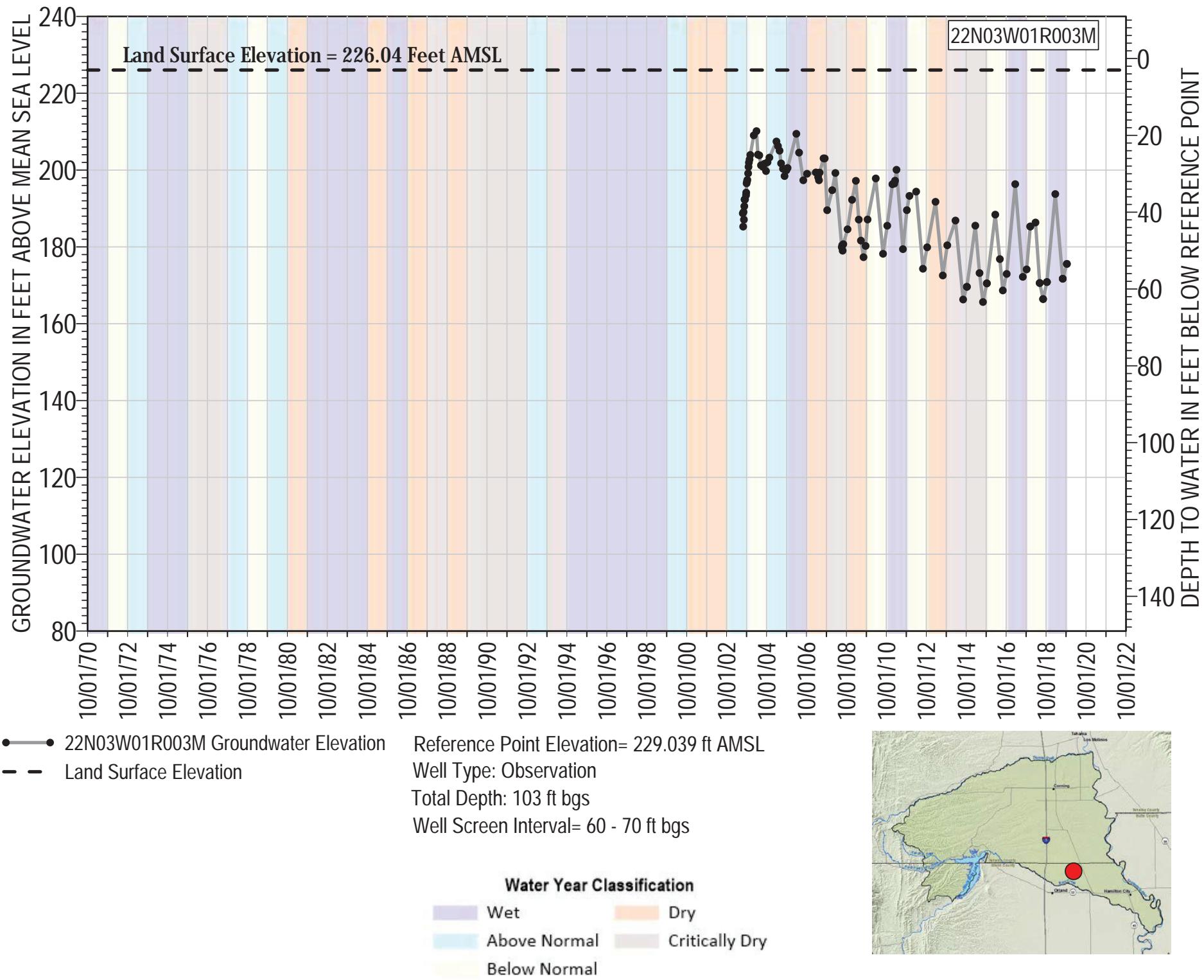


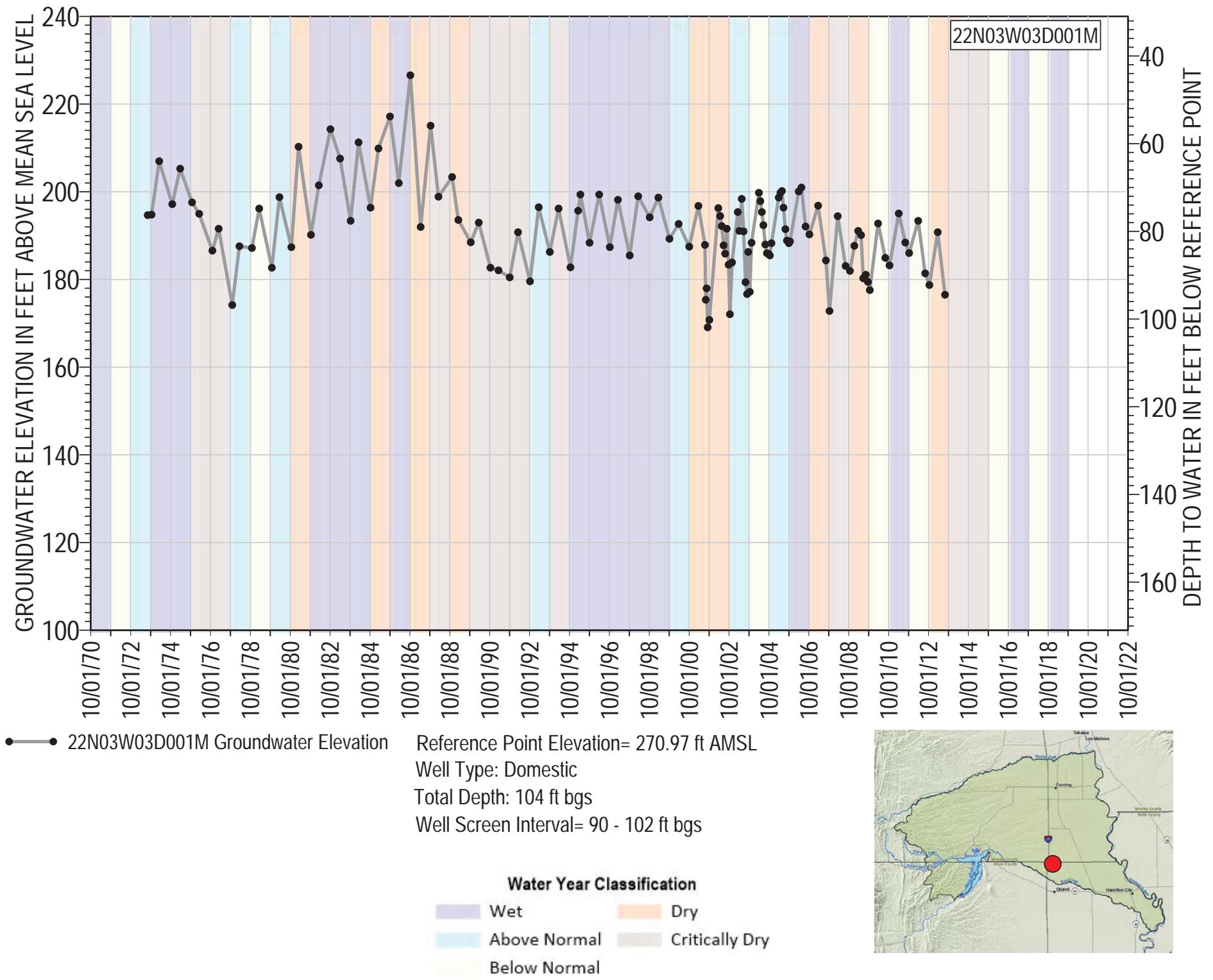


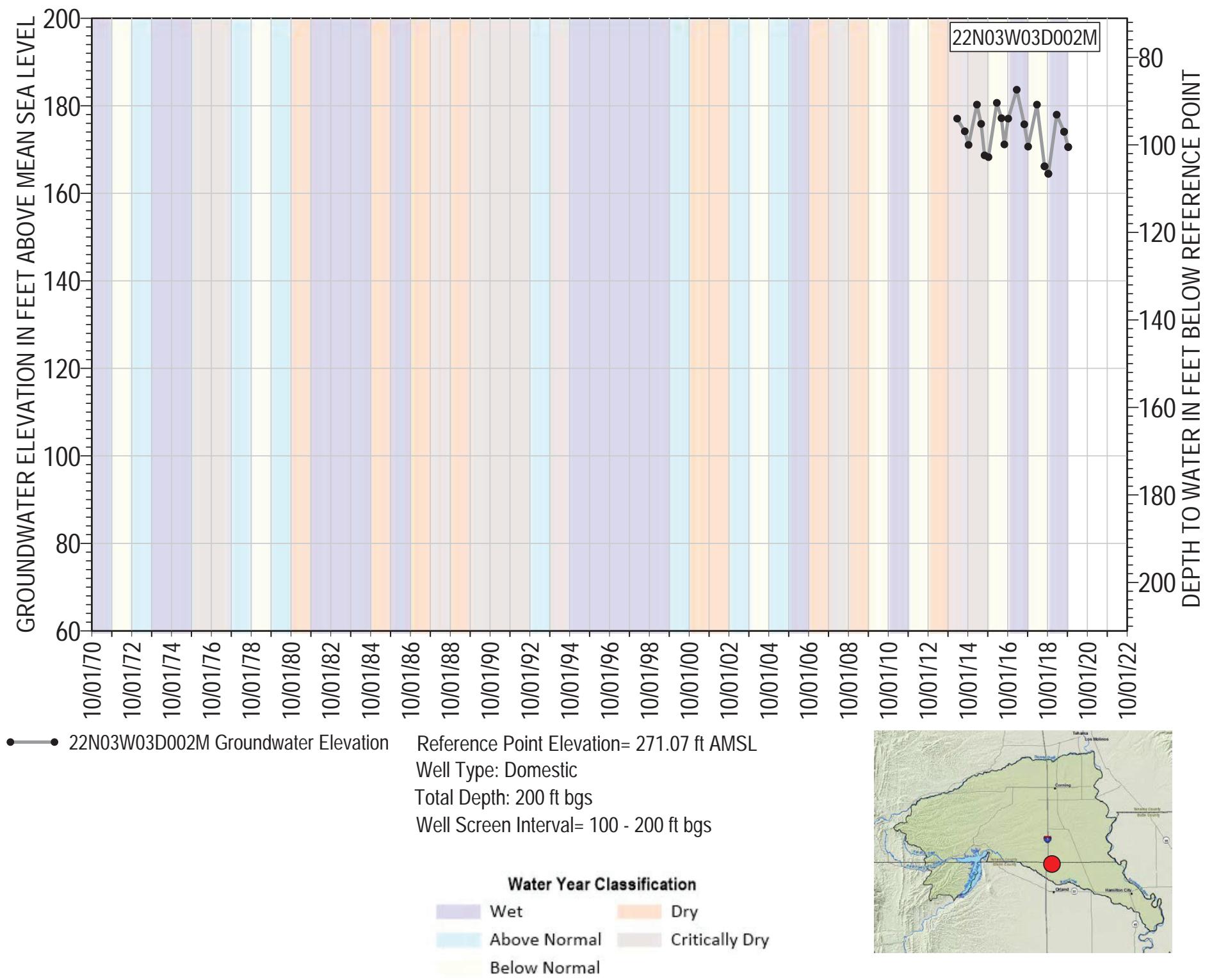


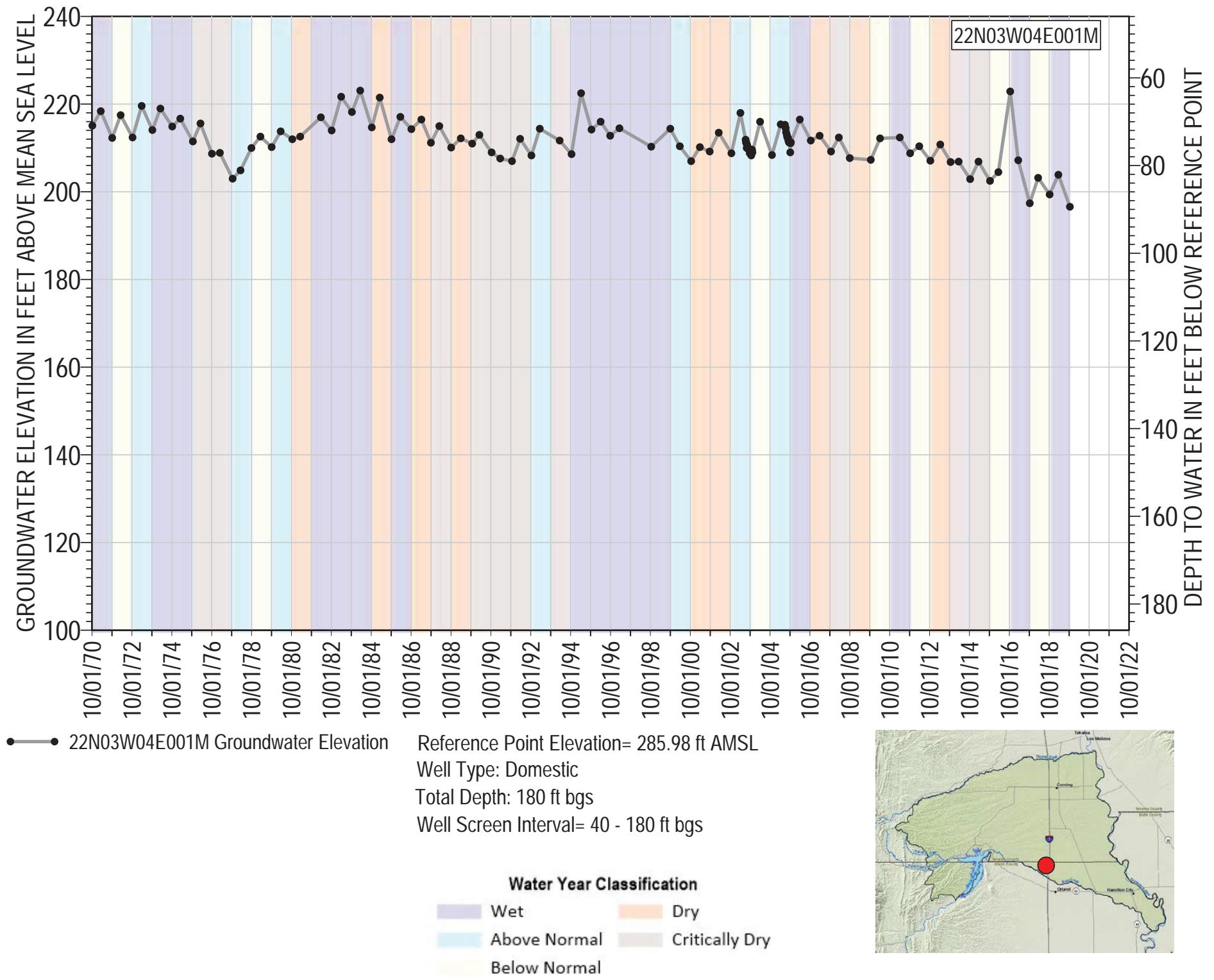


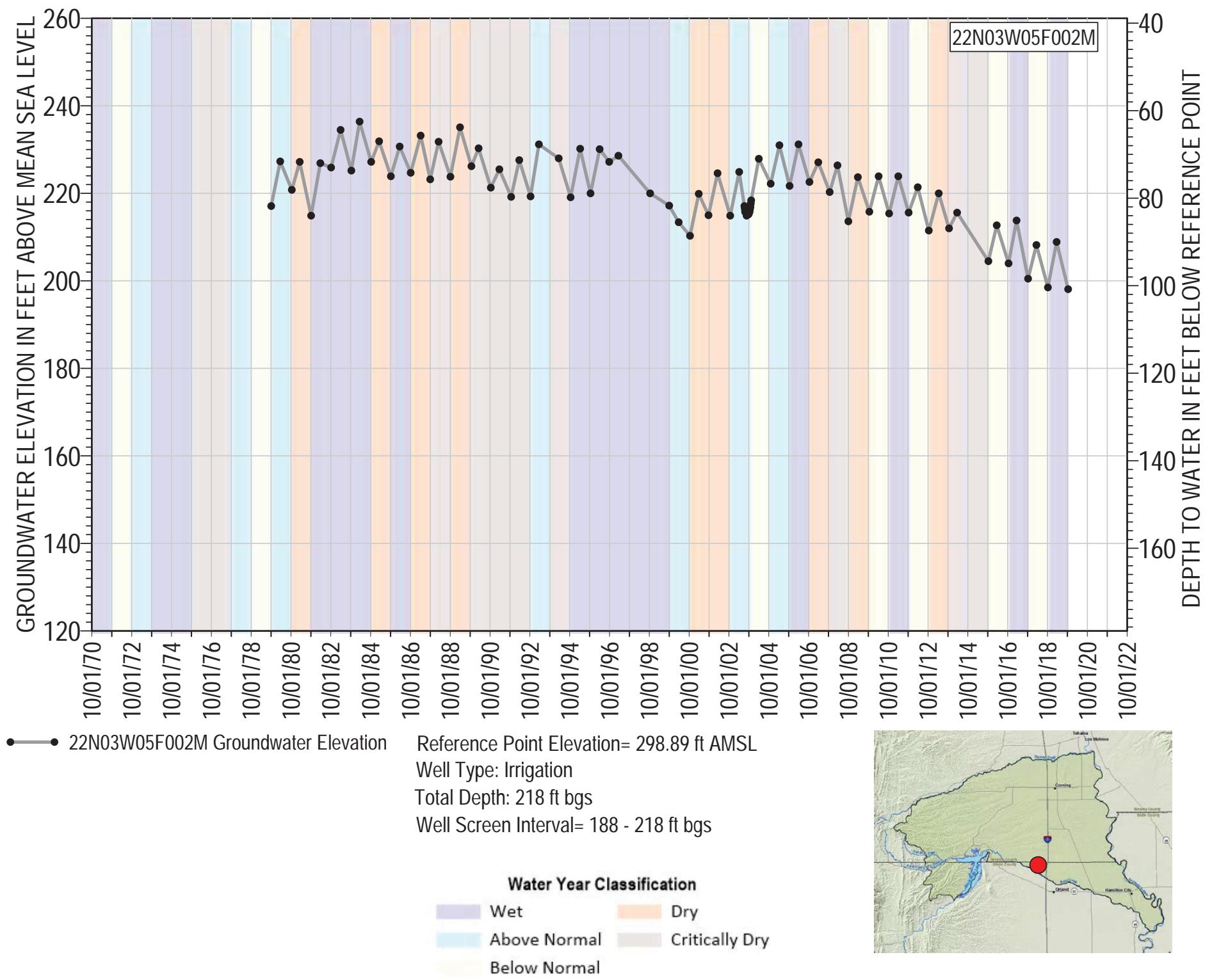


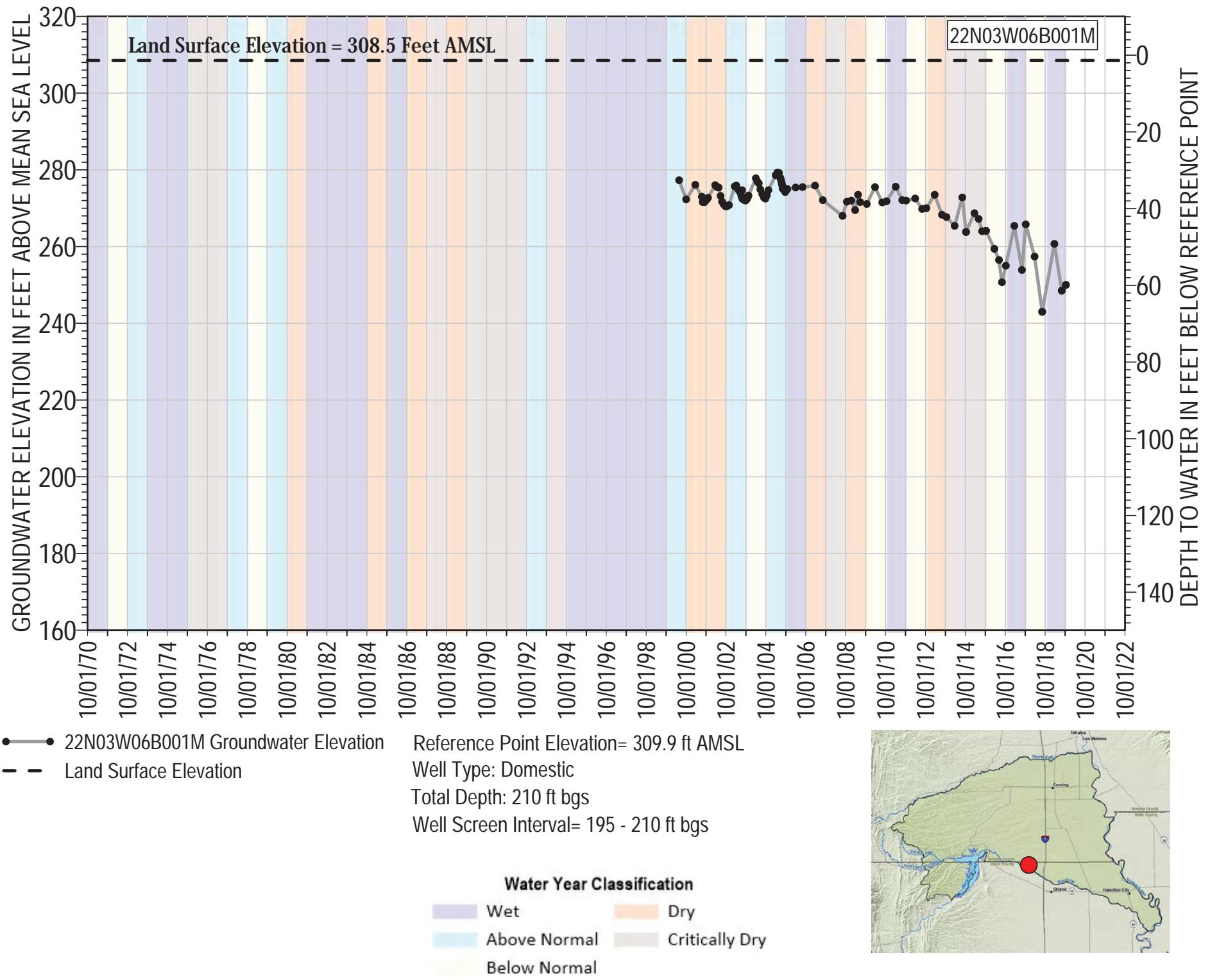


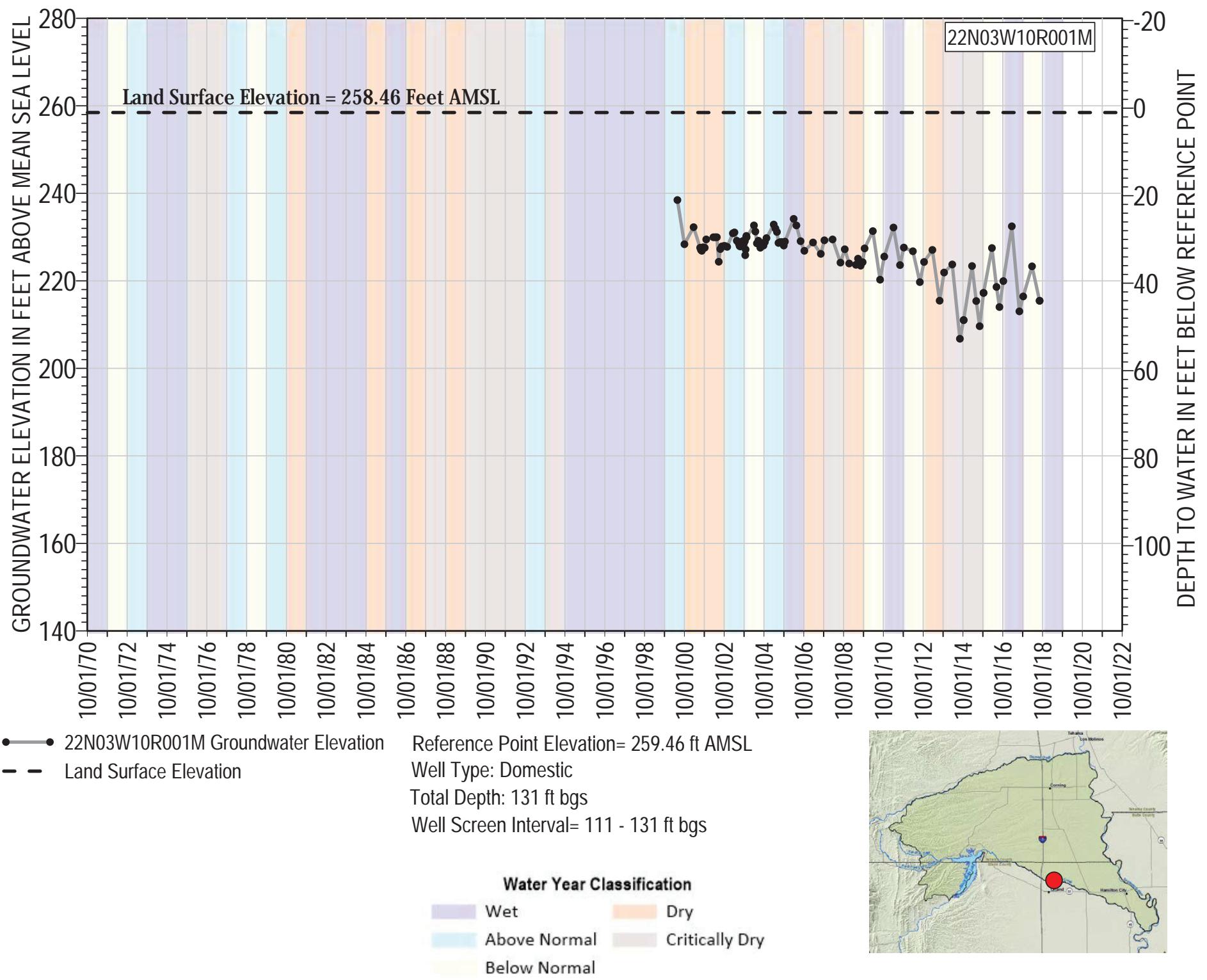


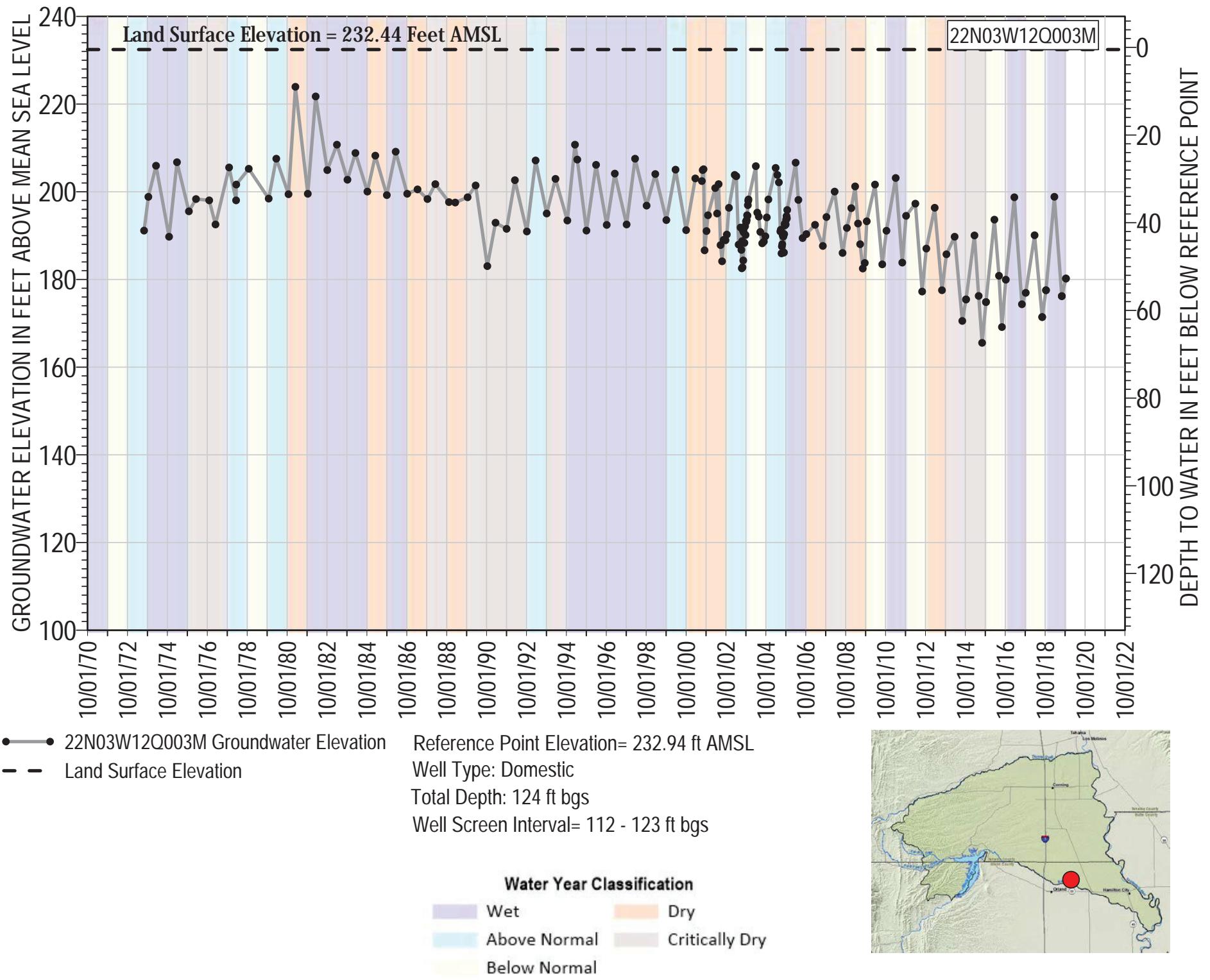


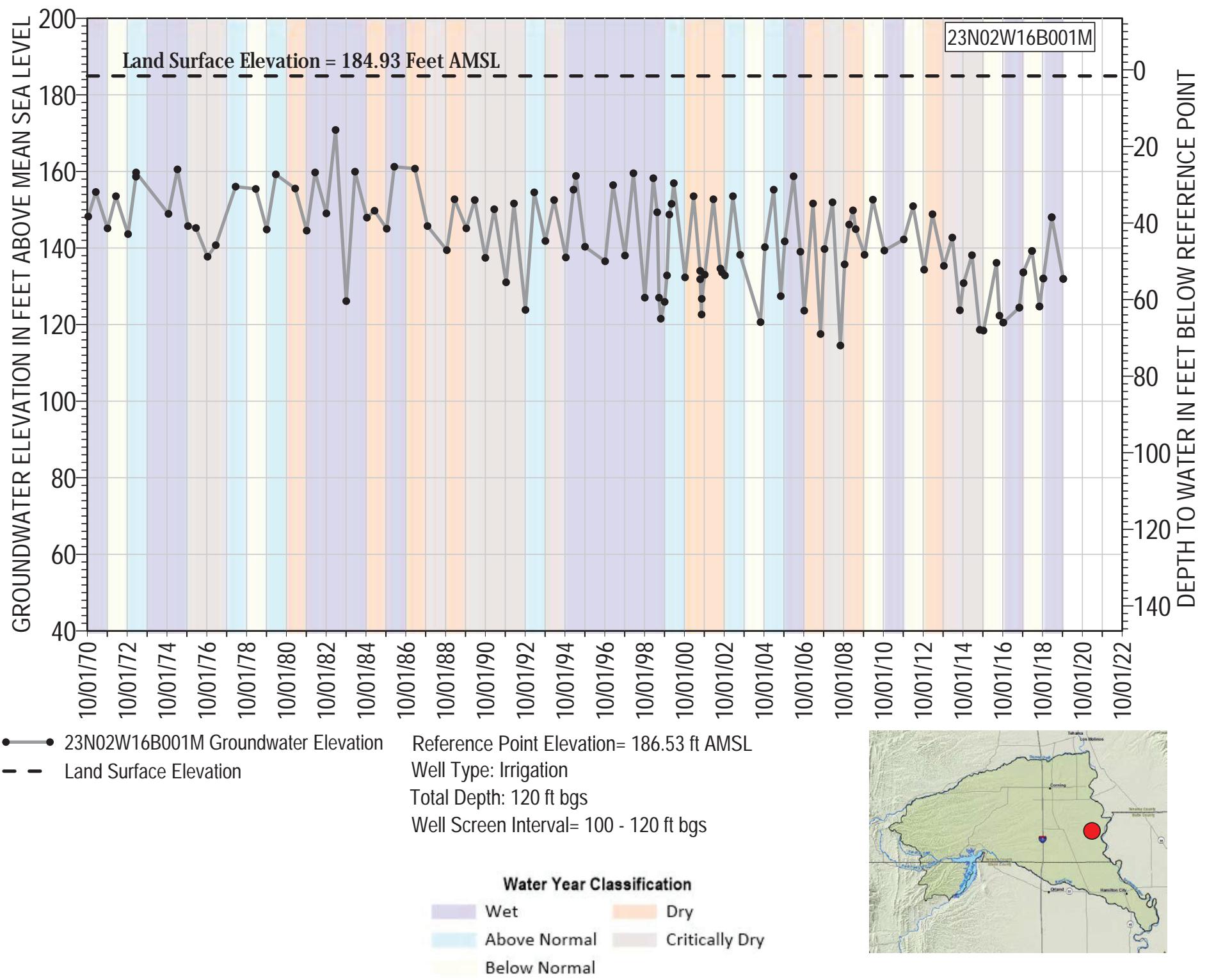


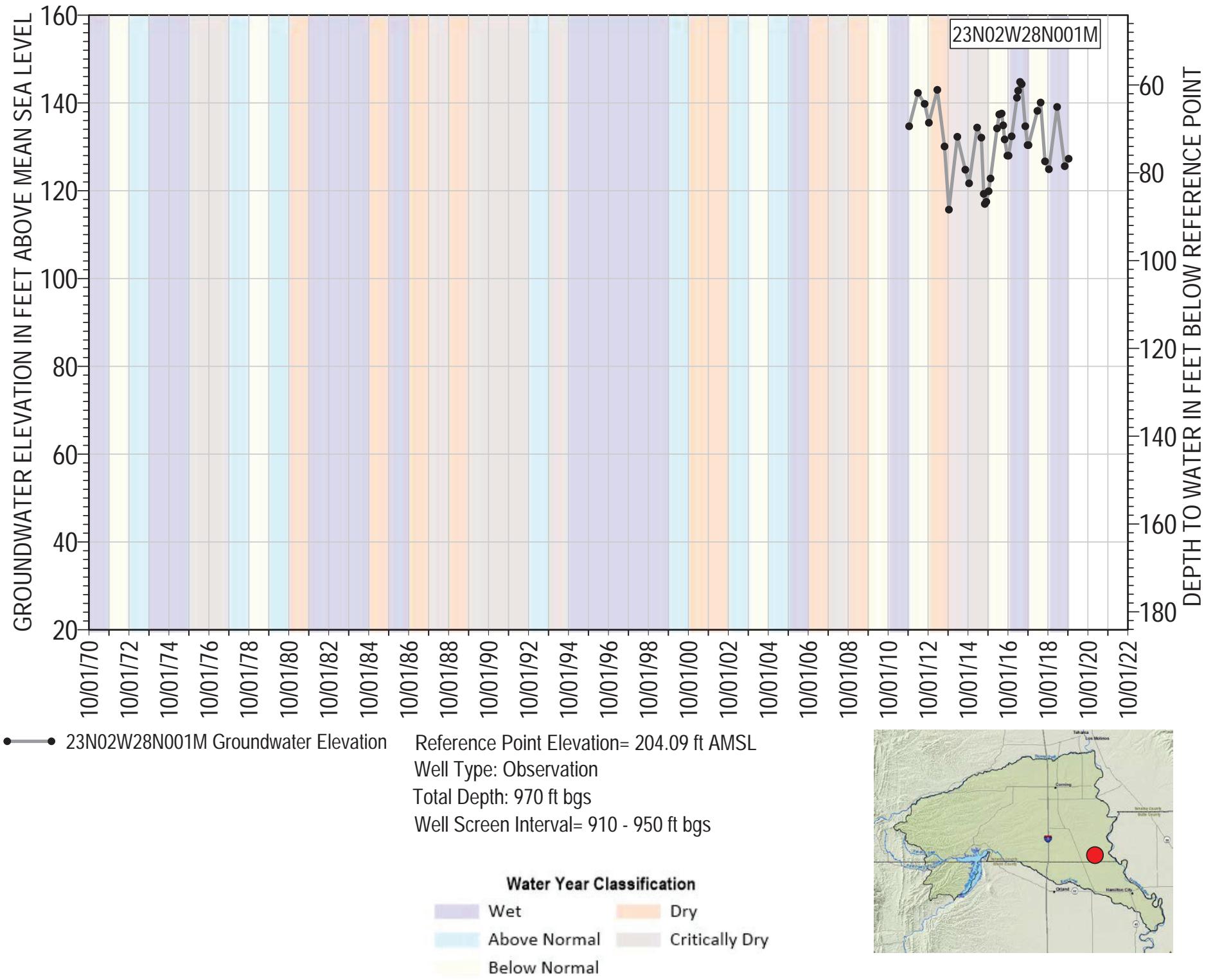


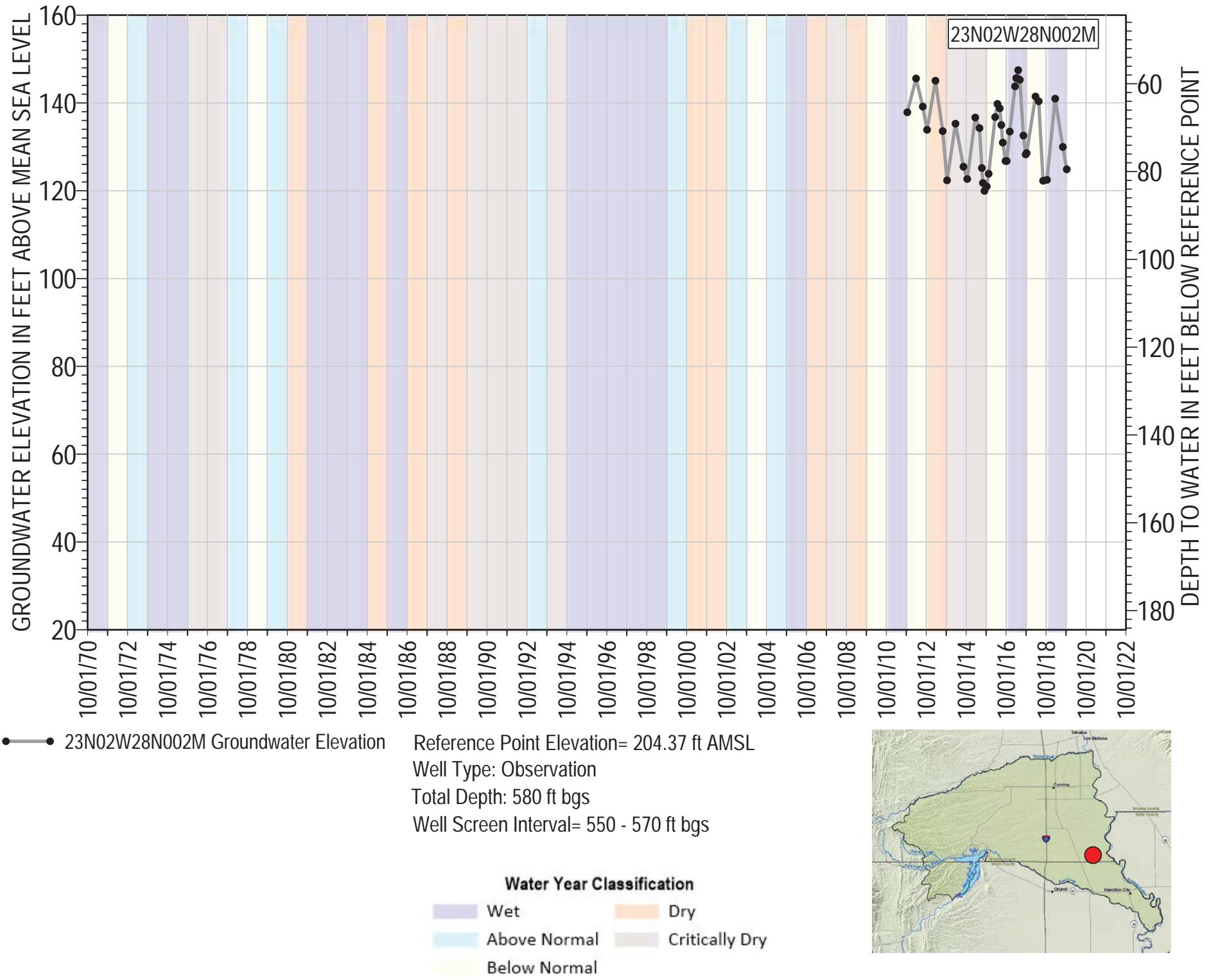


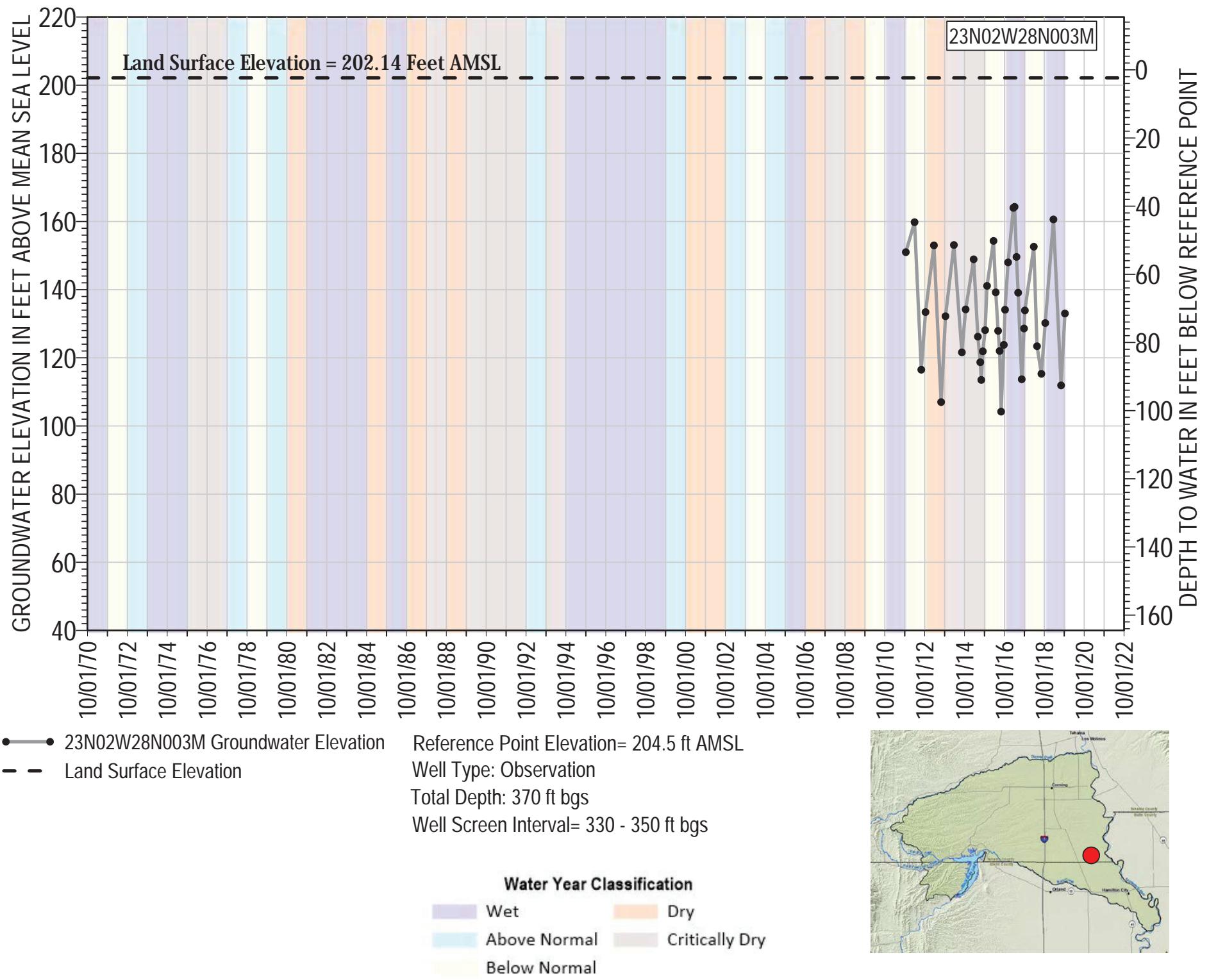


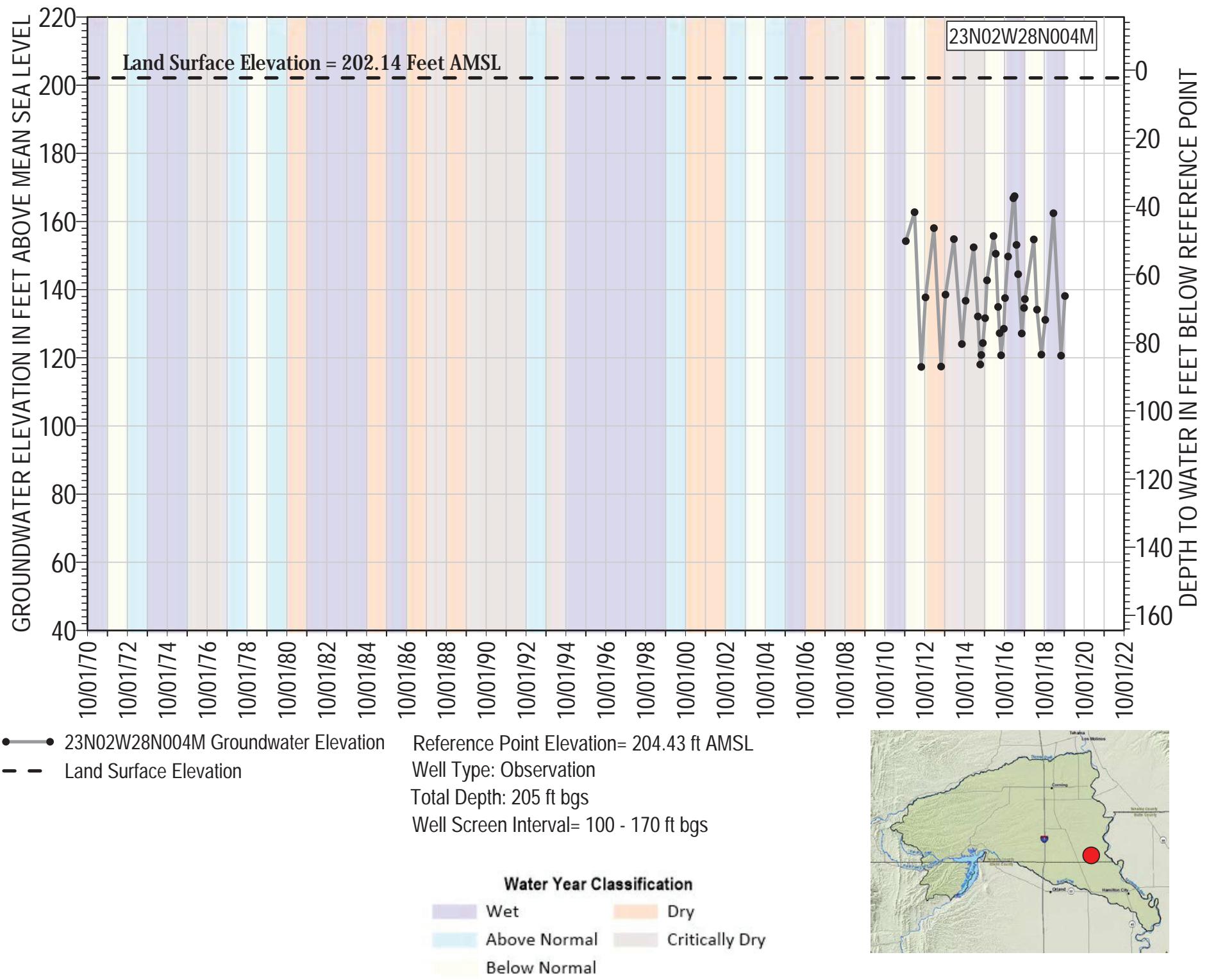


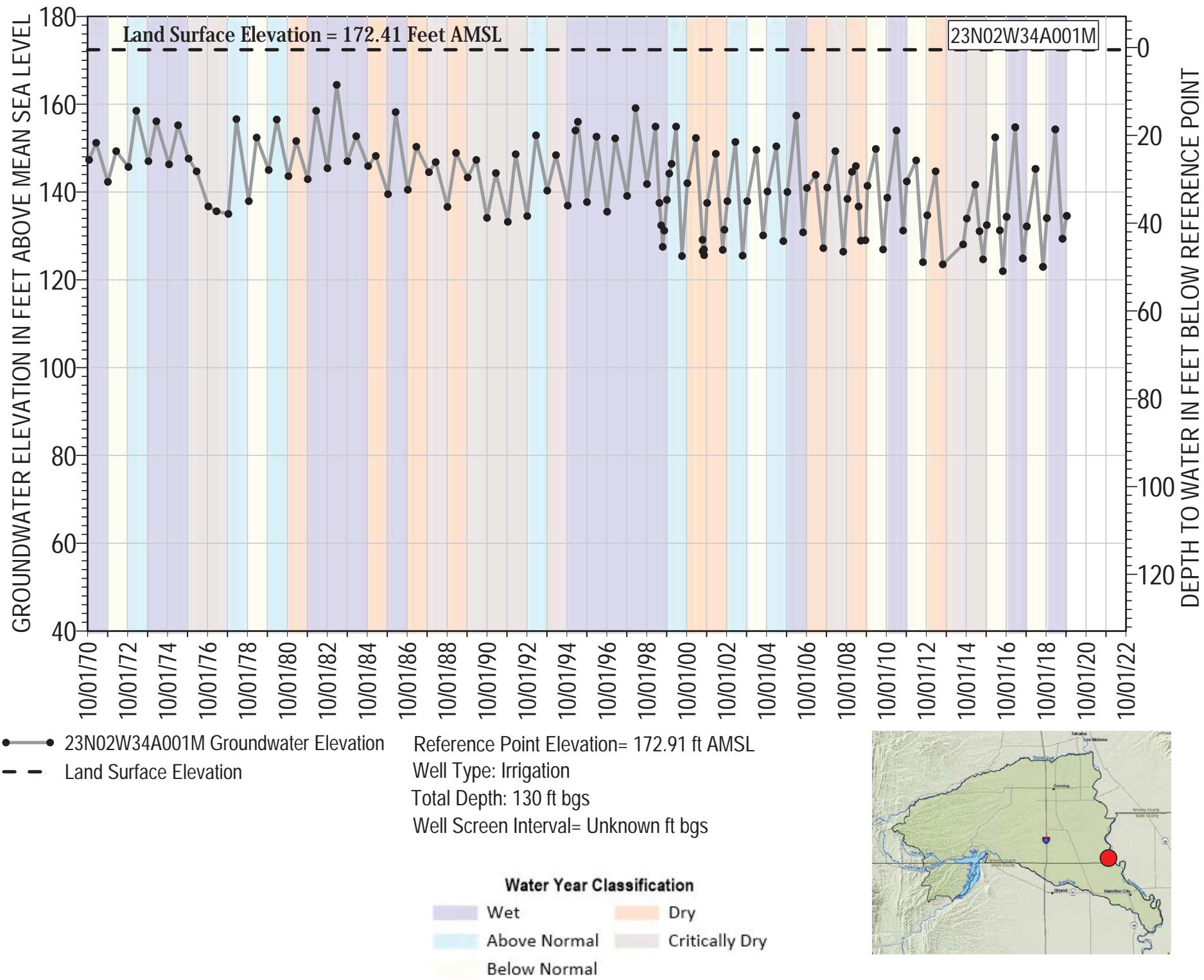


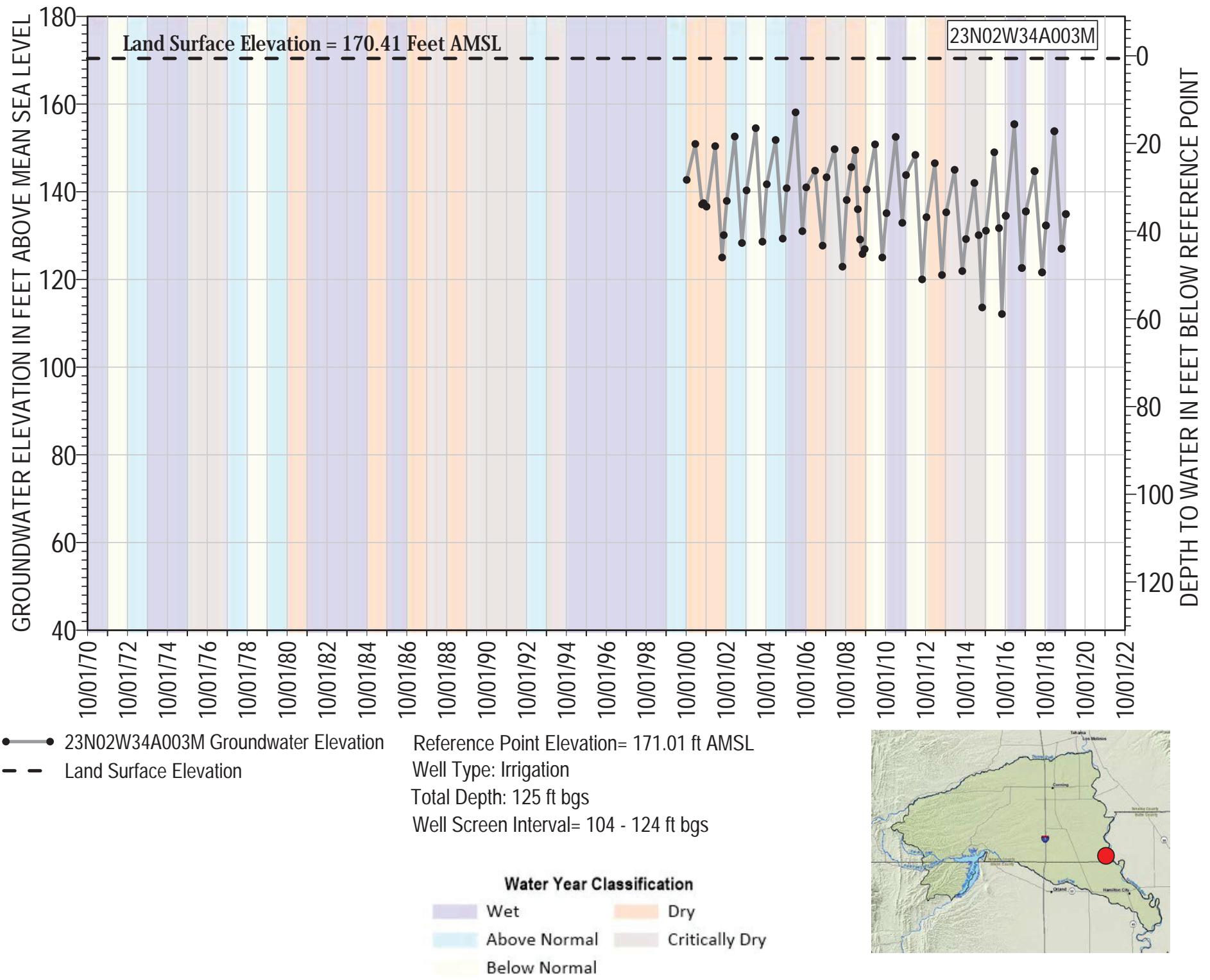


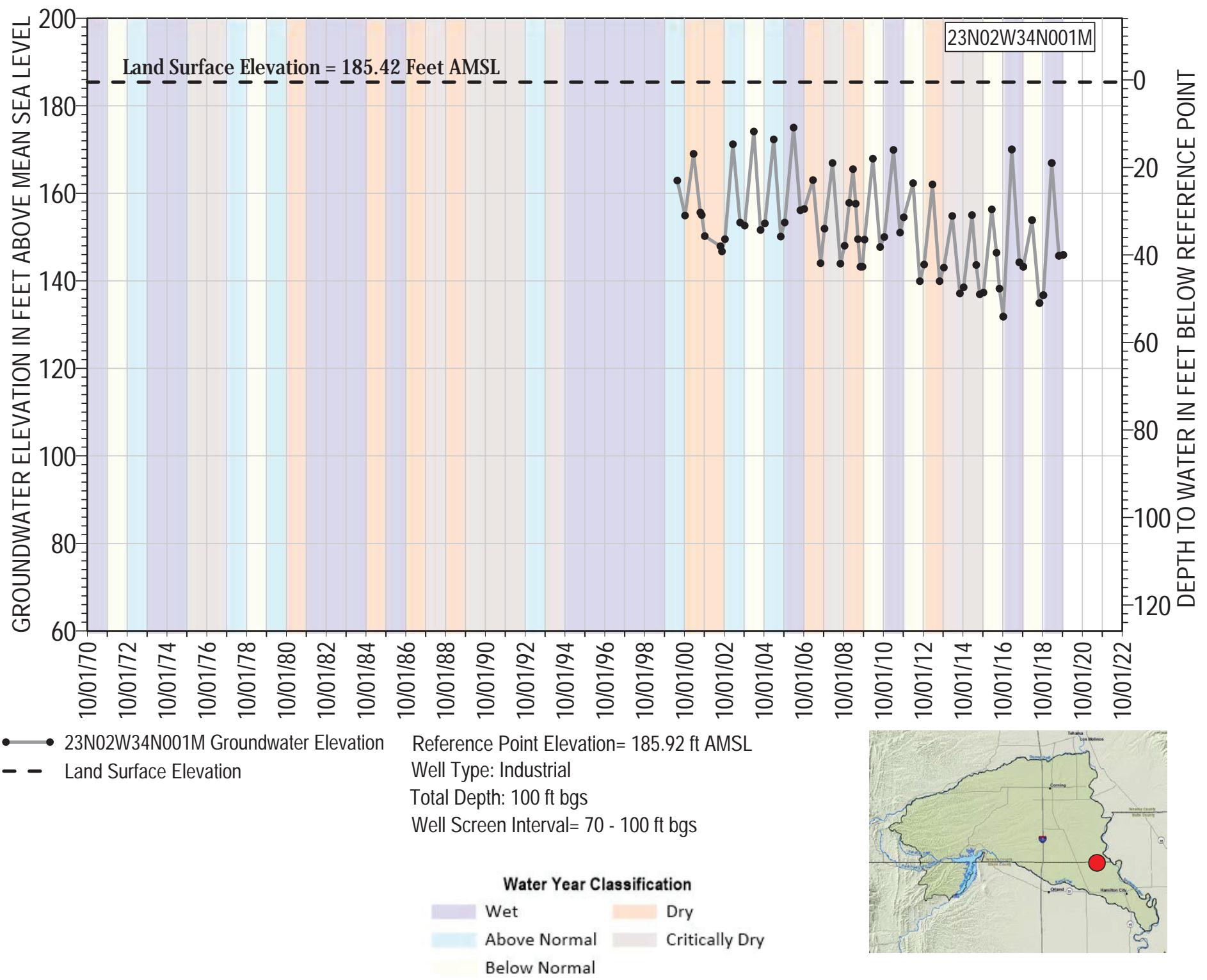


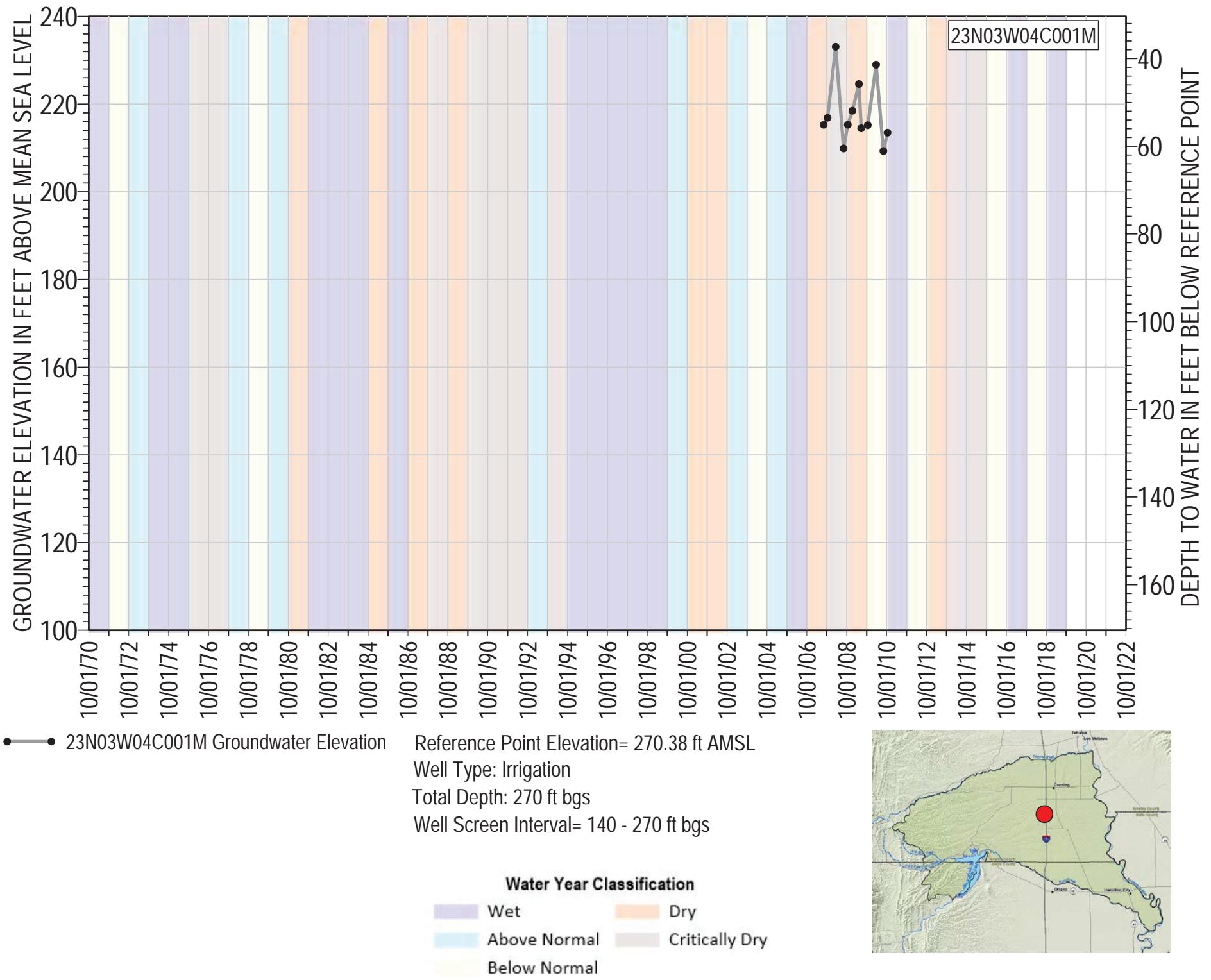


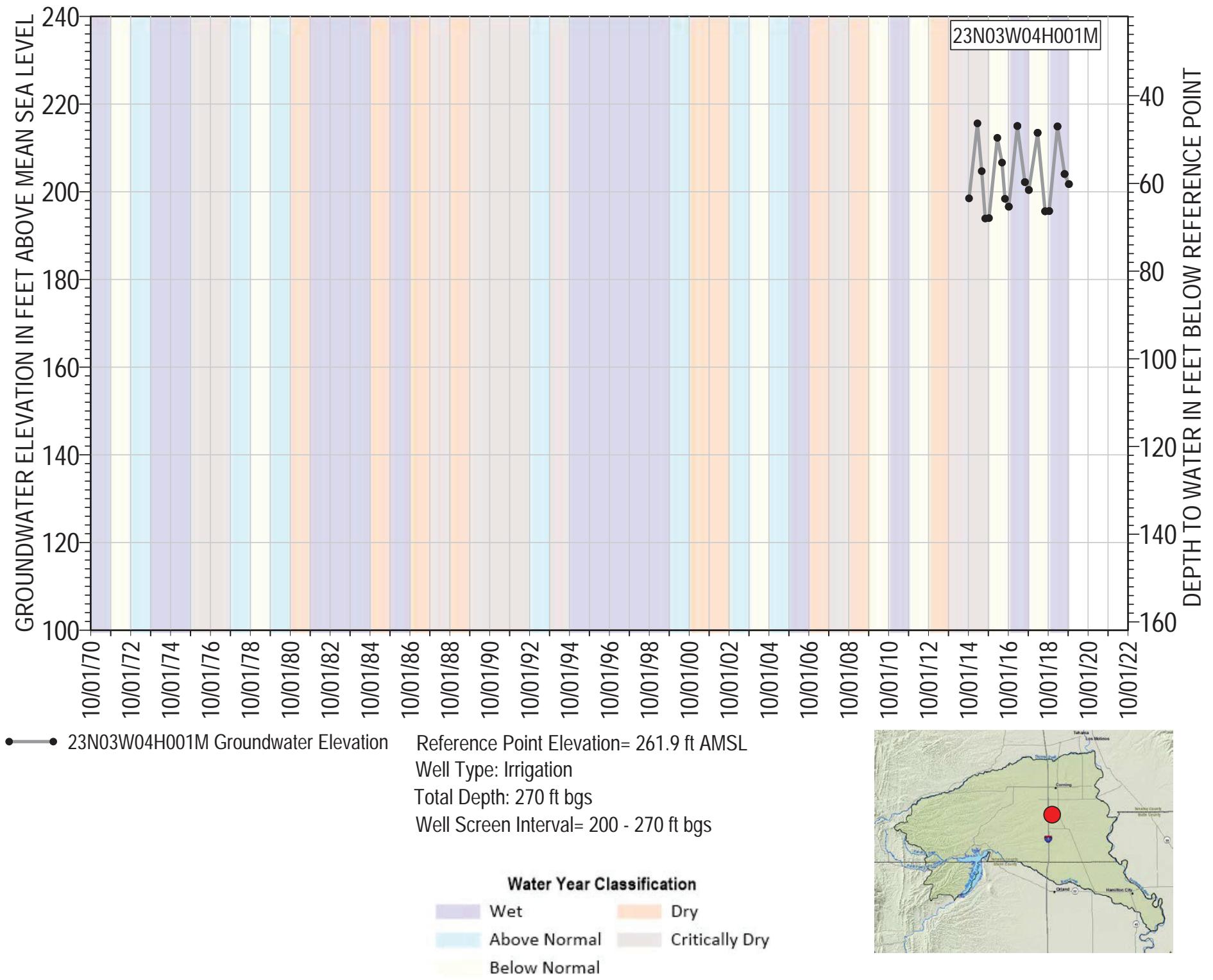


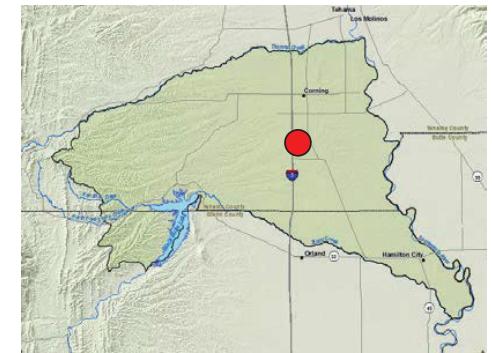
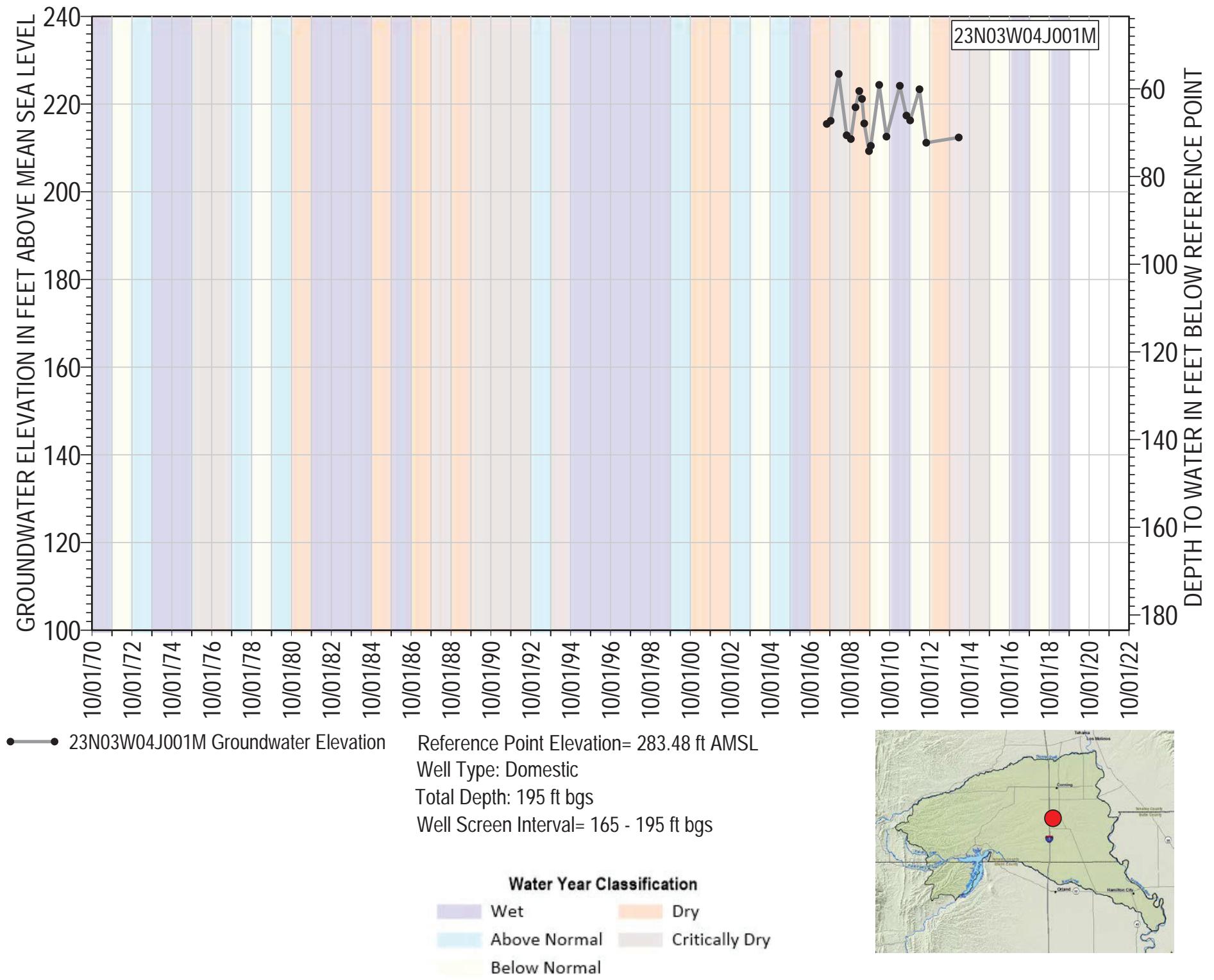


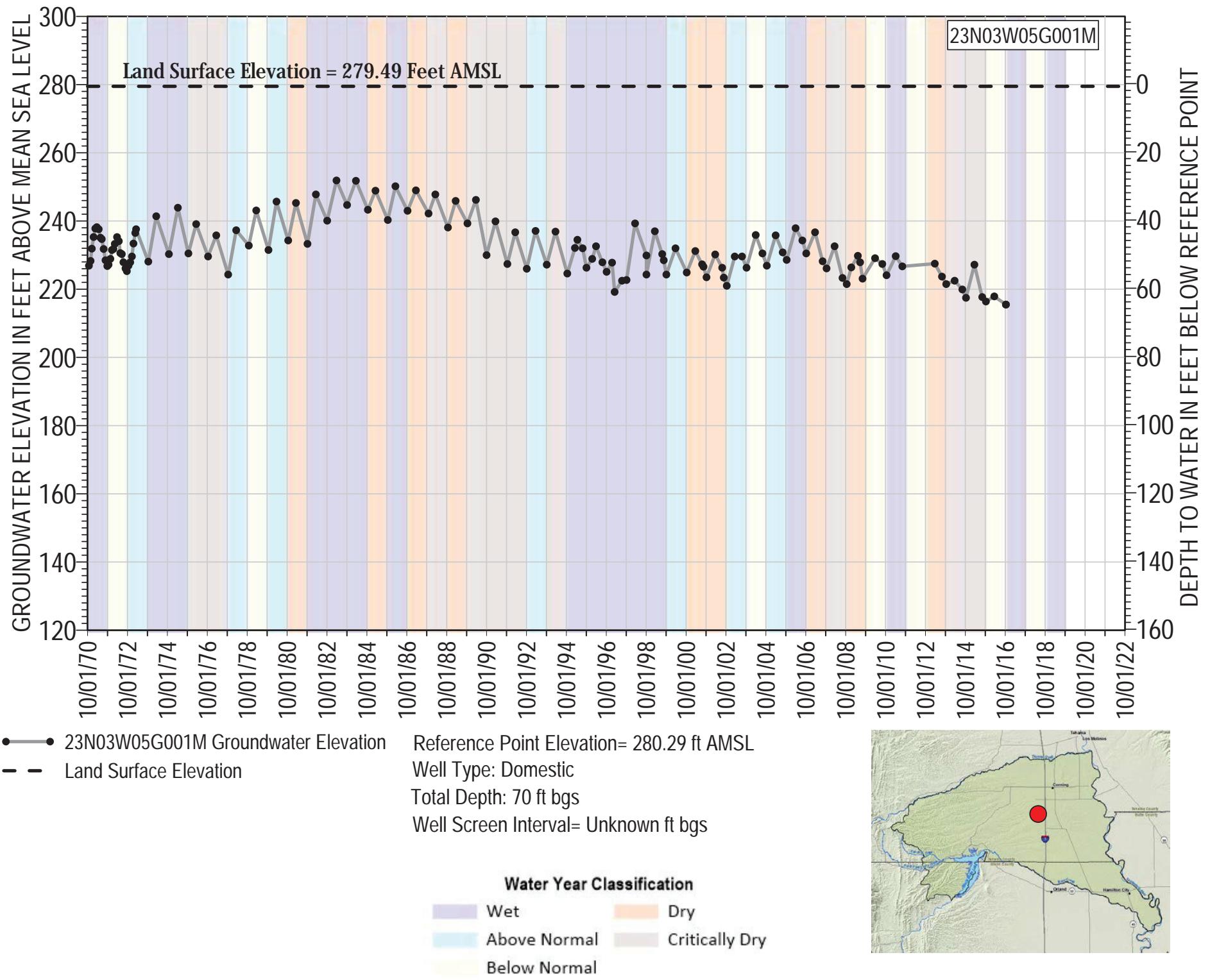


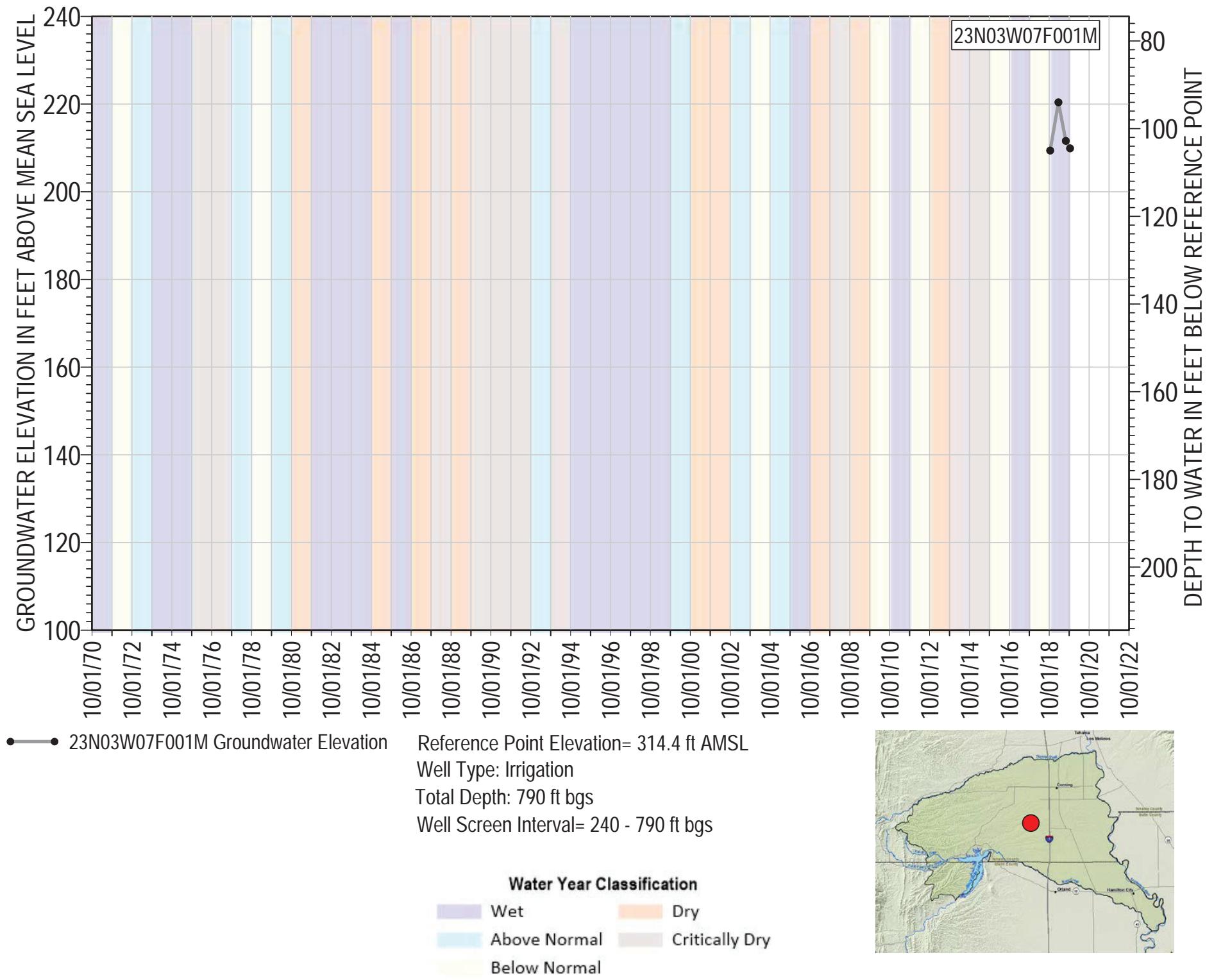


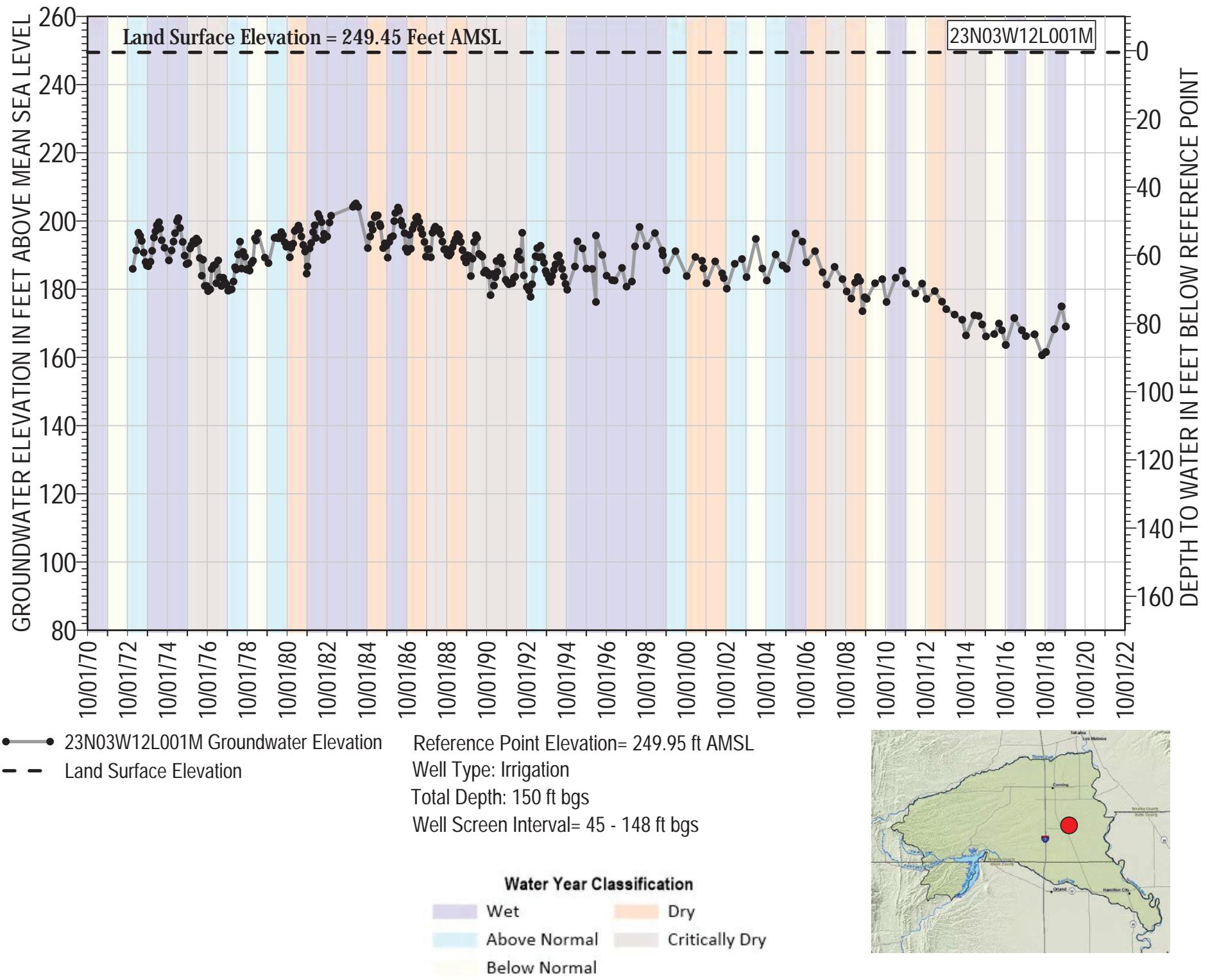


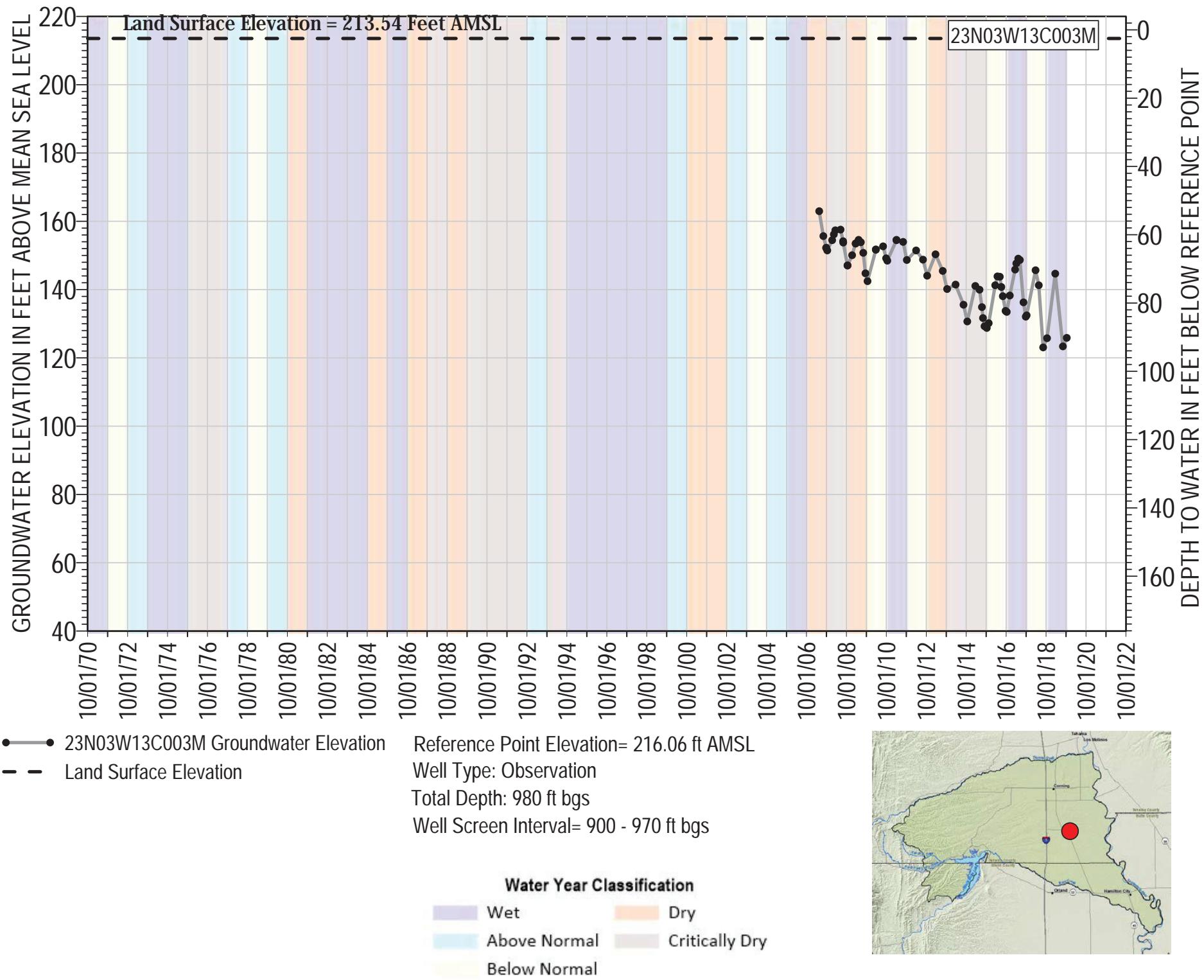


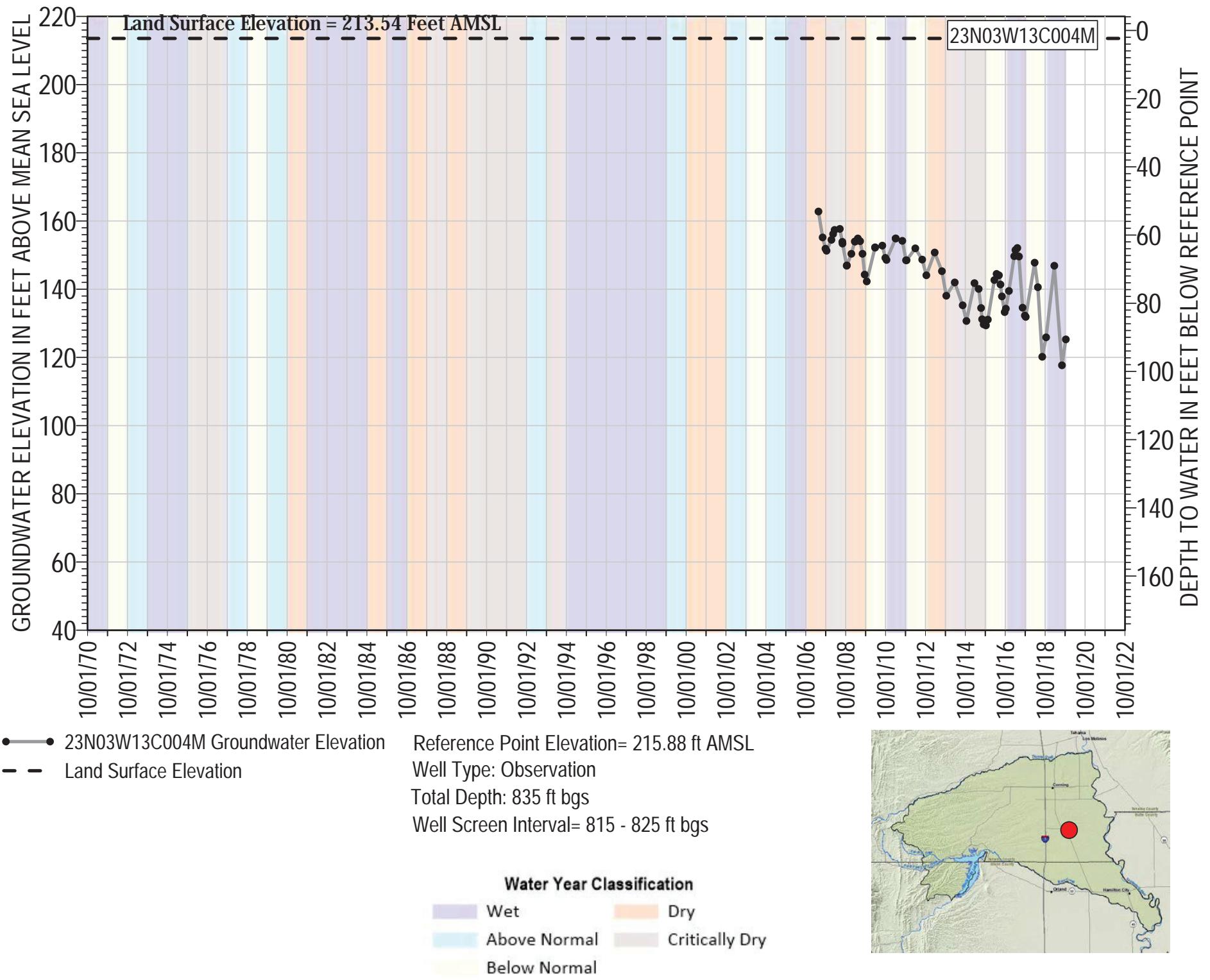


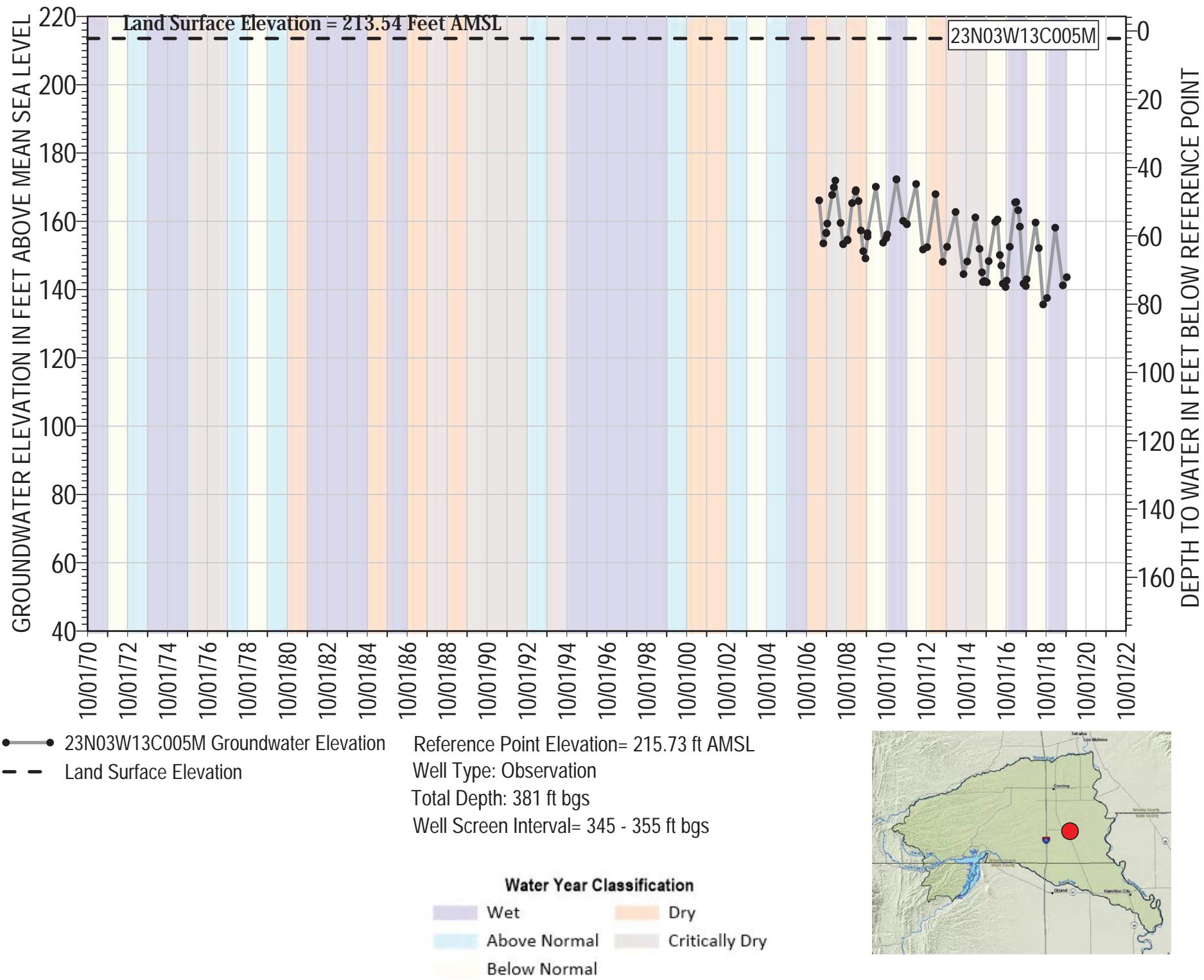


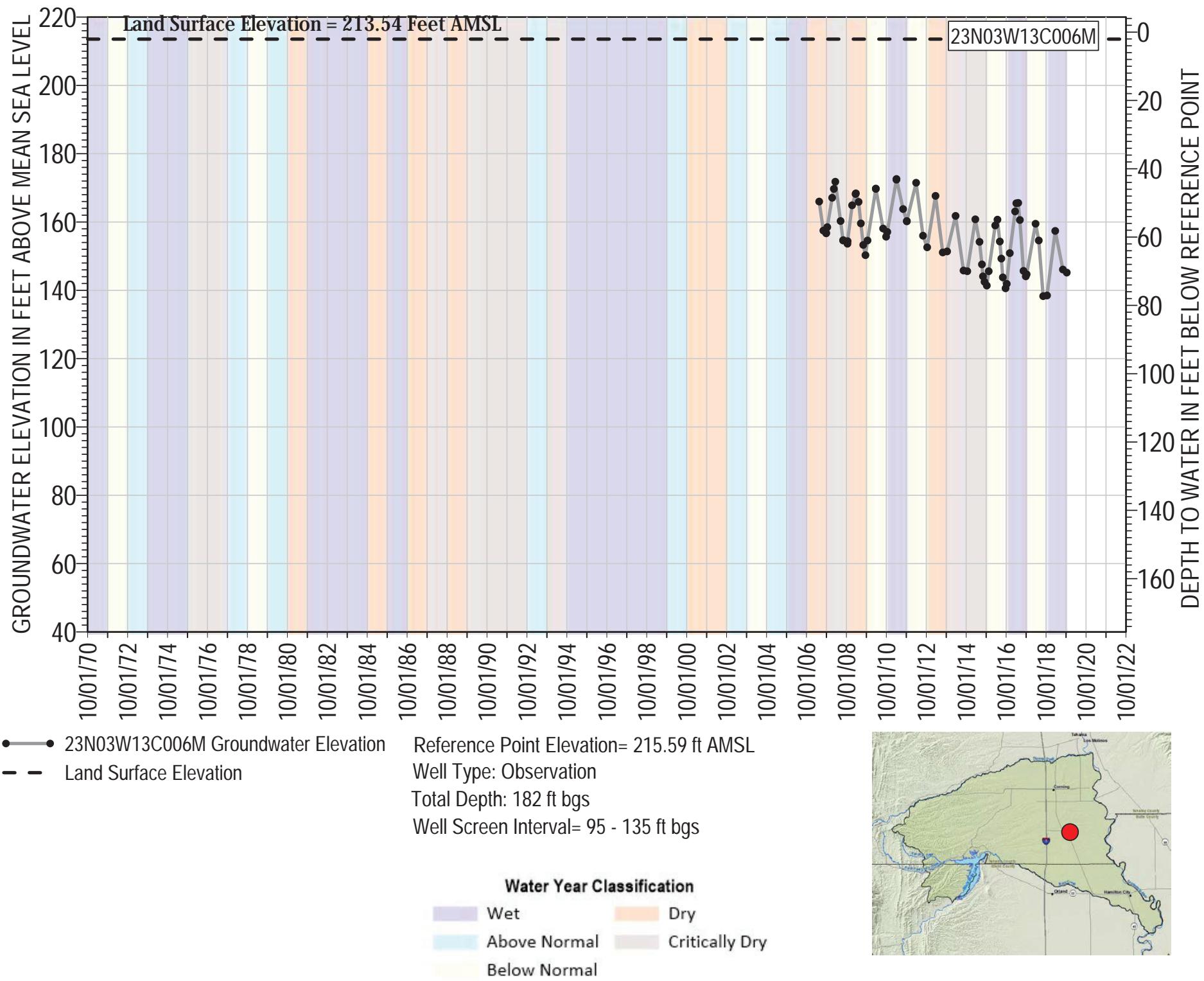


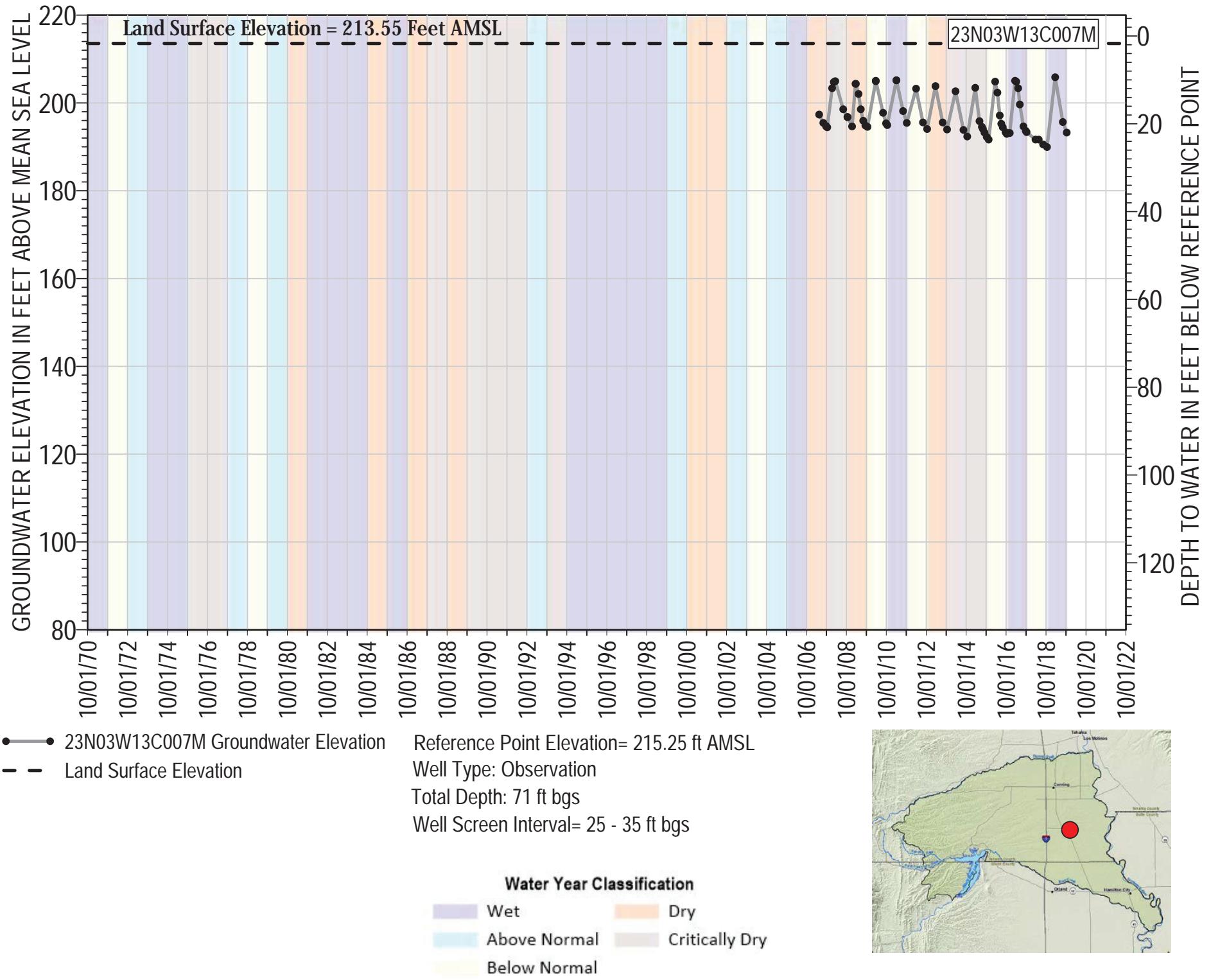


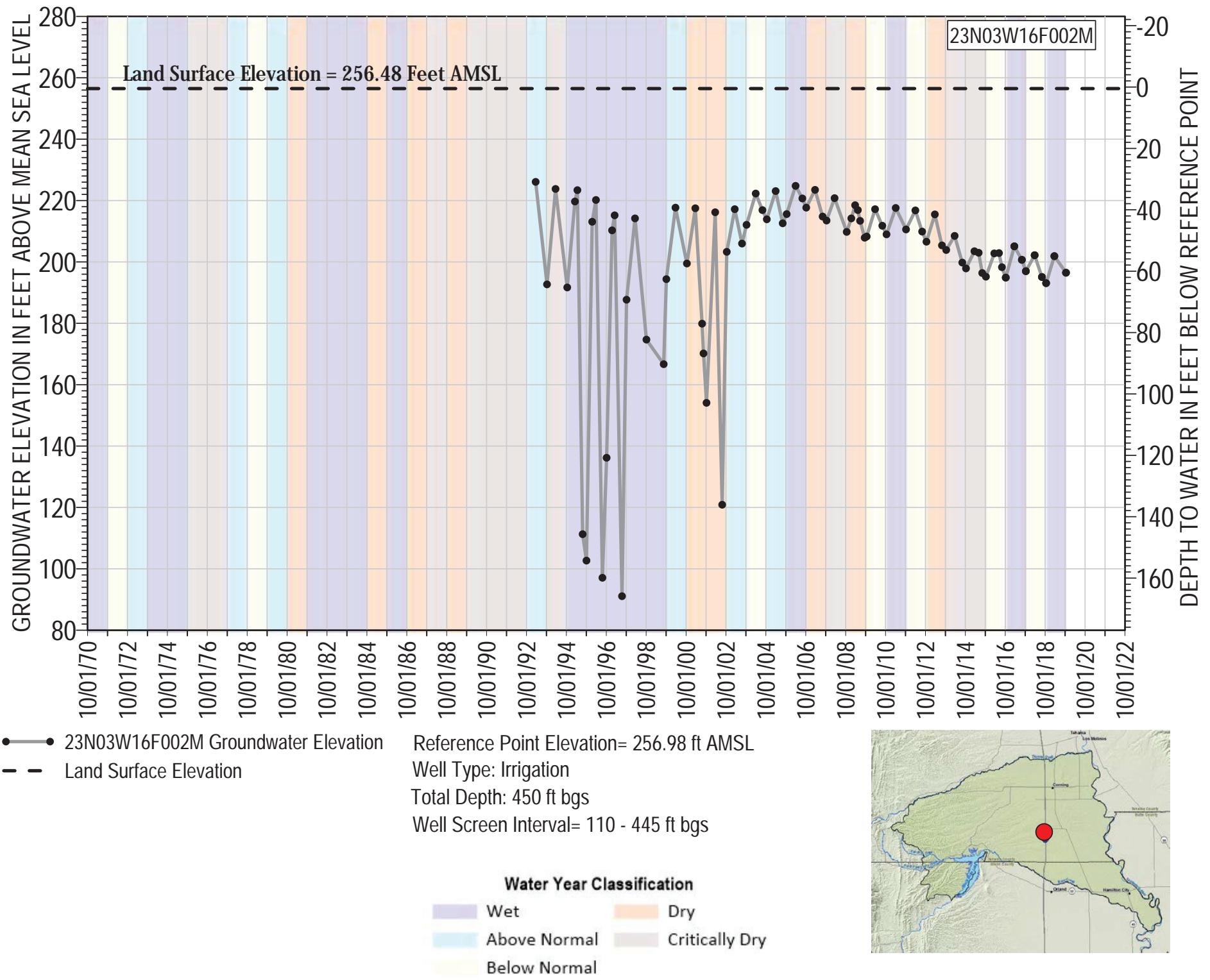


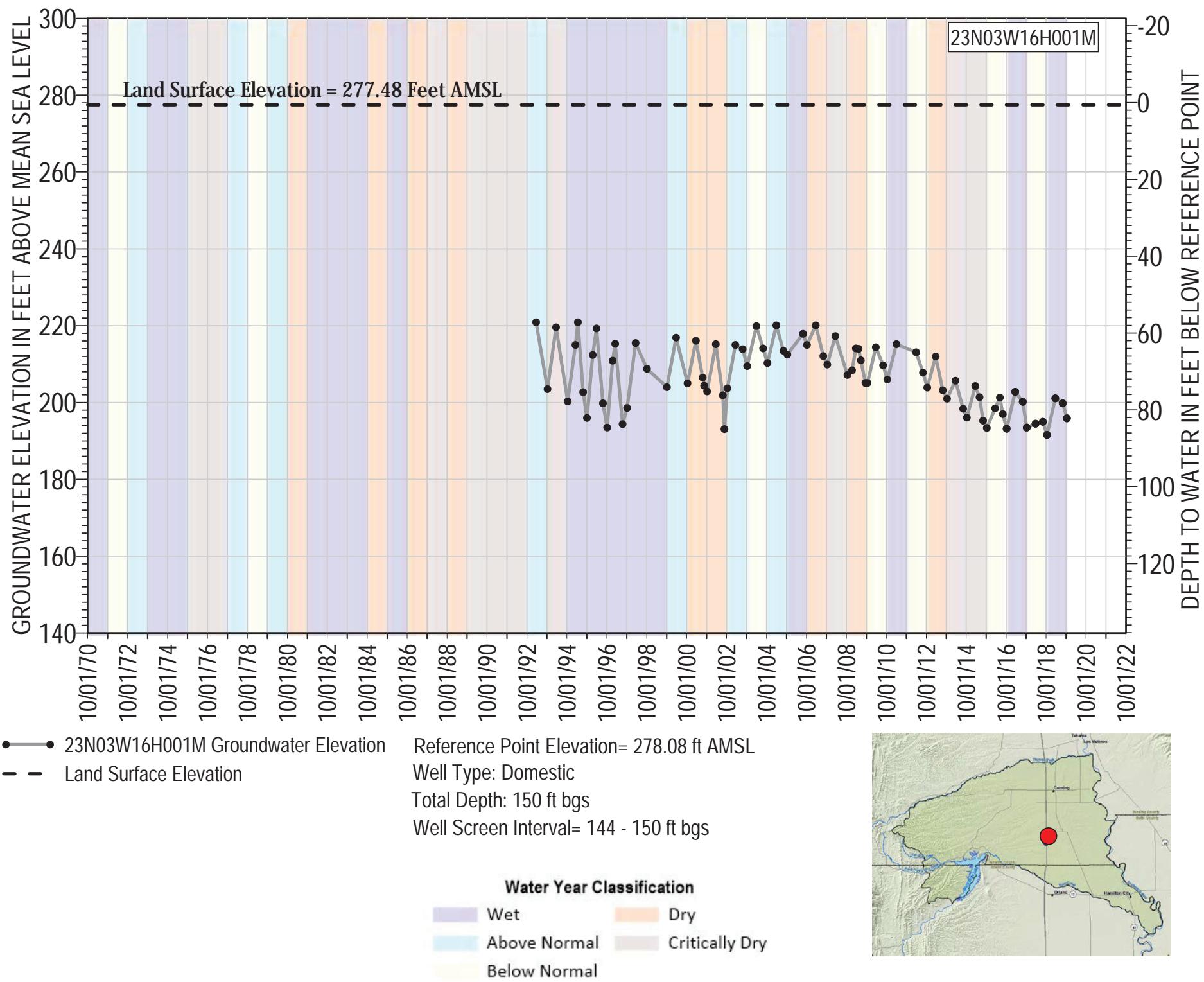


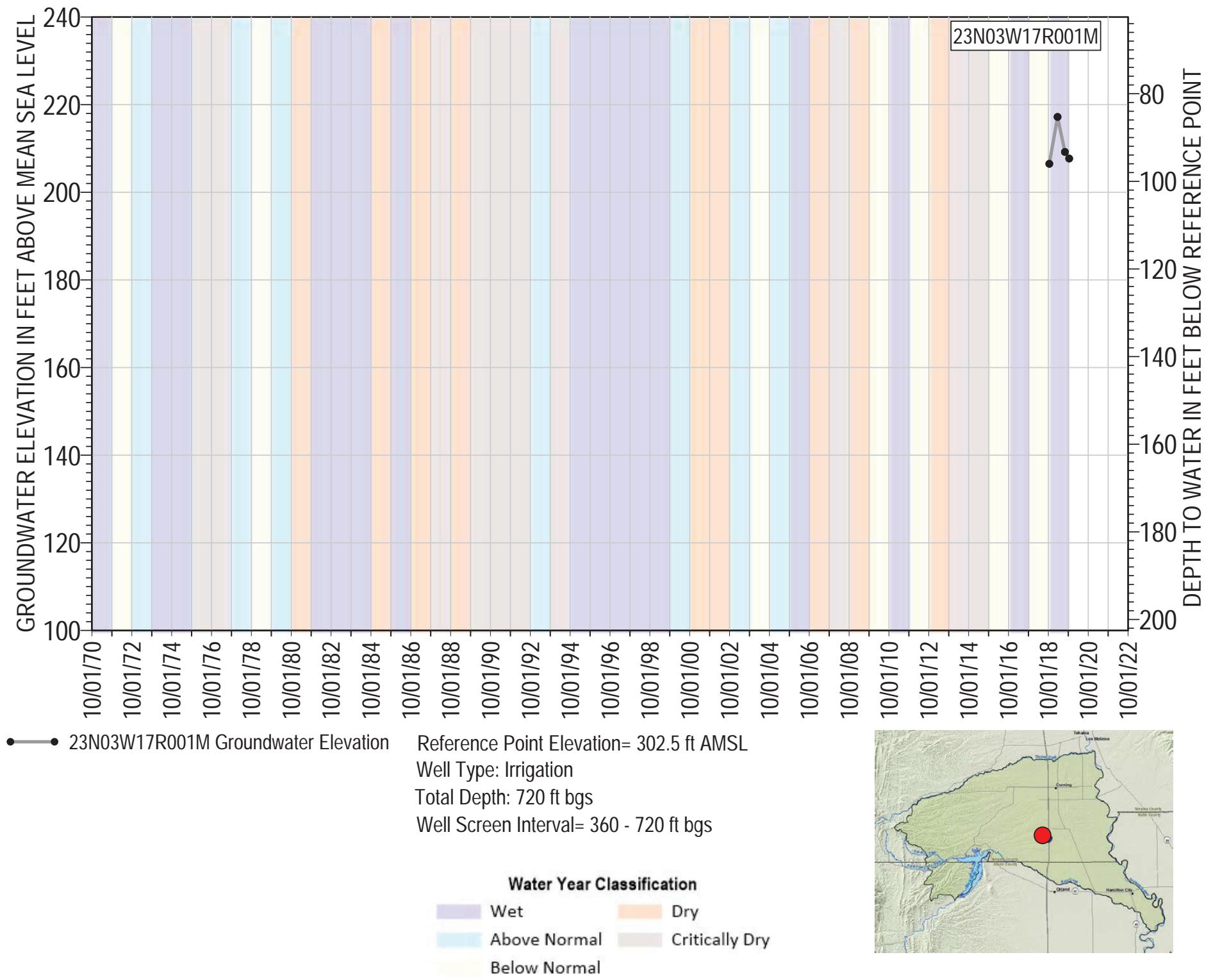


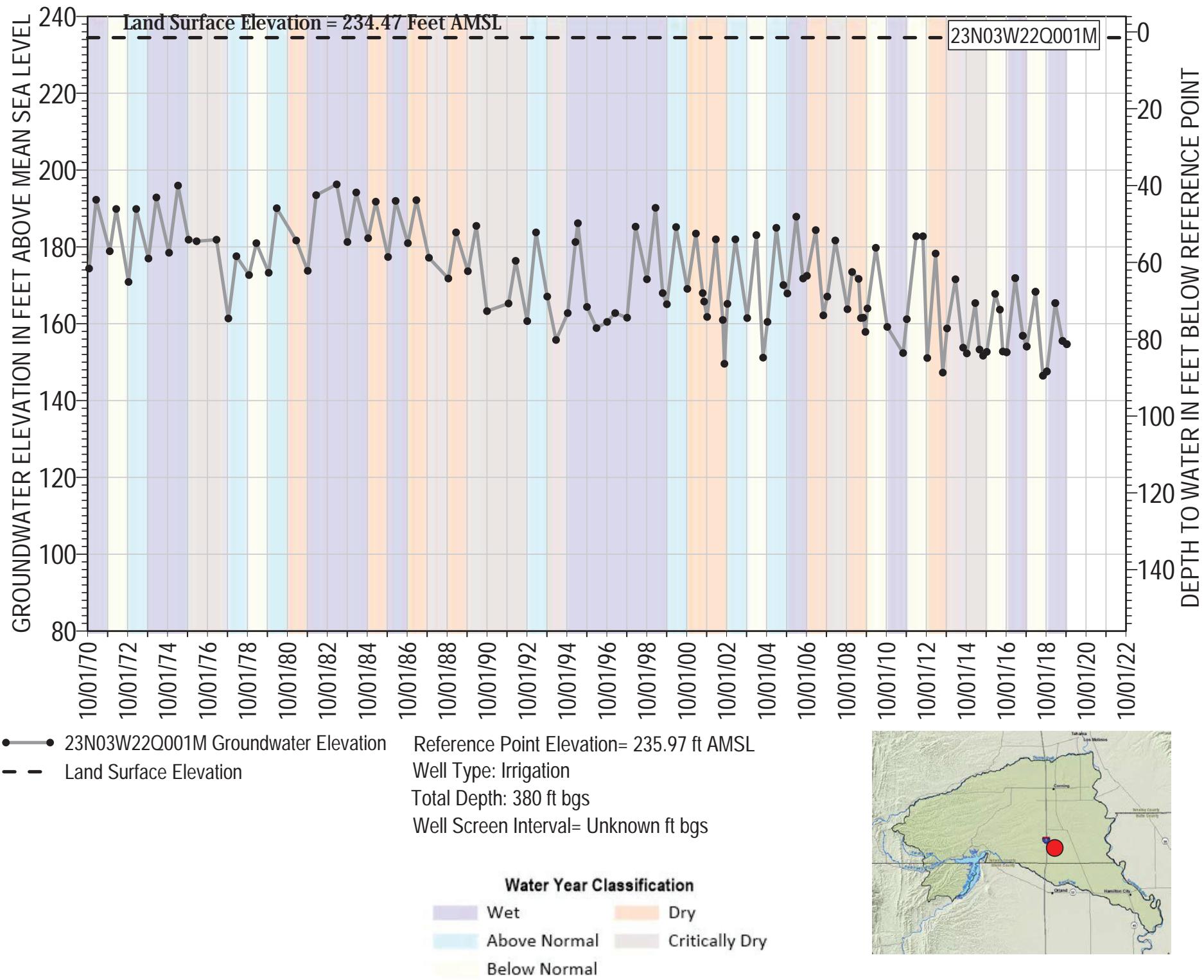


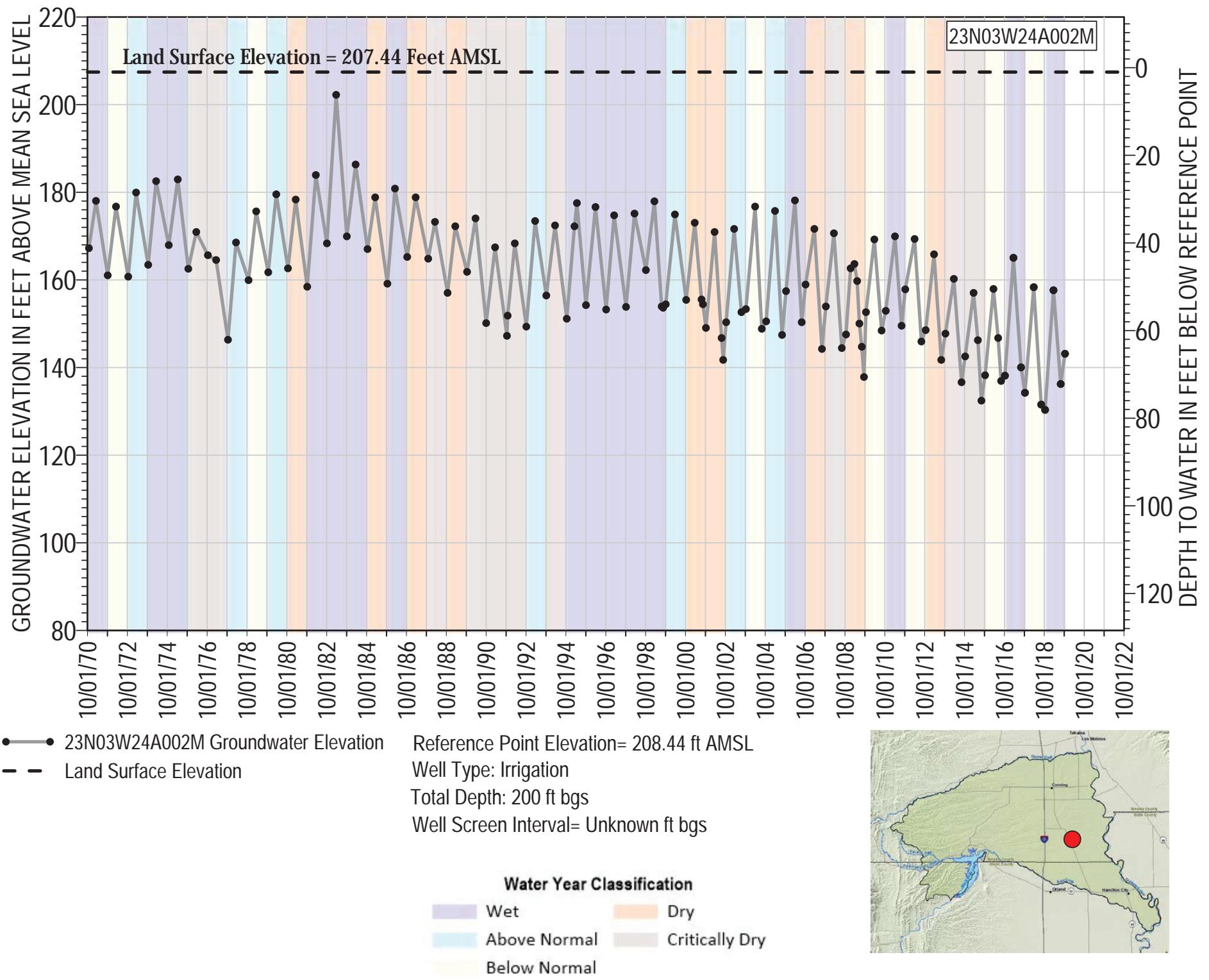


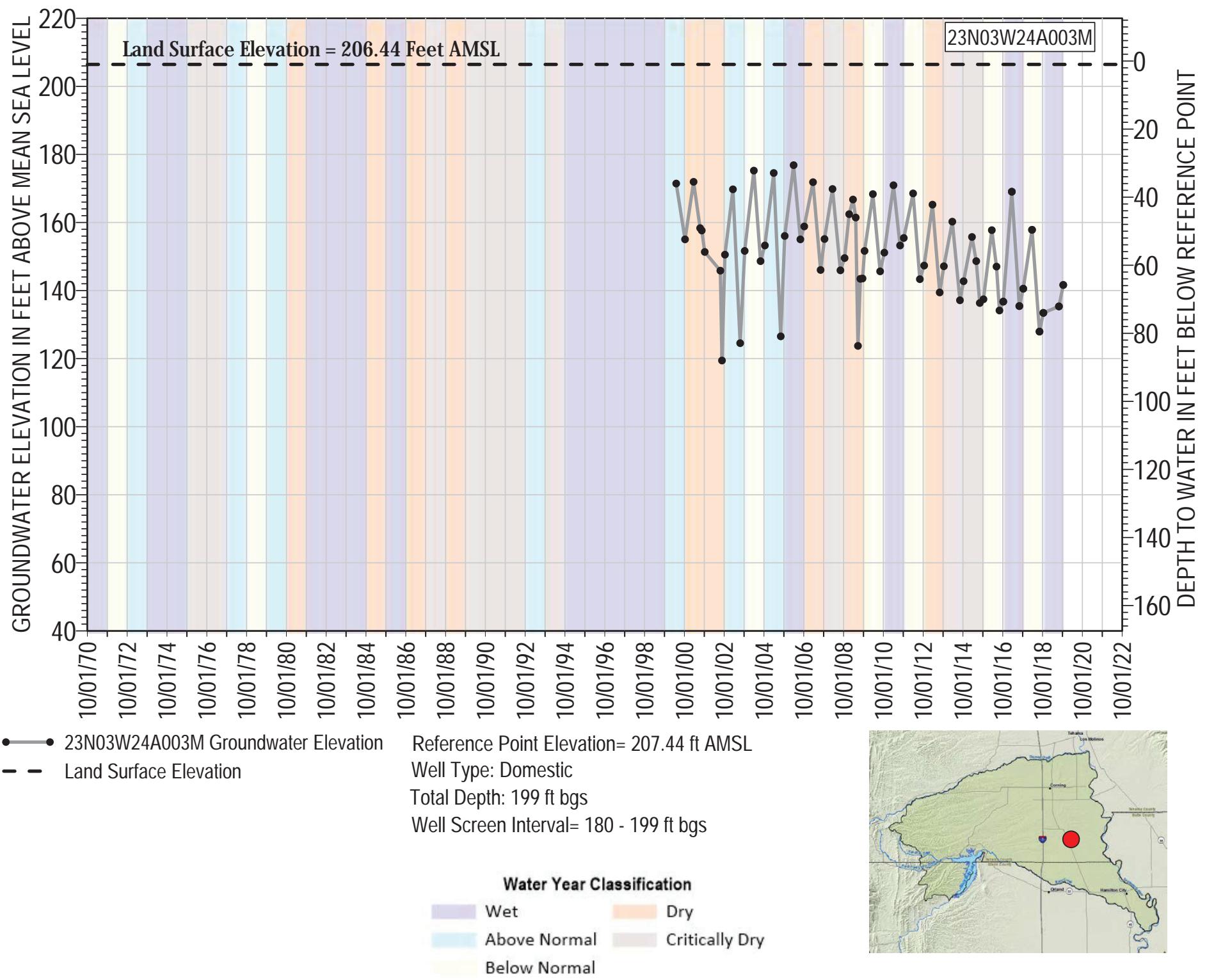


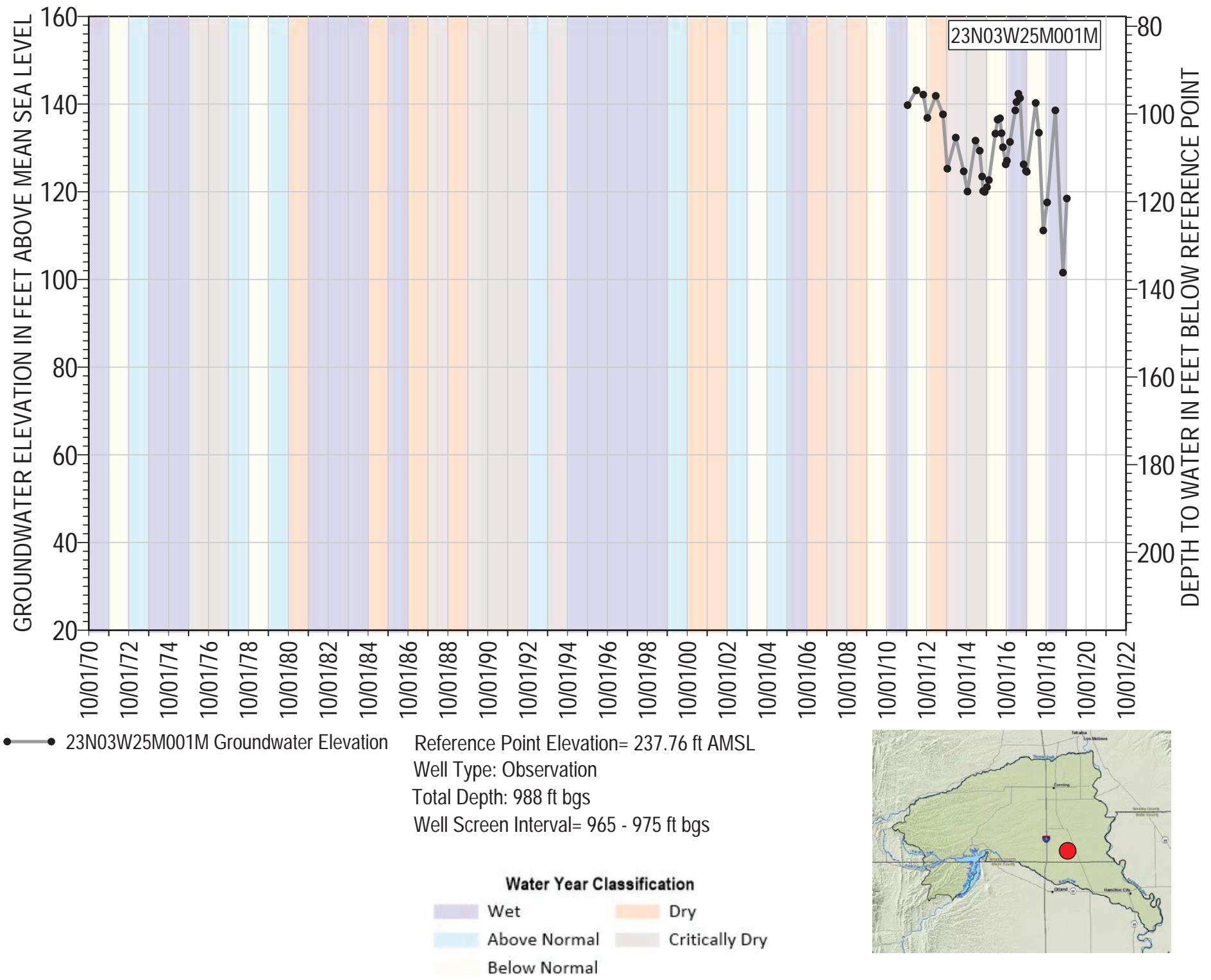


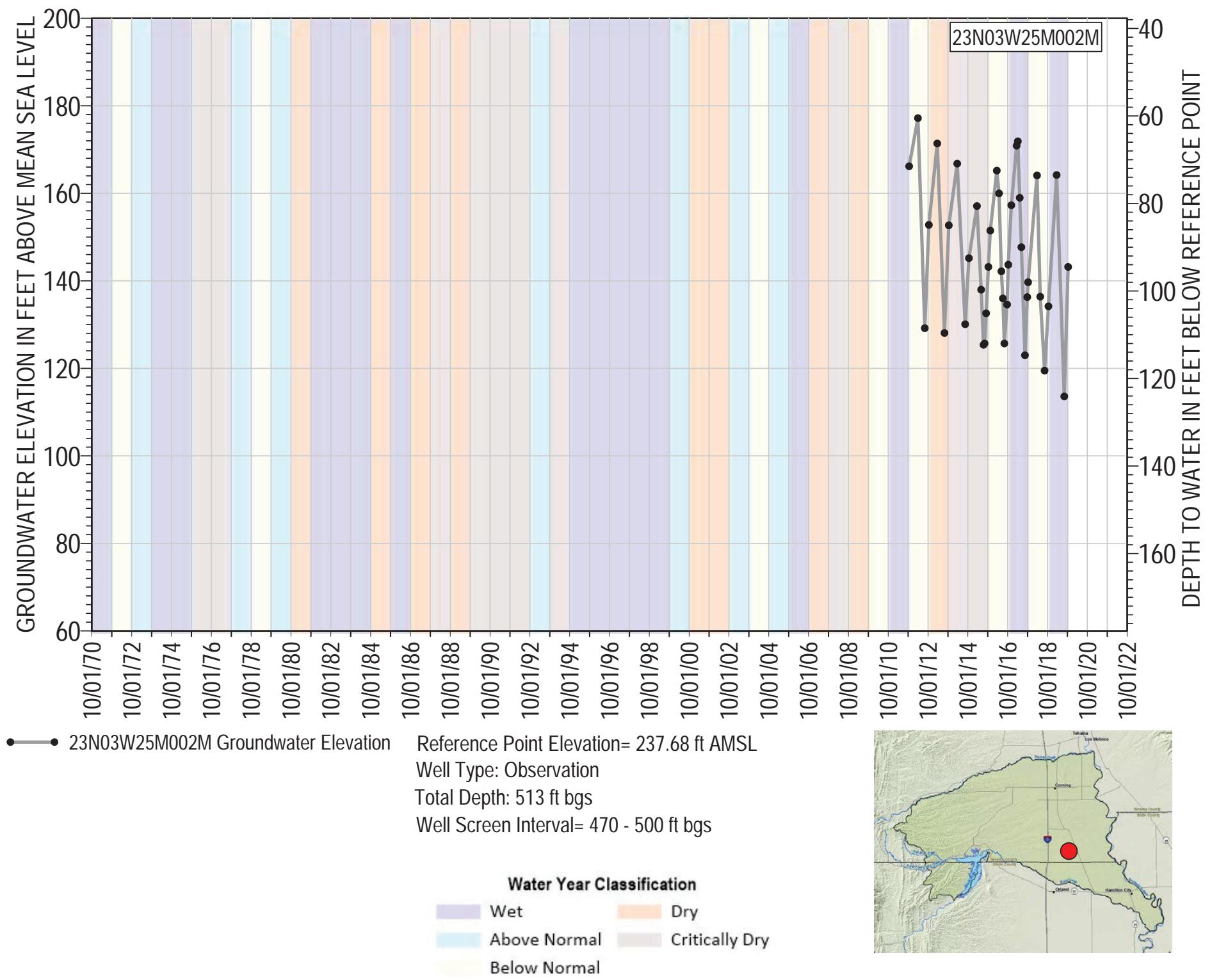


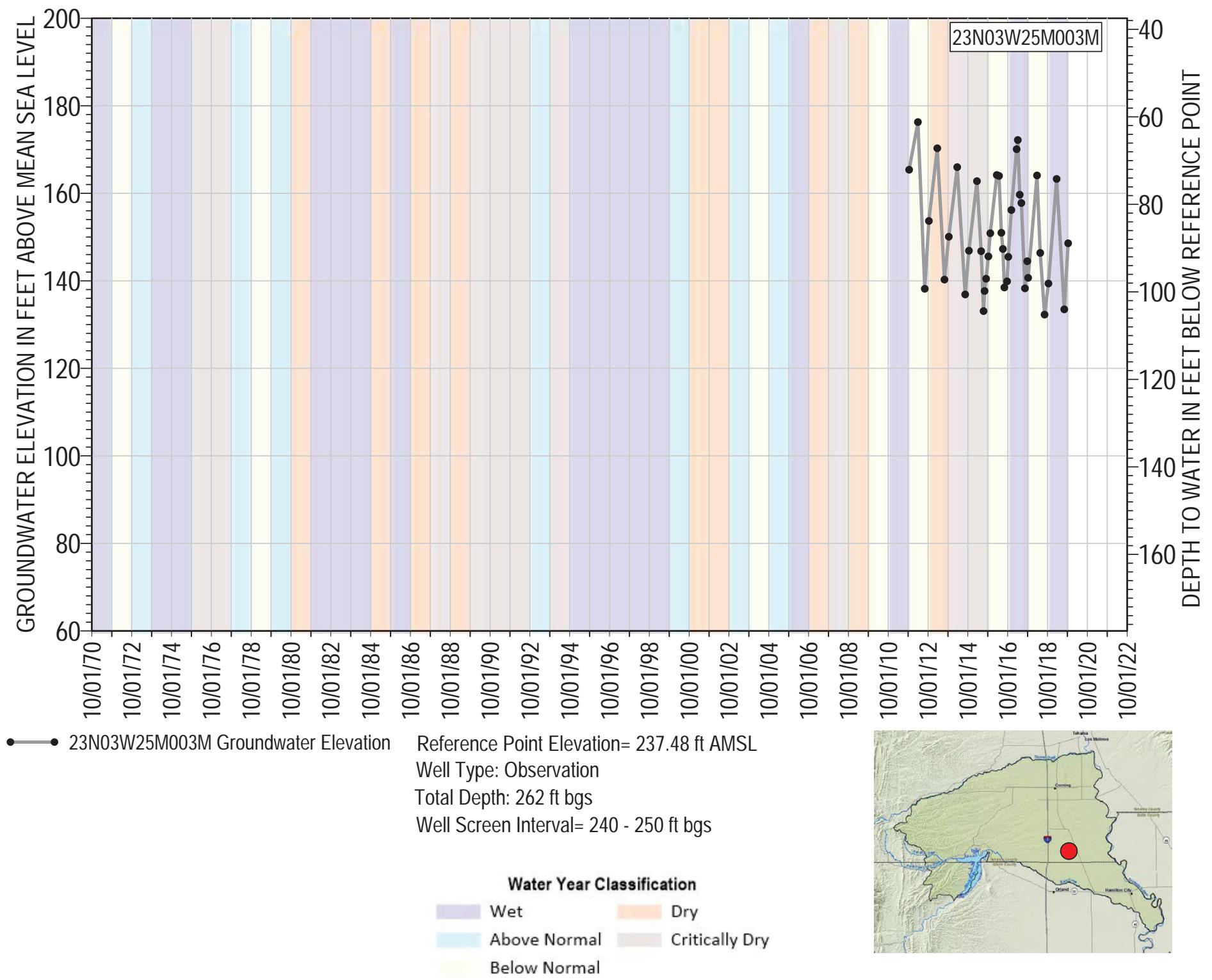


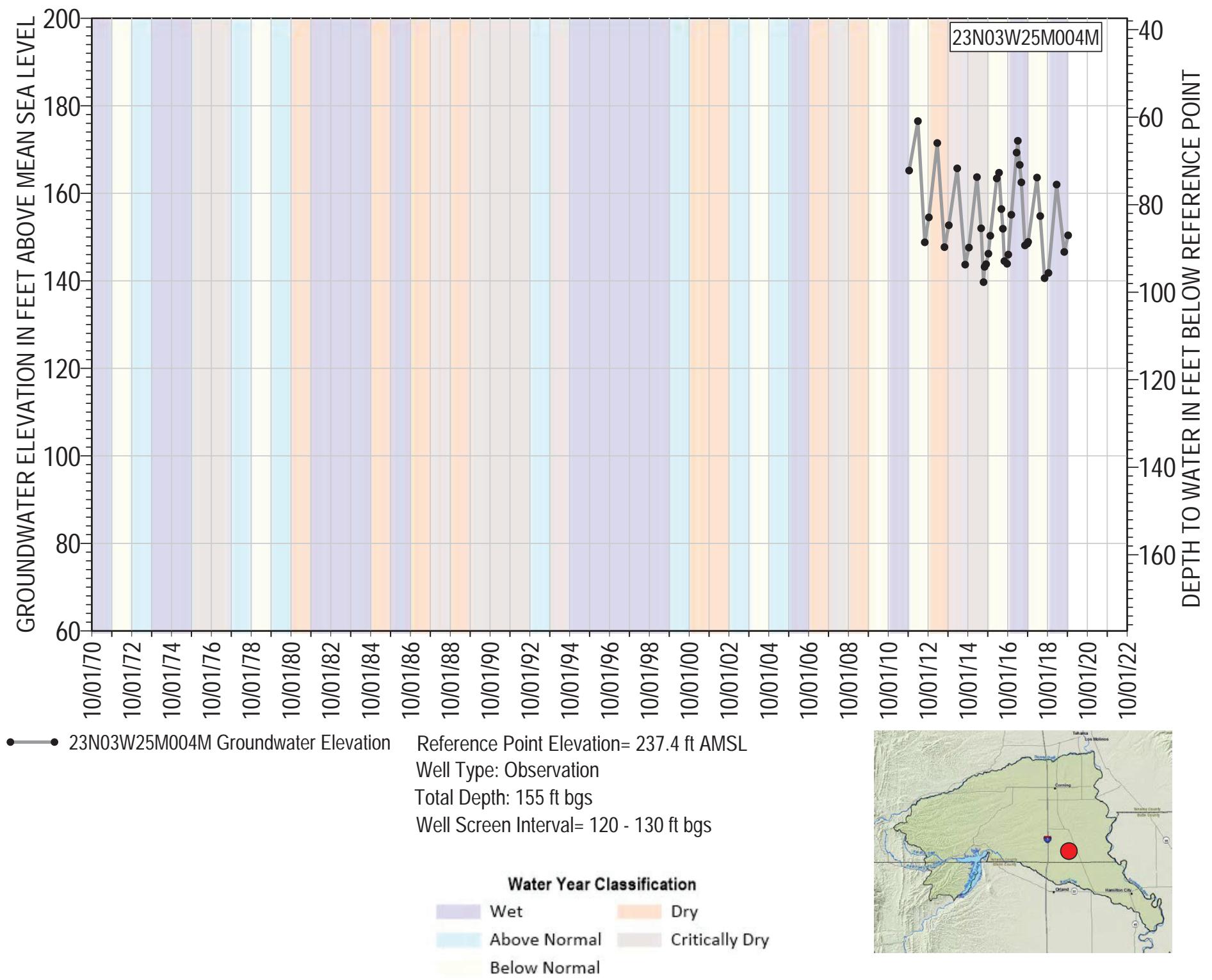


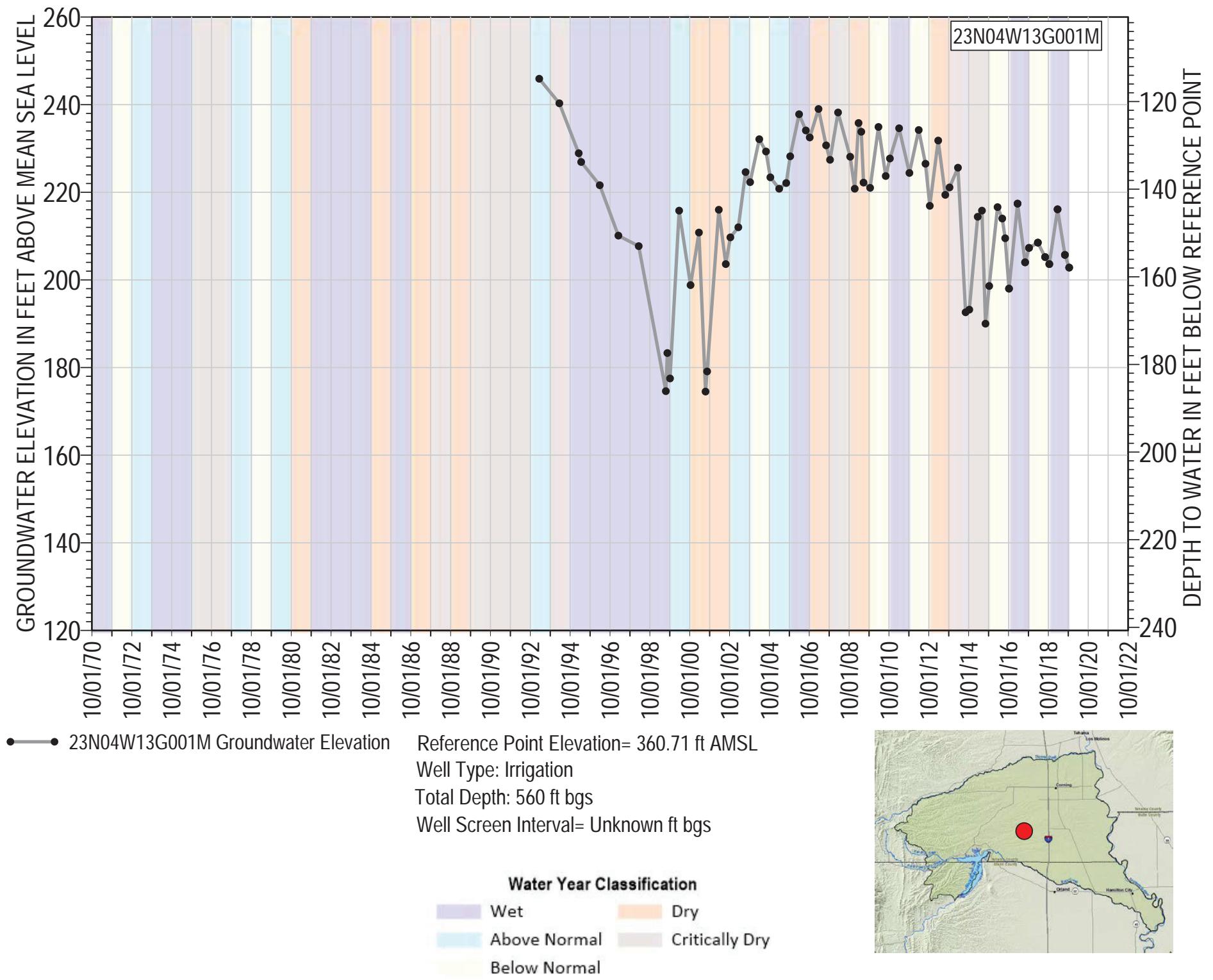


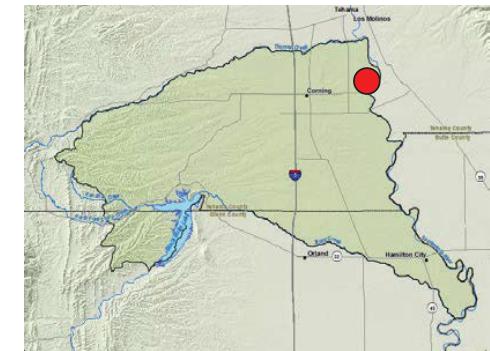
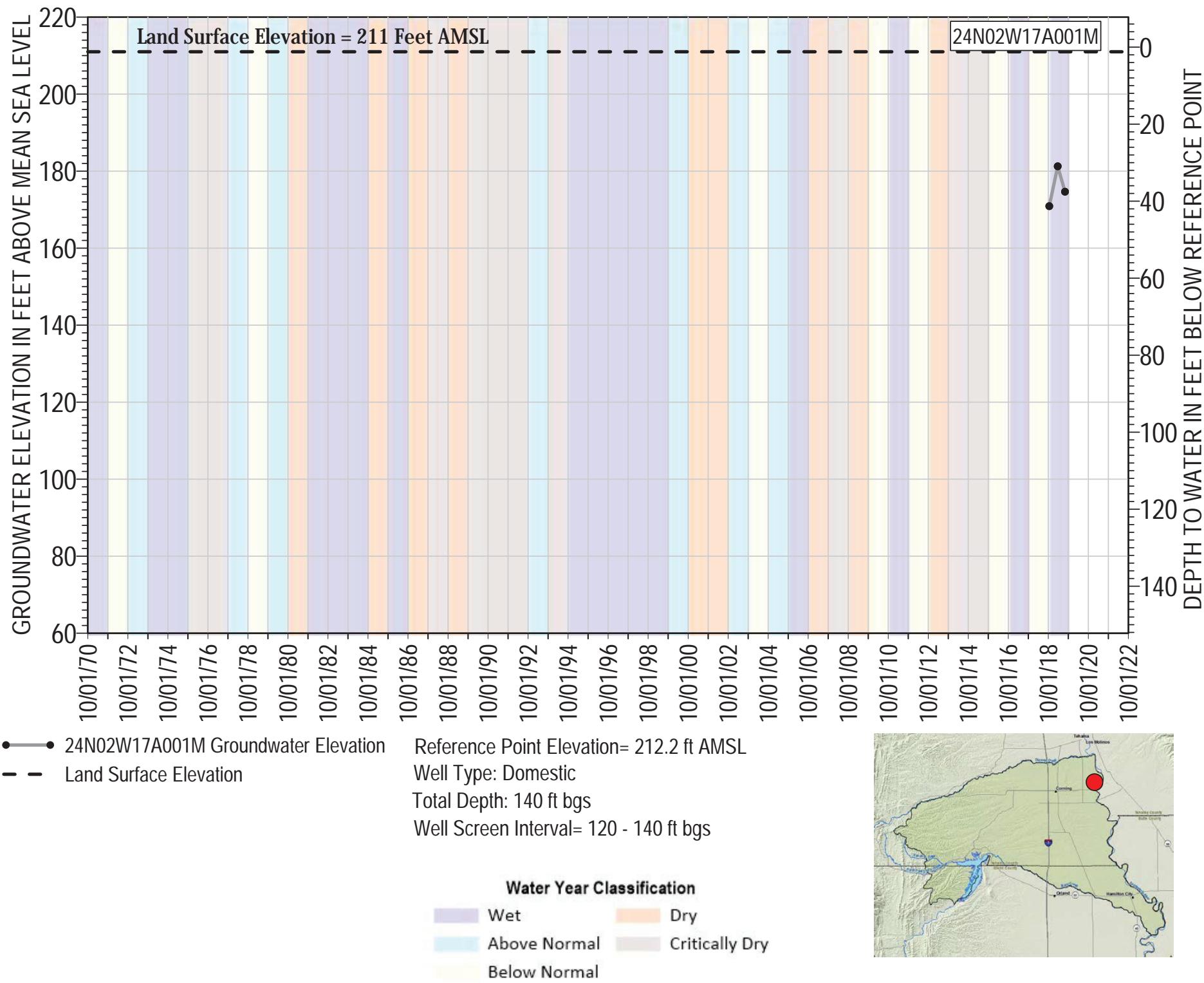


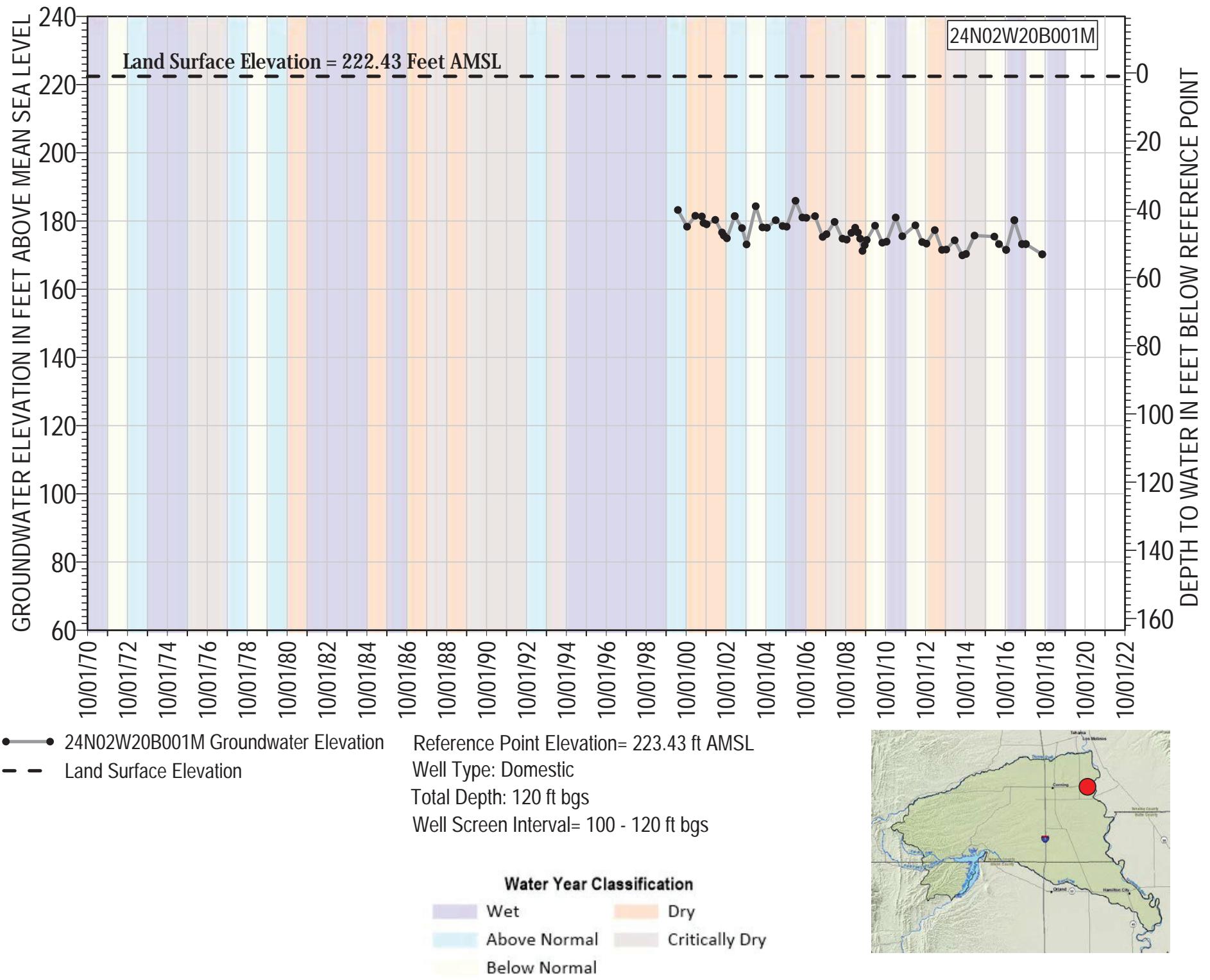


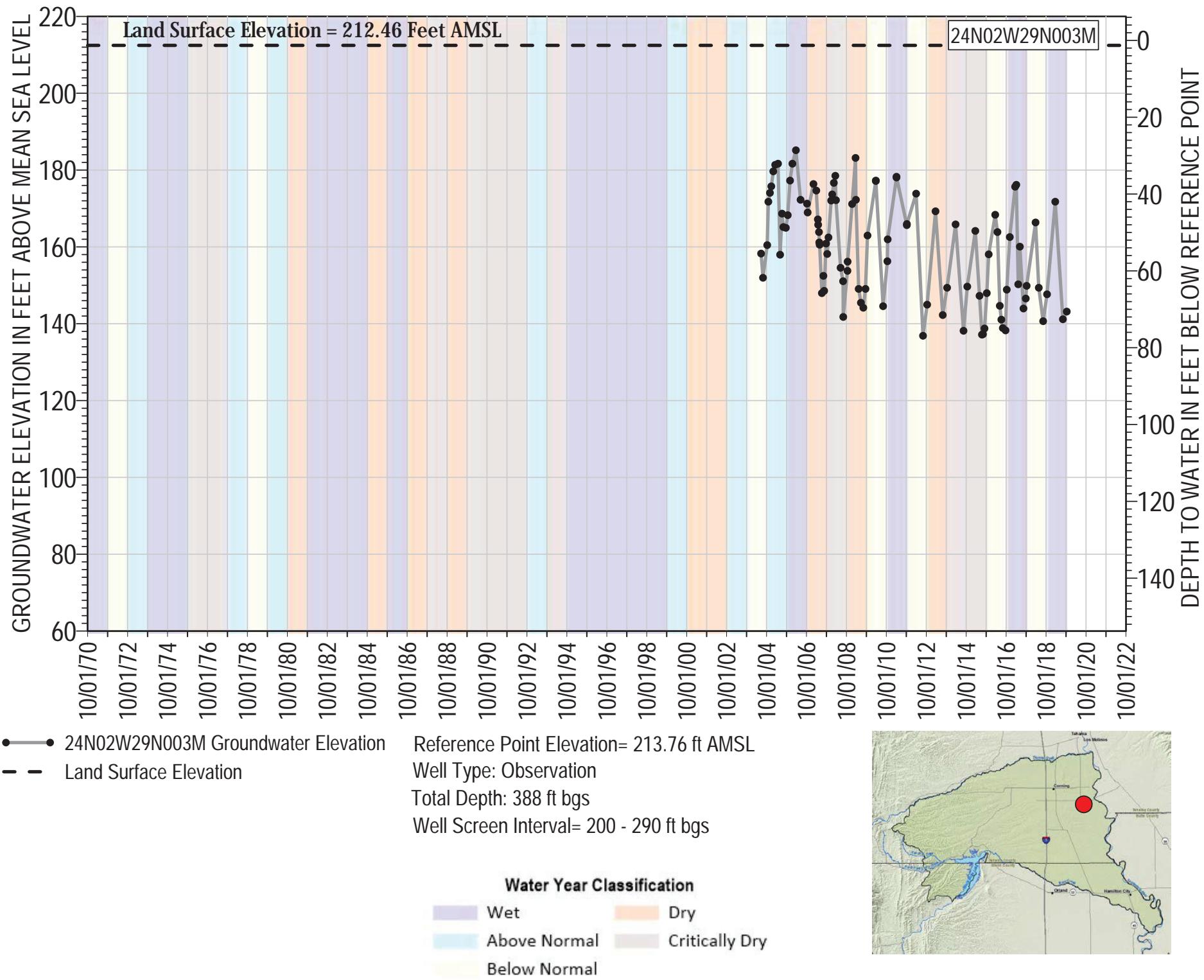


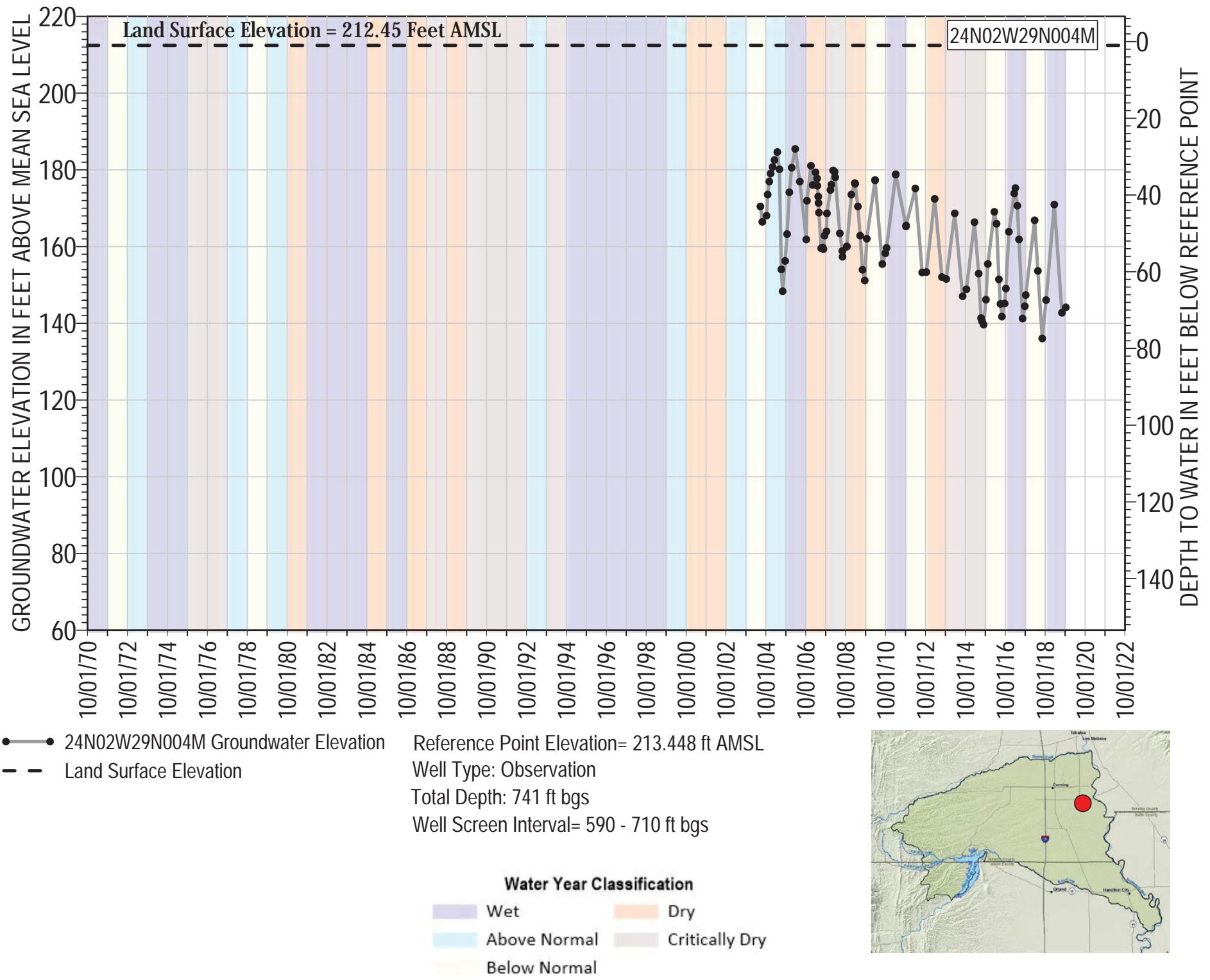


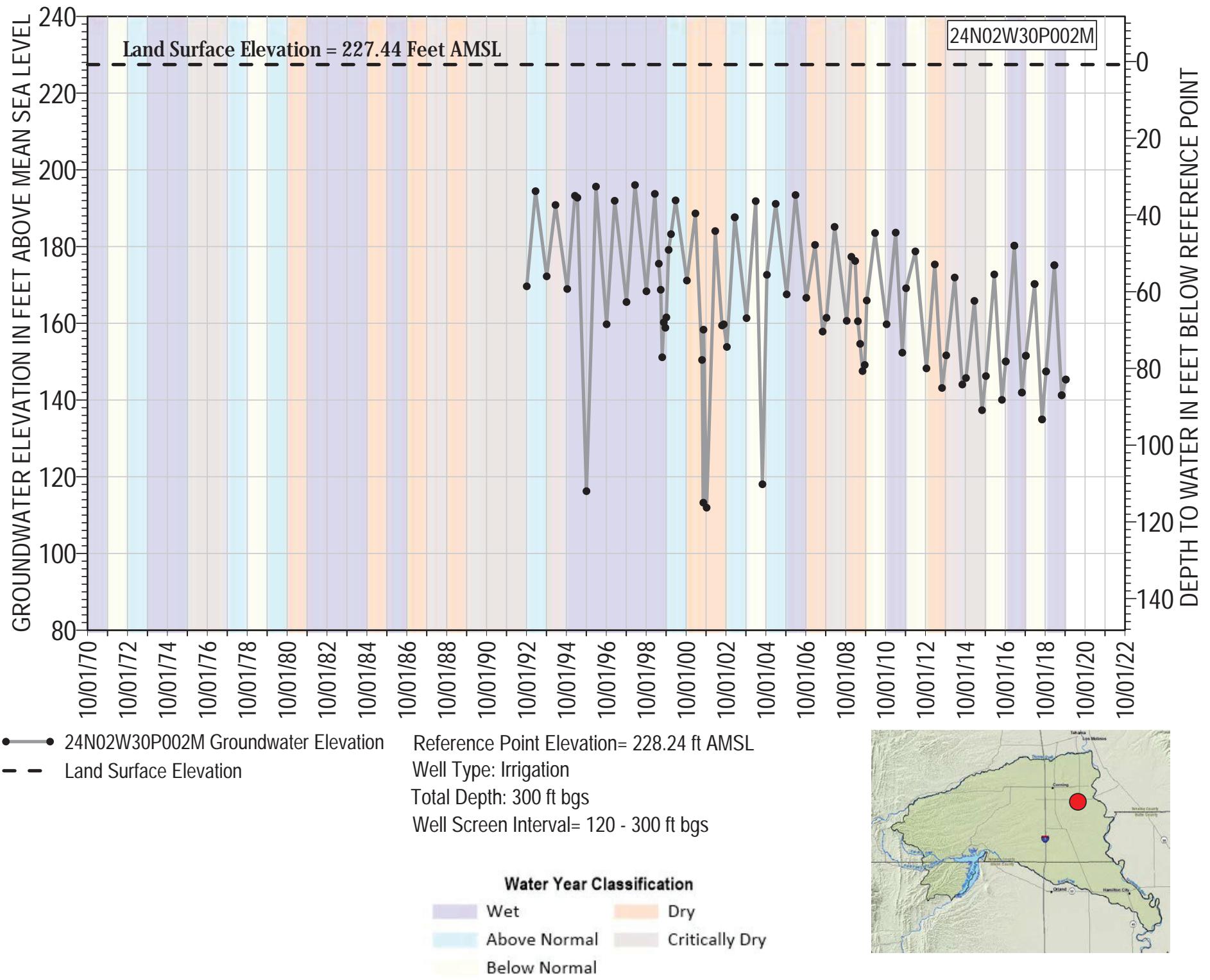


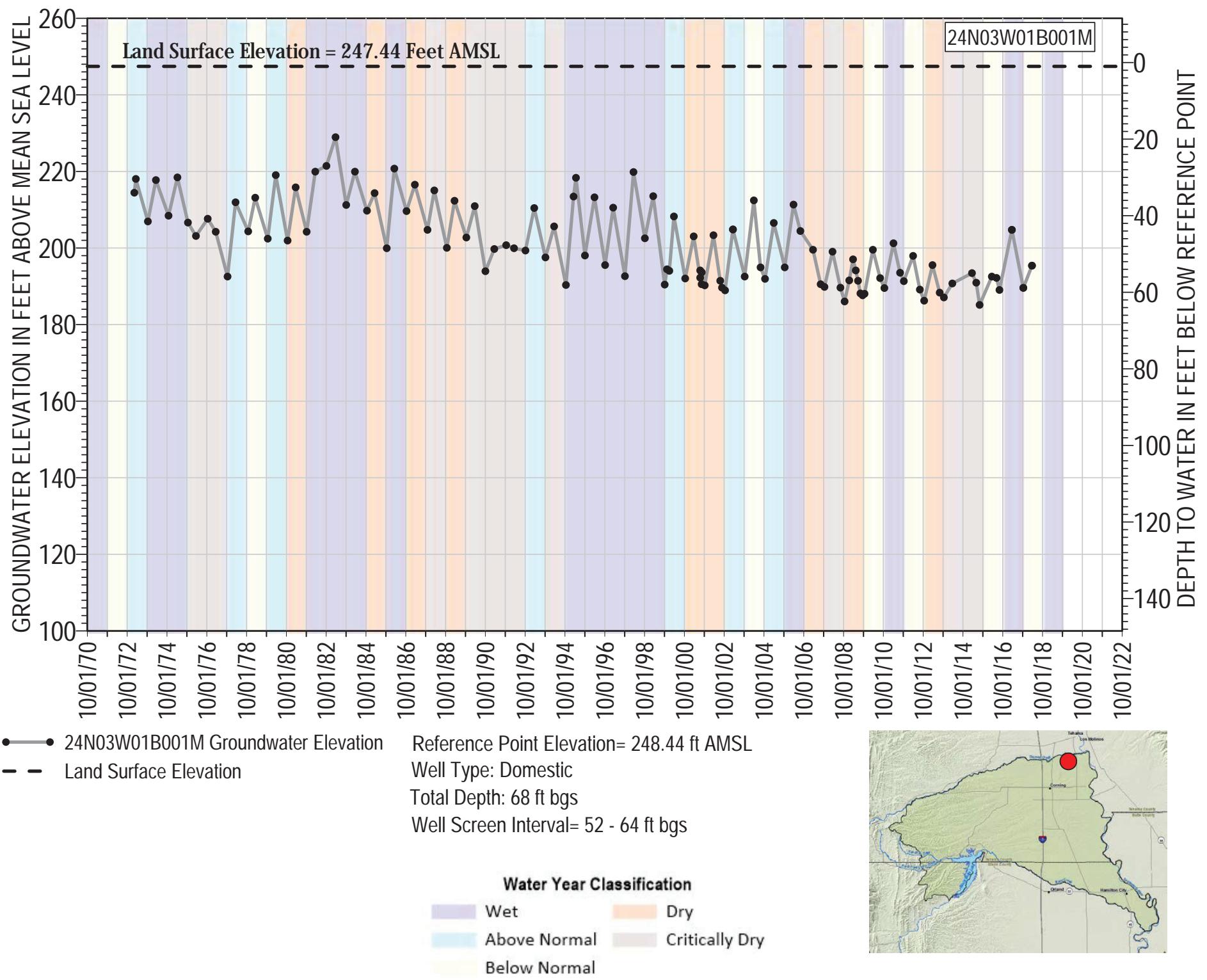


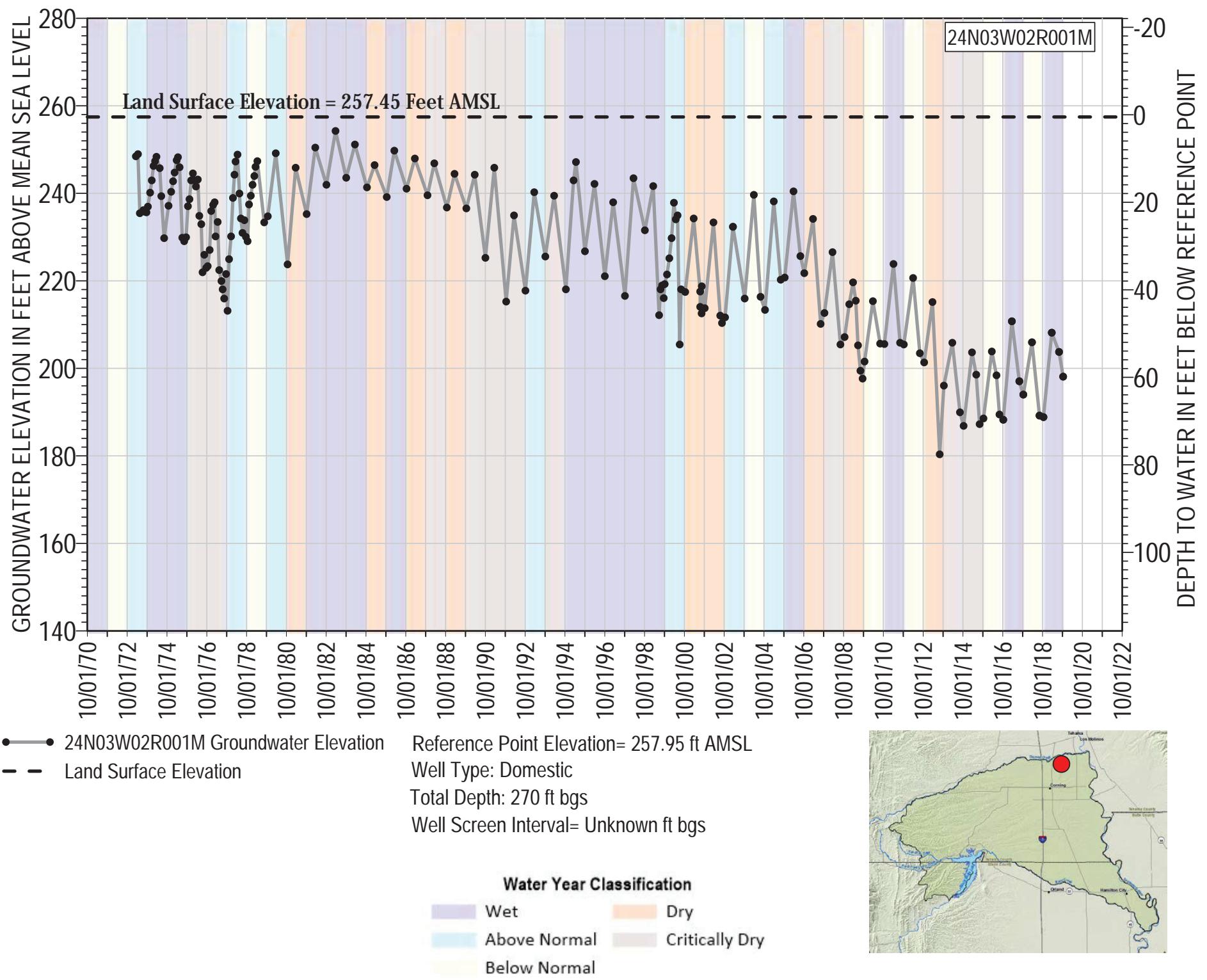


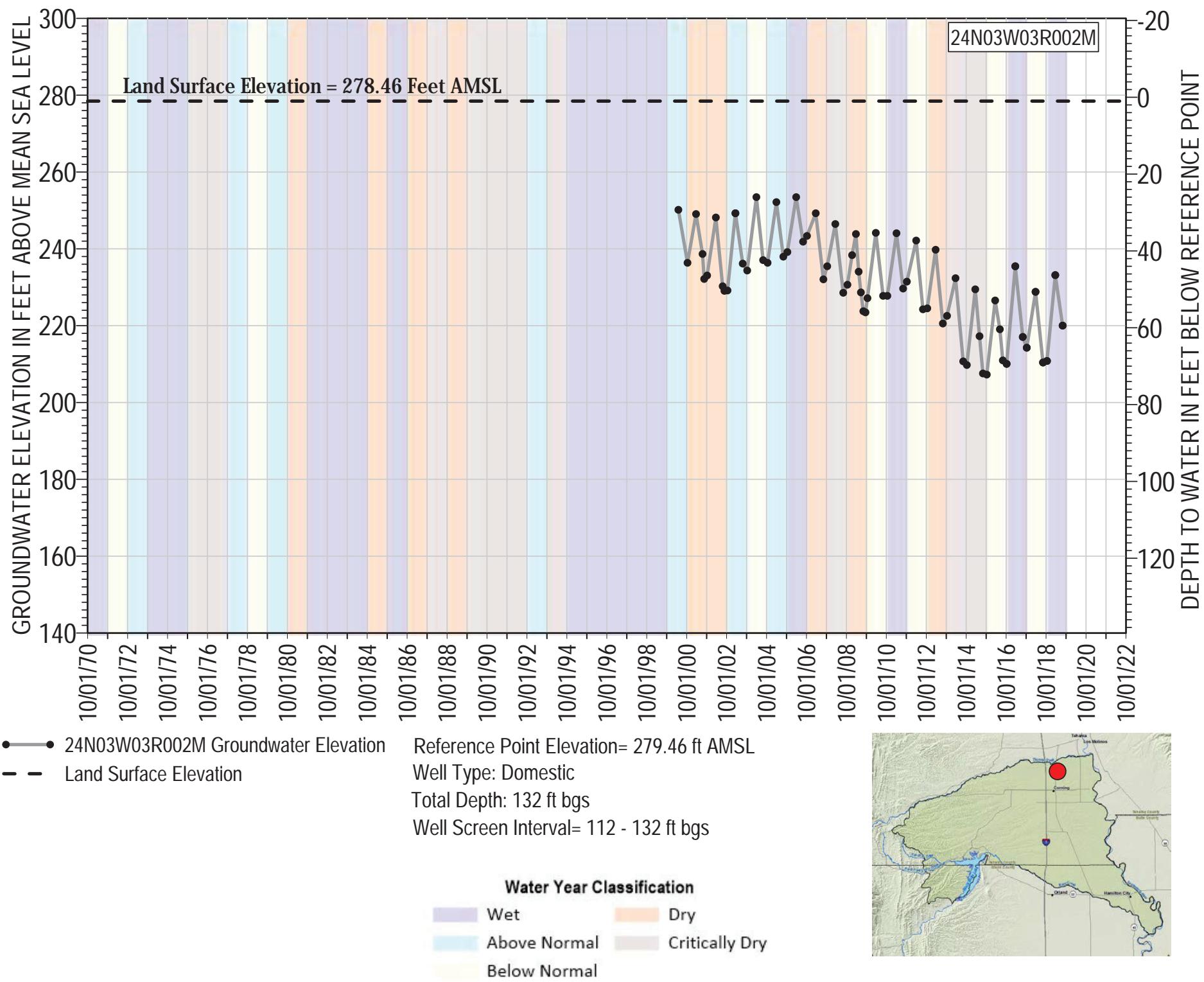


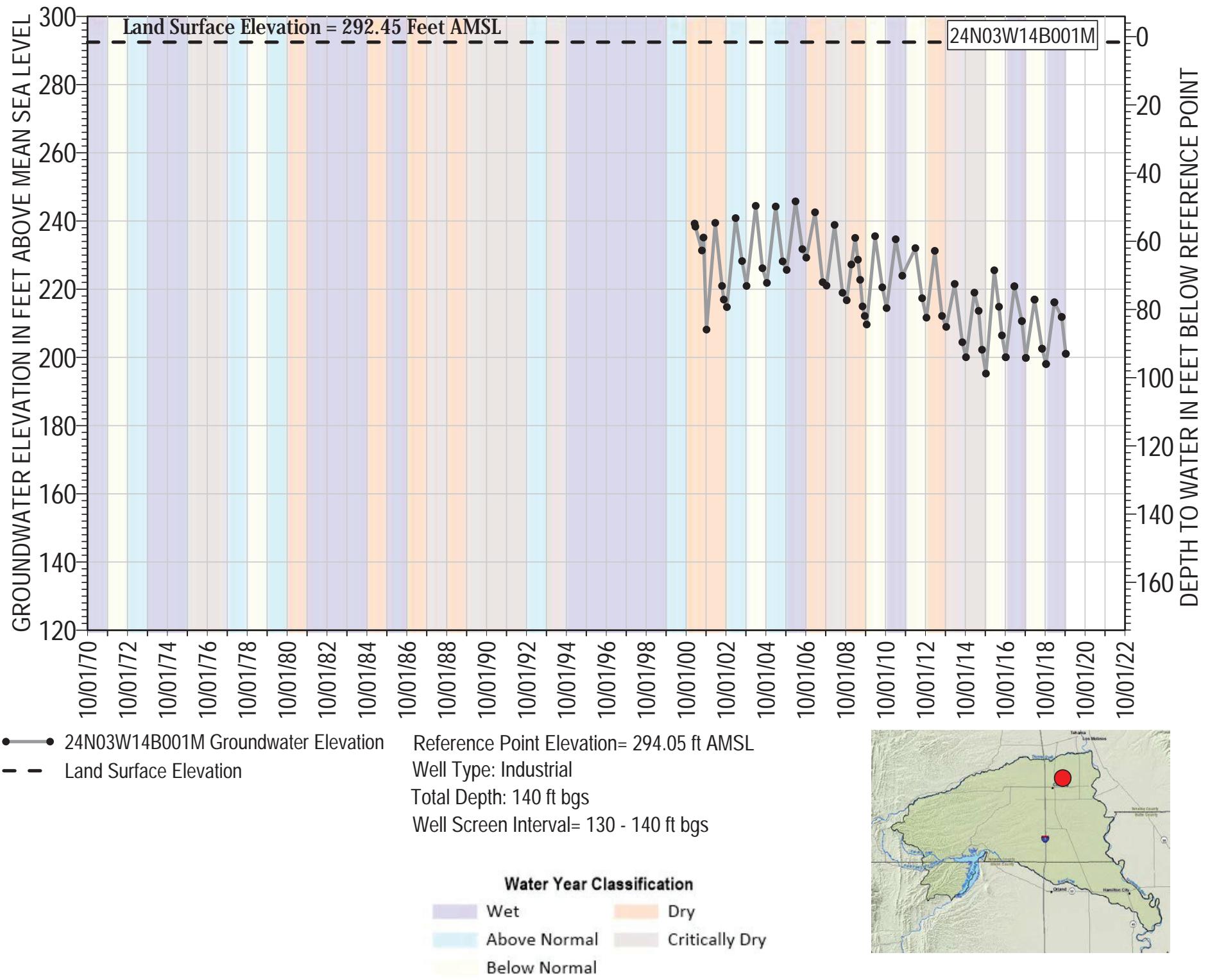


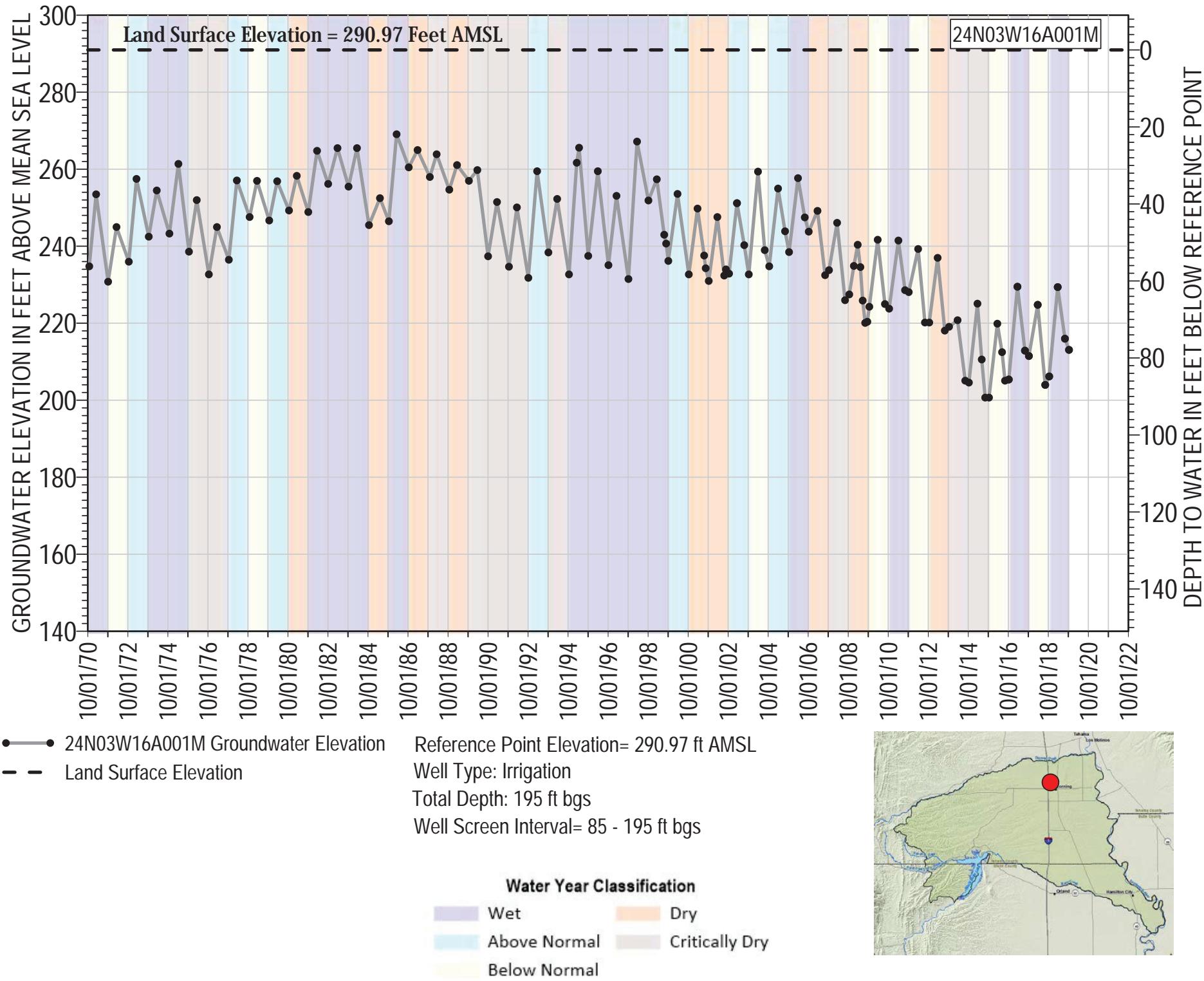


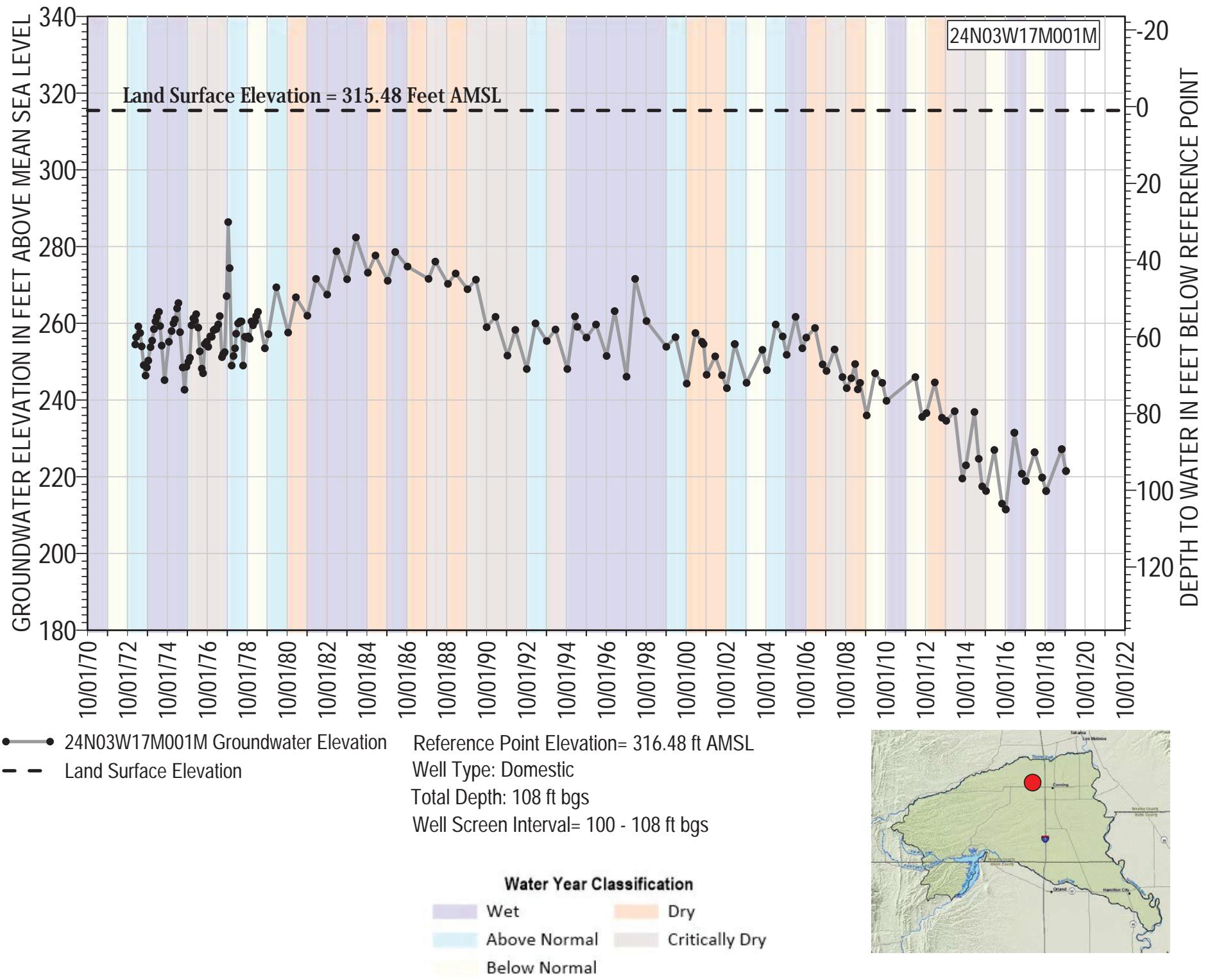


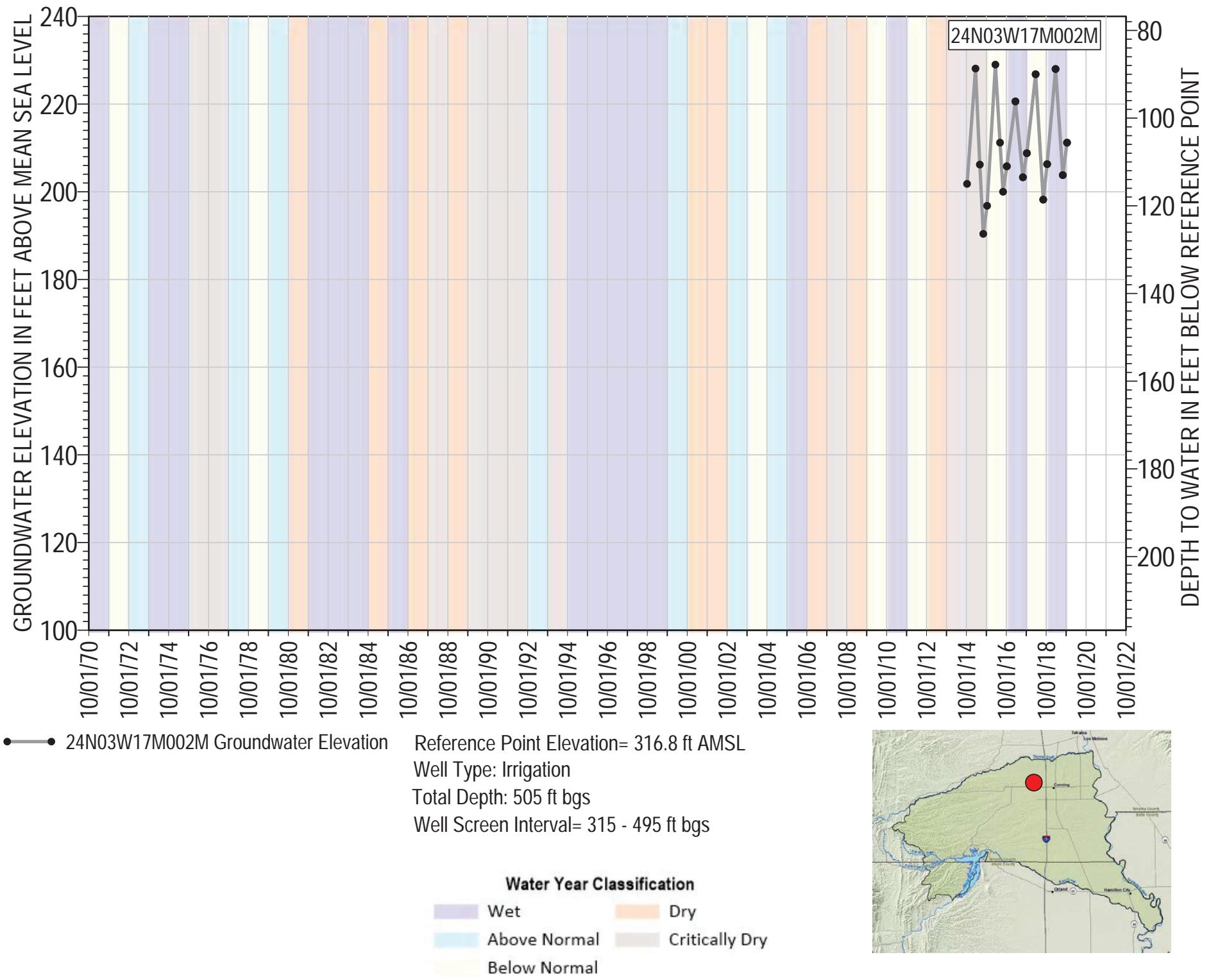


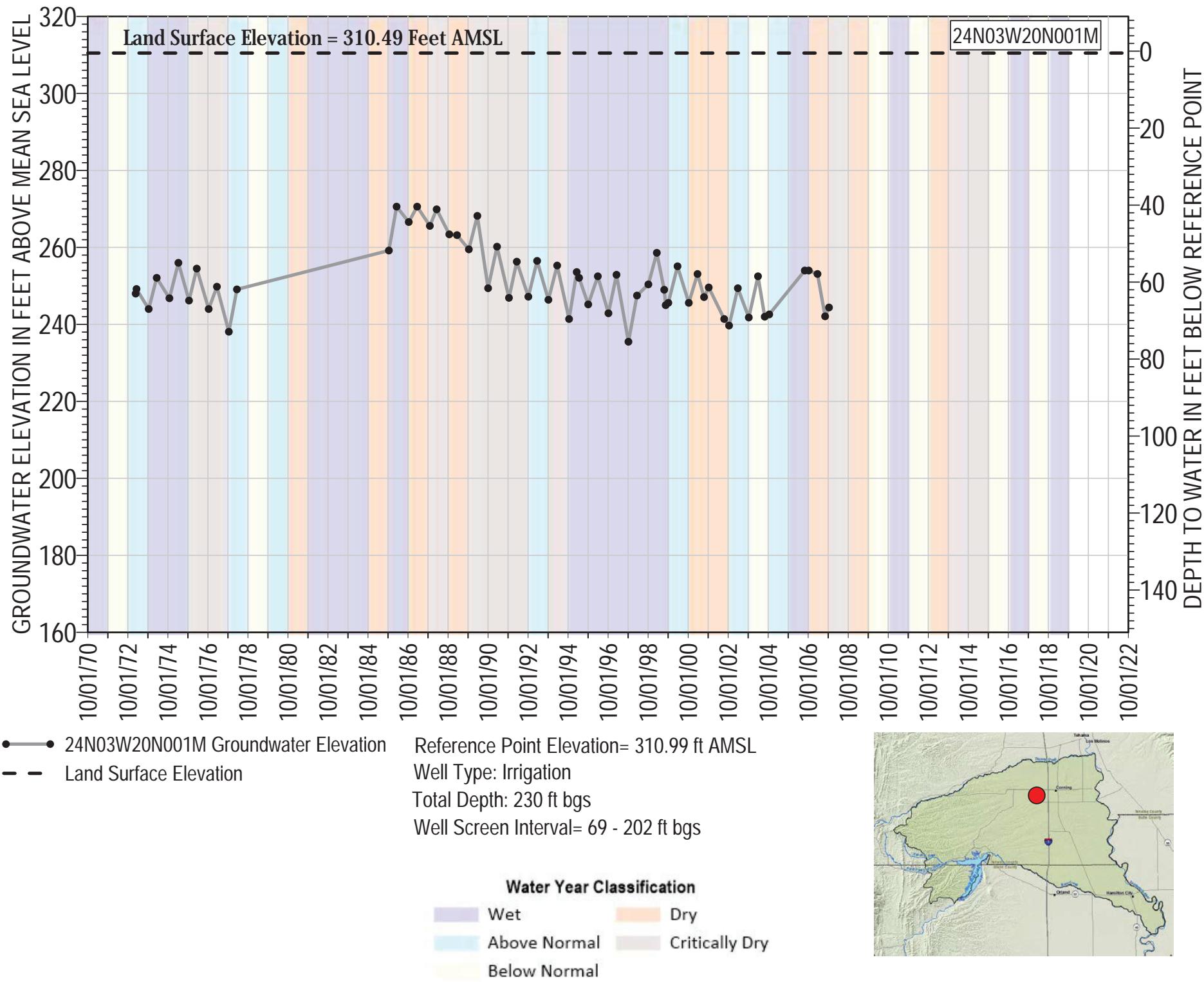


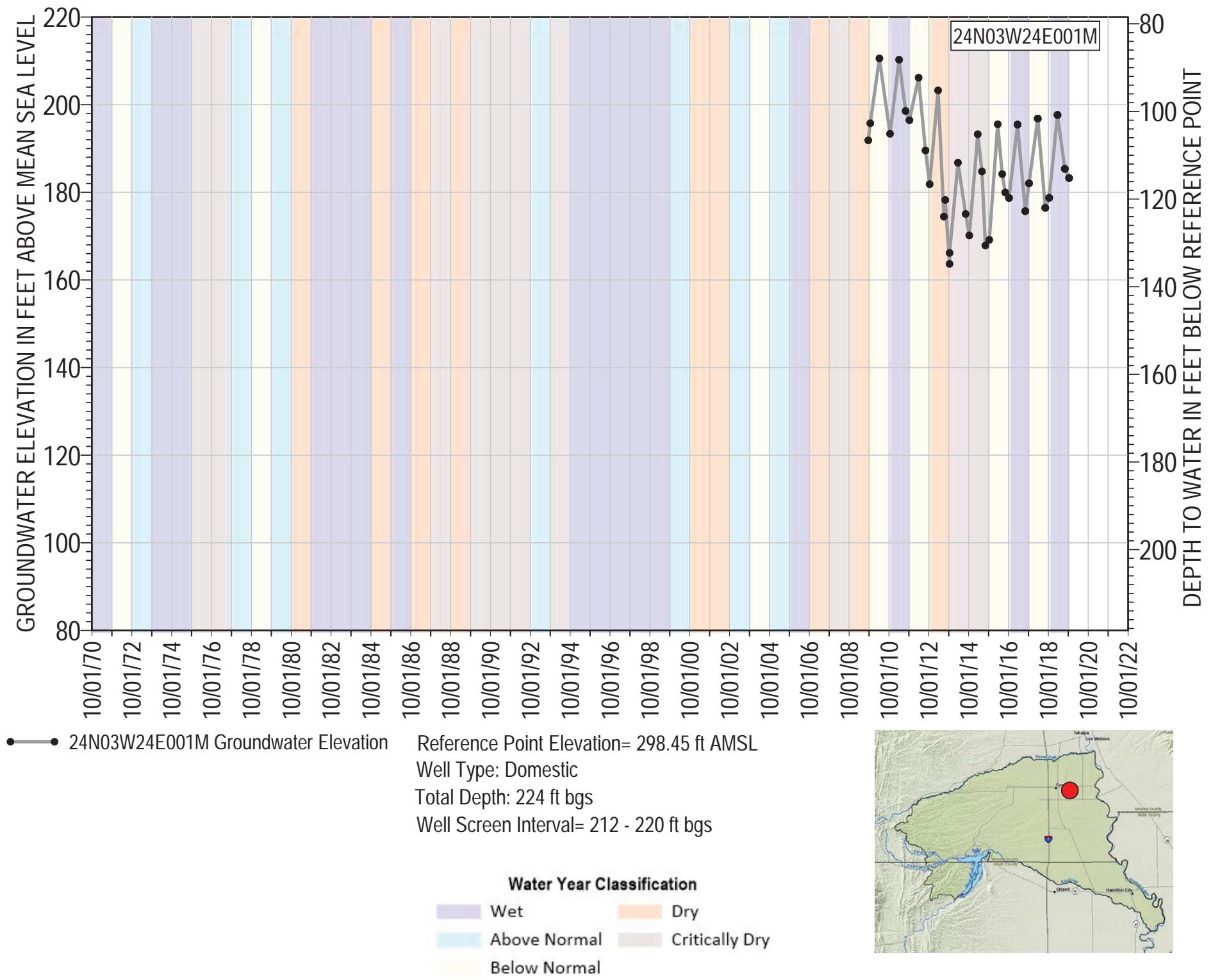


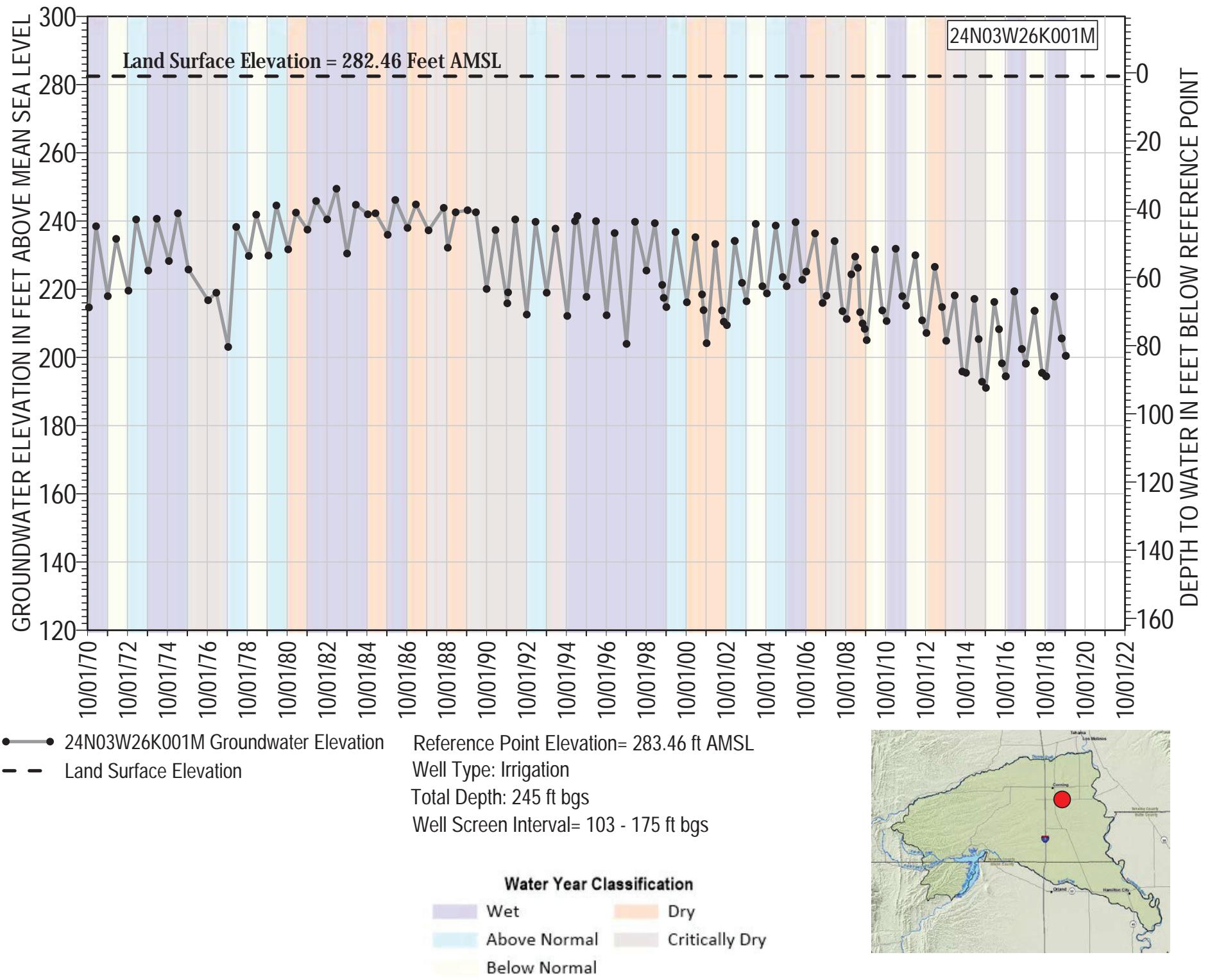


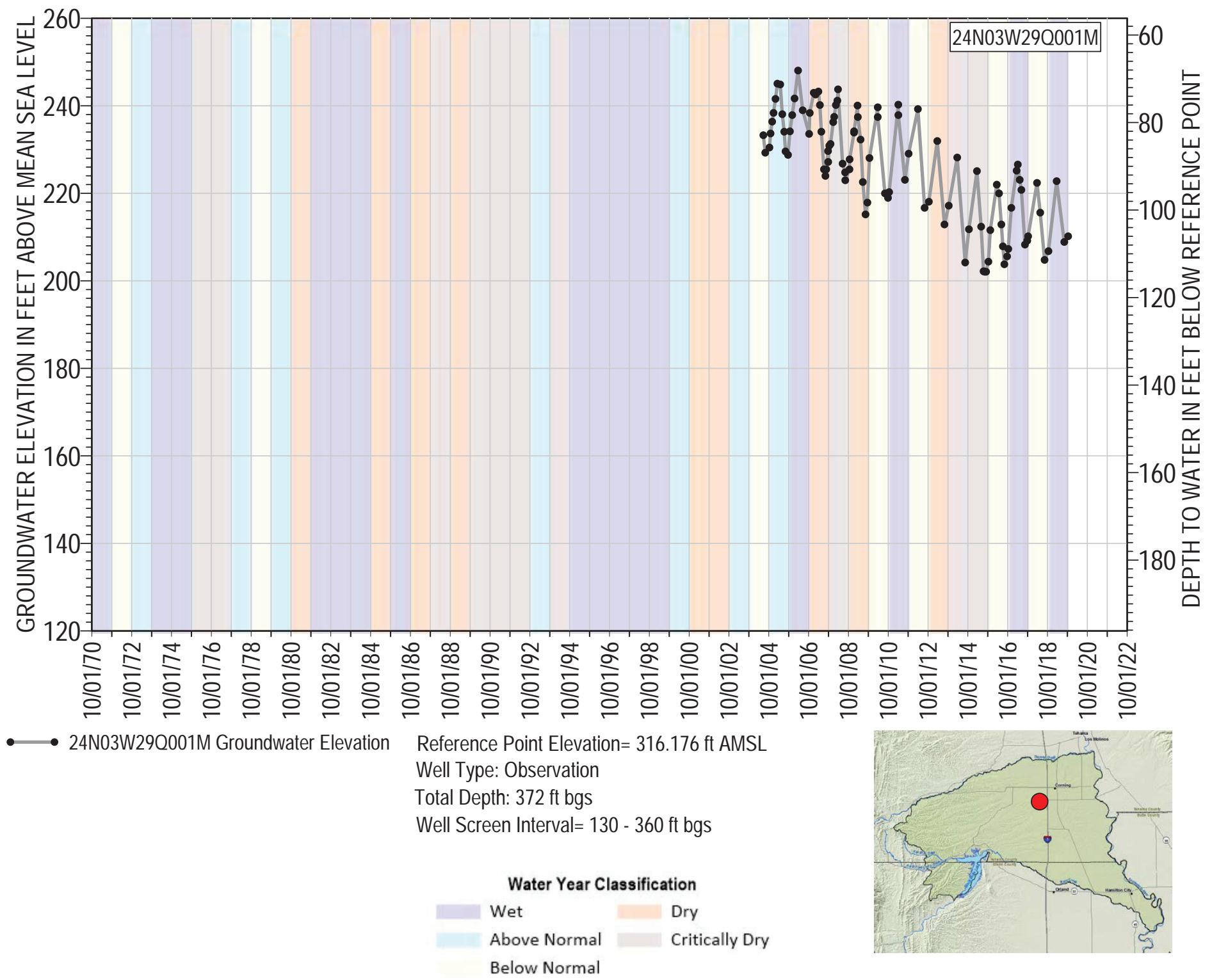


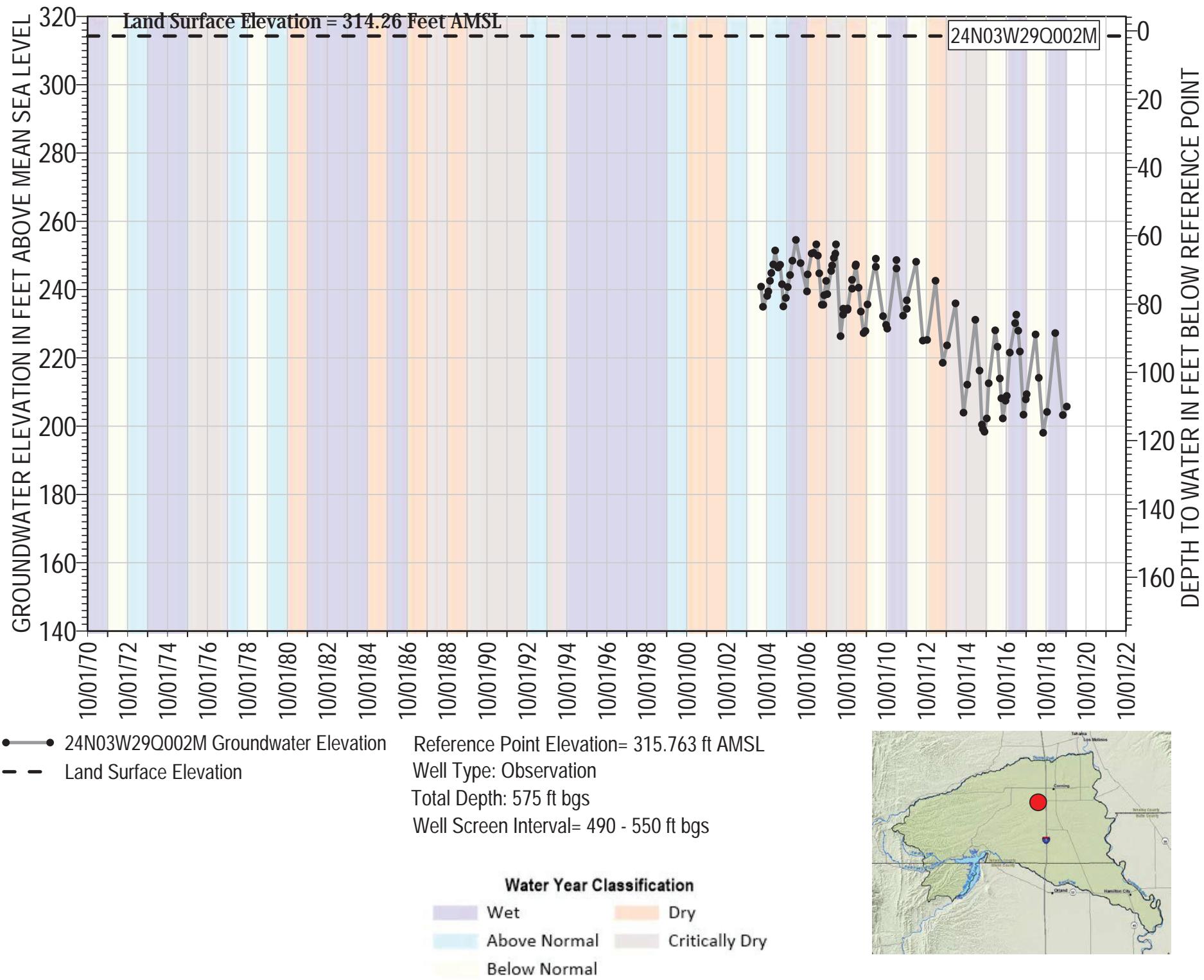


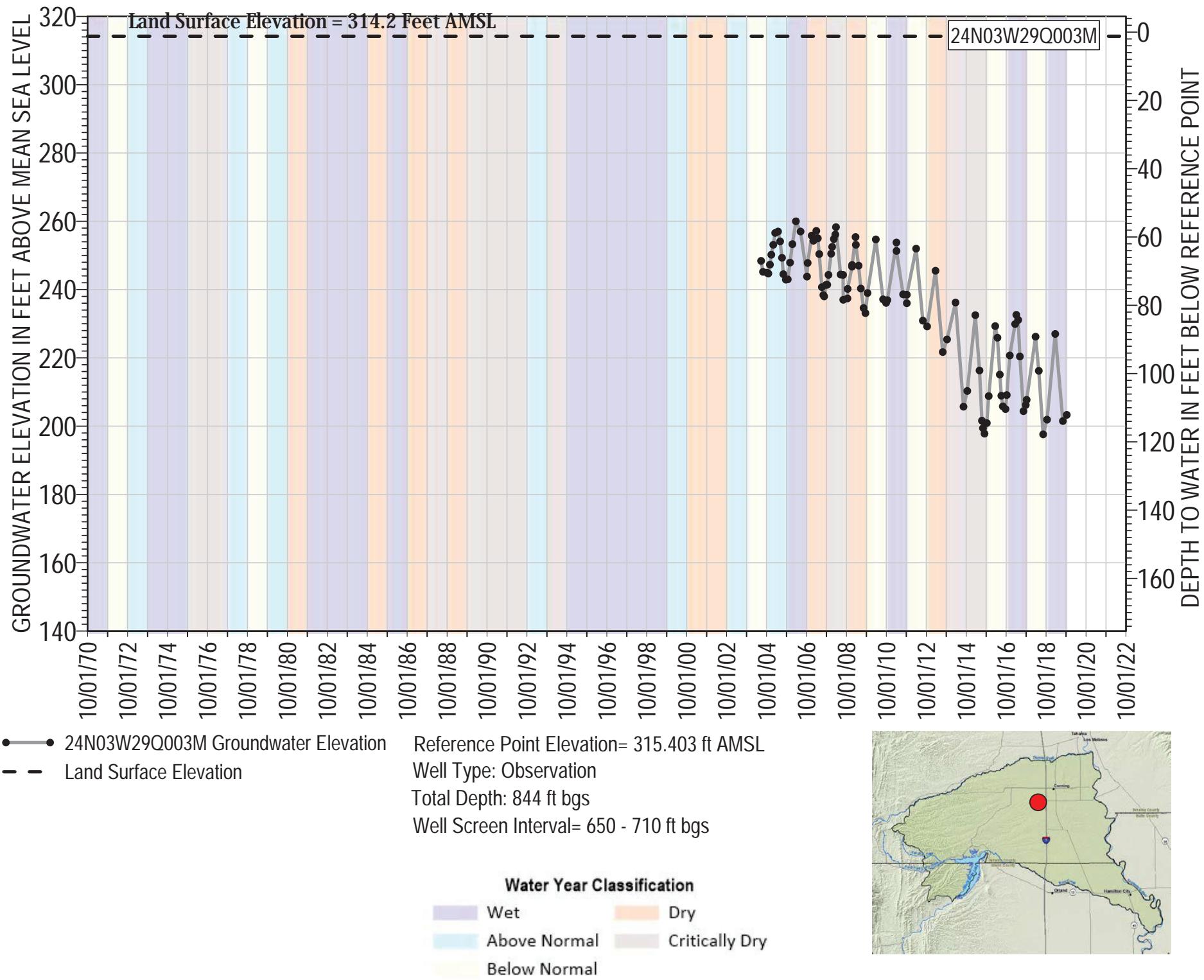


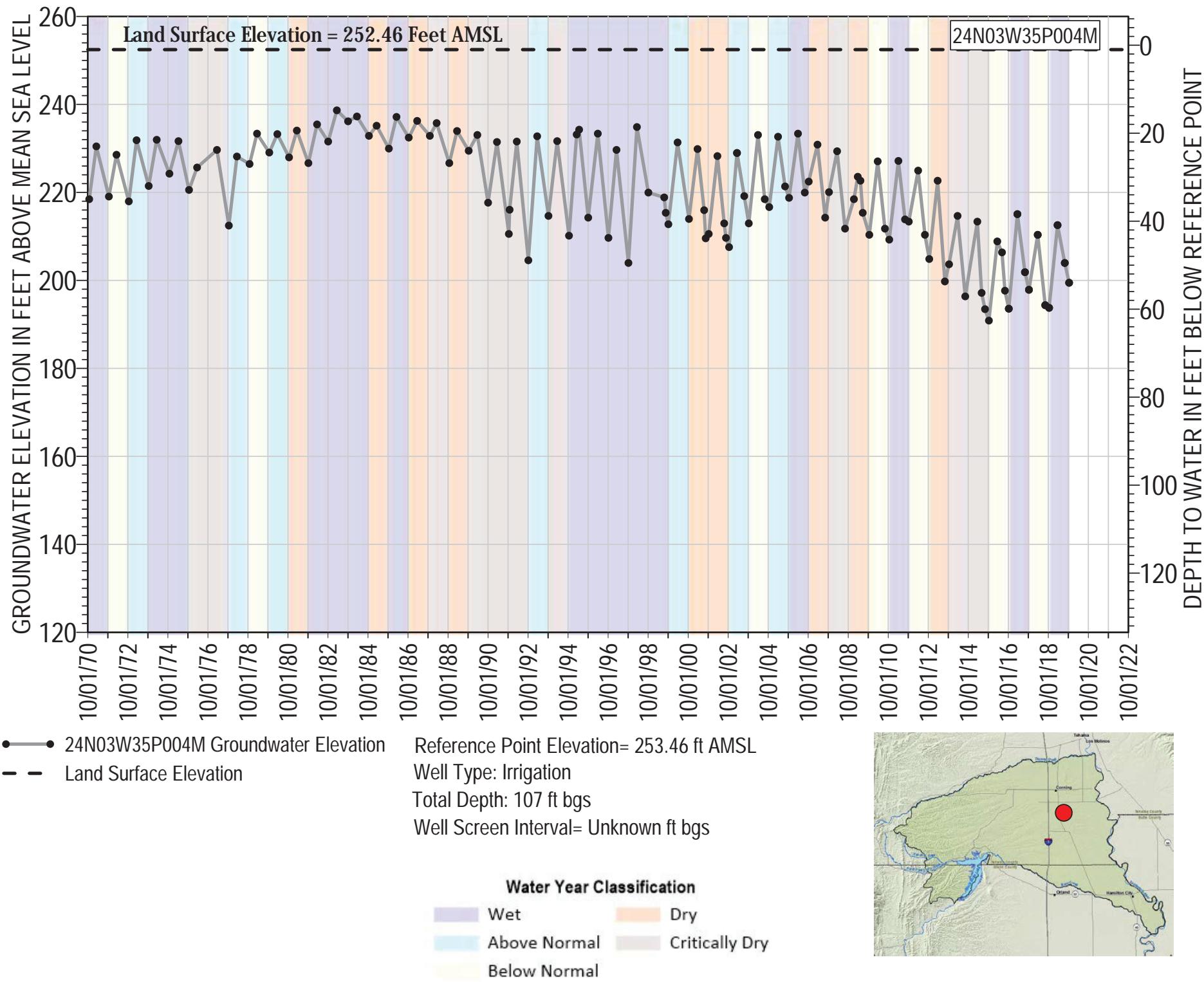


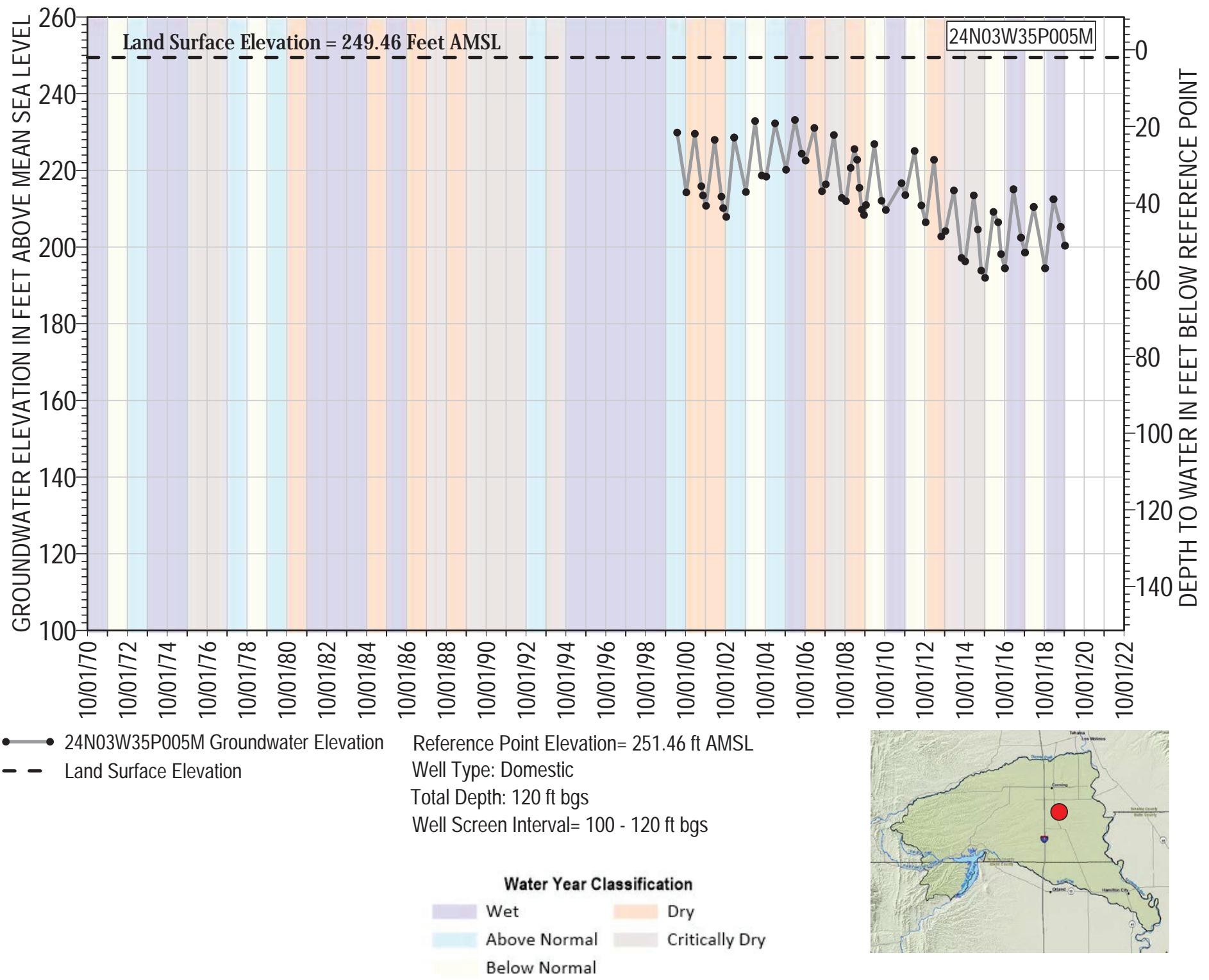


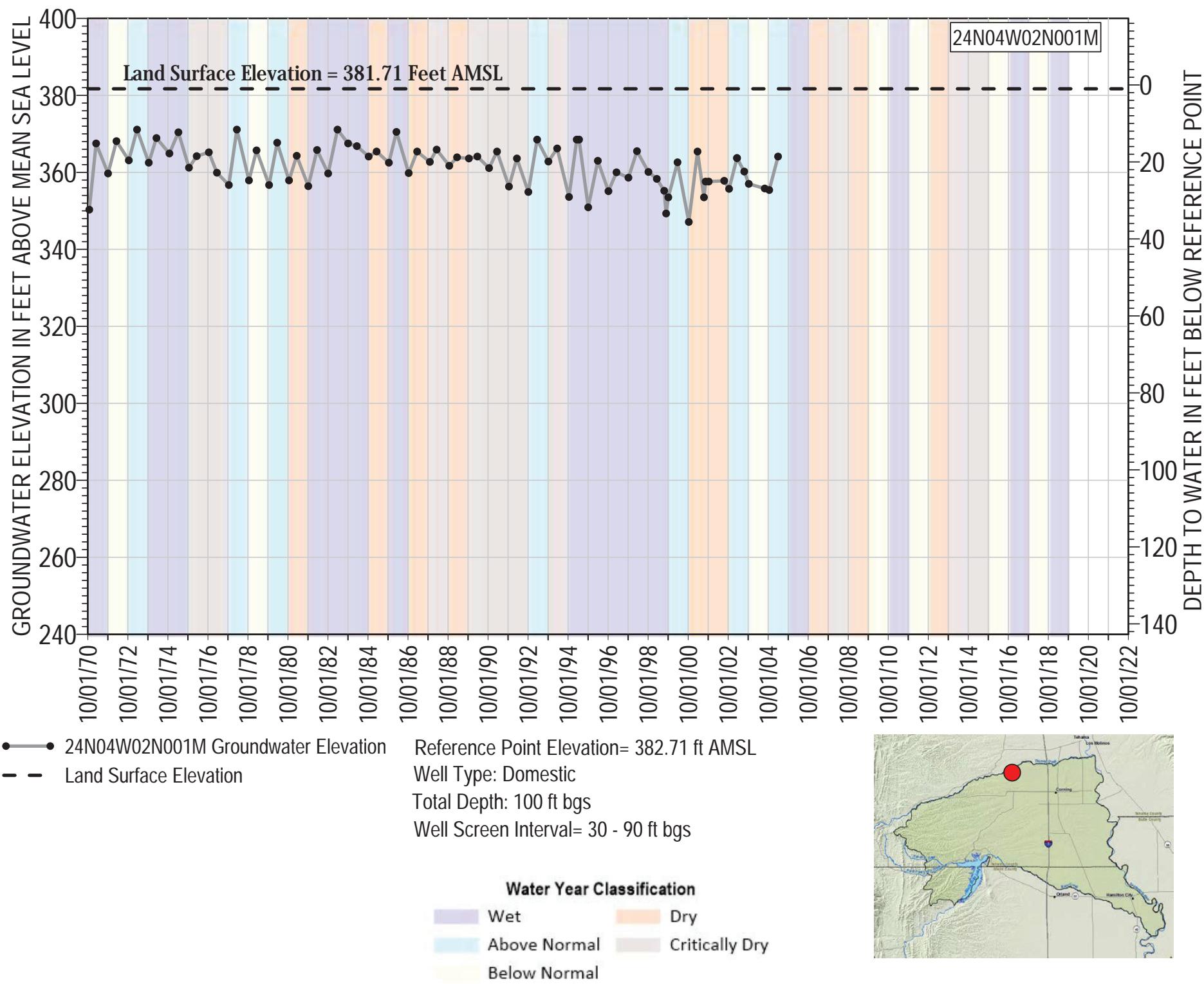


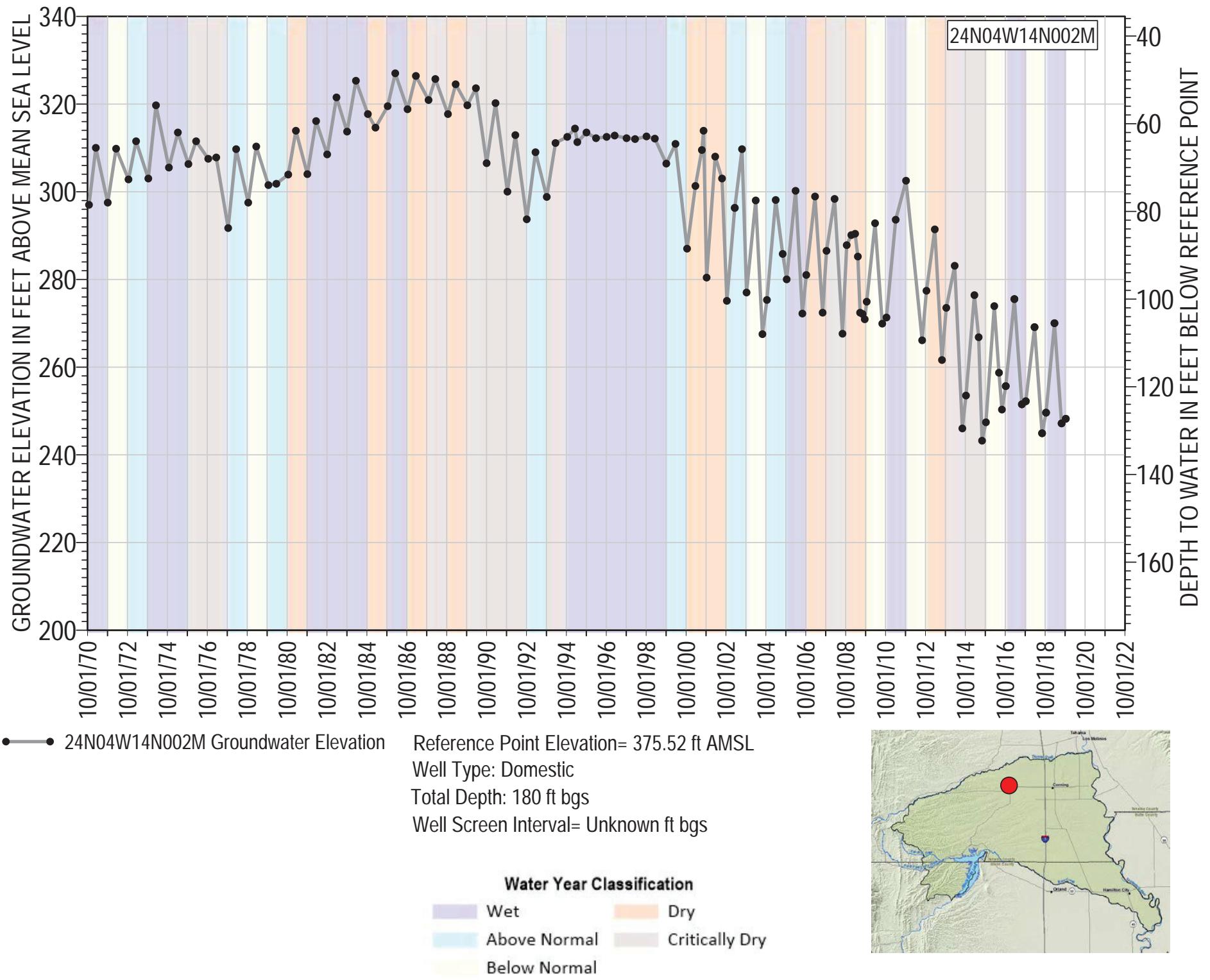


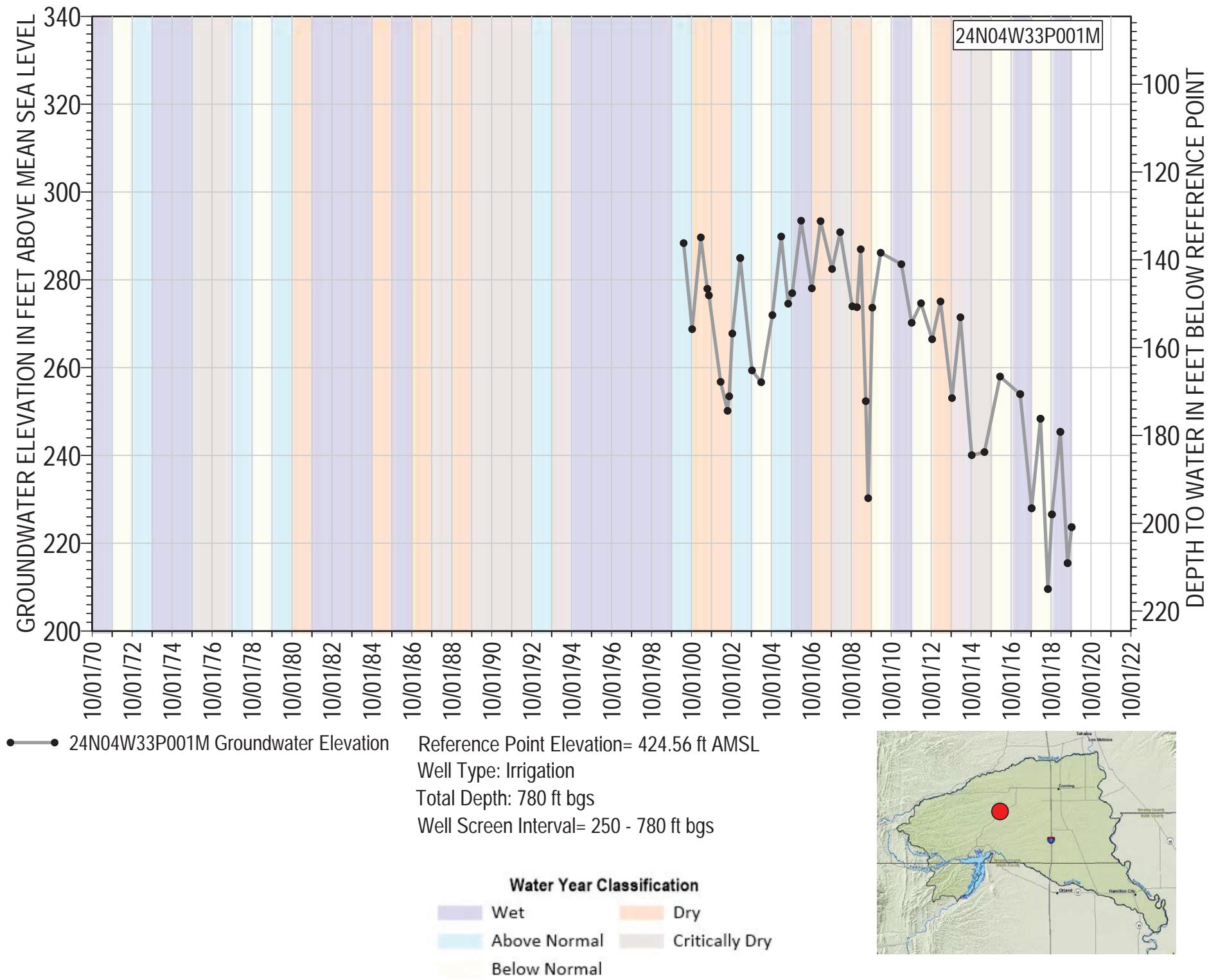


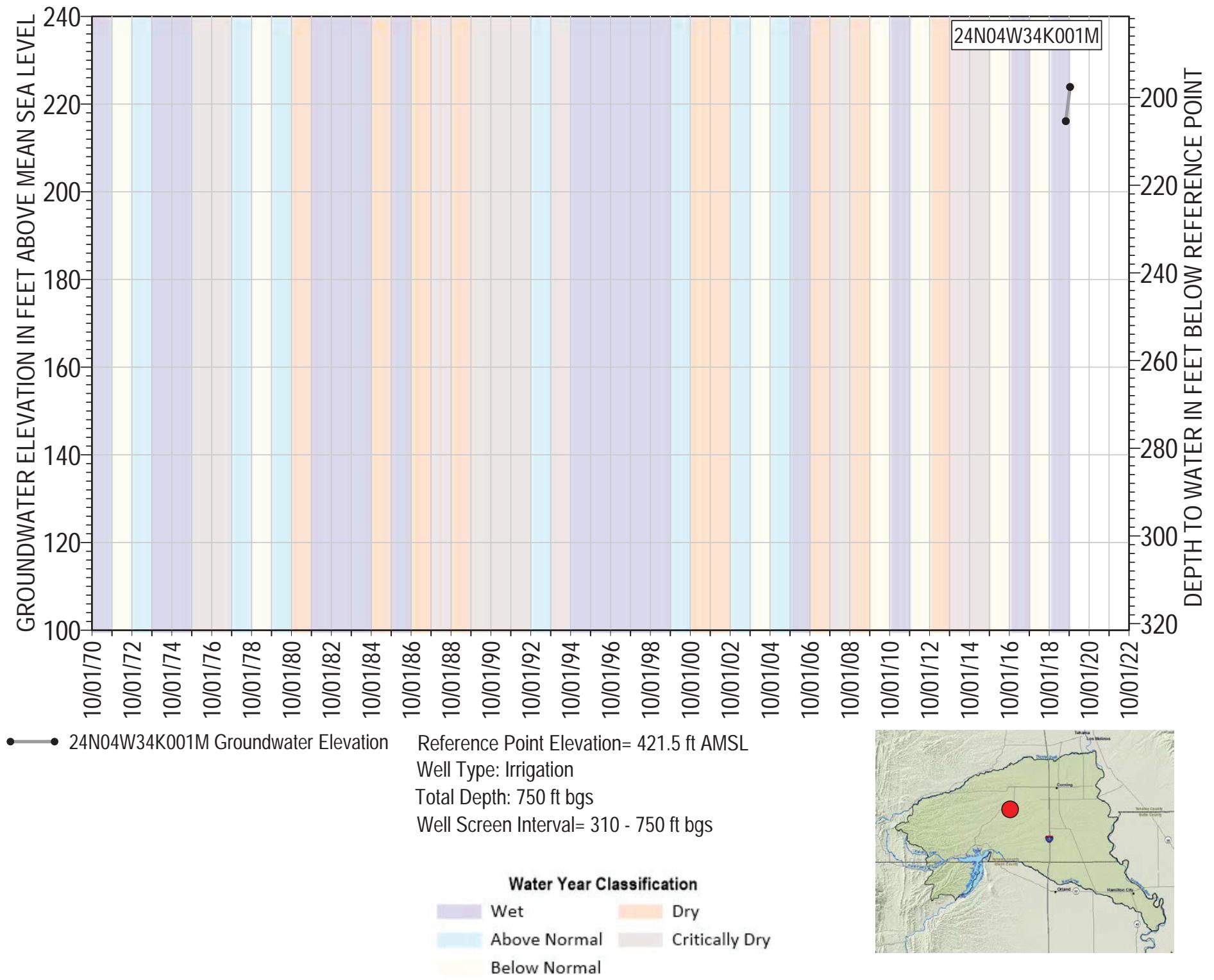


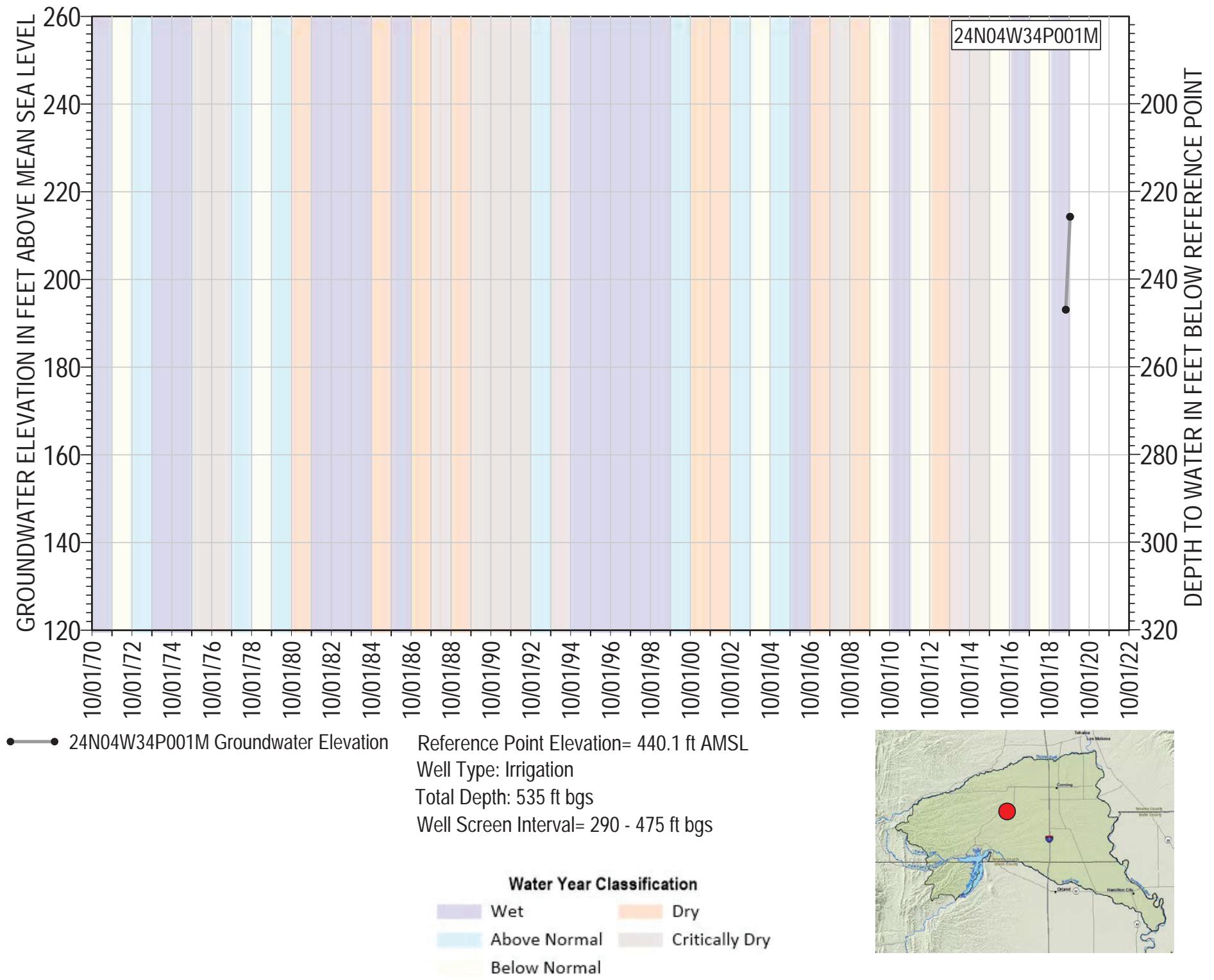


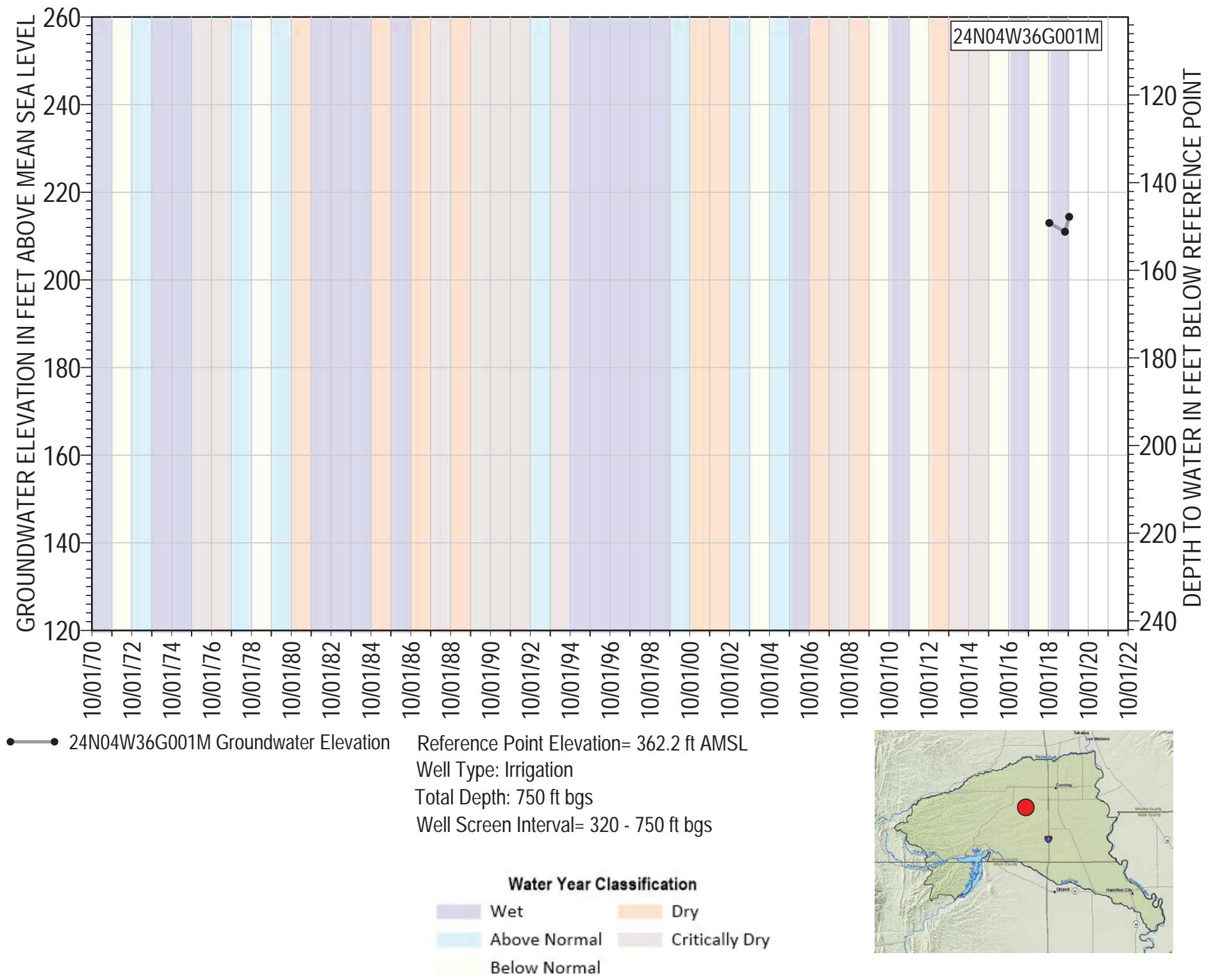


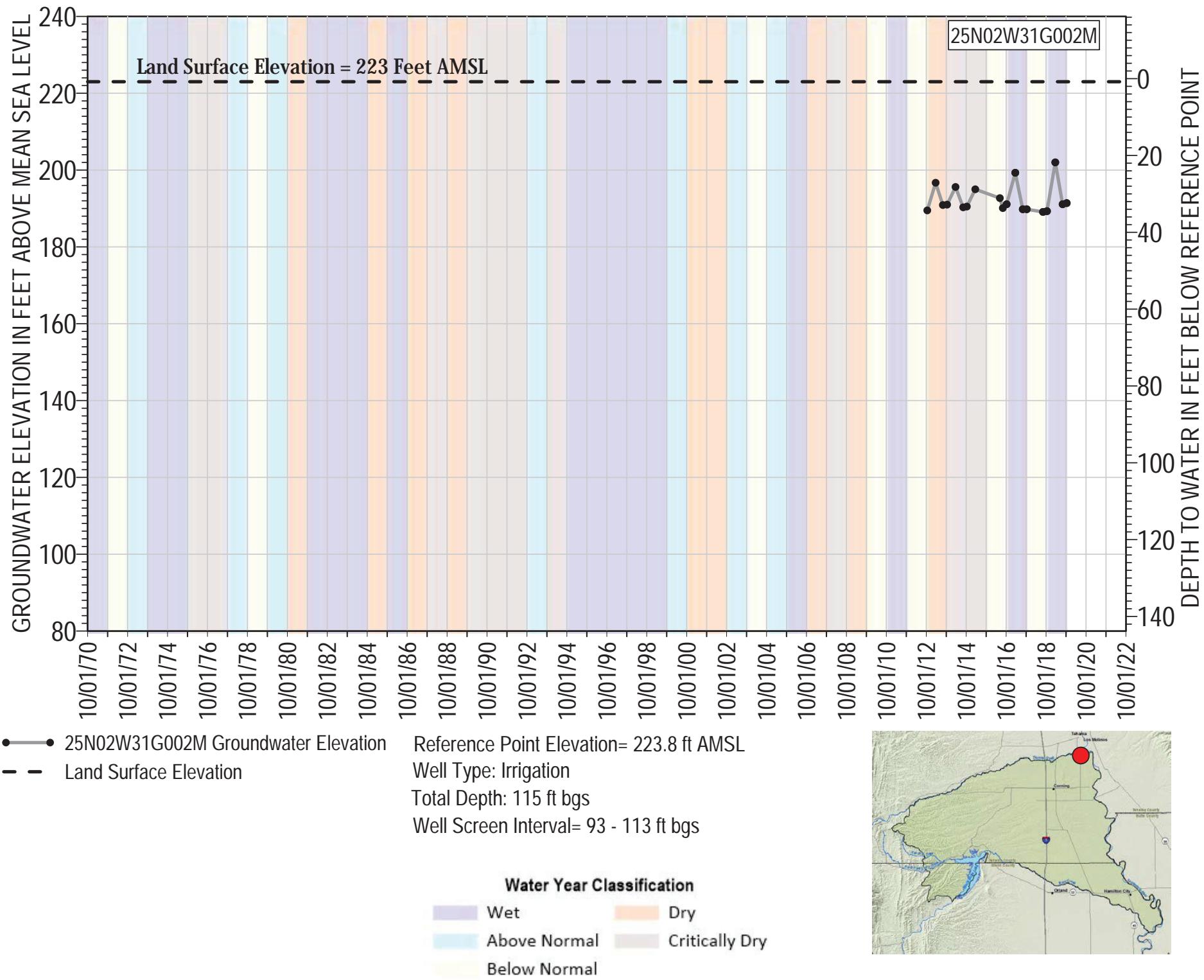


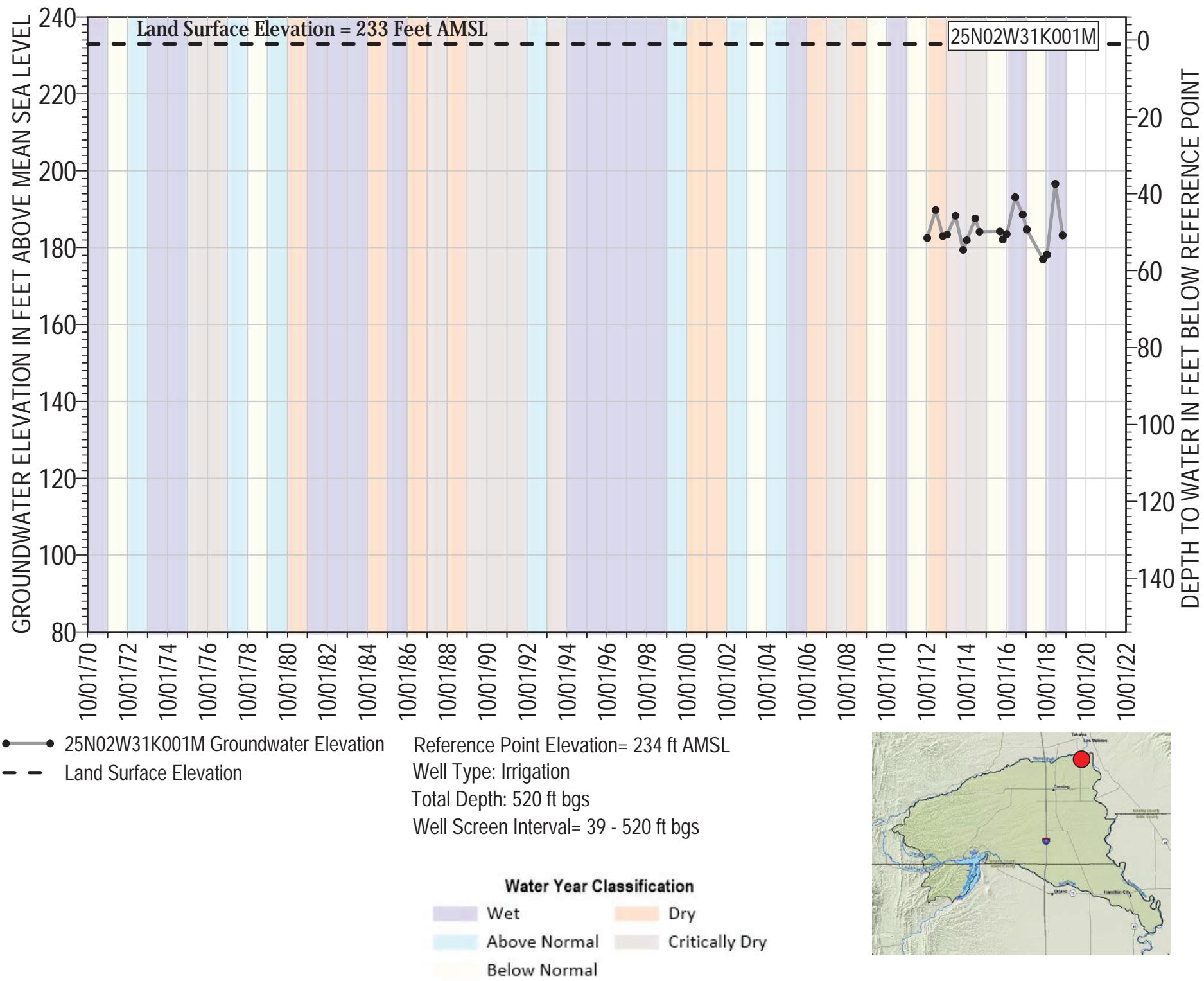


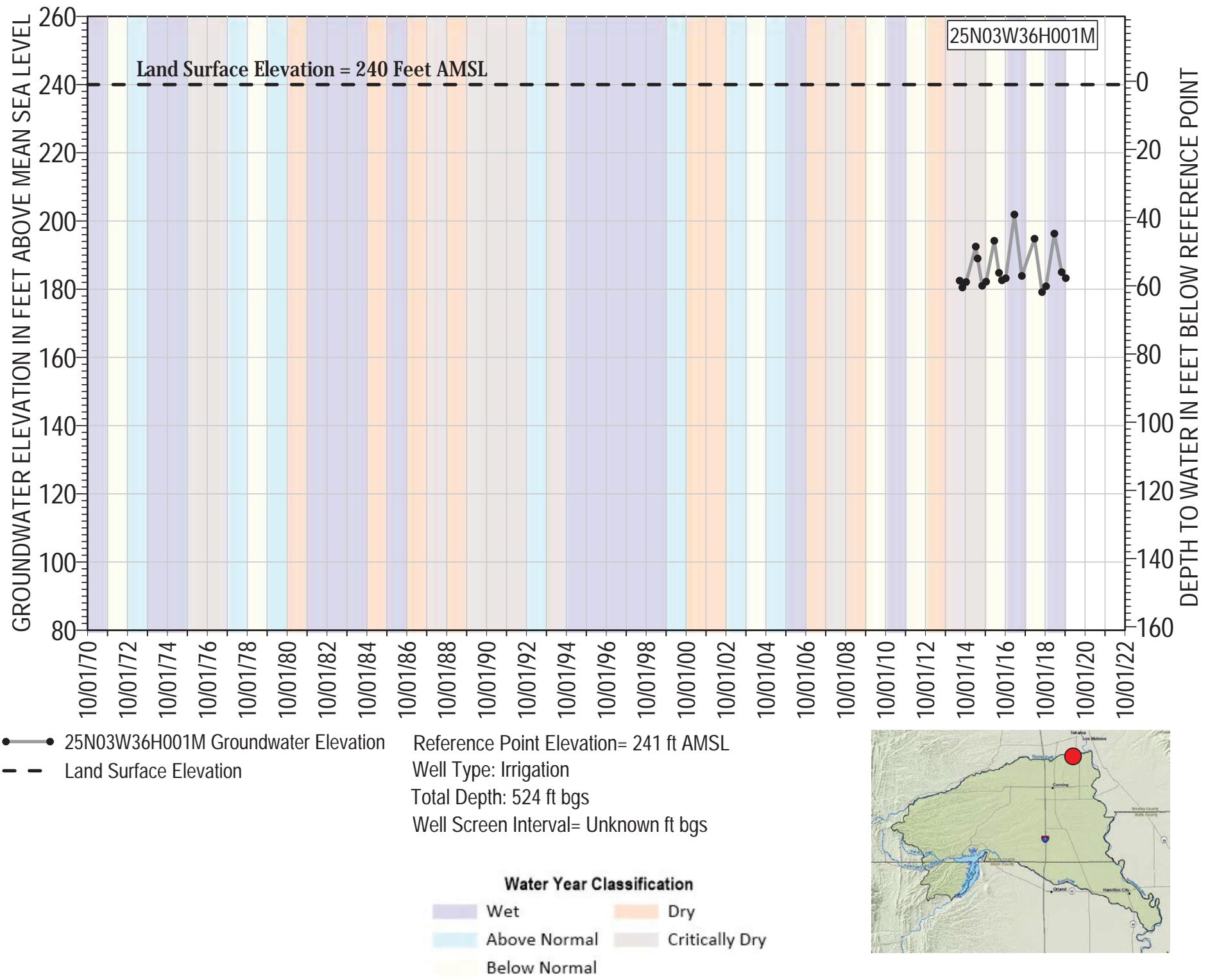












Appendix 3D

Freshwater Species Located in the Corning Subbasin

This list was provided by the NGO Consortium in their Draft GSP comment letter from October 25, 2021.

Attachment C

Freshwater Species Located in the Corning Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result “depletion of interconnected surface waters”, Attachment C provides a list of freshwater species located in the Corning Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the basin boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015¹. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife’s BIOS² as well as on The Nature Conservancy’s science website³.

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
<i>Agelaius tricolor</i>	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
<i>Coccyzus americanus occidentalis</i>	Western Yellow-billed Cuckoo	Candidate - Threatened	Endangered	
<i>Riparia riparia</i>	Bank Swallow		Threatened	
<i>Actitis macularius</i>	Spotted Sandpiper			
<i>Aechmophorus clarkii</i>	Clark's Grebe			
<i>Aechmophorus occidentalis</i>	Western Grebe			
<i>Aix sponsa</i>	Wood Duck			
<i>Anas acuta</i>	Northern Pintail			
<i>Anas americana</i>	American Wigeon			
<i>Anas clypeata</i>	Northern Shoveler			
<i>Anas crecca</i>	Green-winged Teal			
<i>Anas cyanoptera</i>	Cinnamon Teal			
<i>Anas platyrhynchos</i>	Mallard			
<i>Anas strepera</i>	Gadwall			
<i>Anser albifrons</i>	Greater White-fronted Goose			
<i>Ardea alba</i>	Great Egret			
<i>Ardea herodias</i>	Great Blue Heron			
<i>Aythya affinis</i>	Lesser Scaup			
<i>Aythya collaris</i>	Ring-necked Duck			
<i>Aythya marila</i>	Greater Scaup			
<i>Aythya valisineria</i>	Canvasback		Special	

¹ Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoS ONE, 11(7). Available at: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710>

² California Department of Fish and Wildlife BIOS: <https://www.wildlife.ca.gov/data/BIOS>

³ Science for Conservation: <https://www.scienceforconservation.org/products/california-freshwater-species-database>

<i>Botaurus lentiginosus</i>	American Bittern			
<i>Bucephala albeola</i>	Bufflehead			
<i>Bucephala clangula</i>	Common Goldeneye			
<i>Butorides virescens</i>	Green Heron			
<i>Calidris alpina</i>	Dunlin			
<i>Calidris mauri</i>	Western Sandpiper			
<i>Calidris minutilla</i>	Least Sandpiper			
<i>Chen caerulescens</i>	Snow Goose			
<i>Chen rossii</i>	Ross's Goose			
<i>Chlidonias niger</i>	Black Tern		Special Concern	BSSC - Second priority
<i>Chroicocephalus philadelphia</i>	Bonaparte's Gull			
<i>Cistothorus palustris palustris</i>	Marsh Wren			
<i>Cygnus columbianus</i>	Tundra Swan			
<i>Egretta thula</i>	Snowy Egret			
<i>Empidonax traillii</i>	Willow Flycatcher	Bird of Conservation Concern	Endangered	
<i>Fulica americana</i>	American Coot			
<i>Gallinago delicata</i>	Wilson's Snipe			
<i>Geothlypis trichas trichas</i>	Common Yellowthroat			
<i>Grus canadensis</i>	Sandhill Crane			
<i>Haliaeetus leucocephalus</i>	Bald Eagle	Bird of Conservation Concern	Endangered	
<i>Himantopus mexicanus</i>	Black-necked Stilt			
<i>Icteria virens</i>	Yellow-breasted Chat		Special Concern	BSSC - Third priority
<i>Limnodromus scolopaceus</i>	Long-billed Dowitcher			
<i>Lophodytes cucullatus</i>	Hooded Merganser			
<i>Megaceryle alcyon</i>	Belted Kingfisher			
<i>Mergus merganser</i>	Common Merganser			
<i>Mergus serrator</i>	Red-breasted Merganser			
<i>Numenius americanus</i>	Long-billed Curlew			
<i>Numenius phaeopus</i>	Whimbrel			
<i>Nycticorax nycticorax</i>	Black-crowned Night-Heron			
<i>Oxyura jamaicensis</i>	Ruddy Duck			
<i>Pandion haliaetus</i>	Osprey		Watch list	
<i>Pelecanus erythrorhynchos</i>	American White Pelican		Special Concern	BSSC - First priority
<i>Phalacrocorax auritus</i>	Double-crested Cormorant			

<i>Phalaropus tricolor</i>	Wilson's Phalarope			
<i>Plegadis chihi</i>	White-faced Ibis		Watch list	
<i>Pluvialis squatarola</i>	Black-bellied Plover			
<i>Podiceps nigricollis</i>	Eared Grebe			
<i>Podilymbus podiceps</i>	Pied-billed Grebe			
<i>Porzana carolina</i>	Sora			
<i>Recurvirostra americana</i>	American Avocet			
<i>Setophaga petechia</i>	Yellow Warbler			BSSC - Second priority
<i>Tachycineta bicolor</i>	Tree Swallow			
<i>Tringa melanoleuca</i>	Greater Yellowlegs			
<i>Xanthocephalus xanthocephalus</i>	Yellow-headed Blackbird		Special Concern	BSSC - Third priority
CRUSTACEANS				
<i>Branchinecta lynchi</i>	Vernal Pool Fairy Shrimp	Threatened	Special	IUCN - Vulnerable
<i>Lepidurus packardi</i>	Vernal Pool Tadpole Shrimp	Endangered	Special	IUCN - Endangered
<i>Linderiella occidentalis</i>	California Fairy Shrimp		Special	IUCN - Near Threatened
FISH				
<i>Oncorhynchus mykiss irideus</i>	Coastal rainbow trout			Least Concern - Moyle 2013
<i>Acipenser medirostris</i> ssp. 1	Southern green sturgeon	Threatened	Special Concern	Endangered - Moyle 2013
<i>Oncorhynchus mykiss</i> - CV	Central Valley steelhead	Threatened	Special	Vulnerable - Moyle 2013
<i>Oncorhynchus tshawytscha</i> - CV spring	Central Valley spring Chinook salmon	Threatened	Threatened	Vulnerable - Moyle 2013
<i>Oncorhynchus tshawytscha</i> - CV winter	Central Valley winter Chinook salmon	Endangered	Endangered	Vulnerable - Moyle 2013
HERPS				
<i>Actinemys marmorata marmorata</i>	Western Pond Turtle		Special Concern	ARSSC
<i>Anaxyrus boreas boreas</i>	Boreal Toad			
<i>Rana boylii</i>	Foothill Yellow-legged Frog	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
<i>Rana draytonii</i>	California Red-legged Frog	Threatened	Special Concern	ARSSC
<i>Spea hammondii</i>	Western Spadefoot	Under Review in the Candidate or	Special Concern	ARSSC

		Petition Process		
<i>Thamnophis gigas</i>	Giant Gartersnake	Threatened	Threatened	
<i>Thamnophis sirtalis sirtalis</i>	Common Gartersnake			
<i>Pseudacris regilla</i>	Northern Pacific Chorus Frog			
INSECTS & OTHER INVERTS				
<i>Anax junius</i>	Common Green Darner			
<i>Argia emma</i>	Emma's Dancer			
<i>Argia lugens</i>	Sooty Dancer			
<i>Sympetrum corruptum</i>	Variegated Meadowhawk			
<i>Tramea lacerata</i>	Black Saddlebags			
MAMMALS				
<i>Castor canadensis</i>	American Beaver			Not on any status lists
<i>Lontra canadensis canadensis</i>	North American River Otter			Not on any status lists
<i>Neovison vison</i>	American Mink			Not on any status lists
<i>Ondatra zibethicus</i>	Common Muskrat			Not on any status lists
MOLLUSKS				
<i>Anodonta californiensis</i>	California Floater		Special	
<i>Gonidea angulata</i>	Western Ridged Mussel		Special	
<i>Margaritifera falcata</i>	Western Pearlshell		Special	
PLANTS				
<i>Downingia pusilla</i>	Dwarf Downingia		Special	CRPR - 2B.2
<i>Alisma triviale</i>	Northern Water-plantain			
<i>Alopecurus saccatus</i>	Pacific Foxtail			
<i>Ammannia robusta</i>	Grand Redstem			
<i>Arundo donax</i>	NA			
<i>Azolla filiculoides</i>	NA			
<i>Baccharis salicina</i>				Not on any status lists
<i>Bergia texana</i>	Texas Bergia			
<i>Callitricha heterophylla bolanderi</i>	Large Water-starwort			
<i>Callitricha heterophylla heterophylla</i>	Northern Water-starwort			
<i>Callitricha marginata</i>	Winged Water-starwort			
<i>Carex densa</i>	Dense Sedge			
<i>Carex vulpinoidea</i>	NA			
<i>Cicendia quadrangularis</i>	Oregon Microcalia			
<i>Crassula aquatica</i>	Water Pygmyweed			
<i>Crypsis vaginiflora</i>	NA			

<i>Cyperus erythrorhizos</i>	Red-root Flatsedge			
<i>Cyperus squarrosus</i>	Awned Cyperus			
<i>Downingia bella</i>	Hoover's Downingia			
<i>Downingia cuspidata</i>	Toothed Calicoflower			
<i>Echinodorus berteroii</i>	Upright Burhead			
<i>Eleocharis acicularis acicularis</i>	Least Spikerush			
<i>Eleocharis macrostachya</i>	Creeping Spikerush			
<i>Eleocharis radicans</i>	Rooted Spikerush			
<i>Epilobium cleistogamum</i>	Cleistogamous Spike-primrose			
<i>Eragrostis hypnoides</i>	Teal Lovegrass			
<i>Eryngium vaseyi vaseyi</i>	Vasey's Coyote-thistle			Not on any status lists
<i>Gratiola ebracteata</i>	Bractless Hedge-hyssop			
<i>Gratiola heterosepala</i>	Boggs Lake Hedge-hyssop		Endangered	CRPR - 1B.2
<i>Hypericum anagalloides</i>	Tinker's-penny			
<i>Isoetes howellii</i>	NA			
<i>Juncus acuminatus</i>	Sharp-fruit Rush			
<i>Juncus uncialis</i>	Inch-high Rush			
<i>Lasthenia fremontii</i>	Fremont's Goldfields			
<i>Legenere limosa</i>	False Venus'-looking-glass		Special	CRPR - 1B.1
<i>Lemna minor</i>	Lesser Duckweed			
<i>Ludwigia peploides peploides</i>	NA			Not on any status lists
<i>Marsilea vestita vestita</i>	NA			Not on any status lists
<i>Mimulus pilosus</i>				Not on any status lists
<i>Myosurus minimus</i>	NA			
<i>Myosurus sessilis</i>	Sessile Mousetail			
<i>Navarretia heterandra</i>	Tehama Navarretia			
<i>Navarretia leucocephala leucocephala</i>	White-flower Navarretia			
<i>Navarretia leucocephala minima</i>	Least Navarretia			
<i>Persicaria amphibia</i>				Not on any status lists
<i>Phyla lanceolata</i>	Fog-fruit			
<i>Phyla nodiflora</i>	Common Frog-fruit			
<i>Pilularia americana</i>	NA			
<i>Plagiobothrys austinae</i>	Austin's Popcorn-flower			
<i>Plagiobothrys greenei</i>	Greene's Popcorn-flower			

<i>Plagiobothrys leptocladus</i>	Alkali Popcorn-flower			
<i>Pleuropogon californicus californicus</i>				Not on any status lists
<i>Pogogyne douglasii</i>	NA			
<i>Pogogyne zizyphoroides</i>				Not on any status lists
<i>Potamogeton nodosus</i>	Longleaf Pondweed			
<i>Psilocarphus brevissimus brevissimus</i>	Dwarf Woolly-heads			
<i>Psilocarphus oregonus</i>	Oregon Woolly-heads			
<i>Rorippa curvisiliqua curvisiliqua</i>	Curve-pod Yellowcress			
<i>Sagittaria latifolia latifolia</i>	Broadleaf Arrowhead			
<i>Sagittaria longiloba</i>	Longbarb Arrowhead			
<i>Salix exigua exigua</i>	Narrowleaf Willow			
<i>Salix gooddingii</i>	Goodding's Willow			
<i>Salix laevigata</i>	Polished Willow			
<i>Salix lasiolepis lasiolepis</i>	Arroyo Willow			
<i>Salix melanopsis</i>	Dusky Willow			
<i>Schoenoplectus acutus occidentalis</i>	Hardstem Bulrush			
<i>Sidalcea hirsuta</i>	Hairy Checker-mallow			
<i>Stachys stricta</i>	Sonoma Hedge-nettle			
<i>Typha latifolia</i>	Broadleaf Cattail			
<i>Zannichellia palustris</i>	Horned Pondweed			