Albuquerque Bernalillo County
Water Utility Authority

Memo

To: Tom Berardinelli, Director of Staff, 377th Air Base Wing KAFB (via email)

From: Rick Shean, Water Quality Hydrologist, ABCWUA

CC: Mark Sanchez, Executive Director, ABCWUA; John Stomp, Chief Operating Officer, ABCWUA; James Bearzi, Hazardous Waste Bureau Chief, NMED; Will Moats, Project Manager, NMED-HWB

Date: 2/11/2011

Re: Review of *LNAPL Interim Measure Containment Work Plan for the Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111,* by Kirtland Air Force Base, dated November, 2010

Executive Summary

The Albuquerque Bernalillo County Water Utility Authority (Water Authority) has reviewed the *LNAPL Interim Measure Containment Work Plan for the Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-11* and has the following concerns: the design of the interim containment system should use a more appropriate screen thickness (see section I); the location of the injection wells can create additional contamination to the aquifer (see section II) a phased or iterative approach for the design of the interim containment system should be implemented (see section III); more allocation of funding should be spent on the vadose zone investigation (see section III); the LNAPL / dissolved phase lens will not be sufficiently characterized as proposed (see section IV); the plan to characterize aquifer properties is insufficient (see section V); and alternatives to putting investigation derived waste into Water Authority sewer facilities will need to determined (see section VI).

As we are the basin's water rights holder with water resources most affected by the KAFB Bulk Fuels Facility spill, and the biggest indirect "customer" of Shaw's environmental services being provided by the KAFB, we feel it is important to provide input into the process and planning of this environmental restoration project. The Water Authority has retained INTERA, Incorporated (INTERA), to assist with our review of the technical work plans and reports that will describe the activities and detail the multiple investigations results. Below is our combined response to your submittal.

I. Design and Construction of Interim Containment System

Our reviewers are concerned that the interim containment design work plan is void of a phased or iterative approach and a method for quantifying and incorporating uncertainty in key parameters and driving forces. Previous work focused primarily on the topmost part of the aquifer, especially in the vicinity of the LNAPL lens. Very little is known about the source, flow system, aquifer and transport properties, hydrogeologic framework, and dissolved phase plume extent. Uncertainty about all subsurface parameters is large, so we believe it is ambitious to assume that any proposed containment system will be adequate on an interim basis.

The design of the proposed containment system assumes that the aquifer is of limited thickness, isotropic, and no significant vertical flow. We think that the assumption that aquifer thickness equals 50 ft is improbable and would impede the proposed system from actually containing LNAPL and dissolved phase migration. The design analysis did look at variability in hydraulic conductivity, but appears to have ignored anisotropy and vertical flow, either of which would preclude the designed system from achieving containment.

Our reviewers believe, as do we, that the true aquifer thickness is not 50 ft in the vicinity of the LNAPL lens. Several area production wells have screened intervals that are 500 ft bgs or greater. Since drawdown is inversely proportional to aquifer thickness, the work plan estimate is not sufficiently conservative. INTERA's simulated system shows drawdown to be roughly four ft at the downgradient edge of the LNPAL lens (Figure 1). They used the forward modeling tool in AQTESOLVE (HydroSOLVE, 2009) to simulate drawdown contours from the containment system using the same aquifer parameters and more realistic estimates of aquifer thickness, 100 and 500 ft. INTERA's analysis could not accommodate the regional hydraulic gradient, so the shape of the drawdown contours differs slightly from those in the KAFB work plan. With an aquifer thickness of 100 ft, drawdown was approximately 1.5 ft at the LNAPL edge, whereas the 500 ft thick aquifer yielded drawdown of 0.5 ft at the same location (Figures 2 and 3).

Vertical anisotropy should also be included in the design analysis. Given that the aquifer is a fluvial depositional system, vertical anisotropy is highly likely. Adding anisotropy to the present design analysis will demonstrate the expected trade-offs between increased drawdown horizontally, but decreased vertical drawdown for a system, relative to the same design's performance in an isotropic system.

The analytical element modeling code used for the analysis cannot, by definition, directly simulate vertical flow. We believe that containment system performance may be significantly compromised if vertical gradients are sufficiently large, because vertical flow will act to decrease the effective capture area.

II. Injection Well Location

The proposed location and screened interval of the injection well raises the possibility that injection fluxes could accelerate the movement of dissolved phase contaminants to the downgradient public supply wells. In the absence of any groundwater quality data for the injection interval, assuming there is no contamination creates a risk of further compromising the aquifer. A major concern is that by locating the injection well cross-gradient from the known plume, treated water will be dispersed into a clean cell of the regional aquifer. Contaminated water will be introduced to a location where it currently does not exist. Also, there are no wells proposed down gradient of the injection wells to monitor either the resulting levels of contaminants or resulting injection fluxes. The WUA believes this proposed activity is counter to the purpose of the aquifer restoration effort we all want for our ratepayer’s water resources.

Possible mitigation includes constructing the injection well with the longest screen length feasible or else placing the injection screen much deeper than the bottom of the extraction well screens. Mr. James Bearzi, Bureau Chief of the NMED’s Hazardous Waste Bureau, however, indicated during the public meeting on January 12, 2011, that NMED will not accept a design unless the injection is upgradient of the extraction wells. The Water Authority supports the NMED’s position on the injection well location.

III. Characterization of Ambient Flow System

Our reviewers noted that identified data gaps do not include the ambient three-dimensional flow field, especially the relative importance of horizontal to vertical seepage velocities and how they change with vertical and horizontal distance from the LNAPL lens. The work plan does mention a local hydraulic gradient of 0.004 ft ft^{-1} in the section describing simulation of the containment system, but does not cite a source for this value. The work plan does not address regional and local groundwater flow field, either as a data gap or as being reasonably well-characterized.

Pumping to achieve capture of migrating contaminants is strongly dependent on the magnitude of the local and regional flow fields. We would like the work plan to be amended to include characterization of the horizontal and vertical head gradients in the vicinity of the LNAPL lens. This is a critical input to the design of the extraction-injection system, because water from the injection well may end up short-circuiting to the extraction wells through the action of the sub-regional flow field, versus creating a “shield” effect.

In short, we recommend that the interim containment system not be installed until sufficient information is known about the subsurface characteristics and extent of the LNAPL plume has been determined. A phased or iterative approach to designing the interim containment system that acknowledges (and characterizes) the large uncertainties, seeks to reduce the most important uncertainties, and incorporates new information into the design of the next stage of the interim containment.

One step further, we recommend that a greater portion of project funding be spent towards mapping the vadose zone to ensure a more successful remediation effort of the subsurface source area when a full-recovery system is installed.

IV. Characterization of Dissolved Phase Plume Near LNAPL Lens

We found that the work plan does not include any additional wells to determine the extent of the dissolved phase plume near the lens, except below the water table. Some of the 78 new wells proposed in the groundwater investigation work plan may be located within the LNAPL lens, but they should be specified in this work plan as well.

V. Inadequate Characterization of Aquifer Properties

Our reviewers believe that assessment of hydraulic conductivity magnitude and spatial variability from slug tests performed from wells within only the LNAPL plume, as proposed, is insufficient for accurate aquifer characterization. None of the LNAPL plume wells are near the injection well or particularly near the two extraction wells. The response of water to slug insertion or removal can be affected significantly by LNAPL present in the formation, leading to a significant underestimation of the hydraulic conductivity. The work plan appears to assume that LNAPL will be encountered in these six wells, however, no explanation of how lower estimates of hydraulic conductivity will be corrected is provided.

Our reviewers have determined the following is missing from the aquifer characterization discussion:

- What methods will be used if a significant amount of LNAPL is present in the formation?

- How will the slug test data will be analyzed, especially if LNAPL flows into the well during the slug-out test?
- Will a bail down test to estimate LNAPL relative permeability be performed?

We recommend that the aquifer characterization be expanded to include ALL wells that are currently in place.

VI. Investigation Derived Waste Water

The Water Authority understands that NMED is requiring that water created during the drilling, well development, pump and slug testing, sampling activities, and other investigation activities to be containerized, sampled, and if determined to be below Drinking Water MCL's or New Mexico's Water Quality Standards, be disposed of in the Water Authority's "publically-owned treatment works" sewer system. Although the water will be deemed "non-hazardous" through sampling, the Water Authority's NPDES application submitted to the U.S. EPA does not allow for water in association with CERCLA or RCRA investigations or remediation activities to be accepted into our sewer facilities. <u>Other disposal options will have to be determined</u>.

Recommendations

1. Use a more appropriate aquifer thickness in design simulations for the interim containment system. Explain the how the simulations of a 50-ft-thick aquifer accommodate a 100-ft screened interval for the injection well.

2. Move location of proposed injection well upgradient of the interim containment system, so injected water can be potentially captured by the extraction wells.

3. Implement a phased or iterative approach to designing the interim containment system that acknowledges (and characterizes) the large uncertainties, seeks to reduce the most important uncertainties, and incorporates new information into the design of the next stage of the interim containment.

4. It is the Water Authorities preference that interim containment activities be replaced with more vadose zone investigations to ensure a more responsive source are remediation effort.

5. Construct new wells within the LNAPL lens vicinity to determine vertical gradients, anisotropy, and vertical extent of the dissolved phase plume. Conduct

appropriate testing to determine the magnitude of any anisotropy and variability in hydraulic conductivity and storage properties.

6. Plan to characterize aquifer properties at all existing and all new wells to determine the spatial variability of hydraulic conductivity and identify potential preferential flow pathways. Conduct more aquifer testing by pump tests rather than slug tests. Plan to estimate anisotropy in hydraulic conductivity.

7. Work with the Water Authority to determine an appropriate alternative to disposing of IDW water in sewer facilities.

References

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Lee, S. -I., and Kitanidis, P. K., "Optimal Estimation and Scheduling in Aquifer Remediation with Incomplete Information," in Water Resources Research, 27(9), 2203-2217, 1991.

FIGURES

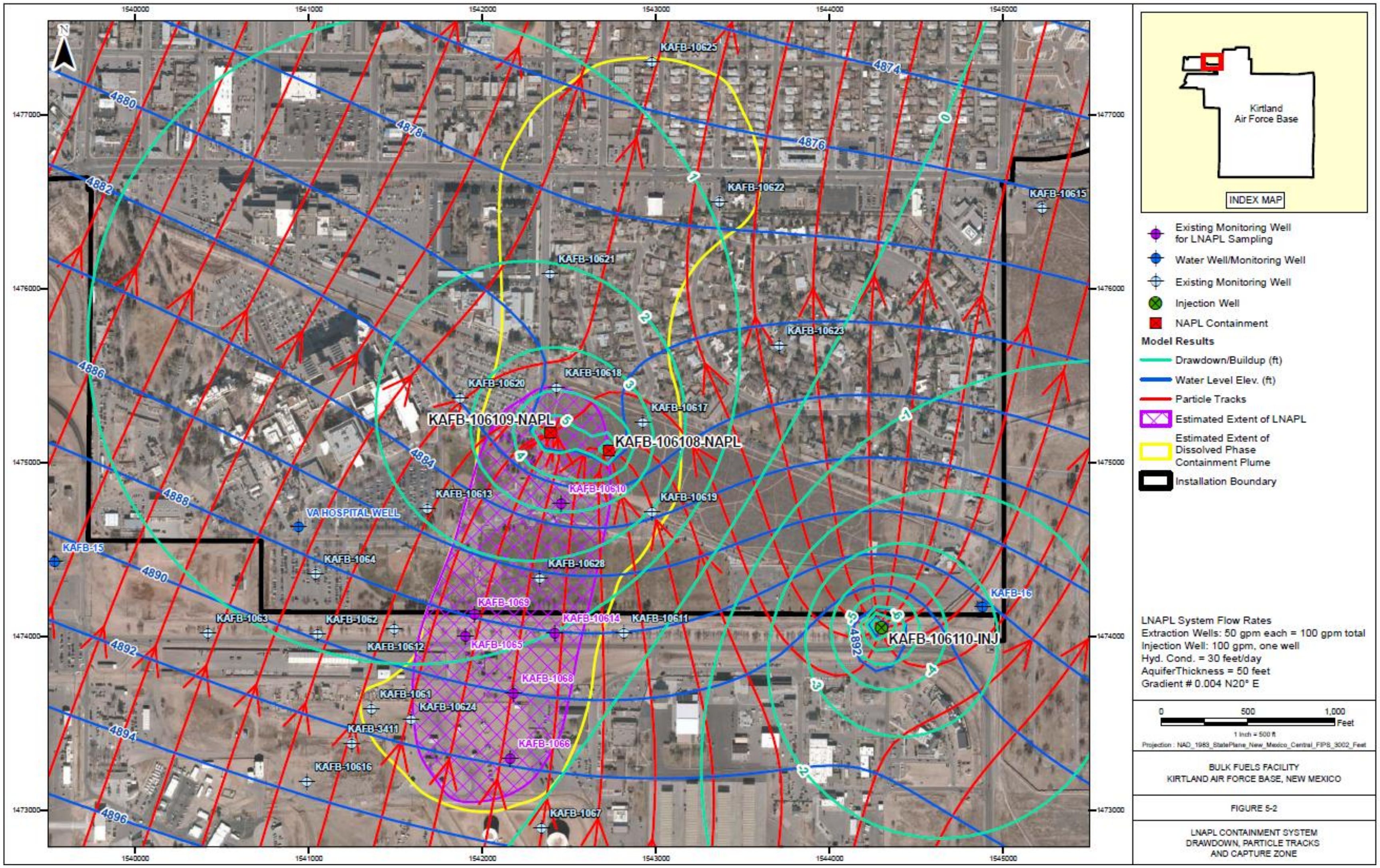

Figure 1. Proposed Containment System (taken from Interim Measure Containment Work Plan, November 2010)

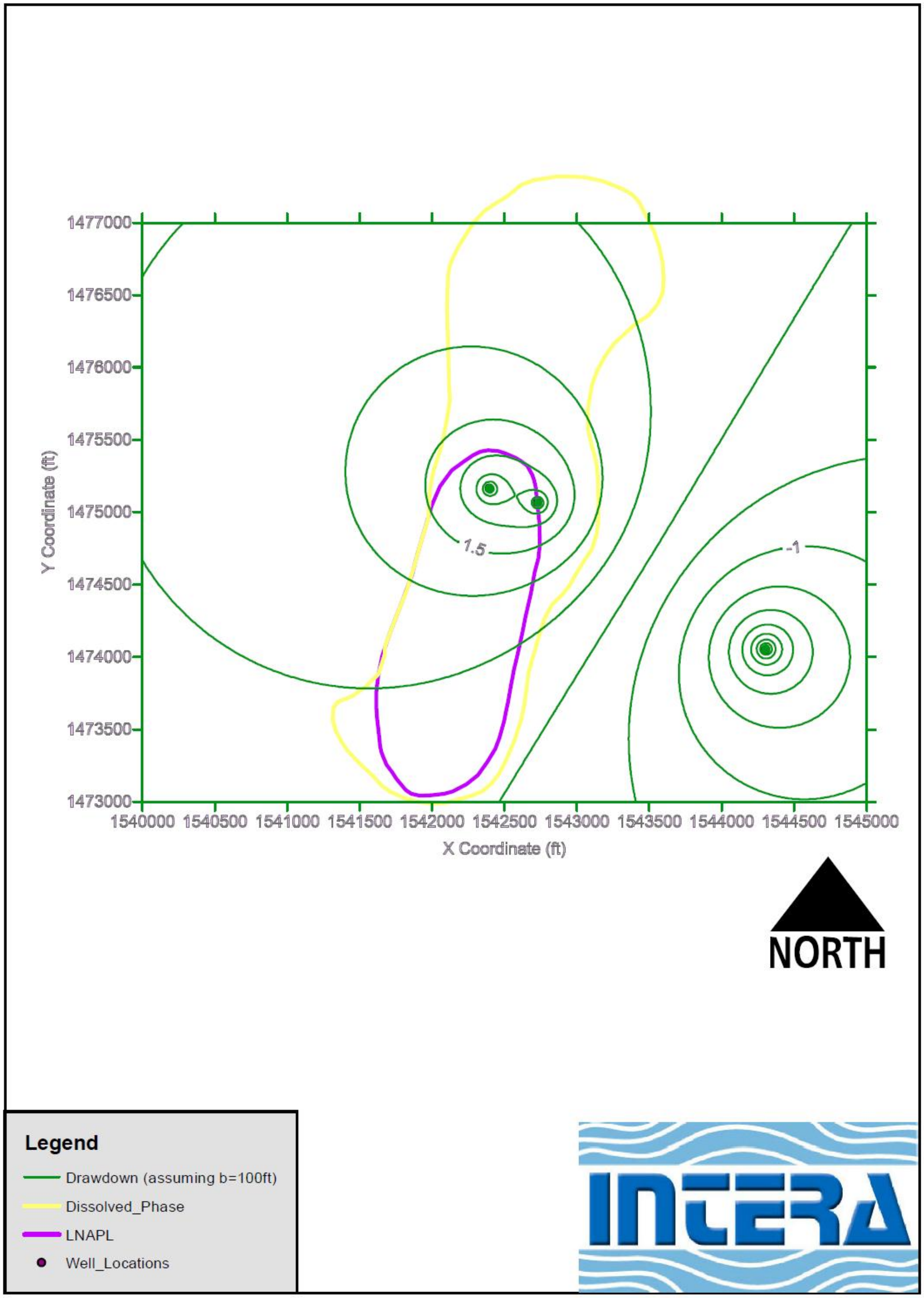

Figure 2. Simulated Drawdown Contours for 100-Foot-Thick Aquifer

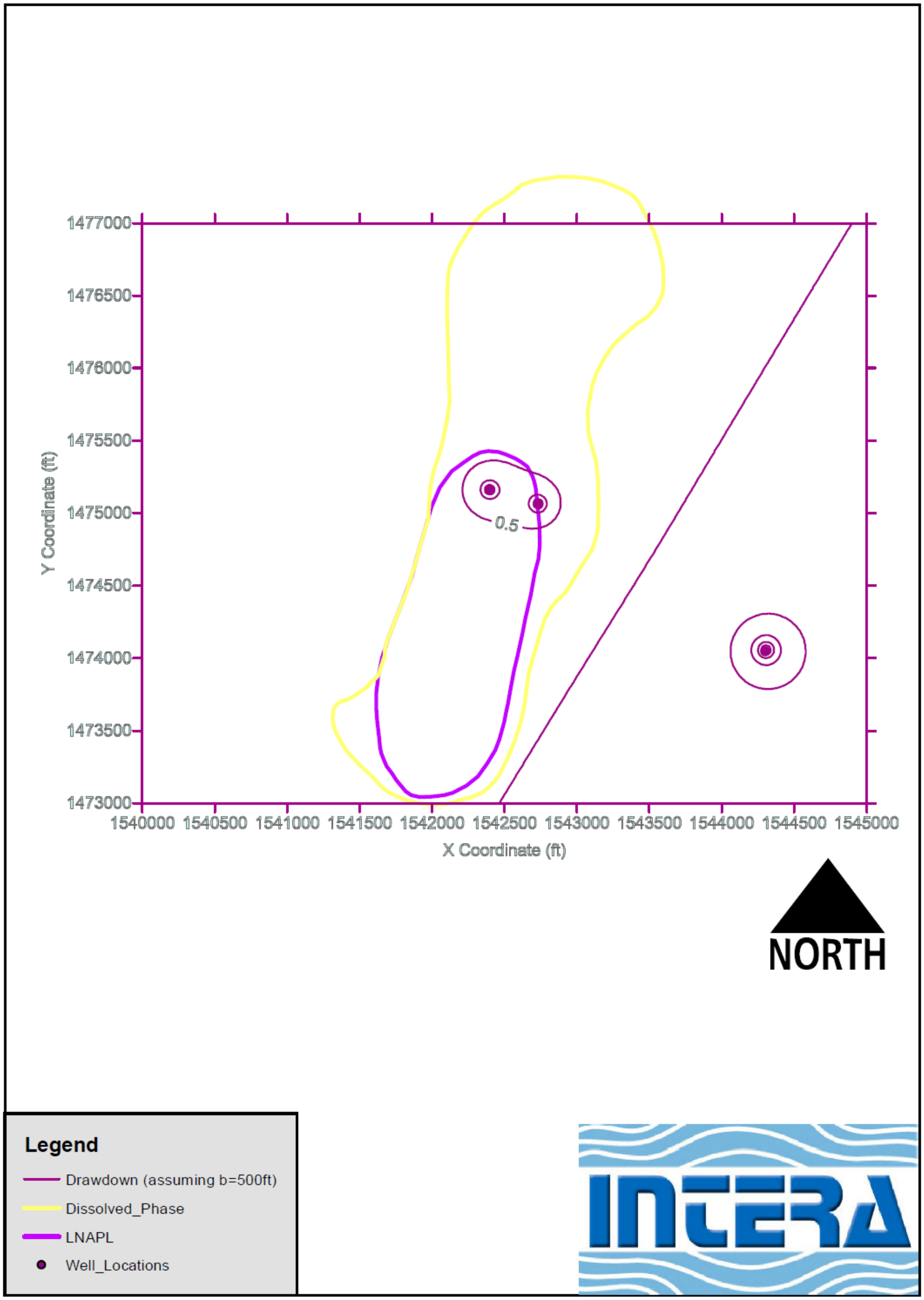

Figure 3. Simulated Drawdown Contours for 500-Foot-Thick Aquifer