WELLHEAD PROTECTION PLAN
WELLS #1, #3 and #4

Village of Deerfield
Wisconsin

June 2010

Prepared by Deerfield Municipal Water Utility
With assistance from
Wisconsin Rural Water Association

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1. BACKGROUND

The Village of Deerfield has prepared this wellhead protection plan for its existing supply wells #1 and #3 and the recently constructed Well #4 for the purpose of reducing the risk of contamination of the municipal water supply. It is planned to abandon Well #1 after Well #4 is placed in service. The water system serves the entire village (population 2,240) plus about five residences outside the village with an average demand of about 150,000 gallons per day (gpd). It is expected that the wells will be operated alternately so that total pumpage will be divided equally. The operational pumping capacities for the wells in gallons per minute are:

Well #1	600 gpm
Well #3	600 gpm
Well #4	600 gpm.

The Village has a ground level storage tank with a capacity of 650,000 gallons. The water is very hard but otherwise of good quality. Treatment consists of chlorination and fluoridation applied at each well.

A wellhead protection area is the area around a well that has been designated for special protective measures intended to minimize the risk of contamination of the well. It is generally the area that contributes groundwater to the well and may be delineated in a number of ways. Wellhead protection areas target specific wells and receive the most concerted protection efforts.

In addition, a larger source water planning area is delineated that contains the wellhead protection areas as well as private wells and locations that might be considered for future municipal wells. It is primarily upgradient of the municipal wells and is intended to receive protective measures that may be less restrictive but are designed to protect the aquifer as well as drinking water sources within the area. At Deerfield the planning area consists of Sections 21, 22, 27 and 28 of the Town of Deerfield (Township 7 North, Range 12 East).

Locations of the wells and the planning area are shown on Figure 1. The lithologic logs and construction details for the wells are included in Appendix A. This plan was prepared in accordance with the Wisconsin Administrative Code, Chapter NR 811, Section 16(5) for wellhead protection planning.

2. HYDROGEOLOGIC SETTING

Deerfield is located in east central Dane County, an area that is characterized by drumlinoid topography with a variable thickness of glacial soils overlying sandstone and dolomite bedrock. Within the village the glacial soil is primarily till, an unsorted mixture of clay, silt, sand, gravel and boulders, which has a relatively low permeability, while east of town the wide, flat valley of Mud Creek is underlain by fine, silty alluvial sand that extends to depths of more than 100 feet.

Bedrock consists of an upper layer of sandstone that is about 100 feet thick, below which is a hundred feet of dolomite and then another sandstone extending to a depth of about a thousand feet. All of the Village wells are cased through the dolomite and draw water from the deeper sandstone, a very productive aquifer. The sandstone contains thin silty horizons that provide confinement of the aquifer, creating artesian conditions, as evidenced by the static water levels in the wells. The clayey glacial till as well as the silty layers in the sandstone afford some protection to the aquifer from contamination, provided that they are not breached by improperly abandoned wells. Vertical relationships of the wells, aquifers and discharge points are illustrated in Figure 2.

3. GROUNDWATER MOVEMENT

The direction of groundwater movement may be inferred from the regional topography and the slope of the water table or potentiometric surface. Shallow groundwater generally moves in the direction toward which the water table slopes. The best available map of groundwater elevations for the area (Krohelski et al, 2000) has a scale too small to show details at Deerfield, but indicates that groundwater in the sandstone moves generally northward toward Koshkonong Creek, into which groundwater discharges (Figure 3). Shallower groundwater moves more directly toward Mud and Koshkonong Creeks. Flow in the dolomite is less predictable because it is controlled by fractures and possibly solution channels. Groundwater captured by the wells is recharged by infiltration of precipitation in an area extending primarily up gradient from each well to groundwater divides that lie west of town.

4. ZONE OF INFLUENCE

It is required that wellhead protection plans include the determination of zones of influence for wells covered by the plan. The zone of influence is the area encompassed within a calculated radius around a well, representing the area of a cone of depression, defined by a drawdown of one foot, that would develop after 30 days of pumping. It is assumed that the well would be pumping at full capacity half of the time. It is also assumed that the aquifer is homogeneous, that the well fully penetrates the aquifer and that drawdown is small compared to the saturated thickness. It simulates theoretical worst-case conditions, in which the cone of depression would reach maximum extent. The zone of influence depends on aquifer permeability and thickness (transmissivity), its storage coefficient and the pumping rate. Transmissivity at each well was determined from the "T-Guess" computer solution from pumping test data. Using the Theis equation, the zone of influence radii for the wells are calculated to be:

Well #1	36,521 ft
Well #3	35.923 ft
Well #4	38,992 ft.

Calculations of the zone of influence and supporting data are included in Appendix B.

5. WELLHEAD PROTECTION AREA

A wellhead protection area is determined from the delineation of a groundwater recharge area around the well. There are different methods of delineating a recharge area, ranging from a simple fixed radius to the use of complex computer models. The computer groundwater flow model, developed by the Wisconsin Geological and Natural History Survey for Dane County was used to determine recharge areas for the municipal wells. In each case an area was defined by a 5-year time-of-travel (TOT) of groundwater to the well. This means that groundwater along the boundary of the area will take five years to reach the well. The 50 and 100-year TOT recharge areas are also delineated to show longer term flow to the wells. Wellhead protection areas include the 5-year recharge area plus a 1,200-foot radius around each well, as required by DNR. These areas can be extended to convenient geographic boundaries for use as overlay districts in a wellhead protection ordinance. The five-year recharge area for each of the wells at Deerfield is contained entirely within the 1,200-foot radius, which therefore is the default wellhead protection area for each well. Wellhead protection areas are shown on Figure 4.

6. POTENTIAL CONTAMINANT SOURCES

In order to design the most appropriate management strategy, it is useful to know the kinds of contaminant sources that are most likely to impact the wells. Potential contaminant sources near the wells were identified in Vulnerability Assessments prepared for the Wisconsin Department of Natural Resources and were supplemented by record review and field reconnaissance conducted for this plan.

The entire village is served by municipal water and sewerage. There are no known private wells in town. All three municipal wells meet construction code standards but are considered susceptible to some types of contamination primarily because of insufficient thickness of clay or shale above the aquifer, proximity to potential sources and past detections at the wells (WDNR, 2003).

Well #1 is in the old downtown commercial area with a long history of use of hazardous materials and chemicals before regulatory safeguards were emplaced. A former leaking underground tank site lies only 100 feet to the southeast and the existing Mobil gas station about a thousand feet to the south on Main Street is the site of formerly leaking tanks. About 600 to 1,000 feet to the north are more leaking underground tank sites, an autobody repair shop and contaminant cleanup sites. The most serious is the former Sta-Rite plant where industrial solvents were used in the manufacture of brine tanks for water softeners. A pump-and-treat cleanup of groundwater is ongoing for solvent contaminants released at the plant. The Village's Well #2 was abandoned because of contamination from this release and Well #1 has had traces of 1,2-dichloroethylene, 1,1,1-trichloroethane and trichloroethylene since the early 1990s. Concentrations of these compounds have been increasing at Well #1 since 2005. This was about the time that the Interpane Glass Company, northeast of Well #1, shut down its well which had been pumping 300,000 gallons per day. Apparently the Interpane Glass well had been diverting the contaminant plume from Well #1. The concentration of trichloroethane is getting uncomfortably close to the drinking water standard of 5 micrograms per liter.

Well #3 is located in the southwest corner of town, adjacent to a cultivated field to the west and close to fields to the southeast. Other than a farm house with septic system 1,300 feet to the southwest, the only other identified potential contaminant sources near the well are sanitary sewers.

Well #4, located along Liberty Street on the west edge of town, is surrounded by fields which are cultivated (north) and recently cultivated (southeast). A new subdivision is being developed to the northeast. A stormwater retention basin lies 600 feet to the east.

Primary concerns include sanitary sewers and use of road salt near each of the wells, agricultural chemical use near Wells #3 and #4, future use of lawn chemicals in new developments near Well #4 and the numerous releases and commercial activities in the old downtown area around Well #1. The locations of potential contaminant sources are shown on Figure 5.

7. MANAGEMENT STRATEGY

There are many measures that can be taken to minimize the risk of contamination of the municipal water supply. The Village has well-abandonment and cross-connection ordinances and has a wellhead protection ordinance which will be updated and amended to include Well #4. That ordinance will be revised to include the required separation distances between community wells and potential contaminant sources specified in NR 811.16. In addition, these separations will be maintained for future structures through the Village's building permit review process. The Village will contact owners of commercial facilities that use materials that could potentially contaminate the municipal wells and work with them to ensure proper handling and storage of those materials. The Village has extraterritorial zoning that extends its authority 1½ miles beyond the village limits. Wellhead protection areas for Wells #3 and #4 extend beyond the village limits.

The Village administers a permit program for private wells within the village and maintains an inventory of those wells. Utility personnel will continue to look for unauthorized wells, and private wells at properties served by municipal water will be evaluated for abandonment requirements. Information concerning the proper handling and application of pesticides and fertilizers will be sent to farmers in the recharge areas and farmland near Well #3 and #4 will be assessed for possible enrollment in the

USDA's Conservation Reserve Program under the wellhead protection provision. The surrounding Town of Deerfield as well as the Dane County Planning Commission will be informed of the wellhead protection plan and asked for cooperation in protection of areas outside the village limits. The Village will request incorporation of essential elements of its wellhead protection plan in Comprehensive Planning ("Smart Growth") for the area and possible locations of future wells will be taken into consideration in land use planning. The Village will promote the periodic "Clean Sweep" operations for the collection of hazardous household wastes conducted by the County. An important additional method of reducing risk will be the program of education and public awareness discussed in Section 8.

A steering committee has been formed to oversee implementation of the elements of this plan. The committee consists of the following individuals:

> Chairman, John Doyle, Director of Public Works, Village of Deerfield,
> Scott Tiebon, Chairman, Public Works Committee,
> Derek Anderson, Water Works Operator, Village of Deerfield,
> Ed Morse, Groundwater Specialist, Wisconsin Rural Water Association.

Additional members and replacements may be accepted by vote of the committee. Local governmental entities that have jurisdiction in the planning area are the Village of Deerfield, the Town of Deerfield and Dane County. These entities will cooperate in implementing this plan, with specific responsibilities including:

> Village of Deerfield- public education and the inclusion of Well #4 in the wellhead protection ordinance,
> Town of Deerfield- consideration of adoption of a wellhead protection ordinance,
> Dane County- consideration of protection of Village wells in any county ordinances and planning activities.

8. PUBLIC EDUCATION

Public awareness and education are an important part of the management strategy for this plan. An article will be placed in the "The Independent" and on the Village's internet site explaining wellhead protection and this plan will be available to the public at the Village Hall and the Deerfield Public Library. Informational materials on the use and disposal of lawn chemicals and common household hazardous materials as well as other wellhead protection issues will be made available to the public at the Village Hall. Utility personnel will discuss wellhead protection during school tours of the utility and classroom presentations. In addition, residents and businesses within the wellhead protection area will be notified and informed of the importance of preventing the release of pollutants within the area and will be provided with informational brochures concerning appropriate wellhead protection topics.

9. WATER CONSERVATION

Water conservation can reduce the costs of pumping and treatment of both water and wastewater. It can also extend the lives of wells and postpone the need for new wells, and it conserves a limited resource while minimizing the impacts of groundwater withdrawal on surface water. Residential water consumption in Deerfield is about 45 gpd/capita, which is reasonable. Conservation by customers will be promoted through the distribution of educational material. The Village will consider the adoption of a water conservation program, which may include promotion of water-saving fixtures, recommendations for efficient lawn watering, alternate day sprinkling and other methods of reducing water use. Parts of the program would be mandatory only in emergency situations. The Village will specifically work with the largest users to reduce consumption. Water bills are screened to find anomalous spikes in water use that might be caused by leaking plumbing and customers are notified of possible leakage.

Public Service Commission records show recent water loss for the system to be about 13 percent, which is within the PSC guideline of 25 percent for Class C communities. If future water audits indicate a substantial increase in water loss, the Village will consider the use of leak detection surveys. The Village has a meter testing and exchange program that meets PSC guidelines. There are no unmetered customers and the only unmetered water uses are main flushing, street sweeping and fire department use. A portable meter is available for bulk sales.

10. CONTINGENCY PLANNING

Contingency planning is done to minimize the disruption of water service in the event of emergencies. The first responder to a contaminant spill would be the Village Fire Department, which has some HAZMAT training. The regional HAZMAT team is in Madison. If any two of the village wells had to be shut down because of contamination or any other reason, the other well could temporarily meet system demand. This would require pumping the remaining well less than five hours per day. With all three wells out of service for an extended period, water could be hauled from Cambridge. Bottled water is available in limited amounts from local stores and larger amounts are available from a distributor in Madison. In the event of loss of power, Well #1 is equipped with an auxiliary motor, Well #3 has a gas powered engine and Well #4 will have a generator. The Village has 650,000 gallons of storage capacity, which would provide more than four day's supply if all wells were out of service. Emergency connection to a neighboring system is not practical at this time. A separate water supply contingency plan has been prepared that includes pertinent information about the system and emergency actions and contacts.

11. REFERENCES

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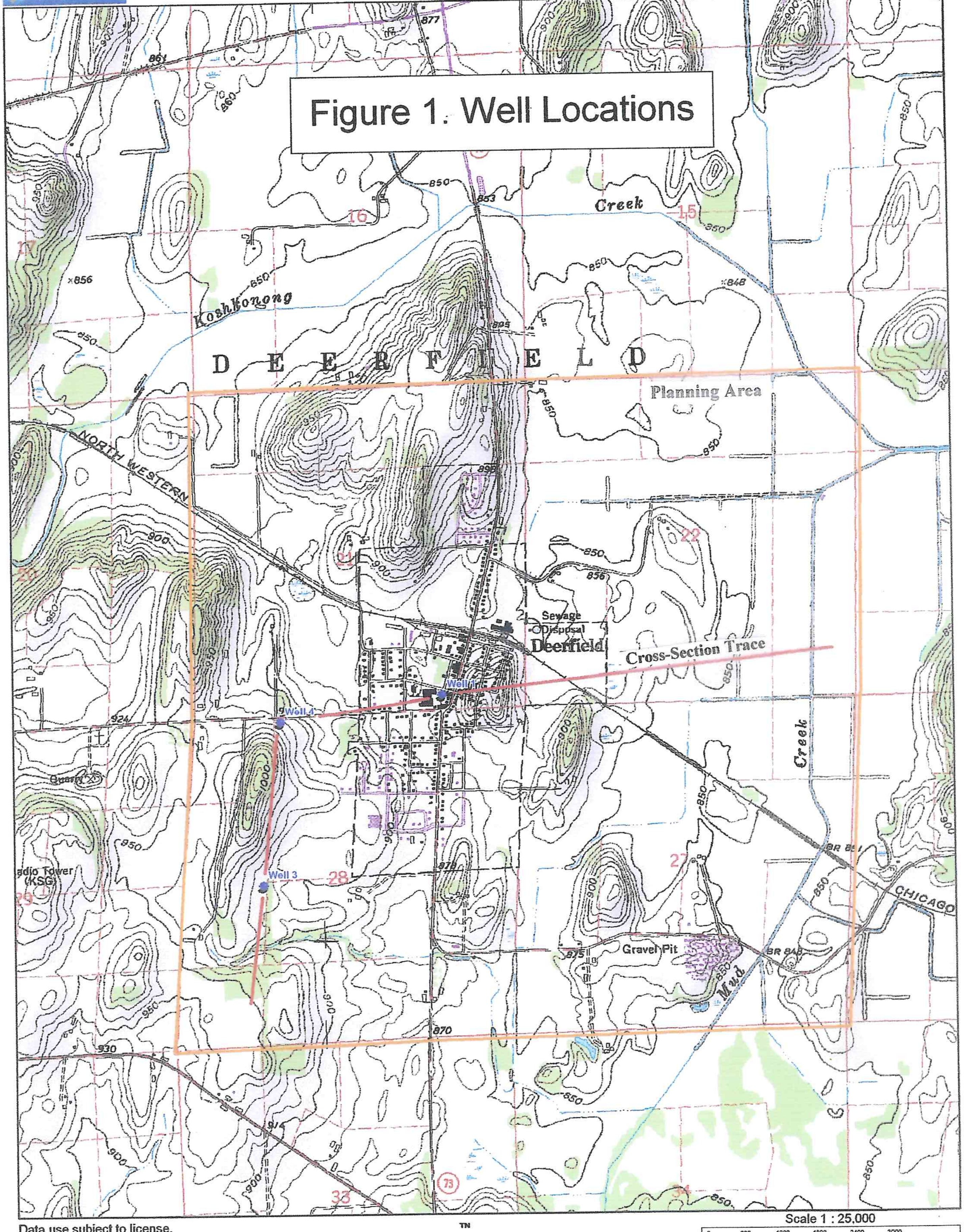


TN

MN (2.6°W)

Scale 1 : 25,000

1" = 2,083.3 ft

Data Zoom 13-0

Figure 2. Vertical Relationships

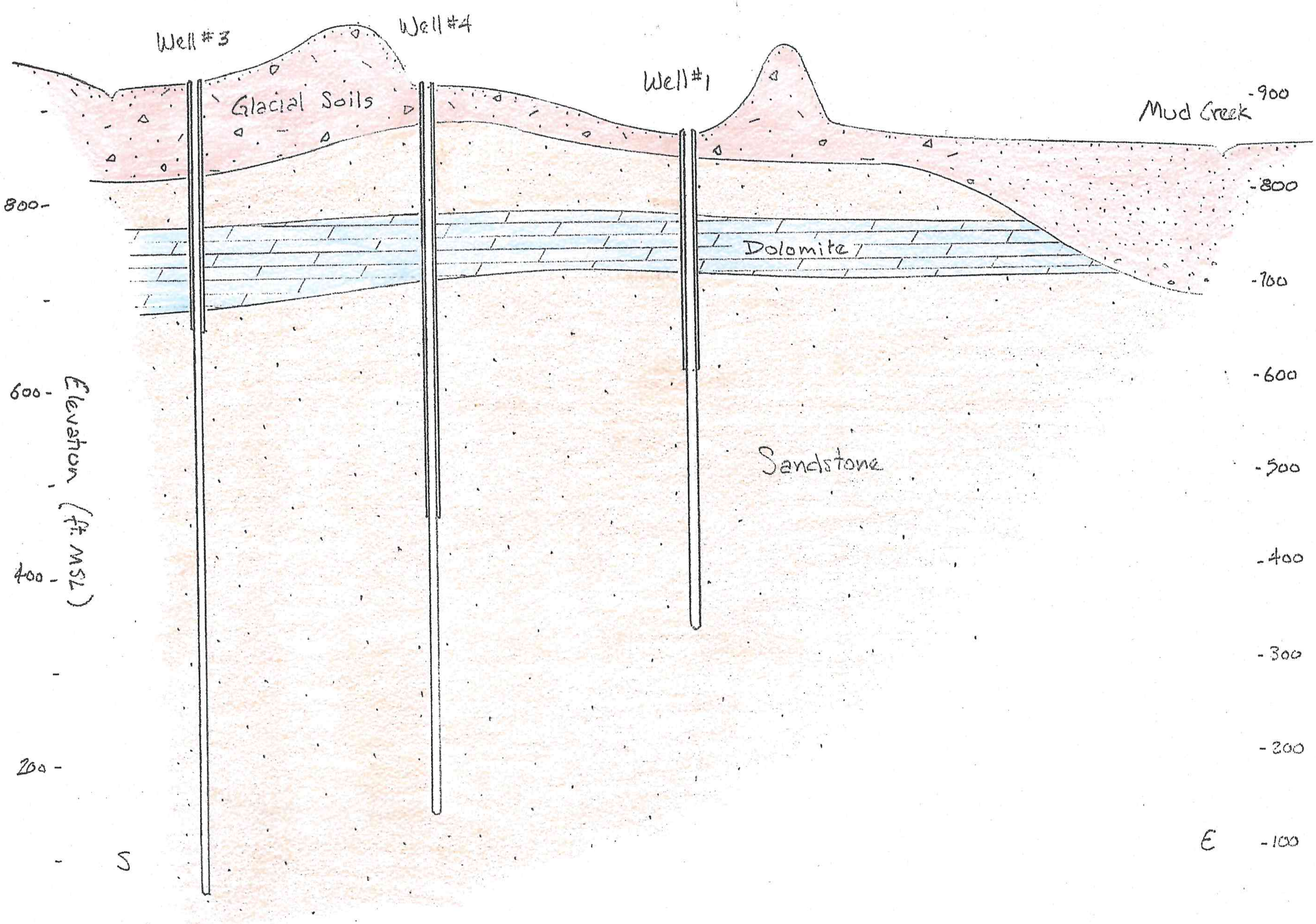
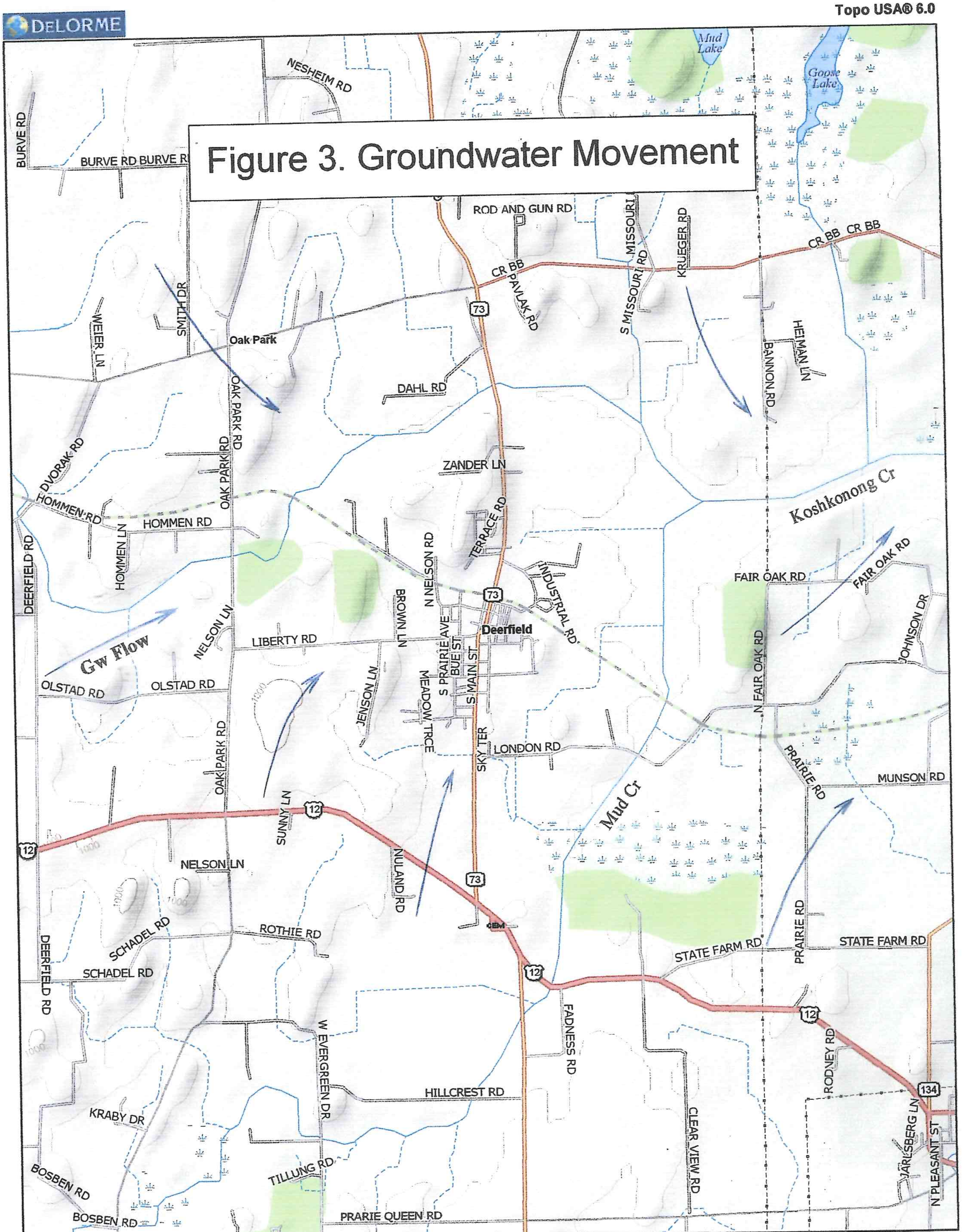


Figure 3. Groundwater Movement



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MN (2.6°W)

Scale 1 : 50,000

1" = 4,166.7 ft

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Figure 4. Wellhead Protection Areas

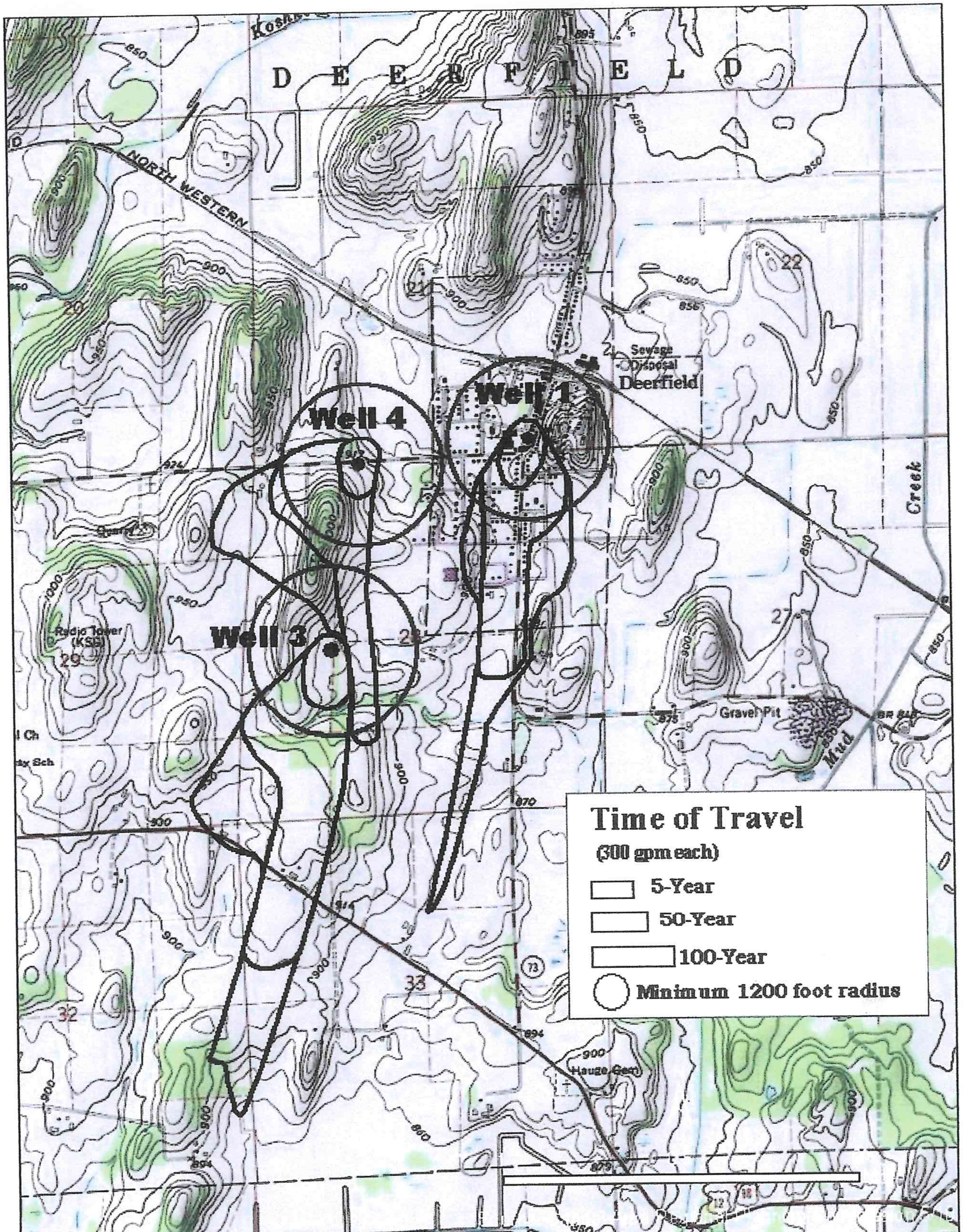

Figure 5a. Potential Contaminant Sources, Well #1

Legend

- Public Water Supply Well
- Point Potential Contaminant Source
- Line Potential Contaminant Source
- Area Potential Contaminant Source

Scale: 1:12,000

The specific locations of drinking water wells, surface water intakes, and source water assessment areas are sensitive information. To prevent misuse of this information DNR staff may not provide this information outside of the Department. Information requests should be directed to Gabrielle Petersen, (608) 266-8470, Gabrielle.Petersen@wisconsin.gov.

Figure 5b. Potential Contaminant Sources, Well #3

Legend

- Public Water Supply Well
- Point Potential Contaminant Source
- Line Potential Contaminant Source
- Area Potential Contaminant Source

Scale: 1:12,000

0 1200 2400 3600 ft.

The specific locations of drinking water wells, surface water intakes, and source water assessment areas are sensitive information. To prevent misuse of this information DNR staff may not provide this information outside of the Department. Information requests should be directed to Gabrielle Petersen, (608) 266-8470, Gabrielle.Petersen@wisconsin.gov.

Figure 5c. Potential Contaminant Sources, Well #4

0 1200 2400 3600 ft.

The specific locations of drinking water wells, surface water intakes, and source water assessment areas are sensitive information. To prevent misuse of this information DNR staff may not provide this information outside of the Department. Information requests should be directed to Gabrielle Petersen, (608) 266-8470, Gabrielle.Petersen@wisconsin.gov.

Legend

- Public Water Supply Well
- Point Potential Contaminant Source
- Line Potential Contaminant Source
- Area Potential Contaminant Source

Scale: 1:12,000

Appendix A: POTENTIAL CONTAMINANT SOURCES
Rev 03/03

CONT CODE	CONTAMINANT SOURCE	DESCRIPTION	SPECIFIC CONTAMINANTS
AAH	Animal housing		Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses
AFA	Animal Feedlot		Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses
AFP	Agricultural farming	Active farming operations	Pesticides, fertilizers
AIA	Irrigation system	Agricultural irrigation	Pesticides, fertilizers
AMH	Agriculture milkhouse		Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses, acids
AMS	Manure storage	Lined and unlined manure storage facilities	Livestock sewage wastes, nitrates, phosphates, chloride, chemical sprays and dips for controlling insect, bacterial, viral, and fungal pests, coliform bacteria, viruses
BCT	Chemical storage	500 gallon or more	Specific to chemical product stored at site
BFS	Fertilizer storage/mixing	Feed mill, agricultural co-op	Nitrates
BFT	Petroleum storage.	500 gallon or more	Specific to petroleum product stored at site
BGS	Grain storage site		Fungicides
BPS	Pesticide storage / mixing / load	Feed mill, agricultural co-op	Herbicides, insecticides, rodenticides, fungicides, avicides
BSS	Road salt storage	Bulk storage sites	Sodium chloride, calcium chloride, waste oil
CAI	Airport		Jet fuels, deicers, batteries, diesel fuel, chlorinated solvents, automobile wastes, heating oil, building wastes
CBS	Auto body shop		Paints, solvents
CBY	Boat yard		Diesel fuels, batteries, oils, septage from boat waste disposal areas, wood preservatives, paints, waxes, varnishes, automotive wastes
CCE	Cemetery		Leachate (formaldehyde), lawn and maintenance chemicals
CCW	Car wash	Car washes in unsewered areas	Soaps, detergents, waxes, miscellaneous chemicals
CDC	Dry cleaning		Solvents (tetrachloroethylene, petroleum solvents, freon), spotting chemicals (trichloroethane, ammonia, rust removers)
CLD	Laundromat	Laundromats in unsewered areas	Detergents, bleaches, fabric dyes
CMP	Plating facility	Jewelry and metal plating	Cyanide, heavy metals
CMW	Machine / metal working shop		Solvents, metals, organics, sludges, cutting oils, degreasers
CPH	Photo processing	Only include processing facilities, don't include photo drop off sites	Cyanides, biosludges, silver sludges
CPR	Printing		Solvents, inks, dyes, oils, organics, chemicals
CPS	Paint shop		Paint, paint thinner, solvents
CRT	Railroad track		Spills
CRY	Rail yard		Spills
CSP	Seed production plant		Fumigants
CSS	Gas service station		Gasoline, oils, solvents, miscellaneous wastes
CSY	Scrap/junkyard		Oil, gasoline, antifreeze, PCB contaminated soils, lead acids batteries
CVR	Motor vehicle repair shop		Waste oils, solvents, acids, paints, automotive wastes,
GFA	Fuel storage tank - above ground	Non-service station tanks	Gasoline, diesel fuel, other petroleum products
GFB	Fuel storage tank - underground	Non-service station tanks	Gasoline, diesel fuel, other petroleum products
GSA	Sewage absorption area	Drainfields, mounds, dry wells	"
GSL	Sewer line (municipal)	Municipal sewer lines	Septage, coliform bacteria, viruses, nitrates
GSN	Sewer line (non-municipal)	Non-municipal sewer lines	"
GST	Sewage tank	Holding tanks, septic tanks, sumps	Septage, coliform bacteria, viruses, nitrates, heavy metals, synthetic detergents, cooking and motor oil, bleach, pesticides, paints, paint thinner, photographic chemicals, septic tank cleaner chemicals, chlorides, sulfate, calcium, magnesium, potassium, phosphate
GWA	Water well (active production)		Potential conduit
GWI	Water well (unused or improperly abandoned)		Potential conduit
IAS	Asphalt plant		Petroleum derivatives
ICM	Chemical production	Industrial chemical production facilities	Chemicals
IEE	Electrical and electronic products		Cyanides, metal sludges, caustics, solvents, oils, acids, alkalis,

	manufacturing		paints, methylene chloride, tetrachloroethylene, trichloroethane, acetone, toluene, PCBs
IES	Electroplating / metal finishing facility		Acids, alkaline solutions, cyanide, metallic salts, solvents, cyanide, heavy metal contaminated wastewater
IFM	Furniture or wood manufacturing / refinishing / stripping		Paints, solvents (toluene, methylene chloride), degreasing sludges
IFW	Foundry / smelting plant		Cyanides, sulfides
IGS	Gravel and Sand pits		Spills, miscellaneous chemicals, bacteria
IMQ	Mining / Mine waste		Cyanide, sulfides, metals, acids drainage
IPC	Plastics manufacturer / molder		Solvents, oils, organics and inorganics, paint wastes, cyanides, acids, alkalis, sludges, esters, surfactants, glycols, phenols, formaldehyde, peroxides
IPM	Paper mill		Metals, acids, minerals, sulfides, chemicals, sludges, chlorine, hypochlorite, chlorine dioxide, hydrogen peroxide
IPP	Pipeline (petro./chem.)		Petroleum, chemicals
ISQ	Stone quarries		Spills, miscellaneous chemicals, potential conduit, bacteria
ITP	Textile / polyester manufacturer		Chemicals
IWT	Wood preserving facility		Treated wood residue, preservatives (pentachlorophenol, chromate, copper arsenate,), tanner gas, paint sludges, solvents, creosote, coating wastes
MFT	Fire training facility		Chemicals
MGC	Golf course		Fertilizers, herbicides, pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests., automotive wastes
MGP	Manufactured gas plant / gasification plant		Petroleum VOCs, Benzo(a)pyrene, PAHs, cyanide
MLA	Laboratory (college, medical, school, private, etc.)		Biological wastes, disinfectants, acids, formaldehyde, miscellaneous chemicals
MMI	Military installation		
MMP	Medical Installation (e.g. Hospital)		X-ray developers and fixers, infectious wastes, radiological wastes, biological wastes, disinfectants, asbestos, beryllium, acids, formaldehyde, miscellaneous chemicals
MOT	Other (specify) ______________		
WDR	Class V injection well	Any well, drilled or dug hole, used to inject fluids into the subsoil	Chlorides, pathogens, petroleum products, pesticides
WHS	Hazardous waste generator (SARA Title III) / RCRA authority clean-ups	Any facility listed on the SARA Title III list thought to pose a threat to the well / RCRA clean-ups	Hazardous waste
WIN	Incinerator (municipal)		Metals, combustion by-products
WLA	Landfill	Solid and hazardous waste sites listed in the DNR "Registry of Waste Disposal Sites in Wisconsin"	Leachate
WLS	Leaking underground storage tank (LUST)	LUST Sites included in the DNR "Leaking Underground Storage Tank List"	Gasoline, diesel fuel, other petroleum products
WRF	Recycling facility		Petroleum products, chemicals
WRP	ERRP Site	Sites on the DNR "Emergency and Remedial Response" list	Spills
WSI	Wastewater Spray Irrigation		Coliform bacteria, nitrate, chloride, pathogens, viruses
WSS	Sludge spreading	Municipal wastewater sludge, paper mill sludge	Viruses, coliform bacteria, heavy metals, dioxins
WSW	Storm water retention pond		Metals, petroleum products
WTS	Solid waste transfer station		Miscellaneous chemicals
WUC	Superfund site	Sites listed in the DNR "Superfund Sites in Wisconsin"	Miscellaneous contaminants
WWL	Wastewater lagoon	Treatment and/or storage lagoons	Coliform bacteria, viruses
WWO	Wastewater discharge to surface water	Surface water outfall	Coliform bacteria, viruses
WWP	Wastewater treatment plant		
WWS	Wastewater discharge to groundwater	Absorption and seepage cells, spray irrigation, subsurface systems, etc.	Coliform bacteria, viruses

APPENDIX A

LITHOLOGIC LOGS AND WELL CONSTRUCTION DETAILS

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A
(Rev 12/00)

Depth 523 FT

WISCONSIN UNIQUE WELL NUMBER BF493
SOURCE: SWAP PROJECT KEYED

Property Owner: DEERFIELD, VILLAGE OF
Telephone Number: 608 – 764 – 5497
Mailing Address: 4 N MAIN ST PO BOX 6
City: DEERFIELD | State: WI | Zip Code: 53531
County of Well Location: 13 DANE | SC | Co Well Permit No: W | Well Completion Date: January 1, 1925

Well Constructor: THORNE, W L | License #
Facility ID (Public): 113022360
Address
Public Well Plan Approval#
City | State | Zip Code
Date Of Approval: 01/01/1925
Hicap Well #: 77113 | Common Well #: 001 | 300 gpm/ft

1. Well Location
V T=Town C=City V=Village | Fire#
of DEERFIELD
Street Address or Road Name and Number: DEERFIELD ST WELL #1
Subdivision Name | Lot# | Block #
Gov't Lot or SE 1/4 of SE 1/4 of
Section 21 T 7 N R 12 E
Latitude Deg. 43 Min. 3.1571
Longitude Deg 89 Min. 4.573
Lat/Long Method: GPS003

2. Well Type 1 1=New 2=Replacement 3=Reconstruction (See item 12 below)
of previous unique well # ________ constructed in 0 ____
Reason for replaced or reconstructed Well?
1 1=Drilled 2=Driven Point 3=Jetted 4=Other

3. Well Serves # of homes and or (eg: barn, restaurant, church, school, industry, etc.)
M M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole
High Capacity: Well? Property?

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties?
Well located in floodplain?
Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in. diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia.(in.)	From (ft)	To (ft)
10.0	surface	251
8.0	251	523

Upper Enlarged Drillhole / Lower Open Bedrock
- 1. Rotary - Mud Circulation
- 2. Rotary - Air
- 3. Rotary - Air and Foam
- 4. Drill-Through Casing Hammer
- 5. Reverse Rotary
- 6. Cable-tool Bit _____ in. dia
- 7. Temp. Outer Casing _____ in. dia. _____ depth ft. Removed ?

Other

8. Geology

Geology Codes	Type, Caving/Noncaving, Color, Hardness, etc	From (ft.)	To (ft.)
___	DRIFT	0	30
__AN	CONGLOMERATE STP	30	45
_NN_	SANDSTONE STP	45	80
__LN	DOLOMITE @ SANDSTONE LMAG	80	115
__LN	DOLOMITE @ SANDSTONE LMAG	115	145
_N_	SANDSTONE FRANCO	145	265
I_N_	SANDSTONE DRESB	265	345
_NH	SANDSTONE EC	345	523

6. Casing Liner Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
8.0		surface	251

Dia.(in.)	Screen type, material & slot size	From	To

9. Static Water Level
25.0 feet B ground surface A=Above B=Below

10. Pump Test
Pumping level 50.0 ft. below surface
Pumping at 450.0 GPM Hrs

11. Well Is: 0 in. A=Above B=Below Grade
Developed?
Disinfected?
Capped?

WISCONSIN UNIQUE WELL NUMBER **HN158**

SOURCE: WELL CONSTRUCTION

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A (Rev 12/00)

Well #3 Depth 865 FT

Property Owner: VILLAGE OF DEERFIELD — Telephone Number: 608 – 764 – 5404

Mailing Address: 4 N MAIN ST

City: DEERFIELD — State: WI — Zip Code: 53531

County of Well Location: 13 DANE — SC — Co Well Permit No: W — Well Completion Date: June 18, 1994

Well Constructor: SAMS ROTARY — License #: 370 — Facility ID (Public): 113022360

Address: PO BOX 150 — Public Well Plan Approval#: 931926

City: RANDOLPH — State: WI — Zip Code: 53956 — Date Of Approval: 02/07/1994

Hicap Well #: 1734 — Common Well #: 003 — 171 gpm/ft

1. Well Location V T=Town C=City V=Village — Fire#

of DEERFIELD

Street Address or Road Name and Number

Subdivision Name — Lot# — Block #

Gov't Lot or SW 1/4 of NW 1/4 of

Section 28 T 7 N R 12 E

Latitude Deg. 43 Min. 2.6349

Longitude Deg 89 Min. 5.221

Lat/Long Method: GPS003

2. Well Type 1 1=New 2=Replacement 3=Reconstruction (See item 12 below)

of previous unique well # __________ constructed in 0

Reason for replaced or reconstructed Well? VILLAGE

1 1=Drilled 2=Driven Point 3=Jetted 4=Other

3. Well Serves # of homes and or VILLAGE (eg: barn, restaurant, church, school, industry, etc.)

M M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole

High Capacity: Well? Y Property? Y

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? Y

Well located in floodplain? N

Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in. diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia.(in.)	From (ft)	To (ft)
19.0	surface	120
17.5	120	260
12.3	260	510
11.0	510	865

Upper Enlarged Drillhole — Lower Open Bedrock

X – 1. Rotary - Mud Circulation
X – 2. Rotary - Air
– 3. Rotary - Air and Foam
– 4. Drill-Through Casing Hammer
– 5. Reverse Rotary
– 6. Cable-tool Bit ____ in. dia
– 7. Temp. Outer Casing ____ in. dia. ____ depth ft. Removed ?
Other

6. Casing Liner Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
12.0	STD BLK PIPE 375 WALL A53B LTV	surface	260

Dia.(in.)	Screen type, material & slot size	From	To

8. Geology

Geology Codes	Type, Caving/Noncaving, Color, Hardness, etc	From (ft.)	To (ft.)
Z	CLAY @ GRAVEL	0	72
X	CLAY @ SAND	72	90
N	SANDROCK	90	123
L	LIMEROCK	123	236
N	SANDROCK	236	865

9. Static Water Level 89.0 feet B ground surface A=Above B=Below

10. Pump Test Pumping level 129.9 ft. below surface — Pumping at 700.0 GPM 48 Hrs

11. Well Is: A Grade 18 in. A=Above B=Below

Developed? Y

Disinfected? Y

Capped? Y

Well Construction Report
WISCONSIN UNIQUE WELL NUMBER **WP601**

State of WI - Private Water Systems-DG/2
Department of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A
(R 9/05)

Well #4

Property Owner: Village of Deerfield	Telephone Number: (608) 764-5404
Mailing Address: 4 N. Main Street	
City: Deerfield	State: WI · Zip Code: 53531-
County of Well Location: DODGE	Co. Well permit No. W____ · Well Completion Date (mm-dd-yyyy): 03 - 30 - 2010
Well Constructor (Business Name): Municipal Well and Pump · License #: 013	Facility ID Number (Public Wells): 11302236
Address: 1212 Storbeck Drive	Well Plan Approval #: 2009 - 0367
City: Waupun · State: WI · Zip Code: 53963-	Date of Approval (mm/dd/yyyy): 05 / 06 / 2009
Hicap Permanent Well #: _ _ _ _ _ · Common Well #: 004	Specific Capacity: 7.47 gpm/ft
3. Well serves ____ # of Village (For example: home, barn, restaurant, church, school, industry, etc.)	High Capacity: Well? [X] Yes ☐ No · Property? [X] Yes ☐ No

1. Well Location
☐ Town ☐ City [X] Village of Deerfield
Fire # (If avail.)
Street Address or Road Name and Number: Liberty Street
Subdivision Name · Lot # · Block #
Gov't Lot # ____ or NE 1/4 of NW 1/4 of
Section 28, T 7 N; R 12 [X] E ☐ W
Latitude Deg. 43 Min. 3.083
Longitude Deg. 89 Min. 5.1
Lat/Long Method _ _ _ _ _ _

2. Well Type [X] New ☐ Replacement ☐ Reconstruction
(see item 12 below)
of previous unique well # ____ constructed in ____
Reason for replaced or reconstructed well?
[X] Drilled ☐ Driven Point ☐ Jetted ☐ Other____

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? [X] Yes ☐ No (If no, explain on back side.)
Well located within 1,200 feet of a quarry? ☐ Yes [X] No If yes, distance in feet from quarry: ______
Well located in floodplain? ☐ Yes [X] No

Distance in feet from well to nearest: (include proposed)

___ 1. Landfill
___ 2. Building Overhang
___ 3. Septic ☐ Holding Tank ☐
___ 4. Sewage Absorption Unit
___ 5. Nonconforming Pit
___ 6. Buried Home Heating Oil Tank
___ 7. Buried Petroleum Tank
___ 8. Shoreline ☐ Swimming Pool ☐
___ 9. Downspout/Yard Hydrant
___ 10. Privy
___ 11. Foundation Drain to Clearwater
___ 12. Foundation Drain to Sewer
___ 13. Building Drain ☐ Cast Iron or Plastic ☐ Other
___ 14. Building Sewer ☐ Gravity ☐ Pressure ☐ Cast Iron or Plastic ☐ Other
___ 15. Collector Sewer: ☐ sanitary ___ units ___ in. diam. ☐ storm ☐ ≤6" ☐ >6"
___ 16. Clearwater Sump
___ 17. Wastewater Sump
___ 18. Paved Animal Barn Pen
___ 19. Animal Yard or Shelter
___ 20. Silo
___ 21. Barn Gutter
___ 22. Manure Pipe ☐ Gravity ☐ Pressure ☐ Cast Iron or Plastic ☐ Other
___ 23. Other Manure Storage ______
___ 24. Ditch
___ 25. Other NR 812 Waste Source ______

5. Drillhole Dimensions and Construction Method

Dia. (in.)	From (ft.)	To (ft.)
24	surface	20
23	20	460
17	460	775

Upper Enlarged Drillhole / Lower Open Bedrock:
☐ 1. Rotary - Mud Circulation ☐
☐ 2. Rotary - Air ☐
☐ 3. Rotary - Air and Foam ☐
☐ 4. Drill-Through Casing Hammer
[X] 5. Reverse Rotary
☐ 6. Cable-tool Bit ____ in. dia. ☐
[X] 7. Temp. Outer Casing 24 in. dia. Removed? 20 depth ft. [X] Yes ☐ No - If no, explain on back side.

8. Geology

Geology Codes				Type, Caving/Noncaving, Color, Hardness, etc.	From (ft.)	To (ft.)
-	-	C	-	Clay	0	5
-	-	C	G	Clay, w/Gravel/Cobbles/Boulders/Stones	5	35
R	-	N	-	Red, Sandstone	35	115
T	-	N	-	Tan/Brown, Sandstone	115	180
T	-	L	-	Tan/Brown, Limestone/Dolomite	180	200
R	-	N	H	Red, Sandstone, Shaley	200	285
I	-	N	H	White, Sandstone, Shaley	285	400
P	-	N	-	Pink, Sandstone	400	447
I	-	N	-	White, Sandstone	447	575
I	H	N	-	White, Hard/Firm, Sandstone	575	660
I	-	N	H	White, Sandstone, Shaley	660	775

6. Casing, Liner, Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
24	casing ASTMA53B 1 x0.500 Wall	surface	20
18	0.375 Wall ASTM A53B PE/BW	20	460
Dia. (in.)	Screen type, material & slot size	From	To

9. Static Water Level
____ ft. above ground surface
59 ft. below ground surface

10. Pump Test
Pumping level 165 ft. below surface
Pumping at 800 GPM for 24 Hrs.

11. Well Is: 24 in. [X] Above ☐ Below Grade
Developed? [X] Yes ☐ No
Disinfected? [X] Yes ☐ No
Capped? [X] Yes ☐ No

7. Grout or Other Sealing Material
Method: Grout (Float) Shoe

Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
Neat cement grout	surface	460	650
(Gravel pack if applicable)			

12. Did you permanently abandon and fill all unused, noncomplying or unsafe wells on this property? [X] Yes ☐ No If no, explain on reverse.

13. Signature of Well Constructor or Supervisory Driller: TG · Date Signed: 04/02/2010
Print Name of Drill Rig Operator (Mandatory unless same as above): BS · Date: 04/02/2010

Make additional comments on reverse side about geology, additional screens, water quality, etc.
Comments on reverse side ____ (CHECK √, IF YES) Variance Issued ☐ Yes ☐ No
Notification #

APPENDIX B

CALCULATIONS FOR DELINEATION OF ZONE OF INFLUENCE

Deerfield em 4-20-10

Well No.		1	2	3	4	5	6
Well Construction							
Total Depth (ft)		523		865	775		
Open Interval Depth (ft)		251-523		260-865	460-775		
Open Interval (ft)		272		605	170		
Diameter (in)		8		11	17		
Pump Test							
Pumping Rate (gpm)		450		700	800		
Duration (hr)				48	24		
Static WL (ft)		25		89	59		
Pumping WL (ft)		50		129	165		
Drawdown (ft)		25	0	40	106	0	0
Specific Capac (gpm/ft)		18	#DIV/0!	17.5	7.5471698	#DIV/0!	#DIV/0!
Well Capacity (gpm)*		600		600	600		
Current Operation							
Ave. Demand (gpd)	150000						
Peak Demand (gpd)	200000						
Ave Pump Rate (gpd)							
% of Total		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Static WL (ft)		22		44			
Pumping WL (ft)		48		78			
Aquifer Thickness (ft)		300		630	330		
Storage Coefficient		0.0001		0.0001	0.0001		
Effective Porosity		0.15		0.15	0.15		
Hydraulic Gradient		0.01		0.01	0.01		
Transmissivity							
(ft2/sec)		0.06658		0.07067	0.02591		
(gpd/ft)		43010.68	0	45652.82	16737.86	0	0
Hydraulic Conductivity							
(ft/sec)		0.0002219	#DIV/0!	0.0001122	7.852E-05	#DIV/0!	#DIV/0!
(ft/d)		19.17504	#DIV/0!	9.6918857	6.7837091	#DIV/0!	#DIV/0!
(gpd/ft2)		143.36893	#DIV/0!	72.464794	50.720788	#DIV/0!	#DIV/0!
GW Velocity							
(ft/d)		1.278336	#DIV/0!	0.6461257	0.4522473	#DIV/0!	#DIV/0!
(ft/yr)		466.59264	#DIV/0!	235.83589	165.07025	#DIV/0!	#DIV/0!
Zone of Influence (half cap)							
W(u) (s=1.0ft)		1.2510378	#DIV/0!	1.3278889	0.4868487	#DIV/0!	#DIV/0!
u		0.1933		0.1762	0.5662		
Radius (t=30d) (ft)		36521.105	#DIV/0!	35923.329	38991.929	#DIV/0!	#DIV/0!

Deerfield

TGUESS -- Version 1.2

****

AQUIFER PROPERTIES AS DETERMINED BY ANALYSIS OF SPECIFIC CAPACITIES

****

WELL NUMBER........= 1

INPUT DATA (English units):
WELL DIAMETER (IN OR M)...................= 8
STATIC WATER LEVEL (FT OR M)..............= 25
DEPTH TO WATER DURING TEST (FT OR M)......= 50
DURATION OF THE TEST (HRS)................= 4
PUMPING RATE (GPM OR CUB.M/S).............= 450
THICKNESS OF AQUIFER (FT OR M)............= 300
OPEN INTERVAL (SCREEN LENGTH; FT OR M)....= 272
STORAGE COEFFICIENT.......................= .0001
WELL LOSS COEFFICIENT.....................= 1

RESULTS:
SPECIFIC CAPACITY (GPM/FT OR SQ.M/S)......= 18.75348
TRANSMISSIVITY (SQ FT/SEC OR SQ.M/S)......= .0665815
HYDRAULIC CONDUCTIVITY (FT/SEC OR M/S)....= 2.219383E-04
NUMBER OF ITERATIONS......................= 4

WELL NUMBER........= 3

INPUT DATA (English units):
WELL DIAMETER (IN OR M)...................= 11
STATIC WATER LEVEL (FT OR M)..............= 89
DEPTH TO WATER DURING TEST (FT OR M)......= 129
DURATION OF THE TEST (HRS)................= 48
PUMPING RATE (GPM OR CUB.M/S).............= 700
THICKNESS OF AQUIFER (FT OR M)............= 630
OPEN INTERVAL (SCREEN LENGTH; FT OR M)....= 605
STORAGE COEFFICIENT.......................= .0001
WELL LOSS COEFFICIENT.....................= 1

RESULTS:
SPECIFIC CAPACITY (GPM/FT OR SQ.M/S)......= 18.63216
TRANSMISSIVITY (SQ FT/SEC OR SQ.M/S)......= 7.066538E-02
HYDRAULIC CONDUCTIVITY (FT/SEC OR M/S)....= 1.121673E-04
NUMBER OF ITERATIONS......................= 3

WELL NUMBER........= 4

INPUT DATA (English units):
WELL DIAMETER (IN OR M)...................= 17
STATIC WATER LEVEL (FT OR M)..............= 59

DEPTH TO WATER DURING TEST (FT OR M)......= 165
DURATION OF THE TEST (HRS)................= 24
PUMPING RATE (GPM OR CUB.M/S).............= 800
THICKNESS OF AQUIFER (FT OR M)............= 330
OPEN INTERVAL (SCREEN LENGTH; FT OR M)....= 315
STORAGE COEFFICIENT.......................= .0001
WELL LOSS COEFFICIENT.....................= 1

RESULTS:

SPECIFIC CAPACITY (GPM/FT OR SQ.M/S)......= 7.780178
TRANSMISSIVITY (SQ FT/SEC OR SQ.M/S)......= 2.591278E-02
HYDRAULIC CONDUCTIVITY (FT/SEC OR M/S)....= 7.852357E-05
NUMBER OF ITERATIONS......................= 4

Equations Used in Calculations

Zone of Influence

Theis Nonequilibrium Equation

$W(u) = (s\ T) / (114.6\ Q)$

$r^2 = (T\ t\ u) / (1.87\ S)$

T = Transmissivity (gpd/ft²)
Q = Pumping capacity (gpm)
S = Drawdown at edge of ZOI (ft)
u Obtained from Theis table
t = Time of pumping (days)
S = Storage coefficient (unitless)

Calculated Fixed Radius

$r^2 = (Q\ t) / (\pi\ ne\ H)$

t = time of pumping (years)
ne = Effective porosity (unitless)
H = Aquifer thickness (ft)

Zone of Contribution

Uniform Flow Equation

$N = (0.16\ Q) / (T\ i)$

N = Null point (ft)
i = Ambient hydraulic gradient (unitless)

$W = Q / (2T\ i)$

W = Width of recharge area (ft)

Groundwater Velocity

$V = (K\ i) / ne$

V = Velocity (ft/sec)

5-Year Time-of-Travel

$TOT = V \times (157{,}680{,}000\ sec/5\ years)$