



United States Department of the Interior

NATIONAL PARK SERVICE
Water Resources Division
1201 Oak Ridge Drive, Suite 250
Fort Collins, CO 80525

IN REPLY REFER TO:

August 31, 2004

L54(2380)
WICA/General

Memorandum

To: Superintendent, Wind Cave National Park

Through: William L. Jackson, Acting Chief, Water Resources Division (WRD)
Gary Rosenlieb, Acting Chief, Water Operations Branch

From: Larry Martin, Hydrogeologist, Water Operations Branch, WRD

Subject: Trip Report for travel to Wind Cave National park on August 16-18, 2004.

Summary: The proposed locations for evaporative sewage lagoons, on the bench north and east of the location of the existing lagoons, will not affect cave resources at the park. The lagoons will be designed as non-discharging evaporative ponds with impermeable liners. The proposed location is downgradient from the known extent of cave passages. Geologic and hydrologic conditions in the area will cause any contaminants that might leak from the lagoons to flow toward the east-southeast, away from the cave resources of the park.

Discussion: The existing sewage lagoons at Wind Cave National park are undersized and poorly located to accommodate the wastewater generated by park facilities. Evaporation rates are not sufficient to keep up with the combined inflow to the lagoons from wastewater and rainfall. The park has conducted a value analysis and environmental assessment of several alternatives to replace the current system. The preferred alternative, at this time, is to abandon the existing lagoons and construct new, larger lagoons at a site that will be more exposed to wind and sun, resulting in higher evaporation rates.

The preferred site is on a bench north and east of the current location, at an elevation approximately 80 feet higher than the existing lagoons. A lift station would be constructed to pump wastewater from the gravity collection system to the new lagoons. Some people have questioned whether leakage from the new lagoons could potentially reach the cave area and impact cave resources.

The new lagoons would be designed to be non-discharging. The current plan is to construct two, or more, lagoons with a total area of 14 acres. The lagoons would be about 6 feet deep and have earthen levees. An impermeable geotextile membrane would cover the bottom and sides of the lagoons to prevent leakage of wastewater into the underlying soils. The lagoons would be managed by alternating use to allow evaporation of wastewater and drying of sludge for removal and processing. Fencing would be constructed to keep wildlife out of the lagoons

The proposed location of the lagoons and the area of known cave resources are shown on the attached map, Figure 1). The proposed location for the lagoons is approximately 1750 feet northeast of the nearest known cave passage. It should be noted that this is the horizontal distance in a 2-dimensional map view and does not account for vertical separation between the lagoons and cave passages, the dip of the geologic formations, or the low permeability strata that separate the Madison and Minnelusa Aquifers. The vertical separation and stratigraphic features between the proposed lagoons and cave passages at the park are shown on the attached schematic cross-section (Figure 2).

True cross-sections, both parallel and perpendicular to the dip of the geologic formations, through the proposed lagoon location are shown on Figures 3 and 4. These cross-sections do not show caves in the Madison Limestone because there are no known caves intersected by the cross-sections. The NW-SE cross-section, parallel to the dip of the formation shows that the dip of the bedding planes within the formations and groundwater flow would carry any potential contaminants toward the southeast, away from the cave areas. The SW-NE cross-section shows that Dog Canyon, on the northeast side of the proposed lagoon area, and Wind Cave Canyon, on the southwest side of the proposed lagoon area, effectively isolate that area as a peninsula. Any leakage from the lagoons would preferentially flow along the bedding planes of the Minnelusa Formation and probably discharge as seep areas on the bedrock walls of Dog Canyon or Wind Cave Canyon, or continue as groundwater flow toward the southeast.

Hydrologic conditions of the Madison Aquifer underlying the proposed lagoon site are not known. To the southeast, the Madison Aquifer is under artesian pressure and the groundwater gradient would be upward, into the Minnelusa Formation. However, the shale and siltstone forming the confining layer at the bottom of the Minnelusa prevent the upward flow of groundwater, creating artesian pressure in the aquifer. To the northwest of the proposed lagoon area, the Madison aquifer is only partially saturated. Directly beneath the proposed lagoon area the Madison might be partially saturated, fully saturated, or under artesian pressure. There are no wells at the site to determine which it might be. However, the confining unit at the base of the Minnelusa Formation would greatly impede downward flow of groundwater from the Minnelusa to the Madison. Any leakage that might occur would likely follow the preferential flow paths along the bedding planes of the Minnelusa Formation; the natural direction of groundwater flow is to the southeast.

The bedrock underlying the proposed location for the new lagoons is Minnelusa Formation. The Minnelusa consists largely of alternating layers of sandstone and siltstone. The lower part of the formation, that part lying directly on top of the Madison Limestone, is primarily shale and siltstone; forming a confining layer at the top of the Madison Aquifer. In this part of the Black Hills the Minnelusa and Madison Formations dip to the east-southeast at about 4° (depth

increases by about 1000 feet in 2½ miles, or a grade of about 7½%). Groundwater flow parallels the dip of the geologic formations and preferentially follows bedding planes within the formation. It is far easier for groundwater to flow along the bedding planes to the east-southeast than to percolate down through the formation. Additionally, the lower part of the Minnelusa Formation is primarily shale and siltstone and is essentially impermeable, as evidenced by its hydrologic function as a confining unit between the Madison and Minnelusa Aquifers. The thickness of the Minnelusa Formation underlying the proposed lagoon site is approximately 250 feet.

Cave resources at Wind Cave are protected from contamination from leakage at the proposed sewage lagoons by the following factors:

1. The lagoons will be designed with impermeable liners.
2. The lagoons are not located over known cave resources.
3. The proposed location is downgradient from the cave passages.
4. If there was any leakage from the lagoons the contaminants would flow along the dip of geologic formations in the area to the east-southeast, away from the cave area.
5. Groundwater flow in both the Minnelusa and Madison Aquifers is to the east-southeast. Any contaminants that did enter the groundwater flow system would be carried away from the cave passages.
6. The Minnelusa and Madison Aquifers are separated by a confining unit that effectively prevents groundwater flow between the aquifers.

If there are any questions regarding this report, please call me at (970)-225-3515.

References

Carter, Janet M., Daniel G. Driscoll, J. Foster Sawyer, 2003, Ground-Water Resources in the Black Hills Area, South Dakota, USGS Water-Resources Investigations Report 03-4049, 36 pp.

Carter, Janet M. and Jack A. Redden, 1999, Altitude of the Top of the Minnelusa Formation in the Black Hills Area, South Dakota, USGS Hydrologic Investigations Atlas HA-744-C, 2 sheets

Carter, Janet M. and Jack A. Redden, 1999, Altitude of the Top of the Madison Limestone in the Black Hills Area, South Dakota, USGS Hydrologic Investigations Atlas HA-744-D, 2 sheets

Driscoll, Daniel G., Janet M. Carter, Joyce E. Williamson, and Larry D. Putnam, 2002, Hydrology of the Black Hills Area, South Dakota, USGS Water-Resources Investigations Report 02-4094, 150 pp.

Kiver, Eugene P. and David V. Harris, 2000, Geology of U.S. Parklands, John Wiley & Sons, pp.678-685

Palmer, Arthur N., 1981, The Geology of Wind Cave, Wind Cave Natural History Association, 44 pp.

Strobel, Michael L., Joel M. Galloway, Ghaith R. Hamade, and Gregory J. Jarrell, 2000,
Potentiometric Surface of the Minnelusa Formation in the Black Hills Area, South Dakota,
USGS Hydrologic Investigations Atlas HA-745-C, 2 sheets

Strobel, Michael L., Joel M. Galloway, Ghaith R. Hamade, and Gregory J. Jarrell, 2000,
Potentiometric Surface of the Madison Aquifer in the Black Hills Area, South Dakota, USGS
Hydrologic Investigations Atlas HA-745-D, 2 sheets

cc:

WASO – Mike Soukup

WICA – Steve Schrempp, Dan Foster

REGION – John Reber, Phil Ayers

DSC – Walt Graham

GRD – Dave Shaver, Ron Kerbo

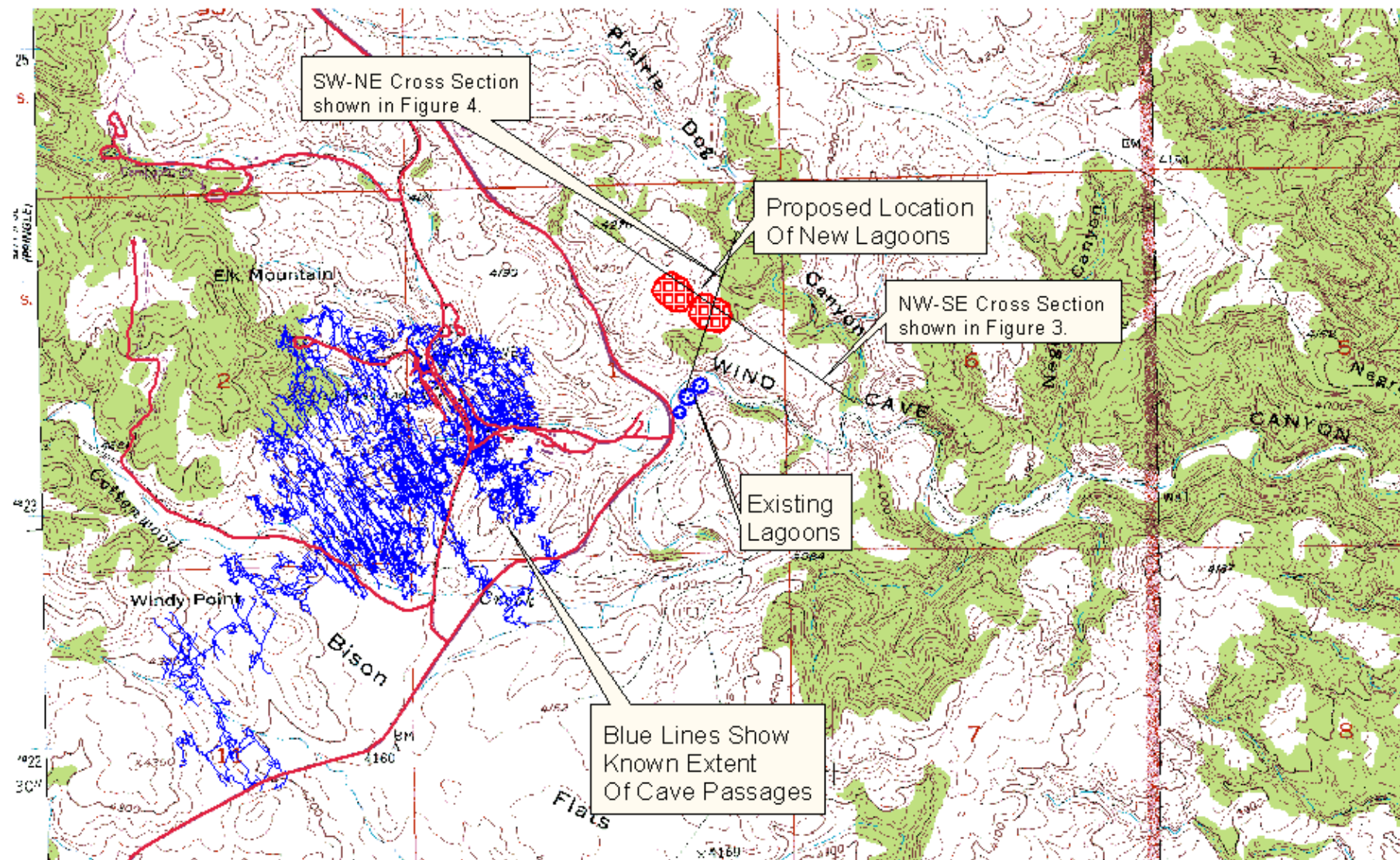
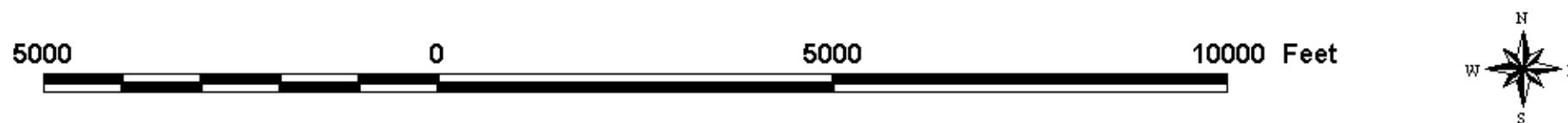


Figure 1. Map view showing locations of existing and proposed lagoons and known extent of cave resources at Wind Cave National Park



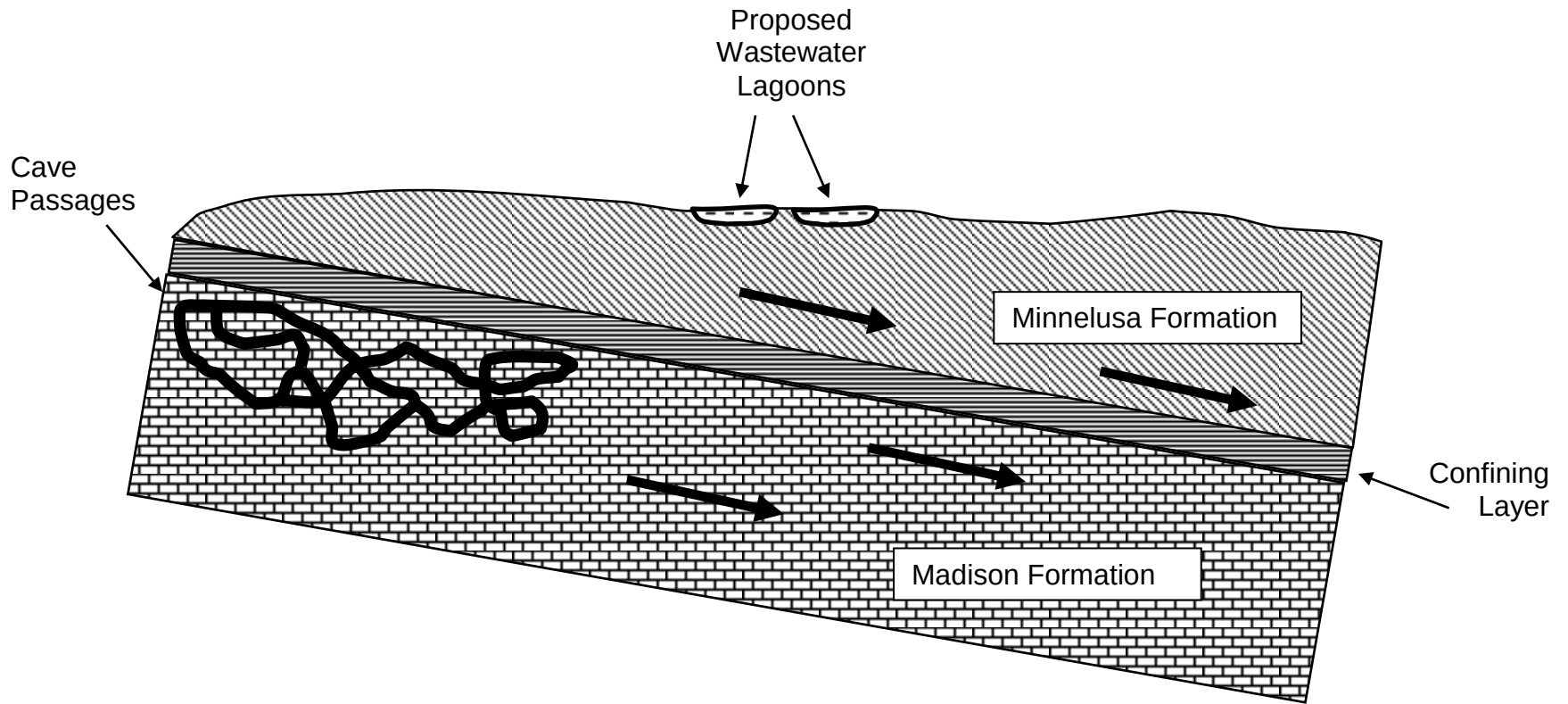


Figure 2. Schematic cross section showing the general stratigraphic relation of proposed lagoons and cave passages at Wind Cave National Park. Arrows show direction of groundwater flow.

Figure 3. NW-SE Cross Section Through Proposed Lagoon Site
Arrows show direction of groundwater flow

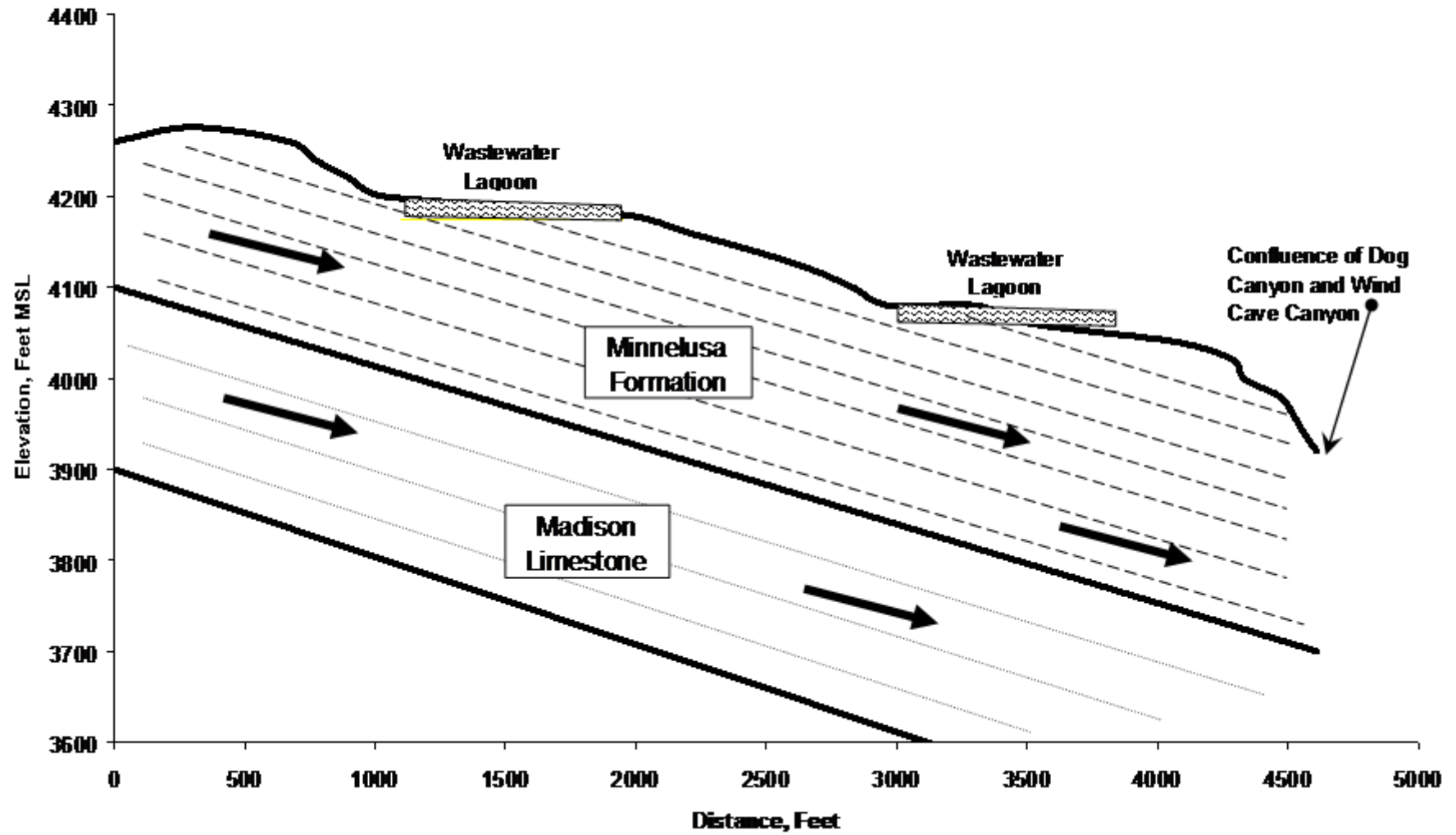


Figure 4. SW-NE Cross Section Through Proposed Lagoon Site

