

CENTRAL STATES COMPACT SITE APPROVAL PROCEEDINGS, MARTINSVILLE, ILLINOIS-LESSONS LEARNED

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ABSTRACT

The Central Midwest Interstate Low Level Radioactive Waste Compact presented its characterization of a site near Martinsville, Illinois to the Illinois Facility Siting Commission in hearings which began in June 1991. The site was a volunteer site, accepted by the city of Martinsville on the basis of a referendum. The commission required an "Extraordinary Level of Scientific Proof" of site acceptability because the site was not chosen on solely technical criteria. The site was both strongly opposed and strongly advocated by local citizens groups. Site approval was denied by the Facility Siting Commission in October 1992. Issues during the hearing included the suitability of the site and broader issues of the philosophy of siting.

INTRODUCTION

The Central Midwest Interstate Low Level Radioactive Waste Compact, composed of Illinois and Kentucky, has been in the process of site selection and site characterization since early 1987. Hearings held before a Facility Siting Commission from June 12, 1991 until October 9, 1992 resulted in rejection of the site. The cost to the ratepayers of Illinois, the delay in opening of a facility, and the implications for other similar facilities make it essential that the technical matters at issue in this proceeding be addressed. The site is in the process of decommissioning and closure after millions of dollars in characterization costs. A new site selection is underway and new legislation has disbanded the Facility Siting Commission.

Most of the following discussion is based on three sets of documents. These are: The Site Characterization Reports (1, 2, 3, 4), The Transcript of The Site Suitability hearings (5) and The Final Report of The Commission (6). References and sources of these documents are in the bibliography.

SETTING

The proposed Central States Compact Low Level Nuclear Waste Disposal Facility Site was near Martinsville, Illinois. The former Martinsville Alternate Site (MAS) is situated on a maturely dissected Illinoian till plain in east-central Illinois. At the surface of the site are veneers of Wisconsinian aeolian and alluvial silts and clays. The Shelbyville Moraine, the furthest southward extension of Wisconsinian glaciation, is located approximately five miles to the north of the MAS. Two intermittent streams, the Kettering and Bluegrass Creeks, are located on the north and east boundaries of the MAS and flow west into the North Fork of the Embarras River, a perennial stream. The alluvial sediments in the stream channels suggest that the North Fork of the Embarras river was a glacial sluiceway for meltwater from the Wisconsinian glacial advances to the north of the site. Further evidence of glacial influence is in alluvial and lacustrine deposits occupying two large buried bedrock valleys under the Illinoian Till. These buried bedrock valleys extend in a north-south orientation across the site and one valley is directly under the present day North Fork of the Embarras River. Site stratigraphy is dominated by two thick Illinoian Tills with basal outwash sands which lie on Pennsylvanian bedrock. The geomorphology of the site has changed little since the last Wisconsinian glacial retreat.

SITE CHARACTERIZATION APPROACH

The general site characterization approach for the Martinsville Alternative Site was to define the geological, hydrological and geotechnical characteristics that could affect the isolation of waste materials, the long-term stability of the site, and the interactions between the site and surroundings environments. The site characterization approach is fully presented in documents developed by Battelle Memorial Institute and Hanson Engineers (1-4). These documents set forth the site characterization objectives, criteria, studies and reports deemed necessary to perform a detailed technical evaluation of the Martinsville Alternative Site. These documents were consistent with standard siting practices and used commonly available technical methods for conducting site characterization. Specific characterization objectives set forth in the "Martinsville Alternative Site Characterization Plan" dated May, 1988 are:

- Achieve and demonstrate compliance with all state and federal statutes and regulations applicable to characterization,
- Obtain sufficient characterization data to determine site suitability,
- Develop sufficient information to reach a high degree of confidence regarding the future licensability of the alternative site, and
- Provide data to the Illinois Department of Nuclear Safety at a quality consistent with licensing requirements.

To assist meeting these objectives, characterization criteria were developed for assessing the geological, hydrological, and geotechnical studies conducted at the site. Geological criteria were developed for the disciplines of geomorphology, stratigraphy, lithology, structural geology and tectonics, seismicity, geological hazards, drilling and mining, and mineral and hydrocarbon resources. Hydrological criteria included surface water flooding and hydrology, water chemistry, water use, regional groundwater hydrology and site groundwater hydrology. Geotechnical criteria included the engineering properties of soils and rock, zoning parameters of soil and rock and site geotechnical parameters. Performance objectives, technical requirements and a standard and/or sufficiency level was established for each criterion. The characterization criteria were to be continuously evaluated to provide high assurance that the performance objectives and technical requirements were met at the MAS.

Paramount in the site characterization was the evaluation of possible offsite movement of contaminants through groundwater flow pathways. Key elements in contaminant transport assessment included development of a detailed stratigraphic model, formulation of a conceptual hydrologic model and preparation of a numerical model to assess ground-water flow and contaminant transport. The stratigraphic model, developed from surficial geologic mapping, sampled borings and geophysical investigations defined the generic relationships, depositional environments and three-dimensional distribution of the Quaternary glacial deposits. This stratigraphic model was used to develop a conceptual hydrologic model. The conceptual model integrated the stratigraphic evaluations with hydrologic data from slug tests, packer tests, pump tests and well hydrographs. The conceptual model provided the geometric framework and parametric input for a numerical model representative of the physical groundwater system at the site. This numerical model, once verified, was used to identify potential contaminant pathways, and the rates and time for travel of contaminants through the ground water flow system to critical environmental access points. The hydrologic model was supported by geochemical and geochronological data obtained from site monitoring wells.

The results of the site characterization activities were presented in a four volume set titled "Alternative Site Investigation Studies, Martinsville Alternative Site, Martinsville, Clark County, Illinois" (1-4) as well as a companion four volume set of data reports. These characterization documents contained an evaluation of the geologic, hydrological and geotechnical conditions at the site and an assessment of site compliance to the rules and statutes. These documents formed the basis for the siting hearings.

SITE SUITABILITY HEARINGS

The Illinois Department of Nuclear Safety began its site selection process in February, 1987. During the next twelve months, 21 counties (out of 102 in the state) and one municipality expressed interest or were considered for siting of the disposal facility. By late January, 1988, only one county and one municipality were left for the Illinois Department of Nuclear Safety to consider for the facility. In March, 1988, the Martinsville site and the Geff site were officially selected as proposed alternative sites. Full scale characterization began at that time. In September, 1989, after 18 months of intensive study of the Martinsville Alternate Site and much controversy with the public and the media, the process of selecting a site was brought to a standstill. Both the Geff and Martinsville sites were still being considered at that time. The Governor of Illinois announced that a hearing officer would be appointed to determine the suitability of the sites. In the meantime, because of public outcry, a special subcommittee of the Illinois *Senate* was formed to investigate alleged improprieties of the siting process by the Illinois Department of Nuclear Safety. In June, 1990, the Illinois legislature amended the Low-Level Radioactive Waste Management Act to include a Facility Siting Commission rather than just one hearing officer. The Siting Commission, as envisioned by the legislature, would be entrusted to assure the public that a low-level radioactive waste facility disposal facility would be safe and suitable. Within a week, the Governor appointed a three-member Siting Commission that included a Chicago attorney and former justice of the Illinois Supreme Court as the presiding hearing

officer, a civil engineer from the University of Illinois, and the former Director of the Illinois Sierra Club.

In January, 1991, the Director of the Illinois Department of Nuclear Safety proposed the Martinsville Alternative Site for the establishment of a low-level radioactive waste disposal facility. On June 12, 1991, the Siting Commission convened in Martinsville for the purpose of public hearings regarding the safety and suitability of the site. Advocates of the proposed facility included the Illinois Department of Nuclear Safety, the Site Characterization Contractor, the Site Design and Operations Contractor, the City of Martinsville, and a local citizens advocacy group. The opponents of the site were a coalition of groups sponsored under the name Concerned Citizens of Clark County. All groups were represented by legal counsel and actively participated during the hearings. The Central Midwest Interstate Low-Level Radioactive Waste Compact funded the local citizens groups, both the proponents and the opponents. The hearings were convened on June 12, 1991 and final arguments were heard on March 28, 1992. During this span of time, 109 witnesses, which included 31 expert witnesses for the proponents, 10 expert witnesses for the opponents, 1 commission witness, 8 governmental witnesses, and 59 public witnesses testified before the commission. Final deliberation took place on October 9, 1992. On December 18, 1992, the Siting Commission issued its final report rejecting the Martinsville Alternative Site.

ISSUES

The central technical positions of the opponents of the site were: the site was not adequately characterized, that the site was too complex for numerical hydrologic modeling to be a reliable tool for estimating contaminant transport, and that the facility design was flawed. The commission took the position that "An especially high level of scientific proof" was necessary to support acceptance of the MAS, since it was a "volunteer" site and had not been uniquely chosen on the basis of "objective scientific criteria".

ADEQUACY OF SITE CHARACTERIZATION

The opponents alleged that the Illinois Department of Nuclear Safety had not adequately characterized the geology of the Martinsville Alternative Site. Witnesses from several agencies and companies, including the Illinois Geological Survey, testified that the Martinsville Alternative Site had been studied more extensively than any other site in Illinois. One contractor testified that he had never been involved in such a massive exploration program that covered such a small area. There was nearly unanimous agreement among Illinois geologists and hydrologists that the Martinsville Alternative Site was well studied. Contractors from the various segments of the characterization program met weekly during all phases of the field work. The plan for each week's boreholes was discussed openly and at length. When each borehole planning meeting was over, every contractor signed off on the proposed drilling program for the following week. Discussions often led to the addition to the boring plan of new boreholes that acquired important new data, and sometimes led to additional lines of inquiry.

Characterization of the 1380 acre MAS included geological, hydrological, and geotechnical studies. Geological and geotechnical studies included 149 boreholes drilled on or near the MAS; 28 additional boreholes south of the MAS; over 10,000 linear feet of logged soil core; 1300 linear feet of logged

rock core; and over 5000 tests of lithic and geotechnical properties of the unconsolidated core: Hydrologic studies included 165 monitored, multilevel piezometers at 75 locations; 100 slug tests; 4 aquifer tests; detailed surveying of the site, detailed measurements of stream morphology; samples for 6 geochemical analysis; 4 angle borehole nests for fracture analysis; 11 packer tests; and examination of over 350 preexisting borehole logs from the Martinsville area. All boreholes included a detailed field log, a secondary examination by a senior geologist, a summary log, and careful cataloging in a controlled access core shed. The aquifer tests included three 7-day pumping tests and one 4 day test. Oversight of the entire characterization program was conducted by quality assurance personnel for both field and in laboratory studies and tests.

SITE COMPLEXITY

In general, the stratigraphy and structure of the glacial till deposits of Illinois are among the least complicated hydrogeologic systems in North America. They are flat-lying saturated, undisturbed layers which have clearly defined hydrologic character. Many such hydrologic systems, and more complex systems, have been successfully evaluated by numerical hydrologic modeling in the last few years. MODPATH and MODFLOW, the models used to characterize the site flow net and to estimate travel times along identified flowpaths to points of contact with the environment, are well accepted models.

The allegation of the opposition that the site is too complex to be adequately modeled was based mostly on the occurrence of local hydrologic inhomogeneities in the till. These included variably distributed fractures, sand inclusions and the disturbance of the tills by hypothetical bedrock tectonic structures which were alleged to have propagated through the till surfaces.

It is well known that the upper surfaces of Tills are often fractured due to desiccation and frost wedging under post-glacial climatic regimes. The opposition alleged that fractures in the till were throughgoing, numerous, and would cause higher rates of contaminant migration than expected. Angle borings through the tills and aquifer tests conducted during site characterization showed that, below a surficial fractured zone, till fractures were too widely spaced to be hydraulically significant.

The allegations of the existence of hydraulically continuous, transmissive sand inclusions in the till were the most extensively debated issue of the hearings. En-glacial channels in the till were alleged to be sinuous, worm-like channels which varied in thickness from fractions of an inch to several feet in thickness, detoured around every boring which could have detected them and hydraulically connected the entire site to the nearest municipal water supply. This issue was debated on a boring-by-boring basis for many days.

The presence of photolineaments, a lattice drainage pattern and Pennsylvanian bedrock structure was alleged to imply Holocene fault activity at the site. Any fault activity was alleged to imply disturbance of the till and potential earthquakes and site surface rupture by faulting. These allegations are far outside mainstream tectonic thinking in the midcontinent region. A few well-known regions having reactivated, surficially expressed Paleozoic structure account for all of the surficial manifestation of faulting in the midcontinental region. No concrete evidence of the displacement of glacial deposits by faulting exists anywhere in Illinois.

The site conceptual hydrogeologic model which was the basis for numerical flow modeling was characterized by the opposition as too simple to represent all of the local hydrologic features of a complex site. The non-site specific parameters used in the numerical model, its boundary definitions and gridding were also foci of disagreement. The site model was confirmed by calibration to a unique set of data from borings excluded from the model database for calibration purposes. The calibration data points were strategically deployed at critical site locations. A calibration was defined as the prediction of hydrologic heads in the calibration borings to plus or minus two feet. The model achieved calibration using site data and regional average data for precipitation and recharge. Much time was spent in the hearing debating the uniqueness and significance of the model result.

Flowpath analysis from the disposal facility area to the nearest point of contact with the environment, a municipal well site, was performed using MODPATH. Travel times in excess of 500 years were predicted using groundwater travel time only as the criterion. Some opposition witnesses, using their own hydrologic scenarios and models predicted travel times as low as sixteen years.

ALLEGATION OF FLAWED FACILITY DESIGN

The opposition was successful in convincing the commission that unless the engineered barriers of the facility could be proven to be totally effective for 500 years, the site must be shown to be capable of total isolation without any consideration of the engineered facility. Three issues were the focus of debate of this matter: The usefulness of waste inventory projection, the service life of concrete and geofabric barriers and the design and monitoring of the post closure drainage system.

The commission and the opponents attacked the Facility Waste Handling Plan and the Radiologic Dose Assessment which was part of the analysis of risk to public health and safety. Some of this issue was focused on assessment methodology, but the most damaging assertion, made by the commission, was that projections of waste inventory should not be used in risk assessment because they could not be known. The reason given for the assertion is that future regulations and disposal needs may change. This argument was used to support conclusions requiring total waste isolation by the site without reference to engineered barriers.

The debate on the service life of the facility included some argument about foundations and earthquakes and long testimony about the stability of high density polypropylene geofabric and concrete. The opponents argued that no in-service experience or studies showed that the facility would maintain absolute isolation of Ions derived from waste by solution for 500 years. This position, in combination with the waste inventory issue convinced the commission that the site alone, without any engineered barriers must totally isolate the waste forever. This position goes far beyond the applicable regulations, and the charter of the commission.

The design and period of institutional care of the facility passive drainage system was also an issue. Design is clearly a licensing issue. The commission called for perpetual monitoring and maintenance of site drainage systems, even though the regulations specify a finite institutional maintenance period.

In the issues surrounding facility design the commission sought justification for its departure from the statutory requirements. The summation of the facility-related issues into a conclusion stating that the engineered isolation of the

facility has no worth in the assessment of risk to health and safety is very controversial.

ALLEGED CONSPIRACY TO FALSIFY THE RESULTS OF SITE CHARACTERIZATION

The opponents alleged that the characterization program was shoddily carried out, data were discarded, and opinions of the site were formed for political and financial reasons rather than scientific. For over 110 respected scientists, including members of Illinois geological survey and Illinois water survey to have endorsed shoddy work or to have subverted the scientific process for political reasons is unthinkable. All databases require editing and are more reliable when spurious and anomalous data are removed. Databases which exhibit exact internal agreement and no variance are impossible in the practice of natural science. Only persons ignorant of natural science in the real world would argue that variability and the presence of occasional outliers in a database indicate that conclusions drawn from that data are invalid.

Thoroughly, sometimes heatedly argued technical interpretations are the most reliable. Disagreement which leads to more thorough consideration and resolution is not, as alleged by the opponents, evidence of a weak investigation. It is, on the contrary, absolutely necessary to the process of scientific study.

The opponents continued to attack the integrity of all proponent parties throughout the hearings. Attacks on corporation's records in the environmental theater, painting of state surveys as political pawns, belittling of local proponents and local government and attacks on individual persons occupied days of hearing time. Often the theme was flawed personal or corporate interest. A very long time was spent questioning the need for more than one hundred fifty flow model runs. Each technical discussion or updating of technical interpretation was represented as a conspiratorial power play by the proponents. This painful aspect of the proceeding was said to be justified by the "political" nature of site selection and the political pressures brought to bear on the site characterization contractors to validate that political decision.

PARTICIPATION OF EXPERTS

The opposition was technically led by a locally born graduate student in hydrology who was seeking his Ph.D. at the state university. Expert witnesses consisted mostly of academics from universities all over the U.S. and a few anti-nuclear consultants. All of the outside consultants for the opposition were incompletely informed about the site and the site characterization results. A few were national experts who came to testify about limited aspects of issues. One opposition expert requested resampling of groundwater from several wells for independent analysis. The samples were taken but results were never testified to.

The advocates called a few expert witnesses of national or world authority stature to rebut arguments offered by opposition witnesses. Many opposition witnesses had their testimony adequately clarified during cross examination.

LESSONS LEARNED

Two kinds of lessons were learned at Martinsville. One kind of lesson is the result of extremely competent and aggressive opposition which found every soft spot in the site characterization documents and presentation. The opposition also

exploited to maximum advantage the commission position that the "burden of proof" lay on the proponents. These lessons concern how to survive an extremely competent and determined attack on a site characterization.

The second kind of lessons learned are more global. The Martinsville hearings were the first of their kind. Somewhat similar proceedings will be a part of the process for other low level nuclear waste facility sites, as well as for other kinds of disposal facilities. Precedents established at Martinsville do not have the same character as courtroom precedence, but the conduct of these hearings and the principles of site consideration adopted will shape future hearings.

SITING LESSONS

- Integrate all aspects of the site characterization for agreement and accuracy during the site characterization process. Carefully review all documents for contradictions and errors. Conduct ongoing review during the entire process by an independent, experienced site integration staff whose ultimate task is insuring the defensibility of the process and results.

There were errors in tabulation of data, omission of critical analytical and confirmatory steps and a failure to address of issues of data sufficiency. By discrediting a small part of the supporting database, the impression of collapse of the proponents conclusions was created. Editing of the database was also attacked as introduction of bias into characterization results. There are strong geostatistical procedures which would have protected the integrity of the database. The errors in the database and the omission of key confirmatory steps in the geochemical analysis should have been prevented by thorough review.

- Leave no loose ends. Unclosed loops are "Fair game" for reinterpretation of unanalyzed or unrepresented results and can be interpreted as "coverups."

A particularly difficult aspect of the defense of the site was a geophysical investigation which was abandoned when it did not deliver expected quality of resolution of the subsurface structure at the site. The opposition acquired the unanalyzed database from the seismic reflection and refraction lines and commissioned reprocessing and reinterpretation of the data by experts in their employ. These reinterpretations were biased to damage the conceptual model of the site, and though conclusively rebutted by proponent experts, eroded confidence in the care and thoroughness of the site investigation.

- Adopt a clear and appropriately documented methodology for change control, not only in such details as data acquisition plans, but whenever fundamental changes in technical interpretation occur. Don't squabble and don't commit unstructured argument to record.

The largest total number of hours during the hearings were spent discussing changes in interpretation of stratigraphic details at the site during the data acquisition phase of work and evolutionary changes in the site model. Lack of structure for dealing with change, poor communication, and a "fire fighting" mentality led to an incorrect but damaging perception that improper pressures were a factor in the final interpretations of the persons responsible for site characterization. Normal and proper debate of issues of technical interpretation during planned data collection and resulting expansion of the database are essential to reliable site

characterization results. Even when the final interpretation is confirmed by characterization and wide supporting consensus is reached among the qualified scientific community, undisciplined behavior weakens the credibility of the final site characterization. Persons who took careful notes about the peripheral aspects of squabbles, including some namecalling incidents, spent some very uncomfortable moments on the witness stand.

- Expect to be smeared. Adopt a sensible, honest set of policies that will keep small disputes, misunderstandings and indiscretions from growing into problems. Don't deny errors and make correction of errors well known.

A very painful aspect of the hearings was the degree to which attacks on the personal integrity and credibility of proponents of the facility was permitted and accepted by the commission.

- Continuously re-review all aspects of interpretation, analysis and models. Technology evolves over the three or five years a site is under consideration. Attacks on adequacy often contain allegations of "new" understanding of issues.
- Use the modern tools: site decision analysis, technical opinion polling, the observational approach to site characterization, data worth analysis, simultaneous engineering, and others. Site characterization is a rapidly evolving art.

Many of the issues which were the source of negative responses by the commission could have been prevented or more clearly addressed through recently developed siting methodology. Documentation of non-site specific parameters and support of mainstream interpretations can be developed through formal polling procedures. Integration of conceptual and numerical models and configuration of database adequacy are most effective when done through available formal geostatistical approaches. Much of the misdirection and miscommunication which took place at Martinsville could have been replaced by clear, structured documentation.

- Don't spare the technical horsepower and use only technically qualified legal staff. Make sure that legal staff and technical experts work together.

GLOBAL LESSONS

- The commission positions that a specific site waste inventory projection is an inappropriate part of site performance assessment and that no credit may be taken for engineered barriers in consideration of site adequacy are outside the regulatory positions on

these matters and make rational site performance assessment impossible.

- Perpetual monitoring and maintenance of closed facilities was endorsed by the commission. The prohibitive costs and societal inability to guarantee perpetual institutional custody of facilities are a fundamental premise of the regulatory framework.
- The commission did not honor the siting regulations, either by its conduct of the hearing or by its willingness to place requirements for approval which went far beyond regulatory requirements. If the regulations are not the guiding principles of siting for facilities of all kinds, the siting and characterization tasks can not provide useable sites within acceptable time frames.

CONCLUSION

The fundamental lessons learned at Martinsville are two: 1. The opposition to low level nuclear waste facilities is strong and extremely competent. Only impeccable site characterizations can be expected to survive the approval process, and 2. Technically uninformed commissions who do not follow the spirit or the letter of the statutes and the regulations, can make the rational choice of sites for these critically needed facilities impossible.

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