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DRAFT

Rec'd 10/16/80
from H. Singh

NCEED-T

SUBJECT: Interagency Agreement No. NRC-03-79-167 Task No. 1 - Midland Plant Units 1 and 2, Subtask 3

THRU: Division Engineer, North Central
ATTN: NCDED-D (James Simpson)

TO: U.S. Nuclear Regulatory Commission
ATTN: Mr. George Lear, Chief
Hydrologic and Geotechnical Engr. Br.
Division of Engineering
Mail Stop P-214
Washington, DC 20555

1. As advised by your staff, the Detroit District is furnishing the following additional questions for interrogatory input for the project. These questions combined with those given in our letter report of 7 July 1980 will form our input for the interrogatory questions. We understand that these questions may be asked after 29 October 1980 following the deposition inquiries.

2. A listing of the questions generated as a result of the review of Midland Unit 1 and 2 follows:

a. Auxiliary Building:

From the minutes of the applicant's presentation of 18 July 1979 in its meeting with the NRC at Bethesda, and also from its presentation of 28 August 1980 at the plant site, it appears that the remedial action measure for the inadequately compacted soil under the electrical penetration rooms of the Auxiliary Building is to bridge over the questionable soil, utilizing the structural capacity of the electrical penetration rooms by providing caissons at their extremities. This arrangement would transmit half of the load of the electrical penetration rooms on the proposed caissons and the remaining half on the control tower, thus increasing the pressure on the foundation soil under the control tower. Provide analyses showing that the fill material under the control tower has sufficient bearing capacity to carry the additional loads with an adequate factor of safety and also the settlement under the control tower created by the additional loads would not create serious cantilever action at the junction of the control tower and the main body of the Auxiliary Building.

b. Diesel Generator Building:

In response to NRC question 27 (10 CFR 50.54f), the applicant has attempted to justify the results of the preload tests as realistic and valid information to predict the future settlements of the Diesel Generator Building and the machine pedestals. In Subsection C, Method of Prediction, on page 27-3, it has been stated that primary consolidation was accomplished quickly after completion of the placement of fill. This was shown by observing that pore pressures were smaller than actually anticipated, and they dissipated rapidly as shown in Figures 27-7a and b.

A review of the piezometer readings obtained after the removal of the surcharge load (PZ-1, PZ-13, PZ-21, PZ-40, PZ-37, etc.) shows a trend of sharp decrease in piezometric heads indicating that excessive pore water pressure was not completely dissipated, and as such, the primary consolidation was incomplete. The gradual slow rise in piezometric head with time, after a sudden drop in the head upon removal of the surcharge could be due to the water table under the preload area not having reached a state of equilibrium with the water level in the cooling pond. The water table was still rising at a decreasing rate under decreasing differential hydraulic head causing seepage through the fill material between the cooling pond and the preload area. The differential hydraulic head affecting the groundwater level under the preload area was less than, and was balanced by, the excessive pore pressure created by the preload and as such, stopped seepage from the pond to the preload area during the surcharge period. As soon as the excessive pore pressure disappeared due to removal of the surcharge, the water table started rising which has been indicated by the rise in piezometric head after the removal of the surcharge.

From the above facts, we conclude that:

(I) The excessive pore water pressure created by the surcharge was not dissipated before the removal of the surcharge load.

(II) The primary consolidation was not 100% complete.

(III) The consolidation parameters obtained from the preload test results cannot be used to accurately predict the future settlements of the Diesel Generator Building.

(IV) The soil above elevation 622.0 was not saturated so consolidation was hindered due to capillary action in this area.

c. Duct Banks:

The applicant's response to NRC Question 7 (10 CFR 50.54f) indicates that prior to their isolation from the footings of the Diesel Generator Building, the duct banks carried a considerable portion of the building loads. The applicant's evaluation of the strains due to such load transfer shows yielding

of the duct banks' reinforcing bars at the critical location, Point A shown in Figure 7-2. The deflections in the duct banks prior to their isolation varies from a maximum of 1.56 inch in bay #1 to a minimum of 0.95 inch in bay #2. Very little rebound (upward movement) of the duct banks were observed after their isolation from the footings of the Diesel Generator Building indicating that the duct banks had yielded.

The yielding of reinforcing bars of a reinforced concrete member is always associated with wider cracks in the member. Therefore, wide cracks are expected at the critical points of the duct banks. The inability of the duct banks to rebound back to their original positions are also an indication of the fact that their flexural integrity is not intact. The capacity of the duct banks, in the existing condition, must be evaluated to determine whether or not these members are capable to withstand seismic loads with an adequate factor of safety. Provide the analyses and discussion that substantiates your statement that the duct banks are capable to perform their functions.

d. Differential Settlement of All Seismic Category I Structures:

(1) On pages 15-1 of the response, the applicant has stated that for Seismic Category I structures, which were founded partially upon fill and partially upon natural soil, the differential settlement would be evaluated in accordance with the provisions of ACI 318-71 code. The code considers the differential settlement in the form of additional factored load combinations as follows:

U = .75 (1.4D + 1.4T + 1.7L)
U = 1.4 (D + T)

Where:
U = required strength to resist design loads
D = dead load
L = live load
T = cumulative effects of temperature, creep, shrinkage, and differential settlements.

The code also gives factored load combination for dead load, live load, wind load, and earthquake. However, there are no requirements for combining the load from differential settlement with the extreme loads from wind and earthquake.

In our opinion, the applicant's interpretation of ACI 318-71 code regarding requirements for combining the loads from differential settlement with those from earthquake is not correct. According to Section 9.3.7 of ACI 318-71, the effects of differential settlements shall be included with the dead load, and the required strength 'U' shall be at least equal to .75 (1.4D + 1.7L). This equation, U = .75 (1.4D + 1.7L) is identical to Equation 9-1 of Section 9.3 of ACI 318-71, and is applicable only when the structure is not subject to wind loads or earthquake loads. When the structure is likely to be subjected to wind load or earthquake load, the provisions of Section 9.3.3 must be used with modified dead load as per requirement of Section 9.3.7.

(2) On page 15-2 of the response, the applicant states that the Midland project structural design criteria for Seismic Category I structures that are partially founded upon fill will be expanded to include the differential settlement effects by the addition of the following load combination:

Normal Operating Condition

$$U = 1.05D + 1.28L + 1.05T$$

and

$$U = 1.4D + 1.4T$$

These loading combinations will insure serviceability by combining the differential settlement effects with long-term operating loads.

Severe Environmental Conditions

$$U = 1.0D + 1.0L + 1.0T + 1.0W$$

and

$$U = 1.0D + 1.0L + 1.0T + 1.0E$$

These loading combinations consider the effects of operating loads and settlement combined with either the design wind or operating basis earthquake. These additional provisions are beyond the ACI 318-77 code requirements, and are included to maintain safety margins consistent with nuclear industry criteria (see ACI 349), because the wind and operating basis earthquake loadings are considered to occur more than once in the life of the plant.

On comparing the above equations with the ACI 349-76, it appears that the requirements of the ACI 349, as claimed by the applicant, are not satisfied. The load factors considered by the applicant for the severe environmental conditions are not consistent with those of Equations 9, 10 and 11 of Section 9.3.1 of the ACI 349-76, which, in conjunction with Section 9.3.3, are used to determine the required strength "U" of the nuclear safety related structure. The applicant should provide explanation for this major discrepancy. The applicant should also explain why other requirements of Section 9.3 of ACI 349 are not considered in the design of Seismic Category I structures.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

8/B2 Sent to Full Service list even though 1st pg is ... ...

JAN 6 1981

Docket Nos.: 50-329/330 OM, OL

APPLICANT: Consumers Power Company

FACILITY: Midland Power Company

SUBJECT: SUMMARY OF JULY 31, 1980 MEETING ON STAFF REQUEST FOR ADDITIONAL SOIL BORINGS AND TESTS

On July 31, 1980 the NRC staff and its geotechnical consultant, U. S. Army Corps of Engineers, met in Bethesda, Maryland with Consumers Power Company, the Bechtel Corporation and Bechtel consultants Dr. Ralph Peck to discuss a staff request of June 30, 1980 for additional soil borings, laboratory tests and studies of results. Meeting attendees are listed in Enclosure 1. Enclosure 2 is the meeting agenda.

Enclosure 3 is the meeting summary prepared by Mr. T. R. Thiruvengadam of Consumers Power Company. Because of the detailed summary provided by Enclosure 3, further summary by NRC would be redundant and is not provided. Enclosure 4 contains the visual aids used during the meeting.

The staff noted that further detail and explanation of the June 30, 1980 request would be provided in a follow-up letter in early August, 1980.

While the meeting provided a worthwhile exchange of views as to the reasons for the staff's request, the meeting did not convince the applicant (1) that the staffs requests were necessary to support a conclusion regarding the adequacy of the proposed or completed remedial actions associated with inadequately compacted soil fills or (2) that further exploration of the earthen dikes of the cooling pond should be undertaken. In addition to reasons stated in Enclosure 3, Mr. J. Wanzeck of Bechtel stated that the estimated costs of the requested borings was about one million dollars and the applicant expressed doubt that the derived benefit, if any, would be comparable. The Corps felt this cost estimate was excessive and noted that comparable borings in its experience would cost about $50,000 at most.

8101140815 (35)

JAN 6 1981

The applicant will consider further what action will be taken to resolve this impass regarding the need for further borings and tests.

Darl Hood

Darl Hood, Project Manager
Licensing Branch No. 3
Division of Licensing

Enclosures:
1. Attendees
2. Agenda
3. Summary
4. Visual Aids

cc: See next page.

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Enclosure 1

ATTENDEES

July 31, 1980

Name	Organization
Darl Hood	NRR/LB#3
Bill Paton	NRC - Attorney
Ralph B. Peck	Consultant, Bechtel
Thiru R. Thiruvengadam	Consumers Power - Civil
S. S. Afifi	Bechtel - Geotech.
Walter R. Ferris	Bechtel - Geotech.
J. O. Wanzeck	Bechtel - Geotech.
Shing C. Lo	Bechtel - Civil
D. E. Sibbald	Consumers Power Co. - Civil
G. S. Keeley	Consumers Power Co.
Karl Wiedner	Bechtel - Engr.
Ron Erickson	Corps of Engineers - Geotech.
William C. Otto	Corps of Engineers - Chief Geotec.
Joseph Kane	NRC, Geot. Engr., DE, HGEB
John Norton	Corps of Eng. - North Central Div., Geotech. Br., Chicago, Ill.
James W. Simpson	Corps of Eng. - North Central Div., Geotech. Br., Chicago, Ill
Hari N. Singh	Corps of Engineer, Detroit District

ENCLOSURE 2

MIDLAND PROJECT MEETING WITH THE
NRC/CORPS OF ENGINEERS ON SOILS
WASHINGTON, D. C.
July 31, 1980

Agenda

1. Summary of total investigative program

2. Update on investigation since last submittal

   a. Settlement observations of structures

   b. Settlement observation during localized construction dewatering

3. Review NRC letter of June 30, 1980

4. Summary

GSK

ENCLOSURE 3

7/31/80

To File 0485.16

From TRThiruvengadam TRT

Date September 24, 1980

Subject MEETING WITH NRC STAFF AND CORPS OF ENGINEERS ON SOILS JULY 31, 1980
FILE: 0485.16 UFI: 00234(S) 71*01 SERIAL 9830

CC SHHowell
JWCook
DBMiller/TCCooke
TRThiruvengadam
JEBrunner
JARutgers, Bechtel
KWeidner, Bechtel
MMiller, IL&B

The following are meeting notes of a meeting between NRC Staff, NRC's Consultants, Consumers Power Company, Bechtel and Bechtel's Consultants.

Place	NRC Offices at Bethesda, MD
Date & Time	July 31, 1980 - 8:30 AM
Subject	Soil/settlement issues - 50.54(f). Specifically, recent requests from Corps of Engineers for additional soil borings and laboratory tests on samples taken and interpretation of results.
List of Attendees	See Attachment 1.
Agenda	See Attachment 2.

1. Opening Remarks (G S Keeley)

Meeting was called by CP Co's request primarily to update NRC and its consultants on investigations done since last submittal and to discuss the technical justifications and need for requesting additional borings and

laboratory tests on samples by Corps of Engineers in the recent letter from A Schwencer of the NRC to J W Cook of CP Co dated June 30, 1980.

2. Summary of Total Investigative Program (J Wanzek) (Attachment 3)

To date a total of 255 borings were made since late 1978, out of which boring logs for 199 borings have already been submitted to NRC. The logs for remaining 56 borings are being checked and will be given to NRC in the next submittal. Most of the borings belonging to the latter case were done for construction dewatering effort in order to repair a duct bank and install a valve pit. A drawing with all the locations for borings and including test pits was shown. The investigations done since the preload programs were circled in green pen to differentiate these recent borings from those taken prior to the completion of the preload program. The majority of the borings were of the standard SPT type; namely, SPT every 2.5 ft for the first 10 ft and 5 ft afterwards. When the soil samples were taken, only specific tests that were needed were performed. For the 56 borings, the standard penetration blow counts were recorded. Some of the boring logs requested by the Corps in the letter referenced earlier were companion holes, mainly for observing the drawdown during operations. Though these holes were identified in the drawing as to their locations, no samples were taken in these borings.

Question: Were any surprises encountered in the results of borings performed after preloading? When were the additional borings in diesel generator building area performed?

Response: No surprises were encountered. The information was similar as before, if not better. The additional borings, for cross-hole tests, were done during December of 1979. The preload was taken off approximately four months earlier.

The test pits (seven of them) were dug in the areas shown in the drawing. Two plate load tests were performed in the tank farm area.

Thirteen dutch cone probe tests were performed with the assistance of Dr R D Woods of University of Michigan in the diesel generator building area. Four cross-hole tests with 21 borings were performed, with the assistance of Dr R D Woods, in four areas as indicated in response to question 35. Laboratory tests performed on selected samples, when required, consisted of shear strengths, consolidation, compaction, Atterberg limits, grain size and clay minerology (with the assistance of Professor Gray of University of Michigan).

Load Tests

1. The preload program on diesel generator building is actually a full scale load test. At present, equipment is being installed in the building.
2. Condensate Storage Tanks: Load test is in progress.
3. Diesel Fuel Oil Tanks: Load tests have been completed. The tanks have been filled for a period of more than three months. Insignificant settlements were observed during the load test and there was no significant rebound after the load was removed.
4. Borated Water Storage Tanks: Load test on these tanks are planned for the near future. There is still some construction work being done on these tanks.

Pump Tests (Dewatering)

Drawdown during construction dewatering for the repair of a duct bank and valve pit work were monitored. Four to six feet of drawdown was measured with no measurable effect on settlement. This aspect will be covered later in this presentation.

Question: (Hood) Last February during a site visit it was observed that the service water pipe entering the pump house structure was supported on wedges. A concern was expressed at that time that if the wedges were removed and if the building or the pipe settled, there is a possibility that the pipe would get hung up on the building, resulting in unacceptable stress levels in the pipe. Has this situation changed and has a program been established to monitor this pipe and other pipes in similar situations?

Response: These wedges have since been removed. In one of the pipes, after the wedges had been removed a movement of 1/32" was measured. Borros anchors installed in the vicinity of service water pipes showed no significant settlements during construction dewatering.

Question: (Heller) How deep were the excavations for the repair of the duct bank? Were any geotechnical tests or investigations conducted during the excavations?

Response: The depth of the excavations were in the range of 18 feet. No geotechnical investigations were conducted. Only borings for dewatering were made.

Update On Investigation Since Last Submittal

Settlement observations made on diesel generator building structure is as shown in Attachment 4. The latest settlement reading, as of June 12, 1980, shows no significant increase in settlement. In comparison, the projection of original slope; namely, the predicted settlement curve, indicates the conservatism in the settlement prediction. Predicted versus measured settlement is shown in Attachments 5 and 6. Again, the comparison demonstrates the conservatism in the prediction.

Question: (Hood) The small break in measured settlement plot in Attachment 4 - does that indicate rebound?

Response: No. Slight rebound immediately after preload removal was observed. However, the break in the curve is not due to rebound. It is due to change in reference bench marks. Again, it doesn't mean data is lost, it merely indicates change in datum.

Question: (Hood) Are differential settlements between condensate pipe line and condensate tank being monitored?

Response: No. Condensate tank is a Nonseismic Category I structure. Only the settlement of condensate tank is being monitored as a part of overall monitoring program.

Question: (NRC) The settlement prediction in Attachment 4 - does it include settlement due to permanent dewatering?

Response: No. The settlement due to permanent dewatering has been computed separately. This has been addressed in Response to Question 27. There was a drop in water level of about 4 ft at the diesel generator building structure due to pond lowering and construction dewatering. There was no settlement observed due to this drawdown. Furthermore, the Borros anchors located adjacent to the service water pipe lines and pump house structure showed only small settlement.

Question: What is the schedule for starting the dewatering operation?

Response: CP Co was ready to issue the contract bids for temporary dewatering on December 6, 1979, however, due to the NRC order issued on December 6, 1979 on remedial action, CP Co has not started temporary dewatering or remedial action.

Question: (Corps) If the dewatering and underpinning operations are done simultaneously or in quick succession, wouldn't dewatering result in settlement of footings of adjacent buildings which could cause additional load on the caissons?

Response: Dewatering is intended to be done down to the glacial till. There will be sufficient time gap between the completion of dewatering and start of transferring load to the caissons.

Question: (NRC) Would the dewatering of the plant area cause inflow from outside sources such as Dow chemical pond? Is there a need for a monitoring program to assure the proper functioning of the cut-off wall in the plant dike?

Sufficient information on plant dike, such as cross-sections, materials used and relative elevations of Dow's chemical pond, etc, is not provided in FSARs.

Response: As a part of dike monitoring program, the dikes are observed for undue seepage. No such seepage has been observed so far. When the groundwater elevation at the plant site was at 623 (±) and elevations of chemical pond on the west end and river on the east being considerably lower no undue seepage was observed. This lack of water movement established the proper functioning of the cut-off wall and, therefore, no special monitoring program is intended. In addition, a few piezometers located on either side of the plant dike confirm the observation stated above.

Remarks (G S Keeley)

CP Co would like to discuss the requests made in NRC's letter dated June 30, 1980, specifically items (1) to (4) in the letter. CP Co would also reiterate the guidance given previously by the NRC that the original requirements in PSAR would not be changed now, and the FSAR would be accordingly revised once the 50.54(f) issues are resolved.

Response: (Hood and Corps)

The statements made in Items (1) to (4) in the letter are to be construed only as comments on responses provided CP Co.

Statement: (Peck) Concerning Items (1) to (4) of the Referenced Letter

There is no doubt that if one goes into the fill now and measures the common properties which are normally used as control properties, such as density, moisture content, etc, one will find considerable scatter in the properties. These are all index properties. The overall control property is compressibility. Stressing the soil by overloading it including the effects of dewatering, allows the compressibility to be measured thereby allowing a reasonable settlement prediction to be made. One of the reasons why the pond water level was raised prior to the completion of the preload was to saturate the fill as much as possible. At that time, the water table was two to four feet beneath the footing level. The capillary action in the zone above the water table would be preserved, sands and clays would consolidate. With regards to the request for additional soil borings in order to obtain an independent verification of the predictions for future settlement, independent results could be obtained from the results of new borings and tests. However,

settlements computed from the results of new borings and tests need not necessarily result in a correct prediction. The answer we want to verify is already known from the preload program. During the boring process there would be sampling disturbance which would result in predications of much higher settlement than would actually be observed. There would also be considerable scatter in test results. Some borings will show stiff material and probably an equal number of borings may show soft material. In order to obtain reasonable conclusions, one would have to treat the data statistically. The settlements computed on these bases would turn out to be too large and the question is what does this data mean, since the preload program has already answered the question. Now, one can turn the tables and ask a question that with soil data having considerable scatter, such as those that would be encountered here, what one would do if settlement prediction is required, one would most surely require proof load testing. In our case this has already been done. There has been no significant settlement in the last eleven months. Except for the pedestal, the structure is almost fully loaded and contact pressure at the bottom of the footing is probably near the maximum value and with this situation no further settlement has been observed. The final soil pressure under the pedestal is going to be considerably less once the diesel generator is placed than that experienced during the preload. Furthermore, during temporary dewatering that is scheduled to be performed for underpinning operations under auxiliary building wing walls, the water table would be lowered almost to the same level as under the permanent dewatering scheme. By this means, the real settlements of the structure would be known before the plant actually goes into operation.

The settlement predictions due to dewatering are not going to be based on information from tests done on soil samples but instead on actual readings taken from drawdown during temporary dewatering programs over a very large area. The entire approach has been based on performance of the soil under fully loaded conditions and the settlements will be known and can be predicted with great accuracy before the plant goes into operation.

Such an approach in settlement prediction is not without precedents for nuclear power plants. In the Kewanee plant, currently in operation, a 40-ft clay layer was encountered. Extensive sampling of the soil was done and the computations from laboratory tests showed a prediction of settlement of 15 inches, which is definitely not a reasonable number. There was evidence that the clay was precompressed by glaciation since a fairly thick layer of till had to be removed to reach the clay layer. One clay layer above the rock was very uniform in moisture content which indicated that it is lacustrine, however, strength values varied widely. From such observations the magnitude of the preconsolidation load was computed and a settlement value of 1-1/2" was predicted. The structural foundation consisted of a raft foundation, which was poured in sections. Very accurate settlement measurements were taken. The measured settlement turned out to be 1-1/2" as predicted for the foundation. At its completion, the structure experienced an additional settlement of 0.15" On the basis of sampling and testing, the predictions would have been ten times higher.

As another example, for the Quanicassee plant, originally proposed and later cancelled by CP Co, borings and sampling indicated 10" to 15" of settlement of thick deposits of clay and granular material. A limited dewatering program was carried out, wherein the water table was pulled down to. the rock level, thereby loading the deposit by removing the buoyancy. Piezometers responded in predictable fashion, deposits behaved elastically and a direct measurement of confined modulus resulted in a measured settlement of 1.5" which was 1/8 to 1/10 of the settlement prediction obtained from conventional sampling techniques. These examples show that the best possible sampling techniques and subsequent laboratory testing and theoretical computations will result in computed settlements which could be very high. By the preloading program the best possible answer was obtained. One will put themselves in a considerably difficult position if one has to go back and start taking samples and predict settlements based on laboratory tests and find that the predictions are orders of magnitude higher than what was observed.

Question: (Hood)

Recognizing that this is the state of the art at that point in time, is it possible to use the observations made in Kenwanee and Quanicassee to refine the sampling techniques and methods of computations so that this can be applied to cases such as Midland?

Response: (Peck)

Standard techniques consisting of sampling, laboratory testing and theoretical computations don't work well on overloaded clays, stiff soils and compacted fills. Such methods are good for materials such as homogenous clays and soft soils.

Question: (Hood)

Why can't results from field experiences such as Kewanee be the source for a great deal of research in the field of soil mechanics in order to devise means to improve the predictions?

Response:

Yes, considerable research is in progress. Considerable advancement has been made in many areas such in sampling techniques, however, not in all aspects of soil mechanics. It should be realized that soil mechanics by no means is an exact science. It is still an art in many areas.

With reference to Item (4) of the referenced letter, it should be pointed out that there was no simultaneous raising of water table and the preload surcharge. Once the final preload was achieved, both levels were constant for the entire period of surcharge. Water level was raised to eliminate capillary as much as possible and to saturate the clays. This enabled the piezometers to react well. By raising the water level three to four feet, the effective load was slightly reduced due to buoyancy effect, however, this was a reasonable price to pay for the benefits stated above.

Questions: (Corps)

If some fill was placed dry of optimum, what would be the effect?

Response: The effect would not be crushing as it could not be that dry. However, it would have been distortion; ie, change in shape. This would have been noticeable in time e.g in settlement similar to creep phenomenon. The bending and distortion shows up in secondary consolidation, which is included in the prediction.

Question: (Corps)

If some fill were placed wet of optimum, what would be effect on strength?

Response:

This question is difficult to address directly. Settlement curves have shown that settlements have been stabilized for the last 11 months. Building footings are now experiencing the soil pressure very close to their final value. With the additional load there has been no settlement. Even in brittle clay, with a nonlinear settlement curve, the curve tends to fall over. There is not a slightest indication of this behavior. Therefore, the factor of safety is considerably higher than 1.0.

The present data indicate some rebound following removal of the surcharge, therefore the foundation contact pressure is less than under the surcharged conditions. The factor of safety must be at least one and is clearly greater than this. There is experience (Fargo grain elevator) that even in stiff materials there is nonlinear behavior at loads above about 80 percent of the ultimate. Therefore, the factor of safety is clearly significantly larger than one since nonlinear behavior has not been recorded. The factors of safety beneath the generator pedestals will be even greater because the current pressure is less beneath them.

Question:

All the preloading has been at the surface, where influence would be to impart maximum stress near the surface and decrease in stress with depth. However, stress due to dewatering will have the opposite distribution. Minimum near the top and increasing with depth. Won't this induce more settlement?

Response:

The part of the material compressed most due to surcharge is the upper part. Borings made earlier showed that the top 15 feet formed the poorly compacted fill. Fill below elevation 615 (±) had high blow counts, indicating good compaction. The deeper the soil layer, the greater is the overburden stress. In e-logp curve, more $\triangle$ p produces less $\triangle$ e. Therefore, one would expect to see little settlement due to drawdown. There may be areas wherein the dewatering would induce stress more than the preload. However, the effect of this would be observed during temporary dewatering.

Question: (Corps)

Settlement plot indicates that contact pressure under footings may not be uniform and wouldn't this cause overstress of soil exceeding bearing capacity and overstress of the structural elements.

Response:

Most of the settlement of the diesel generator building was due to the settlement of the fill. The building just went along for the ride. Because of the differential settlements observed, contact pressure may not be the same. However, the building was surcharged both inside and outside uniformly. Initially a portion of the building was hung up on a vertical duct bank. Once this was removed, the building settled uniformly. The stress in the building was evaluated by analyzing the building with variable foundation modulus.

Response: (Afifi)

Regarding the question of safety factors against bearing capacity failure, the issues have alrady been addressed in response to Question 35. Consolidated undrained triaxial shear strength tests were conducted on samples of plant area clay fill, in areas such as transformer, condensate tanks, taken during the 1978 exploration program. See attachment 7 for a plot of undrained shear strength versus confining pressure from these tests. Based on undrained shear strength from the normally consolidated envelope a factor of safety 3 for dead and live loads and greater than 2 for dead plus seismic loads have been calculated.

Question: (Corps)

How can one be sure that such confining pressures exist.

Response:

It is more likely that very high confining pressure exists in the field due to lateral stresses arising out of surcharge.

Question: (Corps)

The borings from which these tests were done and the depths at which these test samples were taken are not currently available. Could this be provided?

Response:

Yes. The requested information will be provided in our next submittal.

Question:

Modulus of elasticity was computed based upon the unloading curve. Shouldn't this be computed on the basis of a reloading curve?

Response:

The lab tests usually show a hysteresis type of curve for unloading and reloading. This is primarily due to side friction in the sample testing process. However, in the real situation, there is very little difference between unloading and reloading curves.

Question: (J Kane)

We would predict considerable rise of pore water pressure immediately after surcharging. However, piezometers didn't indicate this. Could this be due to bridging and arching of clay over rigid sand seams? Also in fourteen piezometers, recovery of pore pressure was noticed after the load has been taken off. How w ld one explain this phenomenon?

Response:

The rapid dissipation of pore water pressure is anticipated earlier because borings indicated sand layers and seams and clay would have macro voids which are typical of compacted clay fill. The surcharging process took several days and pore pressures were being rapidly dissipated during the surcharging operations. The surcharge causes excess pore pressure to be driven off, which results to a certain extent in negative consolidations and the reason as to why fourteen piezometers showed recovery of pore pressure was the reflection of the pond.

Question: (Heller)

Can't additional testing be done with refined sampling techniques?

Response:

It is possible, however, the reason for not doing it is not to get into a statistical argument because of unavoidable scatter in test results.

Question: (Heller)

The factor of safety for bearing capacity is known only to be at least equal to 1.0. Is it 1.2, or greater?

Response:

Shear strength at footing level may show a lot of scatter. Any compaction of sand layers observable from blow counts in a boring with SPT would be obscured in the scatter of the N values. The bearing capacity factor of safety may need some confirmation. For this purpose, load tests on larger masses of soils are preferable.

Question: (Heller)

The more heterogeneous the soil, the more samples it would require. It still would be possible with adequate samples to reach an independent conclusion.

Response:

The question is what is needed to be known. The preload has given the answer one needs to know. A lot of money has been spent on this preload program. The main purpose was to consolidate the fill and in the process obtain the required answer.

Question: (Corps)

This is not an ordinary structure, one has to be 100% sure, hence the need for additional borings.

Response:

The testing program outlined by the NRC will not erase the doubts so that one can be 100% sure. It will introduce more doubts and raise more questions which cannot be explained with the current state of knowledge.

In summary, there are three basic issues:

1. Dewatering: The effects of dewatering can readily be observed and measured, before the operation of the plant, by starting the temporary dewatering operations soon.
2. Bearing Capacity - (factor of safety): This could be more expeditiously determined by large scale direct tests, such as plate load tests.
3. Adequacy of Surcharge: This is a false concern since evidence of reality (settlement measurements) is quite sufficient.

<u>Discussion of additional borings adjacent to auxiliary building electrical penetration areas, service water pump structure and retaining walls.</u>

Presentation (T R Thiruvengadam)

The referenced letter requested additional borings with extensive laboratory tests adjacent to electrical penetration areas, service water structure and Category I retaining walls. The purpose of this investigation would be to verify the design capacities of caissions and piles for vertical load carrying capability and stability of retaining wall. Caissons will be driven into the till layer. The caissons will be typically,

four feet in diameter such that it enables a person to get down and inspect the till before concrete is placed. Furthermore, the caisson will be load tested to 1.5 times its design load and also has rigid settlement criterion. Similarly, the piles for service water structure also will be driven well into till until refusal. The designs capacity of the pile will be determined from a pile load test. Preliminary capacities for caisson and pile were established from initial recommendations made by Dames & Moore Report. Caissons and piles are designed to carry only vertical load and lateral loads due to earthquake are transmitted through a different system. Skin friction on caissons and piles will be very small since most of the settlement in fill due to its own weight have taken place already. The settlements reported in retaining wall were observed immediately after construction. Since then, no significant settlement has been observed.

Question: (Corps)

Are there any boring and test data from Dames & Moore Report that could provide data in lieu of information that could be obtained from borings requested by the NRC for auxiliary building and service water pump structure.

Response:

The data from Dames and Moore Report will be investigated for such a case. However, in order to provide meaningful information, boring data in the vicinity of the caissons would be required. Due to the presence of adjacent structures, even a new boring would have to be located 20 to 30 feet away from the edge of the auxiliary building.

Statement (Corp)

A boring at that distance would be adequate.

Cooling Pond Dike

Presentation (Wanzek and Sibbald)

The letter requested several borings in cooling pond dike. CP Co's position is that it is not necessary, not only because it is a Nonseismic Category I structure, but also for the following reasons:

1. Extensive stability analyses of the dike slope are provided in the FSAR.
2. The dike was built under a different specification, which is a method specification. This specification relied on the method of compaction such as number of passes of rollers, lift thickness, etc, and compaction test results.
3. The dike was built by a different contractor. It was a large structure, heavy equipment was used with very little use of hand held equipment for compaction and therefore resulted in better control.
4. Monitoring of the settlement monuments, 27 in number, show no significant settlements. The pond has been filled for two years with no adverse conditions noted.
5. Scheduled semiannual inspections are performed by walking the entire dike area to observe seepage, stability problems, erosion, etc.
6. Piezometers located in the dike which are read monthly show stable levels.
7. Several borings in the dike area, during construction, showed considerably better material than in the Category I fill.
8. Drilling holes at this stage might result in a potential for damage due to hydraulic fracture resulting in dike failure.

Conclusion

After all the detailed technical discussion NRC and their staff reiterated their requirements for additional borings and testing. CP Co stated that, based on the recommendations of their consultants, we don't feel the additional borings are needed or justified. CP Co stated that it would provide the information on borings already taken as well as other information requested in this meeting by a submittal on or before September 15, 1980.

ENCLOSURE 4

VISUAL AIDS USED DURING
7/31/80 MEETING

SUMMARY OF INVESTIGATIONS
PERFORMED
SINCE AUGUST 1978 TO DATE

I. Borings, test pits, plate load tests, cross hole shear wave velocity test, dutch cone probes and laboratory testing.

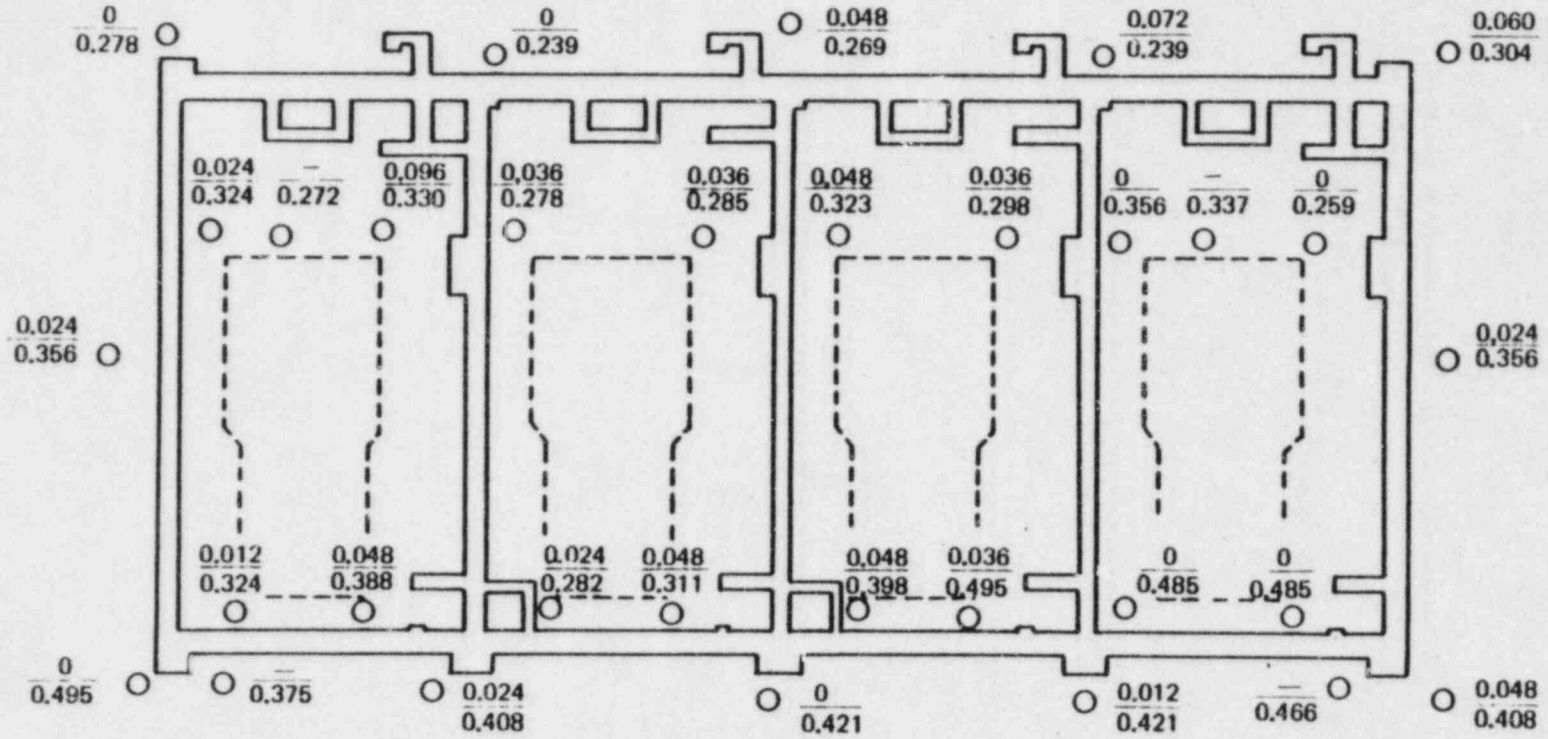
				Reference (partial)
A.	Borings	255	(199 boring logs submitted) 56 to be submitted	FSAR volume 5 section 2.5
B.	Test Pits	7		Volume 4 10CFR 50.54(f) Items 134,135,136,137 & 143.
C.	Plate Load Tests	2		Volume 5 10CFR 50.54(f) Items 138 & 139
D.	Dutch Cone Probes	13		Volume 3 10CFR 50.54(f) Item 11
E.	Cross Hole Probes	21		Volume 5 10CFR 50.54 (f) Items 81 & 142
F.	Laboratory Tests Included			
	1. Shear strength			Volumes 6 & 7 10CFR 50.54(f) Items 144 thru 149
	2. Consolidation			
	3. Compaction			
	4. Atterberg limits			
	5. Grain size			
	6. Clay minerology			

Investigation continued

		References
II. Load Tests		
A.	Diesel Generator Building (~~ERMT~~ Equip. being installed)	Q 4 & 27
B.	Condensate Storage Tanks	Q 4 & 6
C.	Diesel Fuel Oil Tanks (done)	Q 4 & 33
D.	Borated Water Tanks (near future)	Q 4 & 31
III. Pump Tests (Dewatering)		
1.	Construction Dewatering System	See attached
2.	Permanent Dewatering System	Q 24

Also ongoing settlement observation is being done. Q 5
References noted ie are from the responses to various questions.

DIESEL GENERATOR BUILDING



LEGEND:

O — BUILDING / PEDESTAL SETTLEMENT MARKER

0.012 — MEASURED SETTLEMENT BETWEEN 8-15-79 and 6-12-80 IN INCHES
0.421 — PREDICTED SETTLEMENT BETWEEN 8-15-79 and 6-12-80 IN INCHES ASSUMING SURCHARGE REMAINS DURING PLANT LIFE

NOTE:

The measured settlements do not include the heave observed approximately between 8-15-79 & 9-14-79.

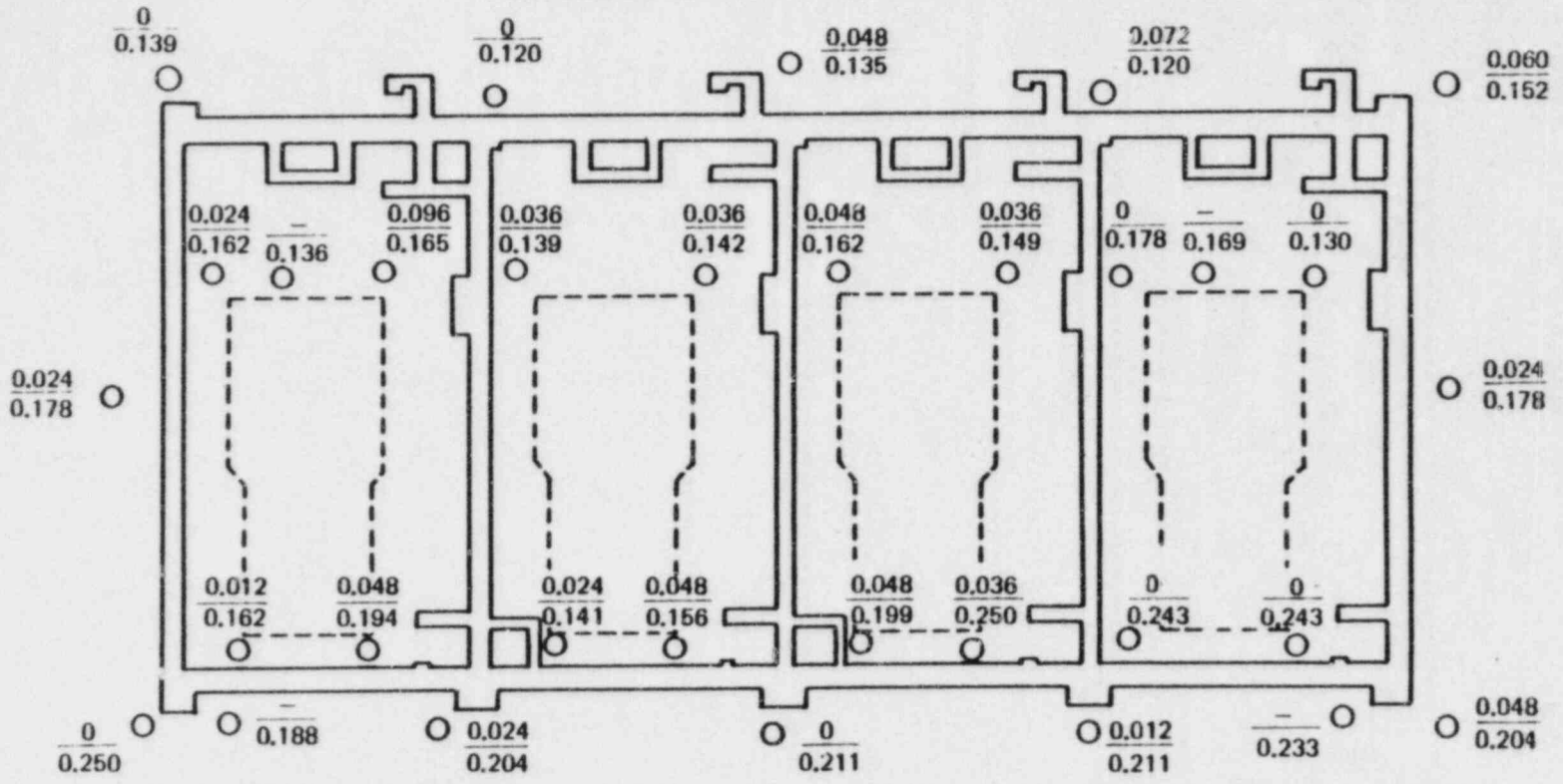
BECHTEL
ANN ARBOR

MIDLAND POWER PLANT

MEASURED VS PREDICTED SECONDARY COMPRESSION SETTLEMENT (8-15-79 / 6-12-80) ASSUMING SURCHARGE REMAINS

JOB NO.	DRAWING NO.
7220	FIGURE 27-15

DIESEL GENERATOR BUILDING



LEGEND:

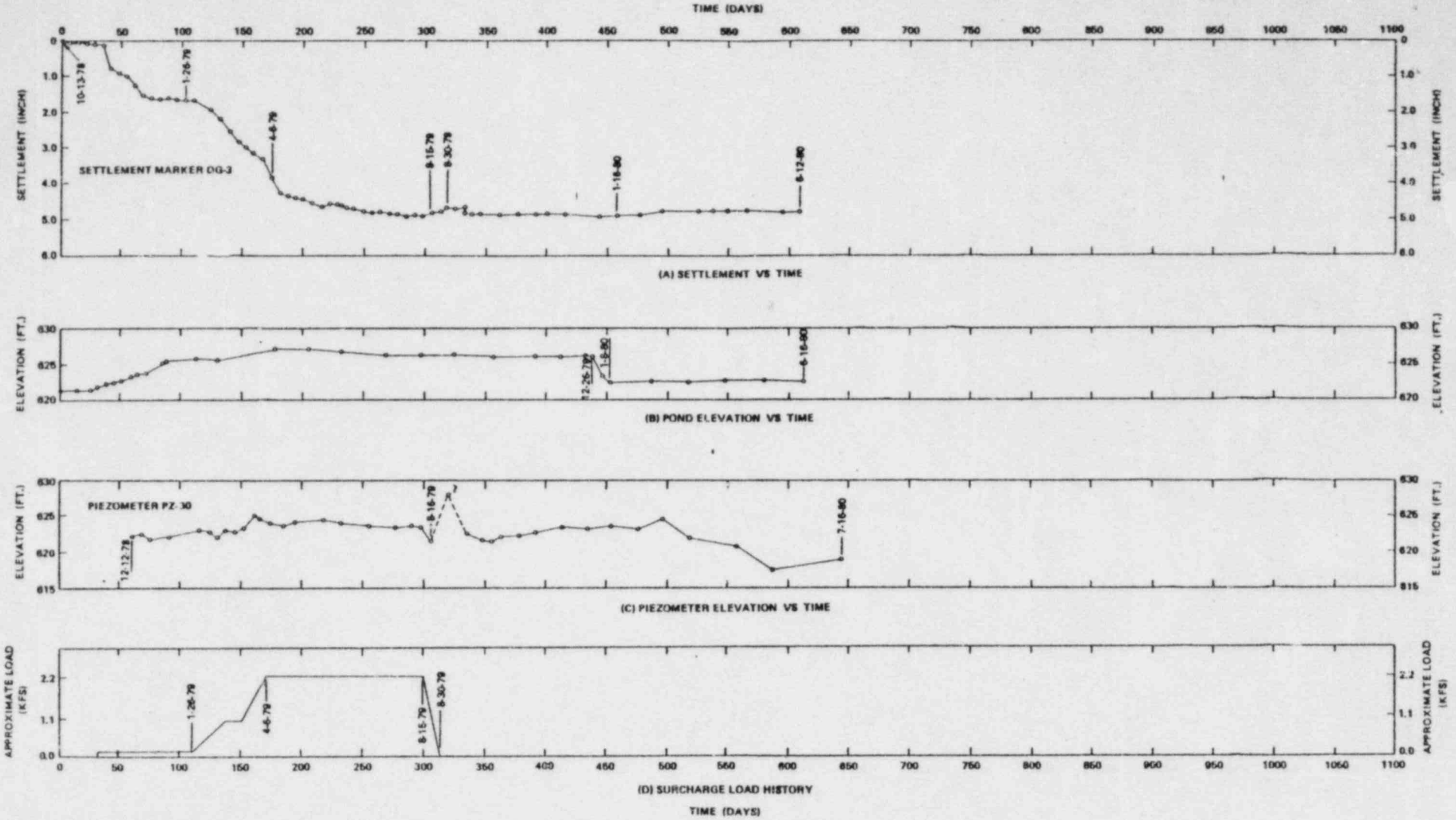
O — BUILDING / PEDESTAL SETTLEMENT MARKER

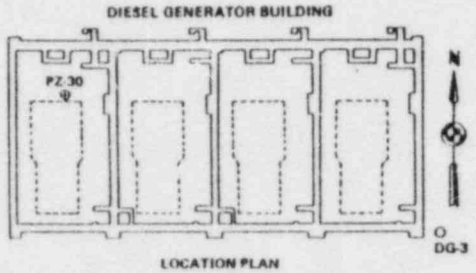
0.012 — MEASURED SETTLEMENT BETWEEN 8-15-79 and 6-12-80 IN INCHES

0.211 — PREDICTED SETTLEMENT BETWEEN 8-15-79 and 6-12-80 IN INCHES AFTER ACCOUNTING FOR SURCHARGE REMOVAL

NOTE:
The measured settlements do not include the heave observed approximately between 8-15-79 & 9-14-79.

BECHTEL ANN ARBOR		
MIDLAND POWER PLANT		
MEASURED VS PREDICTED SECONDARY COMPRESSION SETTLEMENT (8-15-79 / 6-12-80) (SURCHARGE REMOVED)		
	JOB NO.	DRAWING NO.
	7220	FIGURE 27-16





NOTE:

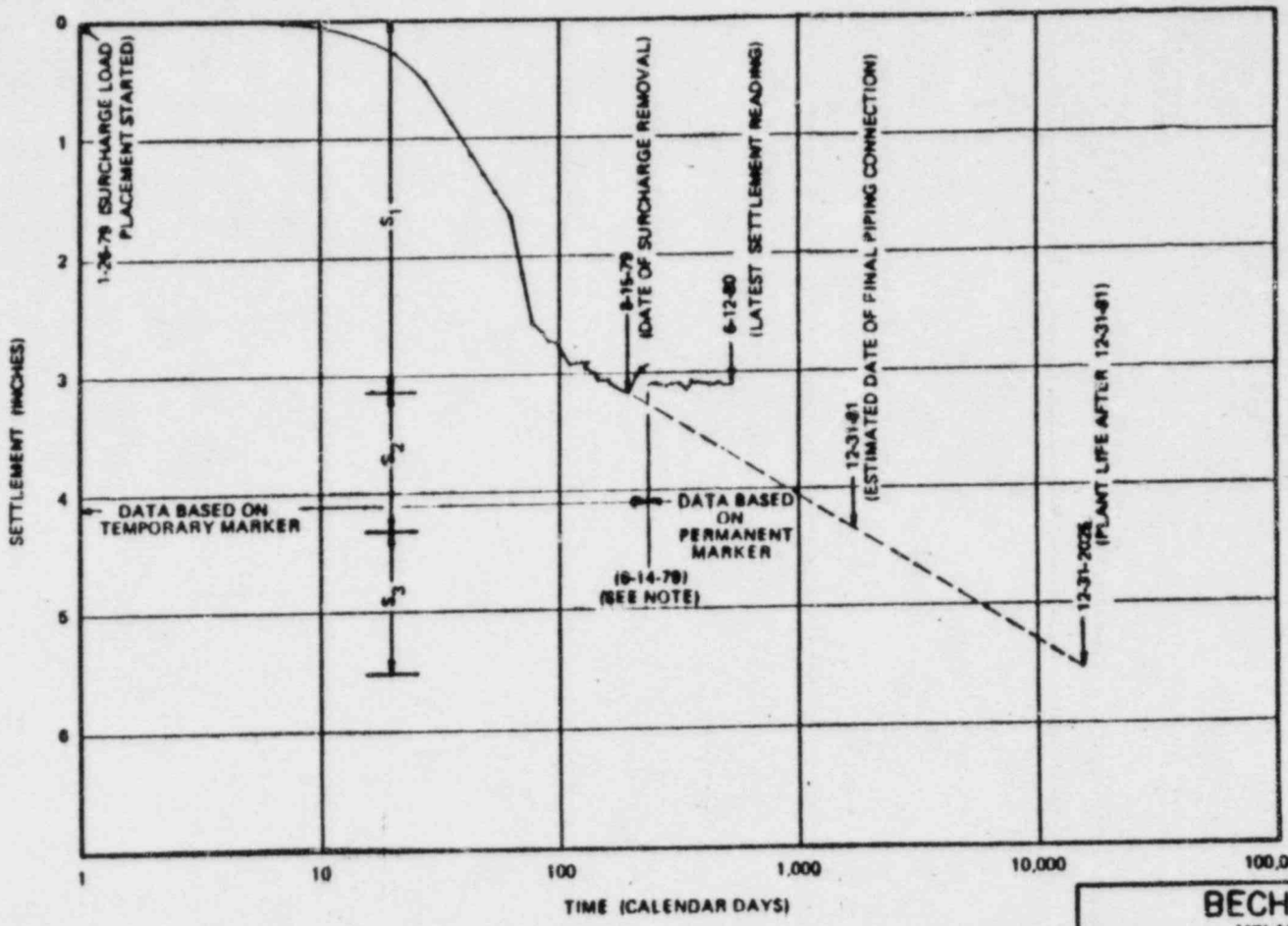
On 10-13-78 the measured settlement at marker DG-3 was 2.692 inch.

BECHTEL
ANN ARBOR

MIDLAND POWER PLANT

DIESEL GENERATOR BUILDING
TYPICAL SETTLEMENT, COOLING POND LEVEL,
PIEZOMETER LEVEL, AND SURCHARGE LOAD HISTORY

7220 | FIGURE 2.5.6 | A



LEGEND

—— MEASURED SETTLEMENT

– – – PREDICTED SECONDARY COMPRESSION SETTLEMENT ASSUMING SURCHARGE REMAINS

NOTE:
The permanent marker could not be monitored from 3-22-79 to 9-14-79 due to surcharge. Temporary markers at elevation 664'-0" & were used during this period to estimate the settlement of the permanent markers. On 9-14-79 the settlement was again based directly upon the permanent markers

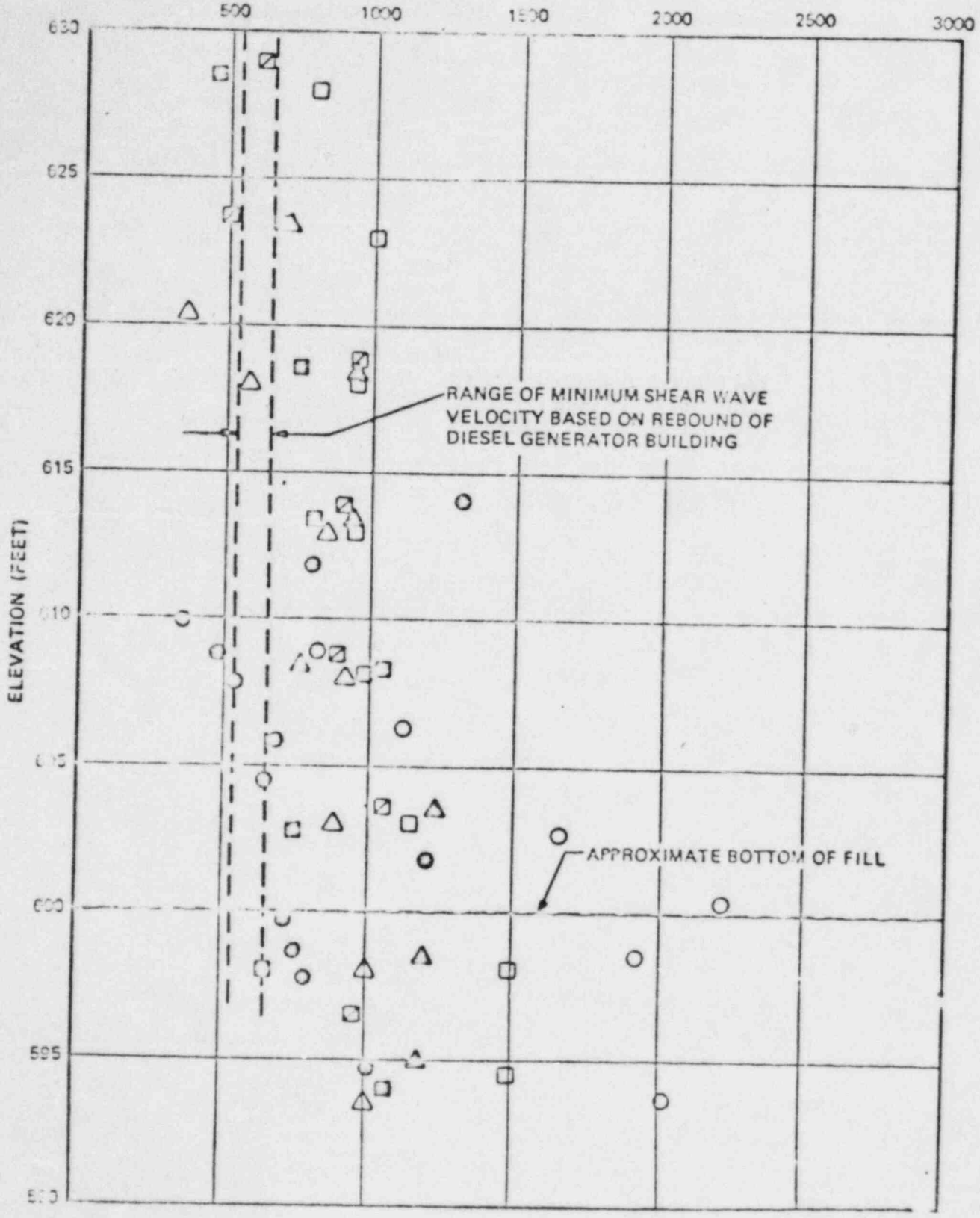
BECHTEL
ANN ARBOR

MIDLAND POWER PLANT

MEASURED AND PREDICTED SETTLEMENT VS LOG OF TIME (DG-3)

JOB NO.	DRAWING NO.	REV.
7220	FIGURE	1

119


500
1000
1500
2000
2500
3000
630
625
620
615
610
605
600
595
590
ELEVATION (FEET)
RANGE OF MINIMUM SHEAR WAVE VELOCITY BASED ON REBOUND OF DIESEL GENERATOR BUILDING
APPROXIMATE BOTTOM OF FILL
LEGEND:
CONDENSATE TANKS AREA
BORATED WATER STORAGE TANKS AREA
SERVICE WATER PUMP STRUCTURE
DIESEL GENERATOR BUILDING

9/82

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 1 1980

Docket Nos. 50-329/330

MEMORANDUM FOR: Midland Technical Hearing Participants

FROM: Darl Hood, Project Manager, Licensing Branch #3, DL

SUBJECT: STAFF REQUESTS FOR INFORMATION AND STATUS OF MIDLAND SOIL SETTLEMENT MATTER PRIOR TO DECEMBER 6, 1979

To assist you in preparing for the Midland hearing on soils, Enclosure 1 identifies the formal requests for information requested prior to December 6, 1979 by the NRC staff in regards to the soil settlement problem at Midland Plant, Units 1 and 2. The date December 6, 1979 corresponds to the issuance of the order by the NRC which prohibits certain construction activities related to soils until the applicant seeks and is granted an amendment to the construction permits. Enclosure 1 does not include requests, if any, during meetings, telephone discussions, or site tours unless such requests were followed up by formal written requests.

Enclosure 1 also shows all of the applicant's responses related to soils by revision number and revision date, to the present date. Revisions listed below the broken line occur after December 6, 1979. The FSAR and 50.54(f) responses maintained by the staff project manager provide a complete set, including superceded pages, and may be reviewed upon request.

In some cases, staff follow-up requests are identified in Enclosure 1. However, the list of follow-up requests is not necessarily complete.

Enclosure 2 provides a chronology of events related to staff review of the soil settlement matter at Midland through 1979.

Darl Hood
Licensing Branch #3
Division of Licensing

Enclosures:
As stated

8012290147 (11)

Enclosure 1

Staff Requests on Soil Settlement Issued Prior to December 6, 1979

1. S. Varga letter of December 11, 1978, "Staff Positions and Requests for Additional Information (Part 1)":

(a) SEB 130.21 Asks for seismic/structural evaluation of settling Cat. I structures, how stresses from differential settlement of foundations and preloading activities have been or will be factored into evaluations, and for comparison to calculated stresses to ACI code allowables.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80
Rev. 27, 3/31/80

Staff Follow-up Requests: 15, 25, 26

(b) G/TE 362.11 Questions differential settlement between Reactor Containment and Auxiliary Building. Asks for assurance that the D&M maximum limit will not be exceeded.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

(c) G/TE 362/12 Asks for description of, and schedule for, the preloading program for Diesel Generator Building.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 21, 5/31/79

Rev. 26, 1/30/79

(d) G/TE 362.13 Asks for program for reassessing backfill properties after preloading. Also asks for program and schedule for confirming dynamic characteristics of fill for seismic analysis.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79

Staff Follow-up Requests: "Fill" Request 5, 35, 37

2. S. Varga letter of January 18, 1979, "Staff Positions and Requests for Additional Information (Part 3)"

(a) PSB 40.106

(1) Asks for criteria and considerations to preclude adverse affects of settlement on diesel generator fuel oil lines.

(2) Asks for method of monitoring and criteria for fuel oil line functional assurance in view of settling and preloading.

(3) Asks for criteria and considerations to preclude adverse affects of settlement on fuel oil tanks, identification of tank backfill, monitoring and settlement results to date, and program to preclude overstressing lines due to tank settlement.

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

Note: Applicant's response fails to reveal that some of the fill for the fuel tanks was not placed as Zone 2.

Staff Follow-up Requests: 6, 33

(b) G/TE 362.14 What measures to avoid excessive settlement of Service Water Intake Structure?

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

(c) G/TE 362.15 Identify changes in compaction control spec.

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 24, 9/28/79

(d) G/TE 362.16 Asks for copy of "Settlement Evaluation for Plant Area"

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

(e) G/TE 362.17 Asks for ultimate settlement of Diesel Generator Building using proper foundation configuation.

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 19, 3/27/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

3. H. Denton letter of March 21, 1979, "10 CFR 50.54 Request Regarding Plant Fill"

Question 1 - Quality Assurance

Applicant Response Dates:	Staff Follow-up Requests:
"Fill" Rev. 0, 4/24/79 Fill Rev. 1, 5/31/79	Question 23

Question 2 - Grouting natural sand deposits

Applicant Response Date:

Fill Rev. 0, 4/24/79

Question 3 - Clarify when the settlement problem was discovered.

Applicant Response Date:

Fill Rev. 0, 4/24/79

Question 4 - Asks for criteria and justification of fill, structures and utilities after preloading program. Also asks for allowable settlement limits after fix and basis.

Applicant Response Dates:	Staff Follow-up Request: 40
"Fill" Rev. 0, 4/24/79 Fill Rev. 3, 9/13/79 --- Fill Rev. 5, 2/28/80	

Question 5 - What borings will be taken after preload? (Follow-up of 362.13)

Applicant Response Date:

Rev. 0, 4/24/79

Question 6 - Asks for assurance for proposed tank fixes.

Applicant Response Dates:	Staff Follow-up Requests:
Rev. 0, 4/24/79 Rev. 1, 5/31/79 Rev. 3, 9/13/79	31, 32, 33, 43, 44

Question 7 - How to determine adequacy of electrical duct banks?

Applicant Response Dates:	Staff Follow-up Request:
Rev. 0, 4/24/79 Rev. 3, 9/13/79	30

Question 8 - Criteria for diesel generator pedestals.

Applicant Response Date:

Rev. 0, 4/24/79

Questions 9 and 11 - Expresses need for borings under structures

Applicant Response Date:

Rev. 0, 4/24/79

Question 10- Effects of settlement under mat foundations

Applicant Response Date:

Rev. 0, 4/24/79

Question 12- Determine properties and performance of soils and natural sands under structures. Compare to PSAR.

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 1, 5/31/79
Rev. 2, 7/9/79
Rev. 3, 9/13/79

Question 13- How has seismic response spectra changed?

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 1, 5/31/79

Question 14- Asks for evaluation of Cat. I structures on fill. Also evaluate cracks.

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 3, 9/13/79

Rev. 5, 2/28/80

Question 15 - Evaluate structures partially on fill. Include settlement before and during SSE.

Applicant Response Dates:

Rev. 0, 4/24/79 (load combinations)
Rev. 3, 9/13/79

Question 16 - Assurance of continuous support for underground pipe

Applicant Response Dates:

Rev. 0, 2/24/79

Rev. 5, 2/28/80 (deletes borings promised by Rev. 0)

Question 17 - Criteria for underground pipe

Applicant Response Dates:	Staff Follow-up Request:
Rev. 0, 4/24/79 Rev. 2, 7/9/79 --- Rev. 5, 2/28/80	Tedesco letter of 10/20/80 and and applicant's reply of 11/14/80

Question 18 - Criteria for piping in and between buildings

Applicant Response Dates:

Rev. 0, 4/24/79

Rev. 5, 2/28/80

Question 19 - Pipe deformation

Applicant Response Dates:

Rev. 0, 4/24/79

Rev. 5, 2/28/80

Question 20 - Stress levels of components

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 2, 7/9/79

Rev. 5, 2/28/80

Question 21 - Basis for selection of D.G. options

Applicant Response Date:

Rev. 0, 4/24/79

Question 22 - Effect of stop work on planned activities

Applicant Response Date:

Rev. 0, 4/24/79

4. S. Varga letter of March 30, 1979, "Open Items Associated with Staff Review of Midland Plant, Units 1 & 2 FSAR"

PSB Item 3 - Reiterates PSB Question 40.106
ASB Item 7 - Expresses concern for integrity of underground pipe
GSB Item 1 - Notes that staff does not accept seismic input design information (g value
GTE Item 1 - Repeats 50.54(f) concerns due to settlement
GTE Item 2 - Notes staff concern as to whether applicant removed loose natural sands at site as required by CP review
GTE Item 3 - Notes staff concerns per 362.8 regarding development of Phreatic surface in cooling pond embankment and comparison of observed surface to that assumed for stability analysis
SEB Item I - Repeats 130.21 and 130.17 concern for stress evaluations of structures on fill and load combination term for differential settlement

5. L. Rubenstein letter of September 11, 1979, "Request for Additional Quality Assurance Information" (23)

Request 23 - Quality Control

Applicant Response Dates:

Rev. 4, 11/13/79

Rev. 5, 2/28/80
Rev. 8, 8/15/80

6. L. Rubenstein letter of November 19, 1979, "Supplemental 10 CFR 50.54 Requests Regarding Plant Fill" (24 - 35)

Note: As stated in the Order, none of these responses were made as of December 6, 1979

Enclosure 2

Chronology of Soils Related Events Through 1979

8/22/78	IE Resident Inspector first advised of unusual settlement
9/7/78	Applicant provides verbal report to IE, Reg. III
9/29/78	First 50.55(e) interim report issued
11/1/78	Keppler memo to Thornburg asking NRR support
11/7/78	Applicant issues second 50.55(e) interim report
11/17/78	NRC extends CP completion dates
12/3-4/78	Tour and meeting with NRC at site
12/11/78	NRC issues Q-2s, part 1
12/14/78	OL Special Prehearing Conference held. Includes two contentions on soil settlement.
12/21/78	Applicant issues third 50.55(e) interim report. States that Preload is corrective action selected for Diesel Generator Building.
1/5/79	Applicant issues further third 50.55(e) interim report.
1/18/79	NRC issues Q-2s, part 3
1/25/79	Applicant issues FSAR Amendment 17 responding to requests 130.21, 362.11, 362.12, 362.13
2/1/79	Applicant begins placing fill at site
2/23/79	OL Prehearing Conference Order accepts Marshall contention 2 and Sinclair contention 24
2/23/79	Applicant issues fourth 50.55(e) interim report
2/23/79	Meeting with applicant at Region III office
2/26/79	Applicant submits FSAR Revision 18 changing responses to requests 130.21, 362.11, 362.12, 362.13, and providing initial response to 40.106, 362.14 through 362.17
3/5/79	Meeting with applicant, IE and NRR at site
3/6/79	Site tour
3/21/79	Staff issues first set of 50.54(f) requests (1-22)
3/27/79	Applicant submits FSAR Revision 19 changing response to request 362.17

3/28/79	TMI-2 accident occurs
3/30/79	Staff letter on open items from FSAR review
4/24/79	Applicant submits initial reply to 50.54(f) requests (1-22)
4/26/79	Applicant submits FSAR Revision 20 (130.21, 362.11-360.14, 40.106, 362.17)
4/30/79	Applicant submits fifth 50.55(e) interim report
5/31/79	Applicant submits FSAR Revision 21 (362.12)
5/31/79	Applicant submits Revision 1 to 50.54(f) responses (#1, 6, 12, 13)
6/7/79	NRC site visit to observe test pits
6/25/79	Applicant issues sixth 50.55(e) interim report
7/9/79	Applicant issues Revision 2 to 50.54(f) responses (#12, 17, 20)
7/18/79	Meeting on soils fixes
7/19/79	Meeting with applicant on seismic design input and geology
8/10/79	Applicant issues summary of 7/18/79 meeting as part of 50.55(e) interim report 6.
9/5/79	Applicant issues 50.55(e) interim report 7
9/5/79	Meeting on draft 50.54(f) request 23 on quality assurance
9/11/79	NRC issues 50.54(f) request 23 on quality assurance
9/13/79	Applicant issues Revision 3 to 50.54(f) responses (4, 6, 7, 12, 14, 15)
9/15/79	Applicant begins removal of surcharge from DG Building
9/28/79	Applicant issues FSAR Revision 24 (130.21, 362.11, 40.106, 362.14-362.17)
9/30/79	Sa: surcharge removal completed
10/16/79	NRC advises that Corps of Engineers to assist with geotech review
11/2/79	Applicant issues 50.55(e) interim report 8
11/13/79	Applicant submits Revision 4 to 50.54(f) responses (23)
11/14/79	Corps of Engineers and NRC visit site

11/19/79	Staff issues supplemental 50.54(f) requests 24-35
12/6/79	NRC issues Order modifying construction permits
12/19/79	Applicant files request for CP amendment and requests staff approval of proposed remedial actions. Amendment 72.
12/26/79	Applicant requests hearing pursuant to Order

D. Hood
116C Ph.1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 26, 1980

Alan S. Farnell, Esq.
Isham, Lincoln, & Beale
One First National Plaza
Suite 4200
Chicago, Illinois 60603

In the Matter of
Consumers Power Company
(Midland Plant, Units 1 and 2)
Docket Nos. 50-329 & 50-330 OL & OM

Dear Mr. Farnell:

This is to confirm, as per our conversation at Bechtel on November 24, 1980 that, although not technically in compliance with NRC rules, the NRC will attempt to answer your interrogatories of November 12, 1980. We will provide our responses to you as soon as reasonably possible.

Sincerely,

Bradley W. Jones

Bradley W. Jones
Counsel for NRC Staff

cc: Charles Bechhoefer, Esq.
Mr. Gustave A. Linenberger
Dr. Frederick P. Cowan
Frank J. Kelley, Esq.
Myron M. Cherry, Esq.
Ms. Mary Sinclair
Michael I. Miller, Esq.
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Ms. Barbara Stamiris
Mr. Steve Gadler
Wendell H. Marshall
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Atomic Safety and Licensing
Board Panel
Atomic Safety and Licensing
Appeal Board Panel
Docketing and Service Section

8012290109 (1)

DEC 1 1980

Docket Nos. 50-329/330

MEMORANDUM FOR: Midland Technical Hearing Participants

FROM: Darl Hood, Project Manager, Licensing Branch #3, DL

SUBJECT: STAFF REQUESTS FOR INFORMATION AND STATUS OF MIDLAND SOIL SETTLEMENT MATTER PRIOR TO DECEMBER 6, 1979

To assist you in preparing for the Midland hearing on soils, Enclosure 1 identifies the formal requests for information requested prior to December 6, 1979 by the NRC staff in regards to the soil settlement problem at Midland Plant, Units 1 and 2. The date December 6, 1979 corresponds to the issuance of the order by the NRC which prohibits certain construction activities related to soils until the applicant seeks and is granted an amendment to the construction permits. Enclosure 1 does not include requests, if any, during meetings, telephone discussions, or site tours unless such requests were followed up by formal written requests.

Enclosure 1 also shows all of the applicant's responses related to soils by revision number and revision date, to the present date. Revisions listed below the broken line occur after December 6, 1979. The FSAR and 50.54(f) responses maintained by the staff project manager provide a complete set, including superceded pages, and may be reviewed upon request.

In some cases, staff follow-up requests are identified in Enclosure 1. However, the list of follow-up requests is not necessarily complete.

Enclosure 2 provides a chronology of events related to staff review of the soil settlement matter at Midland through 1979.

/s/

8012290107

Darl Hood
Licensing Branch #3
Division of Licensing

Enclosures:
As stated

DISTRIBUTION:

Docket File 50-329/330	FRinaldi (2)	JKimball	RKnop
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PDR	JGilray	GLear	
LB #3 RDG	RShewmaker	JKnight	
FMiraglia	EGallagher (IE-R-III)	Ray Gonzales	
DHood	WPaton	RBosnak	
LHeller	Brad Jones	FSchauer	
JKane(2)	RJackson	GFiorelli	

OFFICE	LB3:DL	LB3:DL				
SURNAME	DHood:ch	FMiraglia				
DATE	12/1 /80	12/ /80				

Enclosure 1

Staff Requests on Soil Settlement Issued Prior to December 6, 1979

1. S. Varga letter of December 11, 1978, "Staff Positions and Requests for Additional Information (Part 1)":

(a) SEB 130.21 Asks for seismic/structural evaluation of settling Cat. I structures, how stresses from differential settlement of foundations and preloading activities have been or will be factored into evaluations, and for comparison to calculated stresses to ACI code allowables.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80
Rev. 27, 3/31/80

Staff Follow-up Requests: 15, 25, 26

(b) G/TE 362.11 Questions differential settlement between Reactor Containment and Auxiliary Building. Asks for assurance that the D&M maximum limit will not be exceeded.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

(c) G/TE 362/12 Asks for description of, and schedule for, the preloading program for Diesel Generator Building.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 21, 5/31/79

Rev. 26, 1/30/79

(a) G/TE 362.13 Asks for program for reassessing backfill properties after preloading. Also asks for program and schedule for confirming dynamic characteristics of fill for seismic analysis.

Applicant Response Dates:

Rev. 17, 1/25/79
Rev. 18, 2/26/79
Rev. 20, 4/26/79

Staff Follow-up Requests: "Fill" Request 5, 35, 37

2. S. Varga letter of January 18, 1979, "Staff Positions and Requests for Additional Information (Part 3)"

(a) PSB 40.106

(1) Asks for criteria and considerations to preclude adverse affects of settlement on diesel generator fuel oil lines.

(2) Asks for method of monitoring and criteria for fuel oil line functional assurance in view of settling and preloading.

(3) Asks for criteria and considerations to preclude adverse affects of settlement on fuel oil tanks, identification of tank backfill, monitoring and settlement results to date, and program to preclude overstressing lines due to tank settlement.

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

Note: Applicant's response fails to reveal that some of the fill for the fuel tanks was not placed as Zone 2.

Staff Follow-up Requests: 6, 33

(b) G/TE 362.14 What measures to avoid excessive settlement of Service Water Intake Structure?

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

(c) G/TE 362.15 Identify changes in compaction control spec.

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 24, 9/28/79

(d) G/TE 362.16 Asks for copy of "Settlement Evaluation for Plant Area"

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

(e) G/TE 362.17 Asks for ultimate settlement of Diesel Generator Building using proper foundation configuation.

Applicant Response Dates:

Rev. 18, 2/26/79
Rev. 19, 3/27/79
Rev. 20, 4/26/79
Rev. 24, 9/28/79

Rev. 26, 1/30/80

3. H. Denton letter of March 21, 1979, "10 CFR 50.54 Request Regarding Plant Fill"

Question 1 - Quality Assurance

Applicant Response Dates:	Staff Follow-up Requests:
"Fill" Rev. 0, 4/24/79	Question 23
Fill Rev. 1, 5/31/79	

Question 2 - Grouting natural sand deposits

Applicant Response Date:

Fill Rev. 0, 4/24/79

Question 3 - Clarify when the settlement problem was discovered.

Applicant Response Date:

Fill Rev. 0, 4/24/79

Question 4 - Asks for criteria and justification of fill, structures and utilities after preloading program. Also asks for allowable settlement limits after fix and basis.

Applicant Response Dates:	Staff Follow-up Request: 40
"Fill" Rev. 0, 4/24/79	
Fill Rev. 3, 9/13/79	

Fill Rev. 5, 2/28/80	

Question 5 - What borings will be taken after preload? (Follow-up of 362.13)

Applicant Response Date:

Rev. 0, 4/24/79

Question 6 - Asks for assurance for proposed tank fixes.

Applicant Response Dates:	Staff Follow-up Requests:
Rev. 0, 4/24/79	31, 32, 33, 43, 44
Rev. 1, 5/31/79	
Rev. 3, 9/13/79	

Question 7 - How to determine adequacy of electrical duct banks?

Applicant Response Dates:	Staff Follow-up Request:
Rev. 0, 4/24/79 Rev. 3, 9/13/79	30

Question 8 - Criteria for diesel generator pedestals.

Applicant Response Date:

Rev. 0, 4/24/79

Questions 9 and 11 - Expresses need for borings under structures

Applicant Response Date:

Rev. 0, 4/24/79

Question 10- Effects of settlement under mat foundations

Applicant Response Date:

Rev. 0, 4/24/79

Question 12- Determine properties and performance of soils and natural sands under structures. Compare to PSAR.

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 1, 5/31/79
Rev. 2, 7/9/79
Rev. 3, 9/13/79

Question 13- How has seismic response spectra changed?

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 1, 5/31/79

Question 14- Asks for evaluation of Cat. I structures on fill. Also evaluate cracks.

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 3, 9/13/79

Rev. 5, 2/28/80

Question 15 - Evaluate structures partially on fill. Include settlement before and during SSE.

Applicant Response Dates:

Rev. 0, 4/24/79 (load combinations)
Rev. 3, 9/13/79

Question 16 - Assurance of continuous support for underground pipe

Applicant Response Dates:

Rev. 0, 2/24/79

Rev. 5, 2/28/80 (deletes borings promised by Rev. 0)

Question 17 - Criteria for underground pipe

Applicant Response Dates:	Staff Follow-up Request:
Rev. 0, 4/24/79 Rev. 2, 7/9/79 --- Rev. 5, 2/28/80	Tedesco letter of 10/20/80 and and applicant's reply of 11/14/80

Question 18 - Criteria for piping in and between buildings

Applicant Response Dates:

Rev. 0, 4/24/79

Rev. 5, 2/28/80

Question 19 - Pipe deformation

Applicant Response Dates:

Rev. 0, 4/24/79

Rev. 5, 2/28/80

Question 20 - Stress levels of components

Applicant Response Dates:

Rev. 0, 4/24/79
Rev. 2, 7/9/79

Rev. 5, 2/28/80

Question 21 - Basis for selection of D.G. options

Applicant Response Date:

Rev. 0, 4/24/79

Question 22 - Effect of stop work on planned activities

Applicant Response Date:

Rev. 0, 4/24/79

4. S. Varga letter of March 30, 1979, "Open Items Associated with Staff Review of Midland Plant, Units 1 & 2 FSAR"

PSB Item 3 - Reiterates PSB Question 40.106
ASB Item 7 - Expresses concern for integrity of underground pipe
GSB Item 1 - Notes that staff does not accept seismic input design information (g value
GTE Item 1 - Repeats 50.54(f) concerns due to settlement
GTE Item 2 - Notes staff concern as to whether applicant removed loose natural sands at site as required by CP review
GTE Item 3 - Notes staff concerns per 362.8 regarding development of Phreatic surface in cooling pond embankment and comparison of observed surface to that assumed for stability analysis
SEB Item I - Repeats 130.21 and 130.17 concern for stress evaluations of structures on fill and load combination term for differential settlement

5. L. Rubenstein letter of September 11, 1979, "Request for Additional Quality Assurance Information" (23)

Request 23 - Quality Control

Applicant Response Dates:

Rev. 4, 11/13/79

Rev. 5, 2/28/80
Rev. 8, 8/15/80

6. L. Rubenstein letter of November 19, 1979, "Supplemental 10 CFR 50.54 Requests Regarding Plant Fill" (24 - 35)

Note: As stated in the Order, none of these responses were made as of December 6, 1979

Enclosure 2

Chronology of Soils Related Events Through 1979

8/22/78	IE Resident Inspector first advised of unusual settlement
9/7/78	Applicant provides verbal report to IE, Reg. III
9/29/78	First 50.55(e) interim report issued
11/1/78	Keppler memo to Thornburg asking NRR support
11/7/78	Applicant issues second 50.55(e) interim report
11/17/78	NRC extends CP completion dates
12/3-4/78	Tour and meeting with NRC at site
12/11/78	NRC issues Q-2s, part 1
12/14/78	OL Special Prehearing Conference held. Includes two contentions on soil settlement.
12/21/78	Applicant issues third 50.55(e) interim report. States that Preload is corrective action selected for Diesel Generator Building.
1/5/79	Applicant issues further third 50.55(e) interim report.
1/18/79	NRC issues Q-2s, part 3
1/25/79	Applicant issues FSAR Amendment 17 responding to requests 130.21, 362.11, 362.12, 362.13
2/1/79	Applicant begins placing fill at site
2/23/79	OL Prehearing Conference Order accepts Marshall contention 2 and Sinclair contention 24
2/23/79	Applicant issues fourth 50.55(e) interim report
2/23/79	Meeting with applicant at Region III office
2/26/79	Applicant submits FSAR Revision 18 changing responses to requests 130.21, 362.11, 362.12, 362.13, and providing initial response to 40.106, 362.14 through 362.17
3/5/79	Meeting with applicant, IE and NRR at site
3/6/79	Site tour
3/21/79	Staff issues first set of 50.54(f) requests (1-22)
3/27/79	Applicant submits FSAR Revision 19 changing response to request 362.17

3/28/79	TMI-2 accident occurs
3/30/79	Staff letter on open items from FSAR review
4/24/79	Applicant submits initial reply to 50.54(f) requests (1-22)
4/26/79	Applicant submits FSAR Revision 20 (130.21, 362.11-360.14, 40.106, 362.17)
4/30/79	Applicant submits fifth 50.55(e) interim report
5/31/79	Applicant submits FSAR Revision 21 (362.12)
5/31/79	Applicant submits Revision 1 to 50.54(f) responses (#1, 6, 12, 13)
6/7/79	NRC site visit to observe test pits
6/25/79	Applicant issues sixth 50.55(e) interim report
7/9/79	Applicant issues Revision 2 to 50.54(f) responses (#12, 17, 20)
7/18/79	Meeting on soils fixes
7/19/79	Meeting with applicant on seismic design input and geology
8/10/79	Applicant issues summary of 7/18/79 meeting as part of 50.55(e) interim report 6.
9/5/79	Applicant issues 50.55(e) interim report 7
9/5/79	Meeting on draft 50.54(f) request 23 on quality assurance
9/11/79	NRC issues 50.54(f) request 23 on quality assurance
9/13/79	Applicant issues Revision 3 to 50.54(f) responses (4, 6, 7, 12, 14, 15)
9/15/79	Applicant begins removal of surcharge from DG Building
9/28/79	Applicant issues FSAR Revision 24 (130.21, 362.11, 40.106, 362.14-362.17)
9/30/79	Sa: surcharge removal completed
10/16/79	NRC advises that Corps of Engineers to assist with geotech review
11/2/79	Applicant issues 50.55(e) interim report 8
11/13/79	Applicant submits Revision 4 to 50.54(f) responses (23)
11/14/79	Corps of Engineers and NRC visit site

11/19/79	Staff issues supplemental 50.54(f) requests 24-35
12/6/79	NRC issues Order modifying construction permits
12/19/79	Applicant files request for CP amendment and requests staff approval of proposed remedial actions. Amendment 72.
12/26/79	Applicant requests hearing pursuant to Order

D. Hood
NRC Ph. 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 26, 1980

Alan S. Farnell, Esq.
Isham, Lincoln, & Beale
One First National Plaza
Suite 4200
Chicago, Illinois 60603

In the Matter of
Consumers Power Company
(Midland Plant, Units 1 and 2)
Docket Nos. 50-329 & 50-330 OL & OM

Dear Mr. Farnell:

This is to confirm, as per our conversation at Bechtel on November 24, 1980 that, although not technically in compliance with NRC rules, the NRC will attempt to answer your interrogatories of November 12, 1980. We will provide our responses to you as soon as reasonably possible.

Sincerely,

Bradley W. Jones

Bradley W. Jones
Counsel for NRC Staff

cc: Charles Bechhoefer, Esq.
Mr. Gustave A. Linenberger
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Ms. Mary Sinclair
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Ms. Barbara Stamiris
Mr. Steve Gadler
Wendell H. Marshall
Ms. Sharon K. Warren
Atomic Safety and Licensing
Board Panel
Atomic Safety and Licensing
Appeal Board Panel
Docketing and Service Section

~~8012290109 (1)~~

10/82

MEETING SUMMARY DISTRIBUTION

Docket File
NRC/PDR
Local PDR
TIC/NSIC/TERA
~~LB #4~~ r/f
H. Dneton
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E. Adensam
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L. Rubenstein
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Project Manager D. Hood
Licensing Assistant M. Duncan

SEP 29 1981

10/B2

SEP 29 1981

Docket Nos. 50-329/330 OM, OL

APPLICANT: Consumers Power Company

FACILITY Midland Plant, Units 1 & 2

SUBJECT: SUMMARY OF MAY 5, 6, 7 and 8, 1981 MEETINGS ON PLANT FILL REMEDIAL ISSUES

On May 5, 6 and 7, 1981, the NRC technical staff and its consultants met in Bethesda, Maryland, with Consumers Power Company (the applicant), Bechtel, and the applicant's consultant Mueser, Johnson, Rutledge and De Simone to discuss remedial activities resulting from inadequate soils compaction at the Midland Plant site. A detailed summary of this meeting is provided by Enclosure 1.

On May 8, 1981, some of the applicant and Bechtel personnel provided a briefing to NRC staff management on the previous three days of discussion. Meeting attendees are listed by Enclosure 2. The briefing emphasized the need for timely staff concurrence on installation of twenty dewatering wells near the Service Water and Circulating Water Intake structures. The staff noted it considers the remedial action for the Borated Water Storage Tanks (BWST) to be a soils-dependent matter encompassed within the applicant's voluntary agreement to defer construction activities pending NRC staff concurrence. The applicant stressed that prompt concurrence on surcharging the valve pit portion of the BWST would be needed if construction impact is to be avoided since the tanks are needed for flushing during startup testing. The newly adopted remedial actions for the Service Water Structure (i.e., Bin Wall) and for the Electrical Penetration Area (i.e., concrete pier) were summarized. The applicant will also meet with the staff in the near future to discuss the groundrules for determining which structures, systems and components require detailed seismic re-analysis for the operating license review.

8110050070 (50)

Darl Hood, Project Manager
Licensing Branch #4
Division of Licensing

Enclosures:
As stated

cc w/encl:
See next page

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DATE	9/9/81	9/9/81	9/ /81				

NRC FORM 318 (10-80) NRCM 0240 OFFICIAL RECORD COPY USGPO: 1981—335-96

10/B2

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SEP 2 5 1981

Docket Nos. 50-329/330 OM, OL

APPLICANT: Consumers Power Company

FACILITY Midland Plant, Units 1 & 2

SUBJECT: SUMMARY OF MAY 5, 6, 7 and 8, 1981 MEETINGS ON PLANT FILL REMEDIAL ISSUES

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DARL HOOD

Darl Hood, Project Manager
Licensing Branch #4
Division of Licensing

Enclosures:
As stated

cc w/encl:
See next page

10/82

MIDLAND

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10/82

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Enclosure 1

10/B2

To JWCook, P-26-336B; RAWells, P-14-113A; GSKeeley, P-14-113B; RCBauman, P-14-312B; JEBrunner, P-24-513; DMBudzik, P-24-517A; TCCooke, Midland; DBMiller, Midland (3); ILMiller (IL&B); NRamanujam, P-14-100; HWSlager, P-14-304; TJSullivan, P-24-624A

From TRThiruvengadam, P-14-400 TRT

CONSUMERS POWER COMPANY

Date August 10, 1981

Subject MIDLAND PROJECT - MEETING MINUTES OF THE MAY 5, 6 and 7, 1981 MEETING WITH THE NRC STAFF ON PLANT FILL REMEDIAL ISSUES - FILE 0485.16 SERIAL 13222

Internal Correspondence

CC

Note:

1. The sequence of topics discussed in the meeting was modified from that originally proposed in the agenda so as to suit the availability of NRC Staff personnel.

2. The order of presentation of subject matter in these minutes do not exactly correspond to the order of discussion in the meeting.

3. During the course of the meeting, in some instances the same topic was discussed in different time periods. In these minutes, all discussions pertaining to any one subject matter are presented under that subject.

The purpose of this meeting was to update the NRC Staff and their consultants with the information currently available and also to address certain concerns expressed by the Staff with regards to Amendment 85 submittal and during structural audit.

The subject matter are treated in the following order:

1. Underground Piping
2. Additional Borings
3. Permanent Dewatering
4. Borated Water Storage Tank
5. Amendment 85 (Soils)
6. Amendment 85 (Structures)
7. Remedial Fixes
   - A. Service Water Pump Structure
   - B. Auxiliary Building

NRC MEETING ON SOILS ISSUES

May 5, 6, 7, 1981

5/6 1. Dewatering (5/5/81)

- (a) Field Activities since submittal of Amendment 85
- (b) Dewatering Responses to 50.54(f)
- (c) Items Regarding Installation of 20 BU Interceptor Wells

5/5 2. Underground Piping (5/5/81

- (a) Review of Calculations to Date
- (b) Plans for Reprofiling
- (c) Aceptance Criteria
- (d) Long Term Settlement

5/6 3. Additional Borings (5/5/81)

- (a) Location
- (b) Types of Sampling
- (c) Types of Testing
- (d) Interpretation of Test Results

5/5 4. BWST (5/6/81)

- (a) Description and Cause of Problem
- (b) Current Status
- (c) Proposed Remedial Work

5/5 5. Amendment 85 (Soils) (5/6/81)

5/7 6. Amendment 85 (Structural) (5/7/81)

5/7 7. Remedial Fixes (5/7/81)

- (a) Service Water Structure
- (b) Auxiliary Building

ATTENDEES
5/7/81

Name	Organization
Darl Hood	NRC/DOL
Dennis Budzik	CP Co
Julius V Rotz	Bechtel
Theodore E Johnson	Bechtel
Bimal Dhar	Bechtel
Howard Levin	NRC/DE
N Ramanujam	Consumers Power
John P Martin, Jr	NSWC/WO
Edmund M Burke	Mueser, Rutledge, Johnston & De Simone
James P Gould	Mueser, Rutledger Johnston & De Simone
Thiru Thiruvengadam	Consumers Power Company
Alan J Boos	Bechtel
Jeff Kimball	NRC/GSB
Joseph D Kane	NRR/DE/GES
Hari N Singh	Corps of Engineer Detroit District
James W Simpson	Army Corps of Engineer Division
William C Otto	Army Corps of Engrs Detroit District
F Rinaldi	NRC/DE/SEB
P C Huang	NAVSWC/WO
Ross B Landsman	NRC/IERIII

1. UNDERGROUND PIPING

A. Stresses in piping, reprofiling and presentation of strain based acceptance criteria:

Presentation by H Slager:

Slide 1 shows a general plan of the site showing the buried pipe lines. Area of surcharge in encompassed roughly by the rectangle around the Diesel Generator Building small lines such as oily waste lines are not shown in this figure.

Slide 2 shows a partial listing of buried pipe lines. In the remarks column equivalent lines for those lines that were not profiled are indicated.

Slide 3 shows balance of lines.

Slide 4 shows lines that were rebedded. This information was stated in a previous meeting. Construction operations involving excavations were being performed close to these pipe lines. The pipe lines in these areas that were considerably deformed were rebedded.

Question (Hood): What reasons do you attribute to these deformations? Did surcharge have any effect and were the pipes rebedded before surcharge or after surcharge?

Response (Boos): The pipes are buried at shallow depths. Surcharging might have contributed to the deformation. However, whether all of it was caused by surcharging is difficult to determine. The pipes were rebedded after the surcharge was removed. In one case, passage of a television camera was obstructed in an 8" line. Since the pipe was buried only 3 ft beneath the surface at that time, the top of the pipe was exposed to observe any extreme local dip in the pipe. None was seen. Possibly, the pipe rebounded due to removal of the overburden. The integrity of these pipes were established by hydrotest performed prior to rebedding.

Question (Hood): What is the tolerance in the installation of pipe lines?

Response (Boos): It is ± 2" at the centerline of the pipe. This is applicable to all Category I lines. Quality control checked these limits during installation. However, the as built elevations were not documented by the quality control personnel. We will verify whether this 2" tolerance is specified for non-Category I pipe lines also. Also will verify and provide information later whether the list of pipes shown in Slides 2 and 3 include all Category I pipe lines.

Presentation: Slide 5 shows computed stresses in pipe lines. In a previous meeting similar information was presented. However,

subsequent to that meeting, recently determined profile data were submitted to NRC via J W Cook's letter of mid-February 1981. This table is updated to reflect the current profile data.

The computed stresses are based on a deflected shape following most of the measured data points. In other cases they were within ± ½" which is an estimate of the accuracy of the survey data. A few points that were grossly off the expected shape, were excluded from consideration. There are five instances wherein stresses exceed the allowable of 3 S_c, such as in the case of 20" - 1HCD-169 where the computed stress is 186.9 ksi as compared to the allowable of 47.7 ksi. Computed stress magnitudes do include multiplication factor due to stress intensification factors specified by the ASME code for junctions. Therefore, most of the high stresses are predicted near junction points, such as elbows. Slide 6 shows locations of overstress in the piping system.

Comment (Boos): Per commitment made in the previous meeting, we used a deflected shape that passed through points within ± ½" of measured elevations. This resulted in including of most of the measured points, such as 40 out of 45 points, excepting those isolated elevations that by inspection can be discounted.

Comment (ETEC): The stresses are in the same kind of range that were presented in January meeting.

Response: The table of stresses are based on the latest profile data which were submitted in February. The purpose of presenting this information is to update the stress tables.

Presentation: One of the concerns we have is the accuracy of the profile data. The accuracy of present profile data is in the range of ¼" to ½". Also we have come to the conclusion that it is desirable to profile the lines that were not done since they were parallel to ones that were profiled. Therefore, we have decided to do considerable amount of reprofiling. Consumers has contracted Southwest Research Institute for coming up with a technique which will provide a better accuracy. Basically, they have proposed two methods of improving the accuracy of the survey data. One is to improve the sensitivity of the Nold Aquaducer type of measurement and the other one was to use visual measurement techniques. At least in large diameter pipes optical survey methods can be used. SWRI is the process of fabricating the device and would very soon be ready to demonstrate the ability of the device.

Additionally we have initiated a program with Teledyne Engineering Services to propose an acceptance criteria for the buried pipe lines. Dr Pal Raju from Teledyne Engineering Services will present the status of their program to date.

Presentation (P Raju): Slide 7 shows possible failure modes in pipes. Each one would be examined for applicability in this case.

1. Excessive Plastic Deformation - we do not have this case since displacement due to settlement is limited.

2. Fatigue - failures due to unusual cyclical loads and peak stresses need not be considered since we do not expect large cyclical loads.

3. Brittle facture - this is not possible because of lack of corrosive atmosphere and by proper choice of materials.

4. Creep - Creep is a high temperature phenomenon and we don't have this case here.

5. Stress corrosion cracking - do not anticipate this occurring here.

6. Elastic & Plastic Instability - this would be the most probable mode of failure since the pipe diameter is large.

The basis for the ASME code criteria of $3S_c$ is not well known. Probably, the basis for this limit is the recognition that stresses due to settlement are secondary. Whenever the calculated stresses result in magnitudes such as 200 ksi, it is physically meaningless as it has exceeded yield stress by many times. Once you exceed yield stress in calculations, what is important is how much deformation (i.e., strain) the pipe has undergone. Therefore, we propose a strain based acceptance criteria that A/E can use to evaluate the acceptability of the piping system. As discussed earlier the limiting mode of failure is buckling due to bending. For different pipe diameters and R/T ratios we can perform buckling analysis taking into account stress strain curve well into the plastic range by the use of BOSOR 5 Computer Program resulting in interaction curves with Moment or $\Delta D/D$ and curvature as shown in Slides 11 and 12. Once we determine the curvature, corresponding moment or $\Delta D/D$ for critical buckling point can be determined. Even then, buckling does not constitute failure. The pipe can still retain the function for which it was put in, except that there will be some local ripples in the pipe. The total collapse of the pipe resulting in loss of its function is a different phenomenon.

Slide 13 shows the capabilities of BOSOR 5 program by enumeration of the input data. This program has been in use for 15 to 20 years and is currently being used widely in the Aero Space Industry. It has been well documented and has been verified with closed form solutions and experimental tests.

Dave Bushnel's (the originator of the computer program) assistance is also available to us if needed. The program can handle 6 layers of shells, ring type of stiffners, thermal, moment, pressure and non-symmetrical loadings.

Question (Hartzman): The interaction curves mainly consider moment. One needs to consider effects of internal pressure, axial load, and out of plane bending. Therefore this is not a complete

interaction diagram. Also, one needs to consider torsion at elbows.

Question (ETEC): The interaction curves should also include out of plane bending moment. Also, the effect of surface loads, such as surface traffic and from railroad traffic, should be considered.

Response: The effect of out of plane bending moment on the interaction diagram is negligible since the magnitudes of these moments are very small in practice. The effect of traffic loads would be very minimal since the pipes are buried deep enough so that concentrated loads from traffic would be redistributed by the soil to relatively small magnitudes by the time the pipes have to carry it. If there is a need we could consider torsion at elbows.

Question (Hartzman): Can you compare curvature measured from profile? The calculation is elastic which predicts critical moment based on inelastic analysis. The ASME limit of $3S_c$ comes from fatigue and shakedown phenomenon and since the settlement is here to stay and therefore should be treated as normal load, i.e., causing primary stress rather than secondary stress. Therefore code allowables should be halved. The pipes may have buckled already especially near elbows.

Comment (ETEC): Surface loading such as from train would cause out of plane bending and along with weight of soil would cause circumferential stresses. These should be checked and made sure that they are not significant.

Question (Hood): Are the BWST lines cased in concrete? Are there other rail road lines that cross buried pipe lines?

Response (Boos): There are 3 to 4 railroad spurs in the plant. Information as to what pipe lines lay buried under these tracks will be provided later.

Presentation: Slide 14 shows output data from a typical BOSOR 5 program.

Comment (ETEC): If one has to compare curvature as measured with the interaction diagram, the field measurement of displacements must be done at closely spaced intervals.

Question (Hartzman): Would like to know as to what is the torsional component, especially at elbows, in the table of stresses shown earlier.

Presentation: An alternative method is also available which relates bending buckling stresses to axial buckling stresses, with the expression, such as $\sigma_b = 1.30\sigma_a$ based upon extensive tests.

Question (Hartzman): When will you propose factor of safety on strain corresponding to critical buckling? I suggest that your

report should also include a recommendation of acceptable factor of safety.

Response (Raju): About 2 months.

Question (Hartzman): How would you combine earthquake load once the pipe has buckled?

Comment (Budzik): The criteria is to pass the fluid from one point to another point. We have to look at all the loads and we have not made a decision on this yet. The point that should be emphasized is that the onset of buckling does not mean that the pipe has lost its integrity.

Presentation (Slager): Consumers has decided to reprofile all pipes between 10 inches and 36 inches in diameter. Parallel lines would also be profiled. Only pipes that are greater than 36 inches are the circulating water pipes and they are founded on till. The size of the profiling set up is 8 inches and therefore it is not possible to profile less than 10 inch diameter pipes.

Question (Budzik): Does the staff have a problem with this buckling type of criteria?

Response (Hartzman): No objection to the approach. However, the question is how will you compute the quantity that would be compared with the criteria and what would be the methodology involved in computing this quantity.

B. Long Term Settlement.

Presentation (Afifi): 40-year settlement of fill. The Slide 17 shows location of Borros Anchors BA-34, BA-35 and BA-36 located in plant area fill. In addition to monitoring these Borros Anchors, we also have data on settlement monitoring of all the structures in plant area fill. Slide 18 shows settlement vs time plot for Borros Anchor BA-34 - extrapolating the sloping line to 40-year settlement gives little over one inch of settlement; i.e., one inch of settlement per log cycle. Add to this ½ inch of settlement due to dewatering.

Slide 19 shows conservatively predicted settlement of 0 to 3.4". This is applied to 190 ft length of service water pipe line 26" OHBC-16. The maximum 40-year settlement will be imposed at the point of current maximum settlement and everywhere else the settlement would be appropriately prorated.

Question (Kane): Are you going to relate the settlement to material under the pipe?

Response: No. The best fill will not settle anymore. The worst fill will settle up to 3.4". Because of the random nature of the fill it would not be possible to relate this settlement to the soil material.

Comment (Boos): The pipes in free field are either in sand backfill or clay backfill. It is quite conservative from the pipe stress point of view to prorate the settlements.

Question (Kane): There could be infinite number of profiles that could be visualized by the approach.

Question (Hood): The future settlements are based on assumptions. Why not on boring data?

Response: Because of the variability of the fill material in the plant area it will not be any more accurate to base this prediction on the data from the available borings.

Question (Hood): Is the basis that the maximum settlement point today will continue to be the maximun settlement point at the end of 40 years?

Response (Boos): When the proposed reprofiling is completed, we will have 3 years of settlement data. This would form a very good representative set of settlement pattern as most of the settlement would have occurred in this period. If the point of maximum displacement remains in the same general location, it is reasonable to assume it would remain so for the rest of the operating life. Actually three years of profile date gives a good representation of conditions of soil underneath the pipes.

Question (Hartzman): The built in inelastic deformation due to settlement is in there during actual operating conditions. How are the stresses due to earthquake, which is evaluated on the elastic basis, is going to be combined?

Question (Heller): Was the shear stress in the soil computed due to the deflected pipe forcing down on the soil?

Response (Slager): If the soil reaction that would force the pipe to take the measured profile is computed on the basis of beam on elastic foundation analysis, the computed force far exceeds the overburden weight of the soil mass above the pipe.

Question (Hood): How would you prorate the 3" settlement in the free field to the pipe when it enters a building.

Response (Boos): In Diesel Generator Building area, where the area has been surcharged, we would not expect 3" settlement. It may probably be in the order of 1". There is a transition area. The pipe has to be considered from portal to portal of the buildings including hangers, etc. We have presented a highly conservative approach. If the analyses show overstress, we may have to rebed the pipes. We do not know what is going to be the final result. We have been for 2 years in analyses mode, and we have been looking into the contingency planning of digging up the pipes and rebedding them.

Summary (Slager):

1. We have committed to do reprofiling.

2. Acceptance criteria in terms of allowable strains or stresses by end of July.

3. Provide methodology to compare the results from profile data with Teledyne allowables - probably, end of July.

   Question (Budzik): Does the staff want to provide additional guidance, comments or feedback?

Staff's feedback after caucus:

1. Criteria

   1. The proposed factor of safety should include torsion as well as bending.

   2. Modeling of straight pipe would not be sufficient - bends, tees, elbows etc, should be included in the model.

   3. The report should include details of the application of BOSOR 5.

   4. Independent verification of the results by other computer program, such as closed form solution, etc should be included. If it already exists in literature, it would be acceptable as long as it is so documented in the report.

2. Loads

   1. Include the effects of tees and elbows.

   2. Accelerate your schedule for developing the methodology detailing how the results from profile data will be compared with the criteria.

   3. Usually elastic approach is used in seismic analysis of piping. What technique will be used for pipes in inelastic condition?

   4. Document how the future settlement is determined and how it will be combined with existing settlement. Either a letter format or a 50.54(f) submittal, would be acceptable.

   5. It was stated that pipes within the range of 10" to 36" diameter would be profiled. What about the pipes that fall outside this range? Document this and explain the basis, especially for pipes less than 10" in diameter.

   6. Structural factor of safety criteria was discussed earlier We also need a factor of safety based on functional criteria.

7. For small pipes, we need an overall maximum strain criteria in addition to buckling criteria.

Responses to earlier questions:(Boos)

1. Identifying the lines that have been rebedded.

   8"-1HBC-81

   8"-1HBC-82

   4"-OHBD-739-Non ASME line (Approx 20 ft), see Drawing SK-C-745 submitted in response to Interrogatory No 2 dated 1/2/81.

2. The question was whether the table shown earlier includes all Category I lines - The drawing SK-C-745 shows all Category I buried steel piping except for control room pressurization line installed in January 81.

3. The question was what is the maximum pressure and temperature in service water piping? The maximum pressure in OHBC - 16&15 is 105 psi and the maximum temperature is 147°F.

4. Sleeving of BWST ASME piping for Unit 2 load underneath the rail track - to permit future replacement of pipe if found necessary. Response to Q-34 addresses the analytical stresses.

5. The question was whether the Bechtel Program ME 101 considers the effect of torsion - the answer is yes, it does.

6. We still owearesponse to the method of repairing the hole in the blowdown line and specification tolerances for laying Q and Non-Q piping.

Additional NRC Staff's Feedback

1. Specified tolerances in the installation of buried piping-are the tolerances same for Q as well as Non-Q piping?

2. Address the issue of buried pipe lines crossed over by railroad spurs and whether these loadings are considered in a future meeting.

3. Provide information on repair of pond blowdown line hole.

   Question (Hadala): This is a soil structure interaction question (See Q-45(d)-Amendment 85). The size of opening, i.e., the rattle space seems to be small. The pipe moves with the free field where as the structure has a different response.

   Response: The question will be addressed later.

2. ADDITIONAL BORINGS

A. Soil-Borings - Sampling and Testing Program

Presentation (Ramanujam): The program was prepared in coordination with the consultants, Drs Peck and Hendron, Bechtel, NRC Staff and their Consultants,Corps of Engineers and Woodward-Clyde Consultants. CP Co has stated that NRC and COE are welcome to inspect the boring and testing program during all the phases. Since the start of the borings, either R Ericson or H Singh was present at the Site to observe the borings. At the beginning of the program, we discussed the sampling techniques, criteria for selection of soil samples for testing and testing methods with NRC and COE. During the execution of this program, we are in touch with NRC staff and COE informing them of day-to-day developments.

Slide 1 shows the plant area plan of the site excluding the dike area. The term 'COE' refers to Core of Engineers. Boring numbers COE 14 & 15 are for retaining walls. COE 16 is for Service Water Pump Structure. COE 8 to 13 are for Diesel Generator Building. COE 17 to 18 are for Auxiliary Building. Not shown in the slide are locations for two borings in BWST area.

Slide 2 shows the plan view of the dike, with locations of 7 borings COE 1 to COE 7. There are 5 borings in the main dike area and 2 borings in the baffle dike.

Slide 3 shows soil borings and testing program for dike area.

Slide 4 shows soil borings and test program in the Diesel Generator Building area, total of 12 borings. First is a set of 6 stratigraphy borings to identify the location of cohesive material. The next set of 6 borings are taken about three feet away from the corresponding stratigraphy borings. This time undisturbed samples are taken from clay layers for consolidation tests. This slide describes in detail the type of laboratory testing and interpretation of test results.

Question (Kane): Why do you need CAU triaxial test?

Response: This was requested by Dr Hendron. The basis will be discussed later.

Question (Simpson): Is it possible to get the density of sand?

Response: Indirect means of determining the density of sand is possible. However, there will be inaccuracies in interpretation.

Question (Ramanujam): Any comments regarding Diesel Generator Building from the staff and consultants?

(No Comments)

Slide 5 shows details of the boring and testing program for Service Water Pump Structure.

Slide 6 shows the same for Auxiliary Building.

Any comments or suggestions?

(No Comments)

Slide 7 shows the program for Retaining Walls. The borings are located 14 to 15 ft away from the wall because of interference due to existing structures.

Slide 8 shows proposed program for Borated Storage Water Tank.

The interpretation of tests will be similar to Retaining Walls. We plan to run consolidation tests.

Question (Hood): Where are the borings located?

Response: The borings will be located adjacent to the area where cracks were observed - probably about 10 ft from the ring foundation - one boring for each tank.

B. Soil Sampling and Criteria for Selection of Samples for Testing

Presentation (D Hendron): Initial investigations showed that there was fill from elevation 634 to approximately 600. Beneath the fill we find cohesive glacial lacustrine deposits, granular glacial lacustrine deposits, hard cohesive glacial deposits and till. The problem is to find a right sampler for each particular material.

The samplers that are being used are:

1. Fixed Pistons - Shelby tube samplers - for example, Hvorslev Sampler or Osterberg Sampler - These are very good in fill - 3" diameter.

2. Spring Loaded - Pitcher Sampler - 3" diameter.

3. Rotary Core Barrel Sampler - 3" to 4" diameter. It is very hard to advance sampler in very hard cohesive glacial deposits. The best sampler in this case is #2 Pitcher. We were very lucky in getting good samples of high quality in till.

   Methodology in selecting samples and engineering property tests.

   Two methods: One for DGB area and the other for Dike Area:

   1. DGB - First Boring - continuous undisturbed samples - extrude samples in the field lab. Test visually to examine the consistency based on a system developed by Dr Peck many years ago. Locate the range and consistency of the material - locate the extremes. Then drill another boring close by (approx 3 ft away) and obtain samples at locations of interest.

2. Dike - Lowest recovery and beat up sample give a qualitative handle on stratigraphy, then go back to the best tube and pick the tubes for engineering property.

Question (Hadala): What is the percentage of recovery in your beat-up sample?

Response: Approximately 30% - This done in field, not in the laboratory.

Question (Kane): Did you use Pocket Penetrometer or Torvane tests?

Response: Pocket penetrometer results give a good measure, not Torvane; it is very stiff and shears the material.

Question (Kane): How were the extremes of range determined? Based on Pocket Penetrometer?

Response: To backup, water content, gradation and limit profile are obtained in stratigraphy boring. We take photographs of each tube in laboratory. Each 6" increment of the tube is being photographed.

Question (Hadala): What is the pushing pressure in Hvorslev's sampler.

Response: Pushing pressure - runs right up to the maximum pressure of 1000psi. Do not have the number for the actual pressure.

Current status of boring:

Dike borings are completed.

Completed Service Water Pump Structure boring.

DGB borings are nearing completion.

COE 17 underway. COE 18 not started yet and BWST borings T27 and T28 still to go.

Question (Simpson): Were you concerned about hydraulic fracture during dike borings?

Response: Yes, took precautions to avoid hydraulic fracture-used thicker than normal drilling fluid.

Question (Hood): Is the pipe at COE 15 repaired or is the pipe sealed or vented.

Response (Boos): Don't know. We can check and find out as to what is the current situation.

Laboratory Tests:

The program is underway in Clifton, NJ.

Extruding COE 11 today. Just completed COE 9 and will be extruding by the end of the week. Probably there will be 15 to 20 consolidation tests at the end of the test program. Strength tests CIU and CAU - agreed with Skip Hendron to do CAU. Less concern in terms of urgency to do CIU - no established schedules yet.

Preliminary results: COE 13 - Quality - stratigraphy showed cohesive material very stiff to hard condition.

Pocket Penetrometer 1.4 tsf to 4.5 tsf (limit of the penetrometer). Typical results average around 3 tsf. Density values are high.

γ_{dry} = 115 to 130 pcf. Water content close to optimum. 10 to 11%.

Can't say much about granular materials. Tube densities are a little low in samples. Water content low for this type of materials. Cohesive component is very stiff to hard as a general rule - backed up by 5 consolidation tests.

Question (Kane): COE 9 - Did you observe soft material in the range of 0.75 tsf.

Response: It is expected - There are serveral piping and duct bank runs in this area and local pockets of soft material is not unusual.

Question (Simpson): Any idea of the relative density?

Response: Very tough to measure. Tube samples are not the best source for determining relative density.

Question (Simpson): Any plans to run SPT's to determine relative density.

Statement (Hadala): The analysis for seismic skakedown made by the applicant is very conservative and the numbers obtained were very small.

Statement (Afifi): We did the analysis for each of the 33 borings.

Highest settlement is 1/2" to lowest essentially zero.

Used Gibbs & Holtz density curves, used actual thickness of sand layers observed in borings in 5 ft layers - calculated the shear stresses at the centers of 5 ft layers and used Seed

& Silver data for dry sand to obtain settlement, even though this will be less due to capilliary moisture.

Question: Did you find a greater thickness of sand?

Response: In COE 8 there is sand from top to bottom. There are cuts and fill associated with duct banks and also there is a big pipe trench for circulating water pipes located very close to the original ground surface. It is possible to get sand from top to bottom if one happens to hit this area.

Question (Hadala): Go back and look as to how extensive the sand is. Was it adequately covered in the previous analysis in terms of relative density?

I am fully satisfied with the method of analysis. Do not ignore relative density in tube sample. Review Poulos work in the state of the art paper. Reconcile with the two observations. Relative density derivations from tube samples extremely warranted to correct the data. I would settle for computed void ratio per published methods. Hvorslev sampler is particularly good for sand recovery. There is no vacuum release in Osterberg sampler. One can drill a hole - crude but effective.

NOTE:

Hadala requested the maximum shear stresses vs elevation output from SHAKE analysis for all profiles that has been performed for Part II of Site Specific Response Spectra Report by Drs Vanmarcke and Kausel.

Dike Area

Perimeter dike - improvious fill zone - cohesive soil underneath the fill is till deposit. Baffle dike - random fill both cohesive and granular. COE 7 - Thick deposits of Glacial Lacustrine Granular Material.

Question: Analysis of Baffle dike - did it account for 40 ft of sand - does it need to be reanalyzed? Was the material loose or not? Did you know the stuff was there?

Response: No

Statement (Hadala): It would be better to go back and do a SPT to get the 'N' values in the 40 ft of material and thereby close the issue. If you couldn't push the tube you will definitely get a good 'N' value. But to document properly you need 'N' values.

Presentation: We can auger to the sand and take SPT's in the sand as only the unknown is in the sand. It is not known why sand was there-probably there were channels. No organic

material was observed in deposits themselves. Nothing that would give us a concern. There were a few instances of roots and stringers in the fill portion. One UU test in till indicated a value of 37 tsf equivalent to weak rock, a very strong material.

Hard clay in baffle dike - UU- 10 to 12 tsf about twice that was used in FSAR Schedule:

1. Borings to be completed by end of next week

2. Lab tests - Strength tests in DGB - end of next week - Consolidation test - 1st to 8th of June.

3. SWPS - Testing still to be decided - shooting for middle of June.

Staff & Consultants Feed Back

(1) Submit photographs of all samples - one for COE and one for NRC staff-this is in addition to the report.

(2) Open holes that is not to be grouted and intended to be used for observation: They should be cased. Provide details of the observation wells such as depth, filter pack etc, WCC to detail log of installation of these wells along with 2 feet bentonite seal. Submit one typical detail with summary of hole elevations and screens.

(3) Describe corrective action for the hole bored during boring operation in makeup water concrete pipe - COE 15 (by phone call)

(4) Loss of drilling mud in COE 17 - Western end of Feedwater Isolation Valve pit why it happened and what are the plans for further investigation.

Response (Hendron): We observed coarse grained granular material - we went for casing. The reason for casing is to prevent locking of core barrel in the process of advancing the hole 100 ft below - not to stabilize the hole.

Question (Singh): Drilling was stopped for 8 hours. Why?

Response (Hendron): Our judgement is that the fluid loss is due to coarser and clean backfill not due to the case of an open void - common problem in drilling through generally coarse granular material.

Statement (Singh): After 38 ft the fluid was stabilized.

Response (Hendron): The decision to go to casing (adding cement or thickening drilling mud etc, are alternatives) was

at Bechtel's request-we couldn't use thickened drilling mud, since the hole was close to dewatering well system.

(5) Investigate loss of ground near COE-8 at the surface - any impact on the service water line in this area.

(6) North corner of DGB - thickness of sand layer thicker than previously indicated. Existing SPT's are before preload. Reevaluate earthquake settlements using new borings and layer of thickness information.

(7) Evaluate whether previous SPT's - Old SPT's - get N -get relative density compare with relative densities obtained in COE 8.

Response (Hendron): COE 8 - pipe fill in non representative of fills at that point. Probably COE 10 may be more representative.

Differences up to 20% would be considered adequate. (Discuss by phone between Hadala, NRC, COE and applicant).

(8) Baffle dike - Need SPT's in sand zone near COE 7.

(9) Hvorslev & Osterberg Samples - need area ratios, kerf (inside clearance ratios) and total force on the sample at 1000psi hydraulic pressure - only in fill area. Possible densification during sampling of unsaturated material - below water table might have densified the material. Need maximum pressure used to push the sample through the fill and not the maximum of the machine (can be handled by phone).

(10) After interpretation of the results, dike stability should be evaluated using the correct seismic input.

(11) Document that consolidation test are to be performed for BWST. The results of these tests should be used to estimate settlements.

Response (Afifi): Information from current load test is available. There is 7 months of load test data. Doesn't this mean you are in secondary consolidation? Won't settlement prediction from actual observed behavior be more reliable?

Statement (Kane): Estimate from consolidation tests helps to give you an upper limit.

Question (Afifi): Q-39 Regarding consolidation test for Aux Building - settlement of caissons - 80% - 20% division - is it reasonable to anssume this or do we need a consolidation test to prove this? If consolidation tests agree with this probably it will be only by accident.

Staff: Do not need consolidation test for containment. Present available information to justify 80% value is reasonable. Caissons area - proceed with consolidation test - Will defer decision on Aux. Building till that fix is to be discussed.

(12) Consumers Power Co should furnish P Hadala, of COE, shear stress output from SHAKE analysis.

3. PERMANENT DEWATERING

(Note: D Hood of NRC stated that the NRC staff reviewer for Midland Project for hydrologic issues has been reassigned to other issues and is not currently available to review hydraulic aspects of dewatering. Hence a hydraulic reviewer was not present during the discussion of dewatering issues.)

Presentation (William Paris)

A. Field activities since submittal of Amendment 85.

Slide 1 shows field activities since submittal of Amendment 85.

1. Activities pertaining to PD-20 test well:

Slide 2 shows the location of PD-20 and the ground water levels in the vicinity of the DGB prior to pumping test well PD-20 (10/2/80). The test well was pumped for 6 weeks (10/2/80 to 11/13/80) at the rate of 2.4 gpm.

The water table at DGB area was lowered by approximately 4 ft. The ground water contours before and after pumping are shown in Slides 2 and 3. It can be seen from Slide 3 that the cone of influence extended to the cooling pond to the south but is truncated to the east indicating that the recharge comes primarily from the east.

2. Unit 1 dewatering system: (construction dewatering). On November 19 six days after the completion of the PD-20 pumping test, the Unit 1 construction dewatering system was initiated. Slide 4 shows the ground water levels prior to the start of the Unit 1 dewatering. Flow rates for Unit 1 dewatering increased to 93± gpm and then stabilized at 60± gpm as shown in Slide 5. The effect of 8 weeks of dewatering is shown in Slide 6, which is the ground water levels on 1/12/81.

3. Cooling pond raised from elevation 623.5 to 627.0 (1/12/81 to 1/28/81). On 1/12/81 we began raising the cooling pond level from elevation 623.5 to 627. Slide 6 shows the ground water levels prior to pond raising.

Slide 7 shows the pumping rate of the combined construction dewatering system increased from 66± gpm to 100 gpm. Both during and after raising of the pond elevation we monitored water levels in piezometers and observation wells. Slide 8 shows the location of these piezometers and observation wells. Hydrographs of the observation wells and piezometers are shown in Slides 9 and 10. The hydrographs show that the observation wells and piezometers south of the DGB all responded about the same time regardless of their position in relation to the

cooling pond. On the other hand the observation wells near the CWPS and SWPS responded much faster indicating their nearness to the recharge source.

The observation well that responded the fastest in the DGB area was PD-16 located just south of the DGB (Slide 8). Based on the response of PD-16, we calcuated recharge rate. We first estimated an apparent permeability of 18 ft per day (which compares well with the 11 ft per day derived earlier in response to Q-24). This apparent permeability results in a recharge time of 60 days rather than the 90 days given in response to Q-24. Regardless of the estimate of apparent permability or calculation of recharge time we have committed in Amendment 85 to doing a drawdown recharge test to determine the actual time for water levels to rise to el 610.

Statement (Hadala): Figure out how much time you actually need for recharge and carry out the test to that many days.

Slide 11 shows groud water levels on 4/17/81 about 4 months after raising the cooling pond. The water level in the DGB area has increased about 5 ft to 622 indicating slow recharge whereas the water levels around the CWPS and SWPS are about the same as the cooling pond.

4. Turbine building dewatering and PD-17, PD-20 pump initiated 4/16/81:

More recently on April 17th, 9 more wells in Unit 1 area were made operational as well as 8 TEW series wells in the Turbine Building. PD-17 and PD-20 Test Wells south of the DGB (Slide 8) were also started. The combined system flow rate peaked at 145 ± gpm but quickly decreased to 100 ±gpm as shown in Slide 7. The pumping at PD-17 started at 3.4 gpm but declined to ¼ gpm. PD-20 started at 10 gpm but declined to 6 ± gpm. Slide 12 shows ground water level after pumping for 13 days (4/30/81). This shows that the ground water levels in DGB area have been lowered by 4 ft, whereas they have remained unchanged in the other plant areas. This is the current status with regards to construction dewatering.

B. Staff's consideration of dewatering response adequacy (as of 2/24/81):

We have listed questions pertaining to dewatering in Slide 13 as well as the follow up questions. Most of them are still under review by the staff.

C. COE/Staff's consideration of dewatering response adequacy based on NRC depositions (as of 3/81):

Slide 14 shows a list of the NRC question number versus the status based upon our reading of NRC's depositions. The summary of the status of each item is given below:

47(1)c-COE concurred that recharge test is the best way to go.

47(2)- NRC agreed that majority of recharge is from SWPS Area.

47(3)- The COE agreed with our design but asked that we use a permeability of 17ft/day rather than 31ft/day as used in earlier response to Q-24. The permeability of 31ft/day was based on a pumping test conducted for only three hours, whereas the value of 17ft/day derived from pumping test well PD-14 for five days which was a more representative test.

Question (Budzik): I note here that these are COE/Staff concurrence at the time of depositions. We don't have an official feedback.

Response (Kane): Some of these feedback have been incorporated into the latest COE request which have not been formally transmitted to the applicant yet.

D. Coe/Staff requests under review (3/81): Slide 15 shows a list of items that are currently under review by COE and Staff. We will go through this item by item:

NRC Staff (Kane) and COE Comments:

47(4)-Some aspects of this item are ok.

47(5)-Concur with applicant's position - no need to plug the weep holes.

47(6)-Generally agree with pH value, calcium carbonate or ferrous incrustation not likely but should include cleaning procedure in maintenance plans.

47(7)-Ok.

47(8)-PVC is not like carbon steel. Would there be scaling? 47(6) and (8) go together.

Response: Incrustation, corrosion or scaling can easily be cleaned by acid wash if needed.

47(9)- Perched water table

Response: The fill was placed dry. If the ground water could find a way in, it can easily find a way out through the sand lenses.

COE: Good argument - ok

Response: There are adequate number of monitoring wells. If number is inadequate, they can always be arugumented later.

49(9)- Flow equation - There is a typographical error.

Mr Kane discussed some aspects of the questions that follow with Mr Ray Gonsalez, the previous hydraulic reviewer. The general impression is that Gonsalez doesn't see any major problem with the responses.

E. Request for 20 - Backup wells - outstanding items:

We need these wells to:

1. Obtain dewatering data for SWPS well design.

2. Assist in dewatering SWPS area during construction operations.

3. Establish drawdown - recharge testing program. We recommend that this work be added to current temporary dewatering contractor's scope of work. This contractor's method of work is different than the work that will be required to be done later. We have communicated to the staff via a letter on the issues pertaining to these backup wells.

Slide 17:

1. Laboratory method for sand determination:

For the temporary dewatering we used 5 micron filter because the specified 50 micro filter was not available. It was a method specification. Wells are now tested for 50 micron filter; very few fines were noted - with either filter.

Question: If you do not use a fine filter, you may end up pumping all the silt away, create a void and thereby affecting supporting structures.

Response: There are no silt deposits in this area to be dewatered. If the concern is removal of silt, by imposing a very fine filter, algae and iron particles will also be filtered out giving erroneous results. Possibly one can use a silt refraction test or similar turbidity measurement tests. Our observation is that the water that was being pumped out by the dewatering system is very clear. This issue should be resolved later.

2. Q-listed Installation:

We don't see a need for Q-listing the wells even with the new seismic criteria. We should have at least 30 days of recharge time which would be quite sufficient to take proper action. We agreed that the recharge test, monitoring of wells and fines should be Q-listed. But the need for Q-listing the hardware; such as pipes, etc is not quite evident.

Response (Kane): The parts that are in the hole, below the ground surface that is of concern to us. Like to use common sense approach to quality control. We need to look at items that take significant amount of days for replacement or those that easily degrade the functioning of the well, such as well screens, filter pack, gradation, etc. Also the drilling operation itself should be inspected. NRC staff and COE would take about one week of time to review applicant's April 24th letter. Applicant agreed to make the well installation below the ground Q-listed, but not the well material. Staff concurred.

3. The applicant should develop a list of installation items that should be categorized as 'Q' and get together with NRC staff and COE for further discussion. The proposal should be detailed enough so as to minimize staff's review time.

4. Applicant concurs with the staff.

5. Method of well development: same as COE's practice. Staff does not see any problem.

6. Filter pack design - The adequacy of the filter pack is under review. Suggest one boring for every four wells and have samples tested for gradation. What is the need for 15 ft of blank casing?

   Response: For shallower wells in silt and clay, we need storage and draw down capacity.

   NRC staff will review the gradation and location of bottom of screen, then make a judgement on the adequacy. Will communicate via the response to the April 24th letter, by next week.

7. Estimate of amount of material removed during well development.

   Response: This is tied to the procedure that will be covered in Q program.

8. Well depths may not be deep enough for construction dewatering - No response is need from staff. This is a construction concern, not a safety concern. Below SWPS is there till or 10 to 15 ft of sand?

NRC Staff's Feedback After Caucus

Dewatering

1. Permanent Dewatering - The following items should be resolved before considering installation of wells.

   a. QA, QC aspects.

   b. Silt test.

   c. Filter size - 5 micron is acceptable.

   d. NRC will verbally respond to April 24th letter and follow it up by written confirmation.

4. BORATED WATER STORAGE TANK

Presentation (Boos): The series of slides that will be shown are the same as that was shown during the recent structural audit except slides pertaining to details such as load combinations, etc, are not here. Any questions pertaining to structural area should be deferred to the last day when B. Dhar would be available to respond.

Slide 1 lists the topics that will be covered here, namely description, current status, proposed remedial work and schedule.

Slide 2 shows Midland Site plan and the location of the tanks in relation to other buildings.

Slide 3 shows a cross-sectional elevation of the tank. The two tanks are essentially the same. For Unit 2 the valve pit is slightly small. The ring foundation is designed to restrain the sand and support a certain amount of the weight of the tank and water. The overturning moments due to wind and earthquake are transmitted to the ring foundation by means of anchor bolts.

Slide 4 shows the current status. We have performed in the order of 30 borings and shown that the fill is adequate. Furthermore, we committed to doing the load tests in order to obtain data to better predict long term settlements. We have filled the tanks since 10/16/80 and have been monitoring settlements per Specification C-76. The settlement pattern monitored in the field did not match with the settlement pattern computed by structural analysis based on a simplified model. Therefore, a sophisticated finite element computer model, including soil structure interaction was subsequently developed which was able to better predict the settlement pattern. Slides 5, 6 and 7 show the details of the finite element model.

Slide 8 shows results of analysis for different values of foundation Young's modulus. We conducted a plate load test to determine the 'E' of the soil. To ascertain whether the problem was soil related or structure related, we varied the 'E' in the model as shown and obtained the settlement profile as well as the bending moments at critical sections. The computed settlement pattern for 'E' of 340/980 most closely resembles the observed settlement pattern as shown in Slide 9.

On examining the computed bending moment and existing capacities for this case, it can be seen that the computed moment exceeds the capacity of the section. This was further substantiated by the observed cracks. Therefore, this is not a soils problem. It is due to a structural design oversight. The designer did not take into account the differential pressure of 2 ksf. The valve pit acted like a large support and tended to hold the tank up. The original design primarily discounted the existence of the valve pit. Obviously, the relatively softer soil accelerated the problem.

Question: Plate load test gives 'K' the modulus of subgrade reaction. How did you get 'E'? Also, your model considers 'E' to be same throughout the width of the foundation. Is this acceptable?

Response: There were two plate load tests conducted in two different locations. There is a closed form relationship between 'E' and 'K' and knowing 'K', one can get 'E'.

Presentation: The structural model indicated exceedance of capacity of certain locations indicating that there will be cracks in this area. Indeed there were cracks and this was documented in 50.55(e) interim reports.

Slide 10 show the proposed remedial action by preloading the valve pit. By this technique we are attempting to overcome the fixity provided by the valve pit. We will preload the area by concrete blocks up to 2.5 ksf. We will monitor the surcharging and the settlement.

Slide 11 shows the remedial fix to the ring after the surcharge is removed. This fix will be designed as if we were not going to preload the valve pit. This over design is intended to give extra margin.

Slide 12 shows the schedule. Approximately 4 months time period is allotted to surcharging program. However, this is open ended. We anticipate 4 months time period is adequate. Drain the tank during 9/81. Construct the ring beam modification and shim the tank if found necessary. If tank has to be modified, then hydro test will be done again. The Δ_{tank} is provided by Graver per ASME subsection NC. We are commercially reopening the contract. They would calculate the stresses in the tank today and also after the surcharging program. They would be informed of the surcharging activities and results of settlement monitoring and they will have the responsibility of certifying the adequacy of the tank for the predicted 40 year settlement.

The bolts in North-South end are loose where as the chair/bolt combination in the East-West end are in tension. The effect of differential settlement on the tanks is that transmitted by chair/bolt combination and therefore is restricted to the portion of tank near the junction of vertical wall and flat base. We expect that the proposed surcharge program will receive most of these stresses. We are currently viewing this as a 50.55(e) item, even though the tanks were previously discussed in 50.54(f). We dont't intend to seek permission form the Board for the remedial activities, but we would like to keep the Board informed of our activities.

Question (Kane):

1. Are there any pipes still connected to the tank?

2. Were the dynamic 'E' values directly correspond to cross-hole test and if so they would not represent large strain values usually associated during a sesmic event.

Response (Boos): There are 4" diameter fill and drain lines still connected to the tanks.

(Note: The issue of measured shear modulus corresponding to low strain modulus and need to consider degradation of modulus during a seismic event was responded by Afifi to Kane's satisfaction).

Question (Kane): Are you going to take two borings in the BWST?

Response: Yes

Presentation: The lean concrete fill shown in slide will be Q-listed. Also the connection between new ring and the old ring will be by friction. Dowels will be be added, as shown, if required. The details as to how the reinforcement is computed is best left to B. Dhar to respond.

Question (Kane): What is the calculated future settlement?

Response: The tank has experienced 2½" settlement now. Additional 3/4" is expected. The future settlement will be arrived by extrapolating the measured settlement for the next 40 years.

Question (Hood): Would the tank be removed during modification?

Response: No. The tank will be left in place. The entire modification procedure will be coordinated with the tank vendor.

Statement (Budzik): The schedule is tight due to the fact the tanks are needed during start-up and testing. The failure of the foundation is not due to soils but due to improper design. We would like to proceed unless staff has some concern.

Response (Hood): The argument whether the problem is soils related or not is not so simple. It may not be removed from the hearing. It may not be proper to discuss this issue at this point in the meeting.

Question (Singh): 'E' values for the soil - why such a low unrealistic value of 370 ksf was used for till in the first case, especially since 'E' value for till has already been established?

Response: The values may probably have been chosen to represent from one extreme to another extreme in 'E' values and to understand the effect of 'E' on foundation behavior.

Responses to Earlier Staff's Questions (Boos)

1. BWST piping - What is going to happen to these pipings during valve pit preload?

   Response: The two 18" lines - they have been cut and separated before the tank load test. There may be one or two Non-Q

(diameter in the order of 6" or so) pipes - we feel there is no need to concern about this piping. Then there are, drain and fill lines. They are Non-Q from the valve down stream. We would investigate the functional requirements of these lines.

Question (Hood): Are you going to monitor these lines?

(Note: No response was provided for this question)

2. Remedial work for BWST ring foundation - The question was whether the design is based on friction or dowel reinforcing.

   If it is practicable, solely rely on dowel action and ignore friction. The 'E' to be used will be 340 ksf and designed per load combinations given in FSAR and supplemental load combination equations for settlement load combination equations for settlement as discussed during the structual audit. We will design the beam to resist resulting bending moment and shear forces.

NRC Staff's Feedback After Caucus

BWST

1. NRC would like to receive details of how the transfer of shear between the new ring beam and existing ring beam is achieved.

2. NRC would like to see reinforcement details in the new ring beam.

3. NRC would like to know how torsion is taken into account in the new ring beam design.

4. General concern - the effectiveness of the use of dowels in the severely cracked wall to transfer shear.

5. The tank is still bolted to the old wall. How effective will the new wall be in carrying the load from the tank?

6. Settlement predictions should be based on results from consolidation tests performed on samples from new borings.

7. Staff has no objection to preloading the valve pit provided the two drain and fill lines are disconnected and details are provided as to how the pipes will be monitored.

5. AMENDMENT 85 (SOILS ISSUES)

Presentation (Afifi):

. We have reviewed Mr Kanes' notes after the latest deposition and also notes by Mr Singh. We have tabulated here a list of what we understand to be issues still not resolved by Amendment 85. We would like to review the issues question by question.

Q-39

Slide 2

1. COE - "Applicant has not explained how Young's Modulus (E), Poission ratio (M) and influence factor were obtained."

   Response - The stress increment is 3 ksf for each containment. Stresses were computed on the basis of elastic half space theory. Used HSPASE Program developed by Lysmer using Mindlin's soulution for flexible foundation. Then used Poulos and Davis' procedure to convert to rigid foundation.

   COE - Only clarification of the methodology is needed. Explanation provided is adequate.

2. COE & NRC - "E" - Young's Modulus, not M (constrained modulus) should be used for dewatering settlement."

   Response: For dewatering settlement since the entire area around the plant is dewatered, which for practical purposes could be assumed infinite in extent, the use of constrained Modulus M is applicable. If we really want to take the size effect into account, then one should also consider stress distribution with depth and the settlement is obtained by integrating the variation of stress over the depth. So the use of M is a trade-off.

   Question (Singh): Use of M can be justified only when you have a very large area, such as several hundred square miles. Therefore, it is difficult to see how the plant area could be considered infinite in extent.

   Response: The realistic value is somewhere between E & M. We propose use of the average, i.e., (E+M)/2.

   COE & Staff - The approach is acceptable.

3. COE - "Elastic settlement data was provided; consolidation and secondary settlement not considered."

   NRC - "Elastic and consolidation settlement data were provided. Secondary settlement not considered."

   Response: Slide 14 - For loads on glacial till, it is assumed 80% of settlement to be immediate and 20% delayed based on Dr Peck's

paper presented in second Nabor Carillo lecture. The settlement versus pressure plots for containments for Unit 1 and 2 as shown in Slide 20 shows a linear relationship so far.

COE & Staff - Agreed. No need to consider secondary settlement.

4. Staff - "Time dependent settlement for dewatering. "E" does not address time dependency."

5. Staff - "Consolidation Tests"

   Response: Slide 22 shows plot of dewatering settlement essentially leveled off.

   Slide 13 shows consolidation pressure and compressibility parameters.

   Slide 15 shows compressibility parameters used for settlement evaluation.

   Cr is too high because of heavy disturbance of samples. The data had to be heavily corrected. Otherwise we would only end with predicting unrealistically larger settlements.

   COE & Staff - Staff and consultants will discuss this issue further and provide their response later.

6. Staff - "Update settlement plots"

   Note: Two sets of updated settlement plots were provided at the meeting. One for NRC Staff and the other for COE. These plots will be formally submitted to NRC via another amendment, therefore, this item is considered closed.

7. Staff - "Does settlement history/load history provide enough confidence that settlement will be minimal?"

   Response: We have continued to accumulate data as time goes on. Bechtel will discuss their level of confidence when the next settlement data is presented.

8. COE & NRC - "Bearing capacity - Su and ϕ not representative"

   Response: Shear strength test results on samples from borings currently underway will resolve this concern. The depths of these borings which are located adjacent to electrical penetration areas are being extended to elevation 460, well into the high shear wave velocity material.

Q-40 - <u>Diesel Generator Building</u>

<u>Settlement/Consoliation</u>

1. COE - "Information concerning settlement of DGB is questionable because results are based on data from preload programs."

2. COE - "No evidence to prove that 100% primary consolidation completed before surcharge removal."

3. COE - "Flexibility of footing prevented even distribution of surcharge load."

   Response: Slide 23 shows updated plot of DGB settlement for monitoring point DG-3.

   The plot is updated till 3/18/81 includes effect of dewatering. Data collected so far shows that settlement has leveled off. Furthermore, the predicted long term settlements are based on surcharge being there all the time which is quite conservative.

   Consolidation test results from the samples obtained in the new boring program will be provided to the Staff for evaluation relative to the concerns 1, 2 and 3. However, it should be noted that because of the randomness of fill not every layer would have reached 100% primary consolidation. The tests may indeed show this to be so.

4. COE - "Sudden drop in the piezometric level after removal of surcharge."

   Response: In the data from piezometers 40 and 21, corrections were made for errors. The elevations in piezometers were not surveyed each time. They were computed and in the process of reduction of data, mathematical errors were made. The corrected plots are submitted today along with the settlement update package. This should address this concern adequately.

5. NRC - "Provide update settlement of DGB at least until February 1981."

   Response: The settlement update package handed out today has this requested information.

6. COE - "Preload program not effective in eliminating 100% of the primary consolidation"

   Response: Settlement plots show that the overall fill has undergone primary consolidation and is in secondary consolidation. Again the results from tests on new boring will be provided to the Staff.

7. Bearing Capacity

COE - "Soil parameters used in calculations are not representative"

NRC - "Method of bearing capacity calculation acceptable - parameters not representative.

Response: Representative parameters will be obtained from tests on samples from new borings.

Calculation redone with the same methodology as before but with new properties should be able to confirm that adequate bearing capacity safety factor exists.

8. Miscellaneous

COE - "Warping of building is causing bending moments"

Response: This will be addressed during structural presentation.

NRC - "Anisotropically consolidated as opposed to isotropically consolidated"

Response: In the early soil investigation program, all tests were done in isotropically consolidation condition. Triaxial tests - CIU used different over consolidation pressures. In the new tests, we are planning to do the tests under both anisotropic consolidation as well as isotropic consolidation.

Q-41 - Service Water Pump Structure and Retaining Wall

Slides 6 and 7

1. COE - "Bearing capacity"

Response: The underpinning wall will be treated as a strip footing. Shear strength tests on samples from new boring program will give us representative values to calculate the bearing capacity factor of safety.

2. COE - Settlement E = 600 Su

3. COE - "Settlement (III) - Simplified approach used by the applicant used in conjunction with one-dimensional consolidation theory."

Response to these concerns will be addressed by Jim Gould during the SWPS remedial measures presentation.

4. COE - "Creep Settlement (IV) - Creep settlement is not considered in evaluation of long-term settlement."

Response: The same discussion for similar concern in Q-39 applies here too.

5. COE - "Differential Settlement (V) - Pile Scheme

Response: This concern does not exist anymore since the pile scheme has been abandoned.

Retaining Wall

6. COE - "Soil Parameters 30 feet distance"

NRC - "Same comments plus a request for factors of safety."

Response: Settlement plots for retaining walls are shown in Slide 24. The soil parameters will be verified with test results from new borings. Slide 25 shows cross-sectional elevations of the retaining walls. The Diesel Oil Fuel Tanks are located about 30 feet away from the edge of slip surface for the retaining wall postulated slope stability failure mode. The concern that the fuel oil tanks will be affected due to the non-mechanistic stability failure of retaining wall is not quite likely.

7. NRC - "Method of analysis of retaining wall - seepage and earthquake"

Response: Slide 26 shows stability analysis for the retaining wall.

Question: Did the analysis consider seepage?

Response: No, seepage was not considered. When the pond is full water forces exist on both sides and hence balance out. When the pond is empty and site is dewatered, there is not enough water source to create a steady state seepage condition. Note that Slide 25 shows structural backfill and gravel pack along with drain in the bottom.

Question: Could loss of dike simulate rapid drawdown conditions in which case seepage forces should be considered. There are two concerns due to seepage:

1. Reduction of effective stresses due to seepage.

2. Driving force due to seepage.

Therefore, the analysis with seepage condition should be done.

Response: We would look at couple of water levels between maximum to minimum and include seepage condition and compute the factor of safety. This condition will give lower factor of safety.

For the seismic case, psuedo static analysis was done resulting in a factor of safety of 1.8.

8. NRC - "Future settlement based on DGB C "

   COE - "No concern with settlement"

   Response: Slide 24 shows settlement plots till 3/81 and shows that the settlements have leveled off. The Staff is not deeply concerned about the actual settlements. However, the concern is on the method of calculating the long-term settlement. Using C_{α} from DGB should be conservative for the retaining wall settlement computations.

Q-42 - Auxiliary Building Electrical Penetration Underpinning

Slide 8 and 9 lists the concerns of COE and Staff. They all pertain to caisson underpinning. Since caissons are not going to be used as underpinning, these concerns are not presently valid. The design basis for bearing pressure is that the total pressure due to DL + LL would not exceed total past pressure.

Q-43 - Borated Water Storage Tanks

Slide 10

1. COE - "Settlement prediction using plate load test data and theory of elasticity approach are unacceptable."

2. NRC - "Settlement measured from full scale load test would not provide accurate settlement."

3. COE - "Differential settlement 1 1/2" and soil modulii of 260 Kips and 490 Kips."

   Response: The original settlement prediction using plate load test and theory of elasticity was performed for preliminary calculations. The final calculations for estimate of long-term settlement would be based on full scale load test measurements. Slide 27 shows settlement vs time plot, and the load test has been going on for the past 7 months. The plot shows characteristic primary-secondary consolidation behavior. We believe the long-term settlement prediction on the basis of full scale test is the best approach. We have 7 months of data, and how can this be ignored? Settlement computation based on consolidation tests is expected to give very large values.

   The 1 1/2" differential settlement refers to differential between the edge of the tank to the center of the tank. This was derived from closed form solution for a flexible plate. The soils modulii values of 260 and 490 Kips/sq ft are no longer in use.

   Statement (Kane): You are going to perform consolidation test on samples taken from BWST area. You should calculate settlement

based on consolidation test results, and this would give an upper limit for the predicted settlement.

Slide 11

4. COE - "Creep settlements - Also need to be evaluted to determine the structural adequacy of tanks bottom."

   Response: Additional settlement markers up to 12 are being installed in the tank foundation ring.

   The future settlements can be computed from slope from the test data since the fill is in secondary consolidation.

   NRC & COE - Do the settlement computations form consolidation tests. There is a need for lab data and would provide a good comparison to load test data. We don't believe that there will be much difference in settlement computations between these two methods.

5. COE - "Shear strength used in analysis of bearing capacity of soil under BWST not appropriate."

   Response: The bearing capacity will be recalculated based on new shear strength values obtained from the new boring program.

6. NRC - "Magnitude of differential settlement"

   Clarification - This is the settlement between the edge of the tank and the center of the tank.

Q-44 -Underground Diesel Fuel Tanks - Foundation Design

Slide 12

1. COE - "Settlement - Long-term settlement based on data obtained from DGB not acceptable because similar soil may differ in engineering characteristics."

   Response: Slide 30 shows time settlement plot since the time monitoring was started. The plot shows essentially a flat line indicating stabilization of settlement except for expected dewatering perturbances. Use of settlement date from DGB in predicting long-term settlement even though not exactly representative is considered a conservative approach.

2. COE - "Settlement - due to dynamic loads"

   Response: The concern pertains to four to five feet of sand layer in the vicinity of the tank and the effect of seismic shakedown settlement of this sand layer on pipe settlements. This will be evaluated and responded to in our next amendment.

3. COE - "Uplift pressure on tanks"

   Response: This concern was discussed with the Staff and the COE during the recently held structural audit.

NRC Staff's Feedback After Caucus

Ammendment 85 (Soils)

1. Staff is in general agreement with Amendment 85 (soils aspect).

2. Consolidation tests are required for Auxiliary Building settlement prediction. The concept of 80% immediate settlement in till, which the same concept used in Containment Building is acceptable for use in Aux Building also.

   Diesel Fuel Oil Tanks.

   a. Dewatering - What is the effect on connections in the tank (concrete anchors) due to possible differential settlement?

   b. Outstanding question - borings show sand pockets in the tank area. Seismic shakedown settlement needs to be evaluated.

6. AMENDMENT (85) STRUCTURAL

1. Review of Methodology to consider the effects settlement and cracking in structural design.

Presentation (Johnson): Consideration concern has been expressed regarding the cracks that are observed in the structures in the Midland Plant. We will discuss the Methodology of considering the effects of settlement and cracking in structural design. We also have available with us, results from the latest crack monitoring in the form of crack mapping. If anyone is interested we will go over this with you.

Slide 1 shows types of loads

Mechanical - steady state loads, such as dead, live, wind and tornado are called primary loads.

Earthquake loading is cyclic, however, it is still applied as a static load. In Nuclear Industry the stucture is expected to be in elastic range of behavior during earthquake.

Pipe rupture loads are transient - local yielding of material is permitted under this loading.

Impactive loads are those arising from pipe rupture and tornado missile impact - local yielding is permitted.

The last category of loading is thermal, settlement, creep and shrinkage. They all are similar in effect. ACI-318 code also lumps these loads in the same category. These loads are self limited in nature.

Slide 2 shows definition load nomenclature that will be used in load combinations based on Midland basic design criteria per FSAR and modified criteria to include settlement. The first two load combinations taken directly out of ACI-318 code. The remaining two combinations, settlement with OBE and settlement with wind are considered because both OBE and wind could occur more than once.

Slide 4 shows ACI-349 criteria where settlement was considered. Last two combination wherein, settlement was added to SSE and tornado were included by Reg Guide 1.142. Our commitment is that we will check for these load combinations. This will not be part of the criteria. We will do the load combinations and present the results however we do not believe that SSE and tornado should be combined individually with settlement. Settlement, creep, temperature and shrinkage do not affect the ultimate strength.

Slide 5 shows types of cracking in a typical beam. It is taken out of ACI-318 code commentary. Cracking is expected to occur in normal design and the sole purpose of rebar is to carry the load after cracking. Also shown is a local displacement curve. This is to illustrate the self limiting load concept. Due to

settlement an element undergoes ΔS displacement. If the settlement takes place at low load (stress) level, the pickup in load ΔP is larger. Whereas, at higher stress level, as shown, the ΔS displacemnt causes very little additional increase in stress.

Slide 6 shows behavior of reinforced concrete wall test results when subjected to purely biaxial tension and biaxial tension with membrane shear (refer NUREG CR-1374).

This is to illustrate the way in which two way reinforcing pattern resists cracks. The structures in Midland have two way type of reinforcing.

Slide 7 shows analytical approach to consider settlement and effects of settlement and Slide 8 shows that one should be careful not to include the effects of settlement or cracks twice.

Question (Singh): For the analysis of DGB, was the 'E' value provided by Geotech used or if some other value is used. What is the basis?

Response (Dhar): Yes, the 'E' value provided by Geotech was used. This will be documented.

Slide 9 shows combination of cracking and settlement with various loads.

1. With steady state loads - this is part of the criteria.

2. Cyclic - Do not believe we should combine. Does not have any significance.

3. Transient & Structural Response: Locally 10 to 30% yield. If cracks existed in the area, extreme crack would probably be 50 mils - trivial to add that.

4. Local missile impact - reviewed test results. Structure will have ability to resist the loads without loss of function.

Slide 10 details the flow diagrams of approach for DGB and BWST where major cracking has been observed.

Slide 11 details similar flow diagram for Auxiliary Building and SWPS.

Question (Kane): Would there be any limits on crack widths and see if it exceeds. Would you do something different?

Response: There are several steps. We will monitor displacements and cracks. We would shy away from setting an exact number. A lot of it depends on what is happening, such as exceeding 30 to 35 mils. If it happens at full underpinning force, it has a lot less significance. At 1/3 of

underpinning force, the situation is different and we will have to investigate it.

The goal is to minimize cracking. You will find cracks in any structure, including reinforced concrete containment from 15 to 20 mils.

Normally, cracks are difficult to see unless you actually are looking for it and also use an optical comparator. ACI recommends that if crack widths become objectionable, seal the cracks to prevent potential corrosion of reinforcing steel.

2. Tornado Missile Impact

Presentation (Rotz):

Considerable amount of test-data are available. How to verify the adequacy of concrete walls to withstand impacts from missiles?

For example a 108 lb, 4"x12" plank hurled at 440 ft/sec can be stopped by 12" thick wall. 1" dia rod, hurled at 330 ft/sec, resulted in no damage and when hurled at 435 ft/sec resulted in minor backface cracks. 12" thick slab is adequate.

Question: What is the size of these slabs? How do the slabs compare with actual walls in Nuclear Power Plant?

Response: The test slabs had free spans of 8 ft by 8 ft-compares very well with those at the plant.

A 4000 lb Car Missile - Sandia Labs hurled an auto weighing 3300 lb at 73 ft/sec. No damage to 16" thick wall. Most of the damage was to the car.

1490 lb utility pole - Sanda Labs hurled a 1500 lb pole at 205 ft/sec onto an 18" thick wall - resulted in minor damage. A 12" thick wall had few more cracks, mostly radial cracks. (No evidence of backface fracture plan.) The walls had normal reinforcing concrete through varied between 3 to 5 ksi.

The Diesel Generator Building mostly has 30" thick walls. Minimum thickness of wall in this building is 24". In Stone and Webster tests, the walls were hit more than once with a missile. They showed that existing cracks didn't really affect the local damage cydic effects on crack formation - very small effect or degradation of structure. Cycling at ultimate shear load you will observe some degradation. If the structure is well within the shear capacity then thre will be no problems. (Refer to NUREG-CR/1602.) Hysleresis loops are very stable showing very little effect, or very minor effect.

NRC Staff's Feedback After Caucus

AMENDMENT 85 (STRUCTURES)

1. The number of concerns expressed by NRC Staff during recently conducted Structural audit, specifically items 'a' through 'j' of open items are still open and we request response for these items.

2. Cracks: During the structural audit several questions were raised regarding the method of accounting for cracks. Those comments still apply. Mr Rinaldi has not had time to review today's presentation and has to consult with the NRC consultants before stating any position.

7. REMEDIAL FIXES

a. Service Water Pump Structure-Remedial Measures

Presentation (Dhar):

Slide 1 shows Midland Site plan wherein the location of the service water pump structure (SWPS) is highlighted.

Slide 2 shows a typical section looking west. The area where backfill was used is noted. Slide 3 shows plan at elevation 634' - 6"; an area supported by fill is so indicated. Because of inadequate compaction of the fill, in an earlier scheme presented in 50.54(f) responses, the overhanging portion of the structure was supported on piles. The number of piles that could be driven was limited because of interferences and the pile design concept didn't have sufficient additional design margin to account for possible revisions in seismic input. Therefore, the pile scheme was abandoned and a bin wall (perimeter wall) type of underpinning is presently being considered.

This scheme is shown on Slide 4. It is a perimeter wall, 4 ft thick and extends all around the wall portion of the overhang.

Slide 5 shows a sectional view. The wall as shown will be 4 ft thick and probably belled to 6 ft thick near the bottom. The bottom elevation is at present estimated to be 585'-0" or the level at which competent original soil is present. Connection to the original structure is made through dowels which transmit direct forces and shear. The advantage of this system is that loads from the wall above is transmitted directly to the soil at the bottom without structure undergoing bending or torsion in the process. We are contemplating installing a cable system at the top portion of the structure, which will be post tensioned to counteract loss of buoyancy during dewatering operations. As in Auxiliary Building, services of MRJD Consulting is being retained to develop construction procedures, specifications, etc.

Slide 6 and 7 details the division of responsibility between Bechtel and MRJD in the underpinning activities. Slide 8 shows milestone schedule.

Underpinning - Construction Techniques

Presentation (E Burke):

Slide 9 shows in plan the step by step process of underpinning the SWPS. Access shafts and staircase would be dug out at east and west end of the building. A shaft of approximately 4 ft square will be sunk in stages by removing soil by hand. The sequence of shafts are numbered in this slide. Once the shafts reach firm strata into the original ground, the shaft will be reinforced and concrete poured. The objective is to support the corners and the middle of the sequence shown from 1 to 7. Once concrete is hardened, the building will be

jacked against these piers, and remaining sequence of larger sized piers will be sunk.

Slide 10 shows an elevation view of the construction process.

Slide 11 shows the details of connection between adjacent piers splices would be either cadwelds or lap splices. The couplers shall be Fox-Howlett type.

Slide 12 shows the method of connecting the underpinning to the existing structure by means of rock anchors drilled and grouted. However, before final grouting could take place local transfer to the piers will be accomplished by jacking against the bottom of the slab of the existing structure. The number of jacks and location of jacks will be determined in the design process to effect smooth transfer of load. The jacking force will be frequently monitored, and the jacks will be left in place till all the immediate settlement and a portion of the long term settlement have taken place. Once this is accomplished, wedges will be driven, jacks will be taken out and piers along with rock anchors will be grouted thereby effectively connecting the underpinning to the original structure.

Question (Heller): Will there be enough controls specified in the specification, such as prevention of loss of ground, etc, or Bechtel would write the specification.

Response: MRJD will give input to Bechtel to write the specification and also will develop construction procedures for Bechtel. It will be made sure that currently accepted controls would go into the procedures to avoid situations such as loss of ground.

Soils Issues - Bearing Capacity and Settlement

Presentation (J P Gould):

The proposed underpinning of the Service Water Building overhang will be by a series of piers cast in hand-dug pits, finally forming a continuous wall bearing on sandy clay glacial till. The till is extremely hard, dense and overconsolidated. Its water content is several percent below its plastic limit. Its peak value of undrained shear strength, to be confirmed by current testing by WCC, is expected to exceed 12 ksf and probably will average about 15 to 18 ksf. It is comparable to the glacial tills of New York City and Boston which are classified as "hardpan" and which are assigned allowable bearing capacities of typically 15 tsf.

In the final design condition, the maximum bearing pressure on the base of the underpinning wall will be 7.2 tsf, which includes allowances for downdrag and earthquake. We believe it would be highly conservative to assign a nominal bearing capacity of 8 tsf to the hardpan-like glacial till. Settlements of 0.3" to 0.5" might be expected under the sustained jacking load. The primary consolidation would occur almost simultaneously with the application of the load, leaving perhaps 0.1" to 0.2" of very gradual long-term secondary

compression. An additional 0.1" of settlement could occur at the east side of the overhang due to eventual drawdown of ground water on the interior of the plant site. Between 0.1" and 0.2" of settlement could occur almost simultaneously with the filling of the building water tanks.

In summary, the act of underpinning will impose a resistant support which will initially slightly raise the north wall of the main portion of the building. Later potential settlements will amount to a fairly uniform 0.2". We anticipate that differential settlements will be of the order of 0.1" in 40 or 50 feet, a slope of 1 in 5000 and will be essentially insignificant.

b. Auxiliary Building - Remedial Measures

Presentation (Dhar):

Slide 13 shows the general plan at elevation 634'-6" of the containments and the Auxiliary Building. The portion that is shown colored indicates the electrical penetration areas and control tower which are founded on fill.

Slide 14 shows a typical section of the Auxiliary Building looking east. Showscontrol tower and backfilled areas.

Slide 15 shows the remedial measures presented in 50.54(f) responses to question. As shown, the edge of the electrical penetration areas will be supported on a number of caissons. The fill under feedwater isolation valve pit is not adequately compacted. The remedial measure is to provide a concrete pier underneath the valve pit. Both the caissons and the valve pit pier are extended down into original soil and would be founded on a firm strata.

Slide 16 shows cross-sectional elevation of the remedial measures. A large cap connects the caissons and valve pit pier at the top. This cap would be designed so as to transfer all the lateral load from earthquake loads to the valve pit pier. The caissons are designed to carry vertical loads unly coming from the electrical penetration area.

In order to provide additional margin to withstand possible higher seismic load arising out Site specific response spectra, we had to revise the conce t of the underpinning.

Slide 17 and 18 show the modified. It essentially replaces the caissons with a large pier. Larger area concept is required to provide additional bearing capacity.

So far, we have completed only a preliminary analyses of the total pier concept. The bearing capacity was checked and found to be adequate. The allowable bearing capacity was the basis for sizing the pier. The calculations to determine effect of pier on the building itself is not yet complete. If during this checking process if stresses in members exceed the allowables, we would either strengthen the member or extend the underpinning in Electrical Penetration Areas.

Right now we are not in a position to say how big the pier will be. The pier, though it extends beneath the Turbine Building, it would be isolated from the Turbine Building. The construction requirements of the underpinning system is being developed by our consultants, Meuser, Rutledge, Johnson and Desimone (MRJD).

Through a review of NRC staff depositions and comments made during the structural audit, we have compiled a list of NRC concerns. We would like to go through this list, item by item, and discuss as to how these have been resolved or the plan to resolve them.

Slide 19 and 20 reanalysis of building with modified support condition - in progress.

. Cracks in the structure - This has been addressed by T Johnson's presentation earlier.

. Error in computer model in original seismic analysis - will be corrected.

. Additional loading on control tower due to change of support condition for electrical penetration area - is being considered.

. Bending effect of electrical penetration area and consequent redistribution of load on caissons - Since there are no caissons in the new scheme, this concern is eliminated.

. Load and capacity calculation of caisson considering effect of friction - Since there are no caissons in the new scheme, this concern is eliminated.

. Value of subgrade modules for backfill soil under control tower - soil modules used will be that value that is representative of the fill.

. Unequal pressure distribution under control tower slab - will be considered in the analysis.

Slide 21 shows milestone schedule dates for the Auxiliary Building design activities.

Question (Hood): Is the post-tensioned tendon part of the design or not?

Response: The post-tensioned tendon is provided to guard against settlement due to dewatering. Existing reinforcement is not adequate. The tendon is installed and will be kept in place untill the end of construction.

Question (Hood): How far would the pier extend inwards into the Electrical Penetration Area?

Response: The size is based on the magnitude of the forces that should be transmitted to the firm ground. Since the forces are not

known at present, it is not possible to tell how far this will extend inwards.

We have revised our seismic model to a three dimensional model. This is easier to run and also most appropriate for the complex building. We are also contemplating using a different technique of soil structure interaction, namely, the computation of composite model damping, than that stated in FSAR. This would be the use strain energy type of damping for soils that is an acceptable approach per SRP.

Question (Kane): What is the 'E' for soil under control tower?

Response: Approximately 1/3 of fill modules (dynamic). This property will be varied to determine its sensitivity.

NRC Staff's Feedback After Caucus

Remedial Fixes

1. SWPS - Bin wall approach - appears to have definite advantage over piles and corbels. The information presented is preliminary design and conceptual. Anticipate getting further details by June 1, 1981.

2. Auxiliary Building - The fix was so conceptual there was not much substance in the presentation. However, staff feels there should be no significant snags in the proposed fix.

3. Consumers Power Co to document that for the Auxiliary Building static structural analysis, the soil modulus value provided by Bechtel Geotech Department was used.

Closing Statement: (Hood)

Earlier we thought that an adequately documented meeting minutes would be a way to close out the open issues discussed in this meeting and for documentation purposes this would be sufficient. However, majority of the concerns didn't disappear. Therefore, the Staff will proceed with issuance of COE's letter after certain amount of review in house.

AGENDA

- INTRODUCTION
- COE AND NRC NOTES ON RESPONSES TO 50.54(f)

  QUESTIONS
  - Q39 Settlement of the Containment Structure
  - Q40 Diesel Generator Building
  - Q41 Service Water Structure/Retaining Wall
  - Q42 Electrical Penetrations
  - Q43 Borated Water Storage Tanks
  - Q44 Diesel Oil Fuel Tanks
  - Q45 Service Water Lines
  - Q46 Dikes
- PIPING SETTLEMENT EVALUATION
  - Settlement Prediction
  - Differential Settlement Evaluation Based on Assumed Pipe Profile

QUESTION 39: REACTOR CONTAINMENT BUILDING AND DEWATERING SETTLEMENT

COE	NRC
SETTLEMENT Applicant Has Not Explained How Young's Modulus (E), Poisson's Ratio (μ), and Influence Factor Were Obtained	
E, Young's Modulus, Not M (constrained modulus) Should Be Used for Dewatering Settlement	Same
Elastic Settlement Provided; Consolidation and Secondary Settlement Not Considered	Elastic and Consolidation Settlement Provided; Secondary Settlement Not Considered
	Time-Dependent Settlement for Dewatering.E Does Not Address Time- Dependency
	Consolidation Tests
	Update Settlement Plots
	Does Settlement History/Load History Provide Enough Confidence That Settlement Will Be Minimal?

QUESTION 39: REACTOR CONTAINMENT BUILDING AND DEWATERING SETTLEMENT (cont'd)

COE	NRC
BEARING CAPACITY Su & ϕ', Not Representative	Same

COE AND NRC NOTES
MEMORANDUMS 1 AND 2, SLIDE

Amendment 85 (Soils): Slide 3

QUESTION 40: DIESEL GENERATOR BUILDING

COE	NRC
SETTLEMENT/CONSOLIDATION Information Concerning Settlement of Diesel Generator Building Questionable Because Results Are Based on Data from Preload Programs	
No Evidence to Prove that 100% Primary Consolidation Completed Before Surcharge Removal	
Flexibility of Footing Prevented Even Distribution of Surcharge Load	
Sudden Drop in the Piezometric Level After Removal of Surcharge	
	Provide Updated Settlement of Diesel Generator Building at Least Until February 1981

Amendment 85 (Soils): Slide 4

QUESTION 40: DIESEL GENERATOR BUILDING (cont'd)

COE	NRC
PRELOAD EFFECTIVENESS Preload Program Not Effective in Eliminating 100% of the Primary Consolidation	
BEARING CAPACITY Soil Parameters Used in Calculations Not Representative	Method of Bearing Capacity Calculations Acceptable; Parameters Not Representative
MISCELLANEOUS Warping of Building Is Causing Bending Moments	
	"Anistropically Consolidated," as Opposed to "Isotropically Consolidated"

COE AND NRC NOTES:
MISCELLANEOUS PANEL [illegible]

Amendment 85(Soils): Slide 5

QUESTION 41: SERVICE WATER PUMP STRUCTURE AND RETAINING WALL

COE	NRC
SERVICE WATER STRUCTURE BEARING CAPACITY	
SETTLEMENT E = 600 Su	
Settlement (III): Simplified Approach Used by Applicant Used in Conjunction with One-Dimensional Consolidation Theory	
Creep Settlement (IV): Creep Settlement Not Considered in Evaluation of Long-Term Settlement	
Differential Settlement (V), Pile Scheme	

COE AND NRC NOTES
MEL AND UNITS AND [illegible]

[illegible]

Amendment 85 (Soils): Slide 6

QUESTION 41: SERVICE WATER PUMP STRUCTURE AND RETAINING WALL (cont'd)

COE	NRC
RETAINING WALL Soil Parameters 30 Ft Distance	Same Comments Plus a Request for Factors of Safety
	Method of Analysis of Retaining Wall Seepage and Earthquake
No Concern with Settlement	Future Settlement Based on Diesel Generator Building Cα

COE AND NRC NOTES
MEETING MINUTES AND [illegible]

QUESTION 42: AUXILIARY BUILDING ELECTRICAL PENETRATION UNDERPINNING

COE	NRC
Settlement of FIVP Same as Caissons: Monolithic	
Caissons 4 Ft into Till - Different Tip Elevation	Same
Caissons Failing Load Tests	
EST Will Not Work	
Load Release Due to Jacking Additional Caissons	

COE AND NRC NOTES
MIDLAND UNITS 1 AND 2 5-1-81

G-1556-07

QUESTION 42: AUXILIARY BUILDING ELECTRICAL PENETRATION UNDERPINNING (cont'd)

COE	NRC
Su - Reduced by Factor	
Consider Weight of the Concrete Fill and Soil	
Dynamic Bearing Capacity Factors of Safety	
Settlement - See Question 41	
	Breakdown of 4,000 K in Terms of DL, LL, SSE
	Excavation Through Concrete Backfill

QUESTION 43: BORATED WATER STORAGE TANKS

COE	NRC
SETTLEMENT Settlement Prediction Using Plate Load Test Data and Theory of Elasticity Approach Are Unacceptable	
	Settlement Measured from Full-Scale Load Test Would Not Provide Accurate Settlement
DIFFERENTIAL SETTLEMENT 1-½ Inches and Soil Moduli, 260 Kips and 490 Kips	

COE AND NRC NOTES
MIDLAND UNITS 1 AND [illegible]

Amendment 85 (Soils): Slide 10

QUESTION 43: BORATED WATER STORAGE TANKS (cont'd)

COE	NRC
CREEP SETTLEMENTS Also Need to Be Evaluated to Determine the Structural Adequacy of the Tank's Bottom	
BEARING CAPACITY Shear Strength Used in Analysis of Bearing Capacity of Soil Under Borated Water Tanks Not Appropriate	
	Magnitude of Differential Settlement

QUESTION 44: UNDERGROUND DIESEL FUEL TANKS - FOUNDATION DESIGN

COE	NRC
BEARING CAPACITY Acceptable Response	
SETTLEMENT Long-Term Settlement Based on Data Obtained from Diesel Generator Building Not Acceptable Because Similar Soil May Differ in Engineering Characteristics	
SETTLEMENT Due to Dynamic Loads	
UPLIFT PRESSURE On Tanks	

COE AND NRC NOTES
ABS AND UNITS 1 AND 2 SAR

G 1556 11

Amendment 85 (Soils): Slide 12

SETTLEMENT EVALUATION
CONTAINMENT STRUCTURES

- PRECONSOLIDATION PRESSURE

  At Least 15 to 20 ksf as Given by D&M and Shown in FSAR Figure 2.5-24

- COMPRESSIBILITY PARAMETERS

  $C_r/1 + E_0$ Values Given in FSAR Table 2.5-16; Comparison of These Parameters with Long-Term Elastic Moduli Values Follows

SETTLEMENT EVALUATION
CONTAINMENT STRUCTURES (cont'd)

- RATE OF SETTLEMENT

  As Stated in FSAR Subsection 2.5.4.10.4, Most Settlement Occurs as Load Is Applied. It Is Estimated That 20% of the Ultimate Settlement Can Be Expected After Vital Piping Connections Are Made. This if Reasonable Based on:

  Experience on Nuclear Power Plant I Reported in the Second Nabor Carrillo Lecture, Mexican Society for Soil Mechanics.

  Settlement versus pressure data for Containment Units 1 and 2 at Midland

SOIL COMPRESSIBILITY PARAMETERS FOR SETTLEMENT EVALUATION

ELEVATION (ft)	$CR/1+E_o$ FSAR TABLE 2.5-16	$E = 600\ S_U$ (ksf)
603 - 582	0.002	2,400
582 - 562	0.003	3,600
562 - 543	0.002	4,800
543 - 503	0.003	4,800
503 - 363	0.006	4,800

NOTES: (1) Average E value backfigured from settlement measurements on containment structures is about 6,380 ksf.

(2) Average low strain E value based on shear wave velocity measurements is approximately 67,280 ksf.

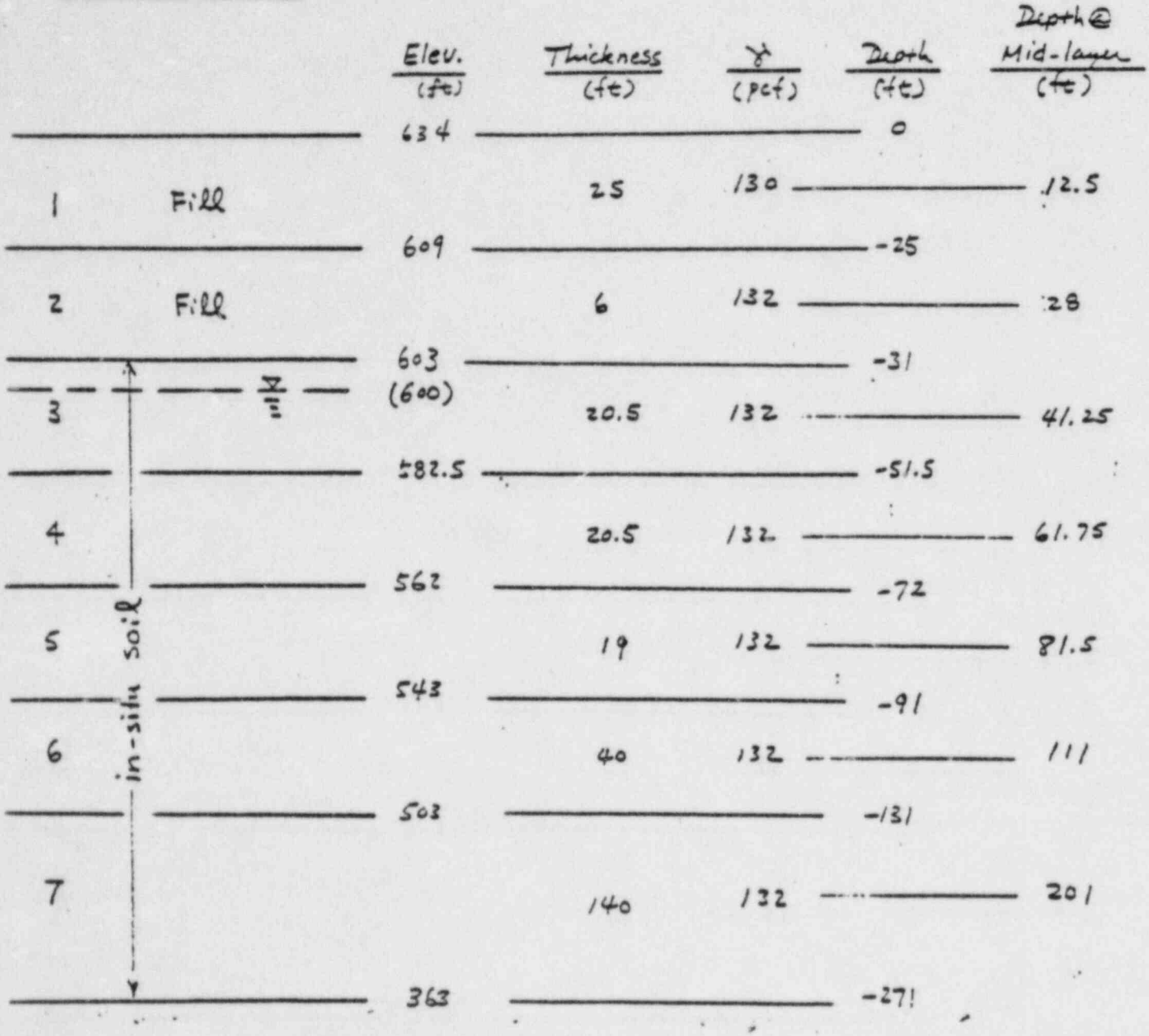
(3) Average E value based on the statistical relationship $E = 600\ S_U$ is approximately 4,500 ksf.

COE AND NRC NOTES
MIDLAND UNITS 1 AND 2 5/1/81

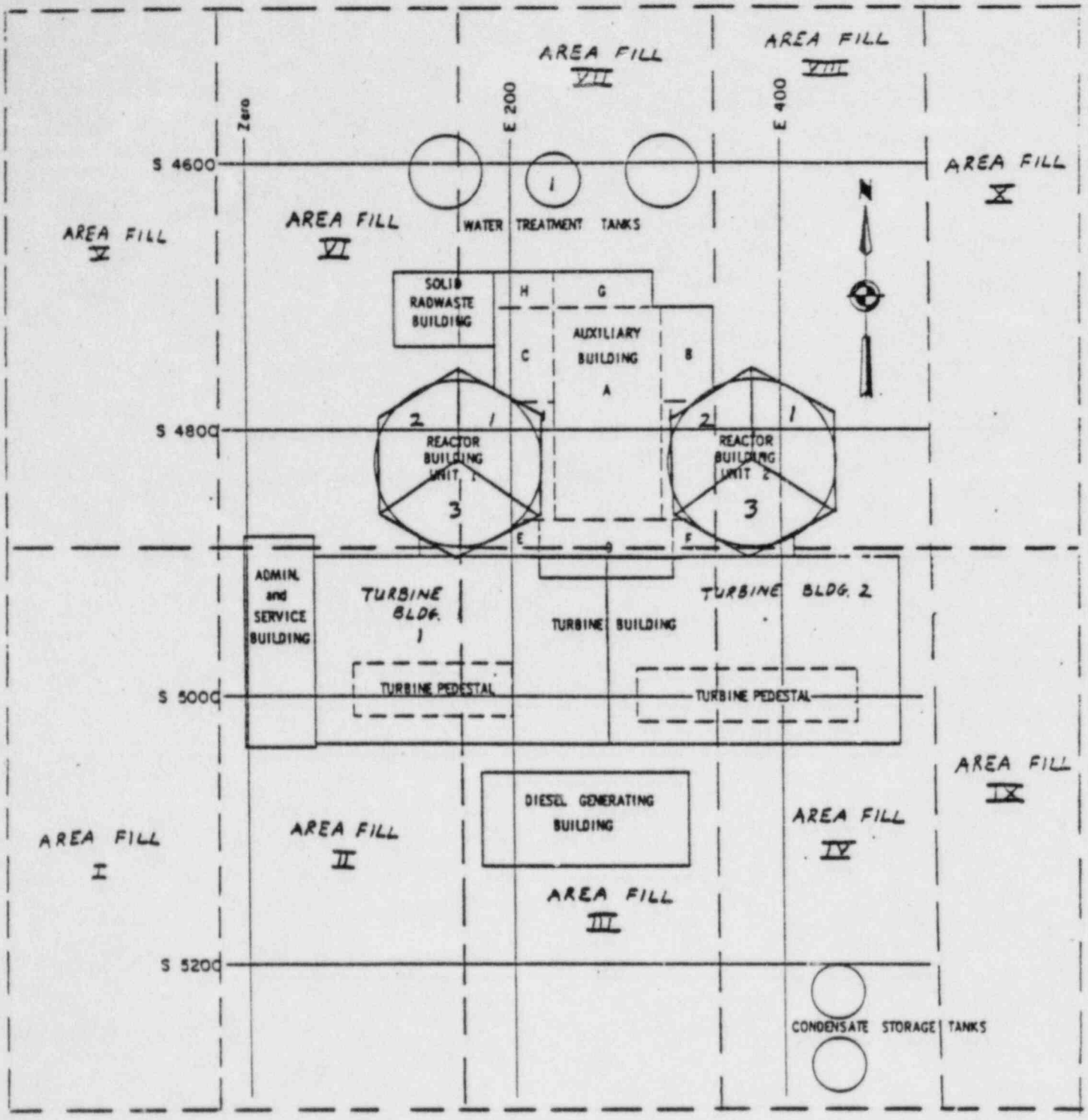
G-1556-15

Amendment 85 (Soils): Slide 15

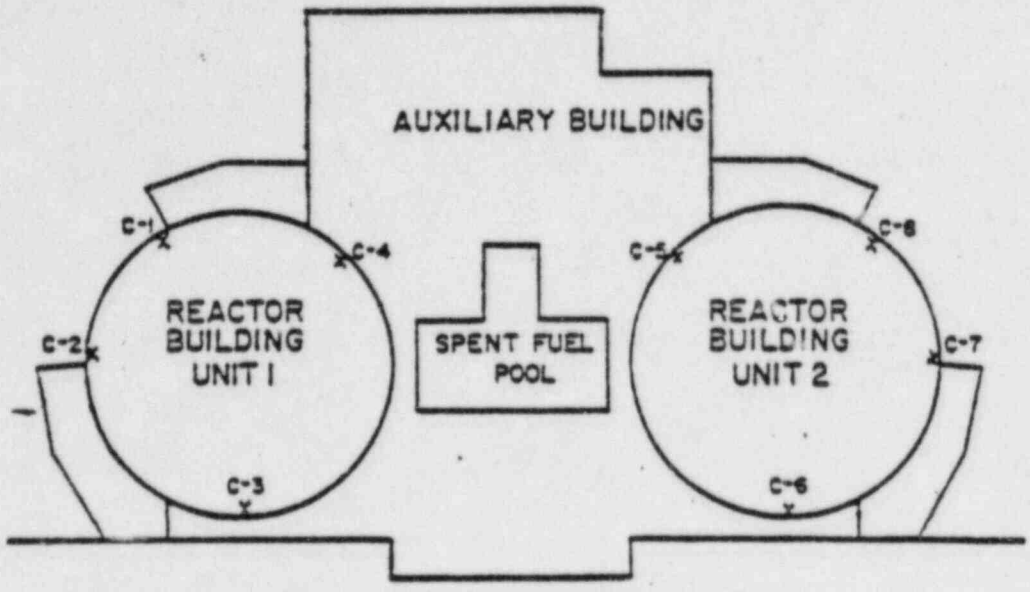
Soil Profile (not to scale)



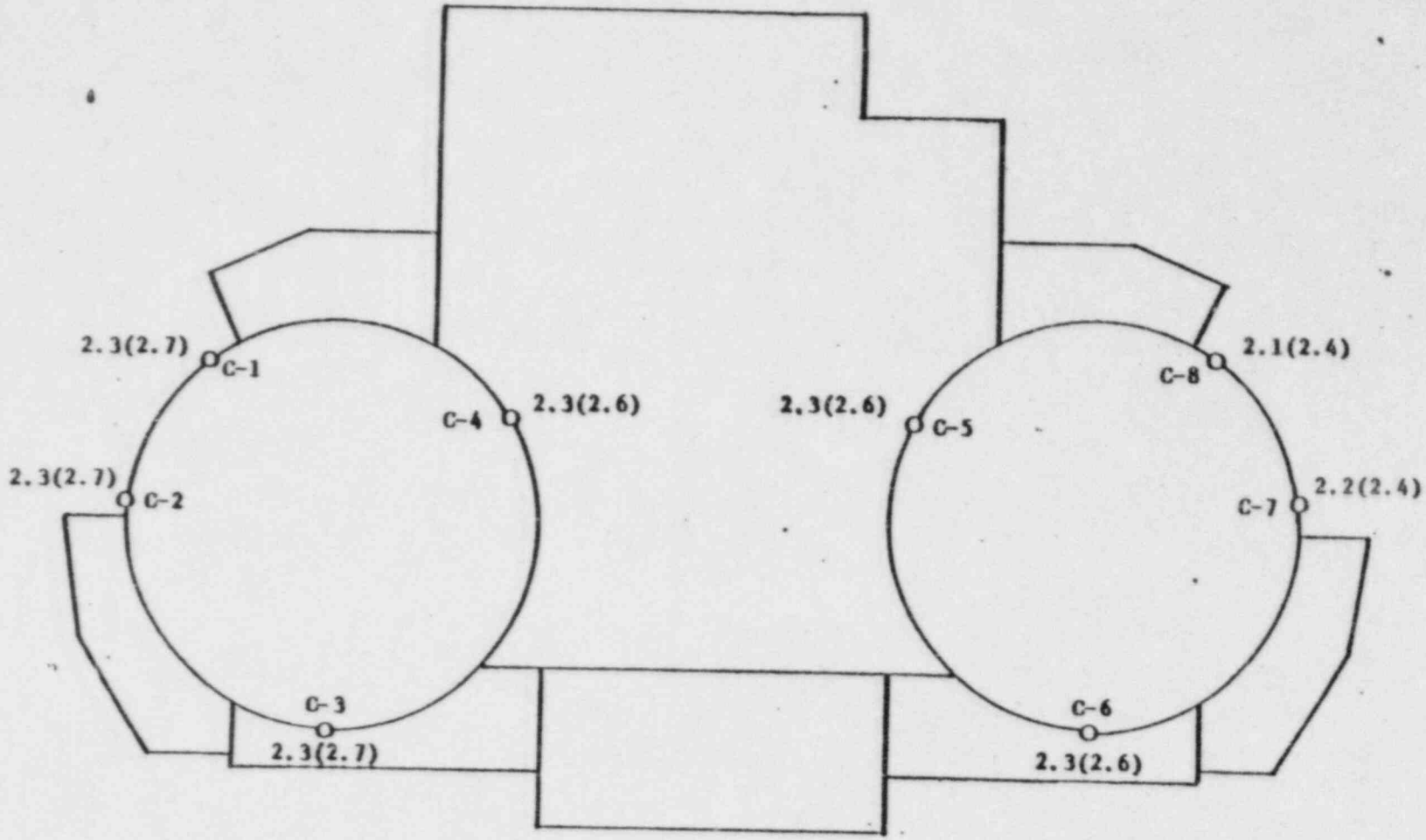
SOIL PROFILE USED FOR SETTLEMENT ANALYSIS



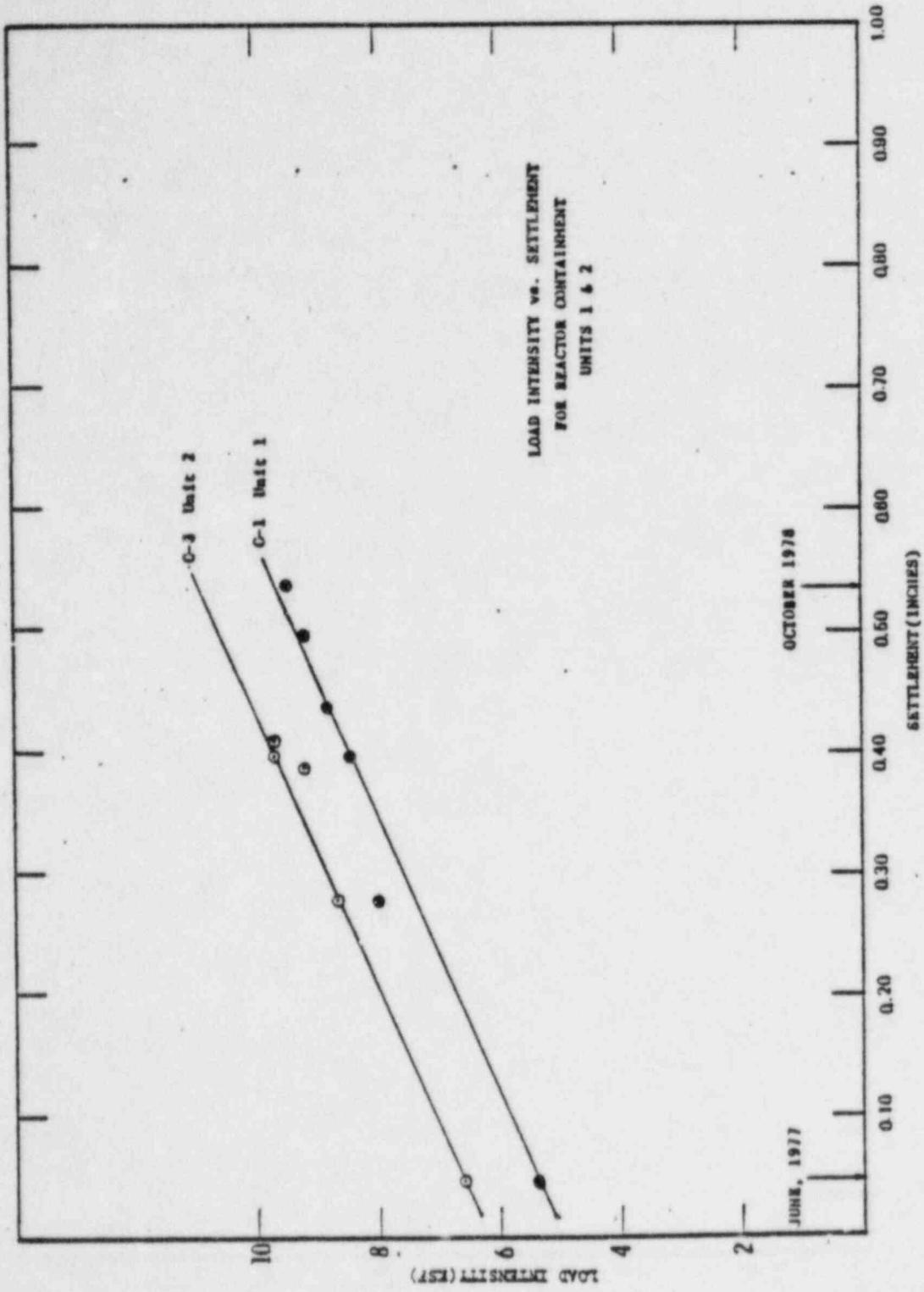
AREA LOADS USED FOR SETTLEMENT ANALYSIS

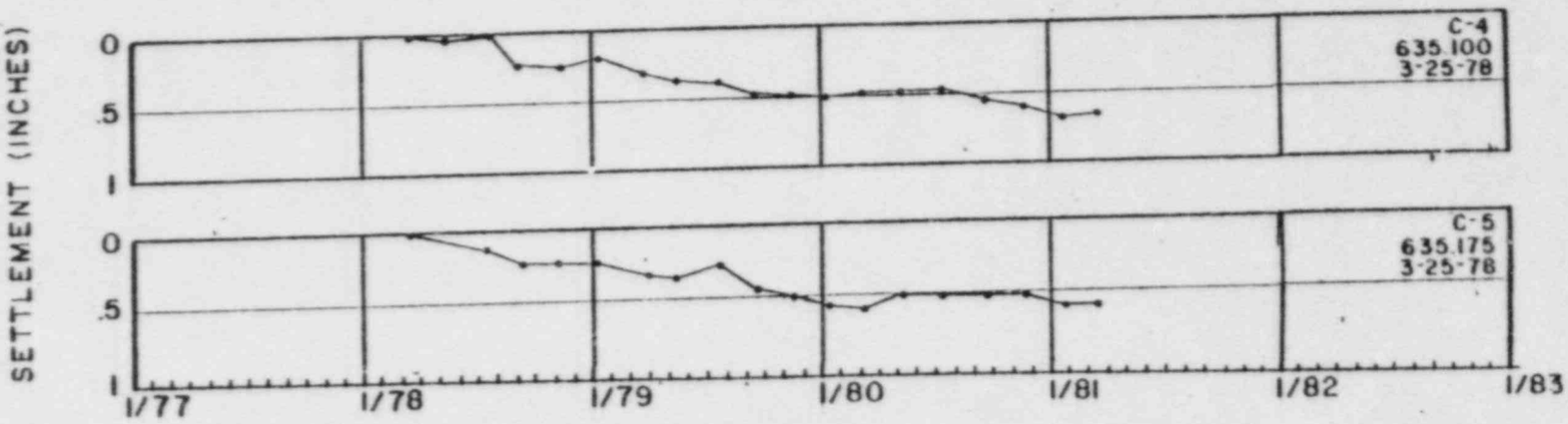


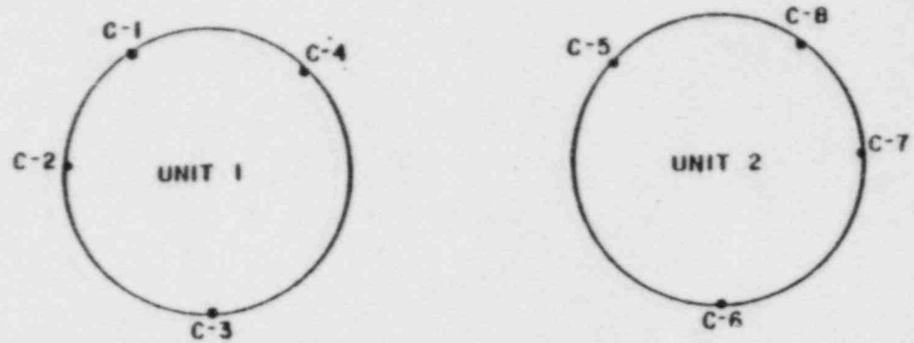
LOCATION OF SETTLEMENT MARKERS



COMPARISON OF CALCULATED ULTIMATE SETTLEMENT
BY C_r AND(E)METHODS


LOAD INTENSITY vs. SETTLEMENT
FOR REACTOR CONTAINMENT
UNITS 1 & 2
C-2 Unit 2
C-1 Unit 1
JUNE, 1977
OCTOBER 1978
LOAD INTENSITY (KSF)
SETTLEMENT (INCHES)
2
4
6
8
10
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

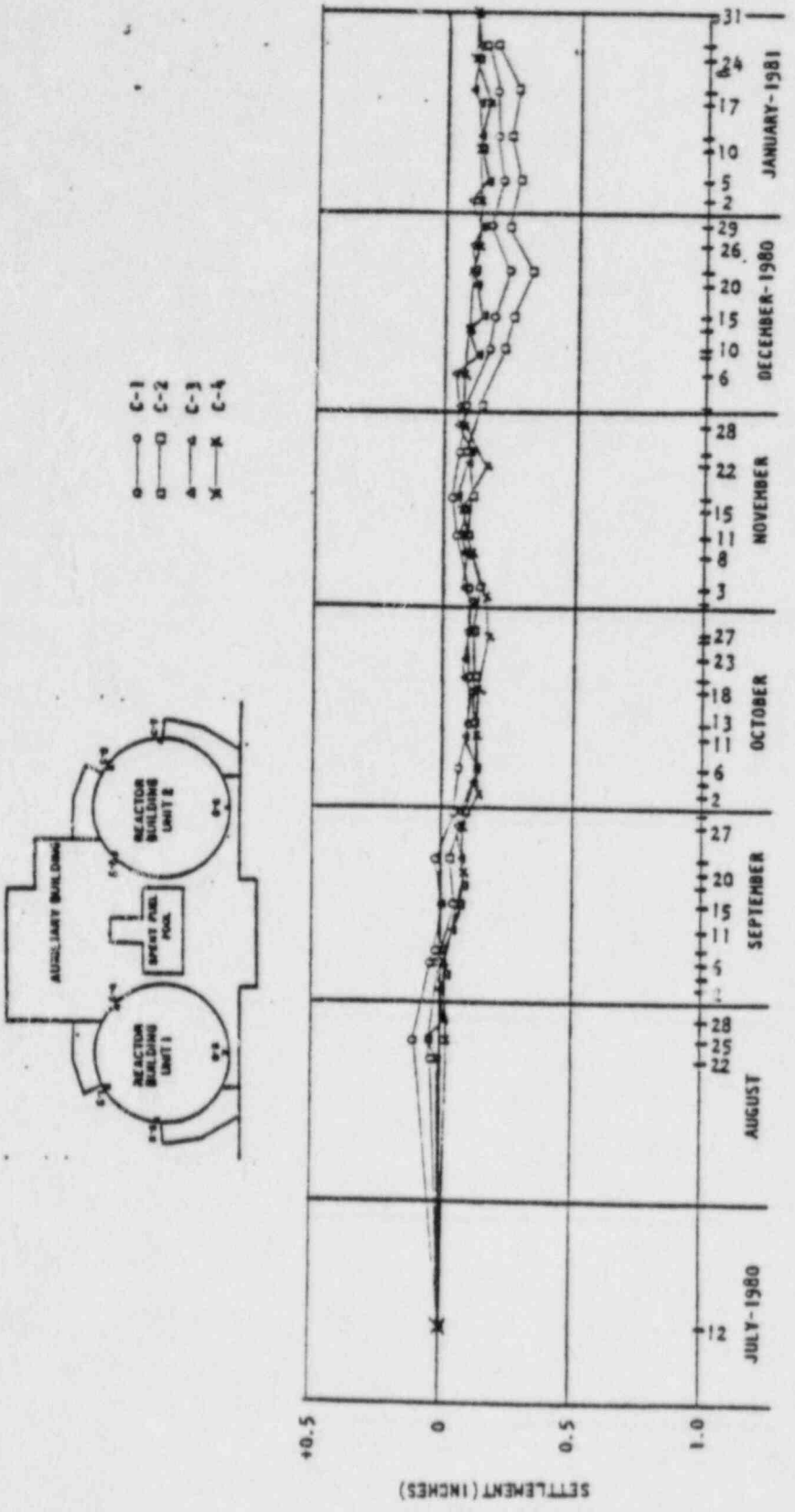


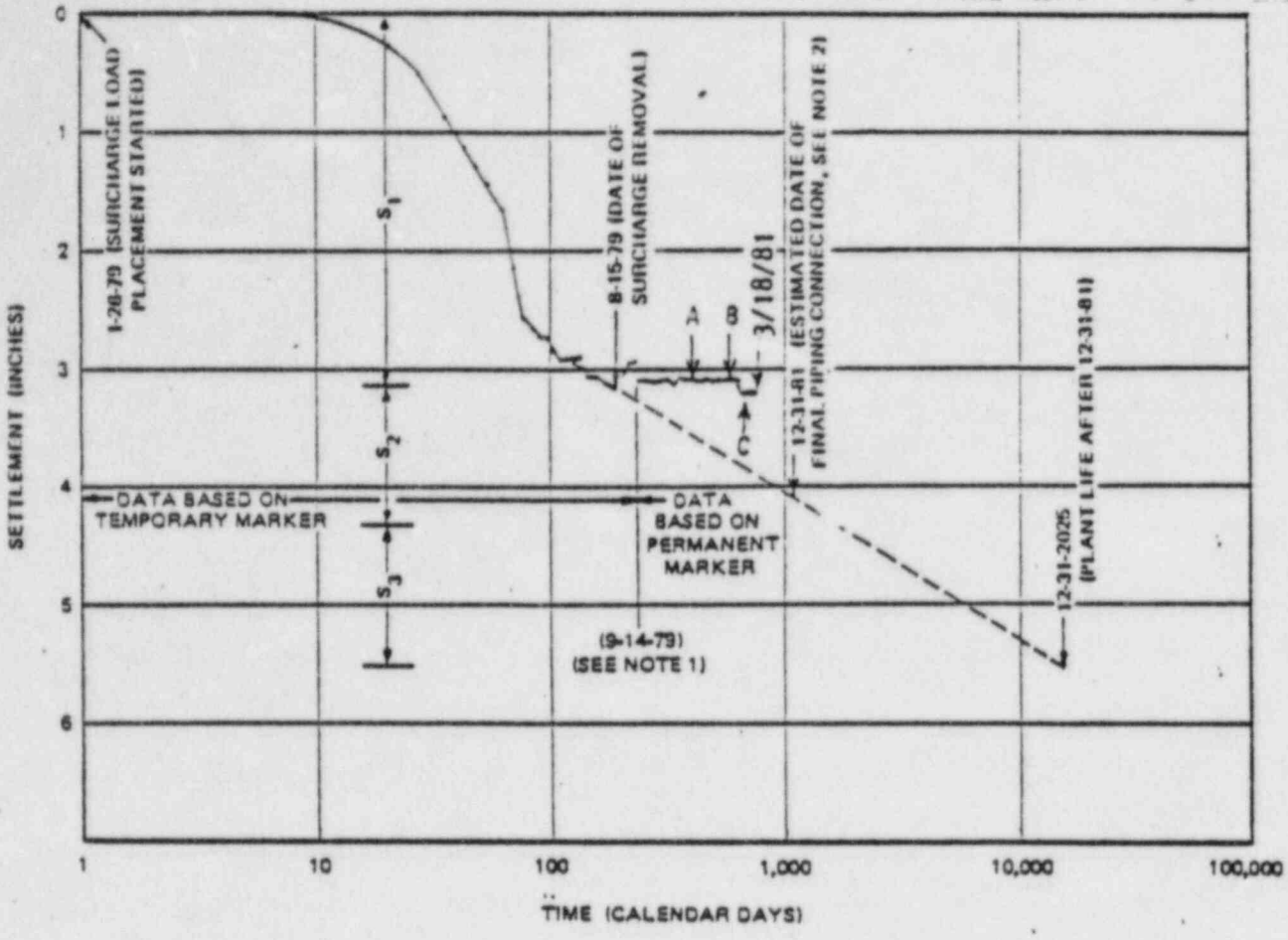


REACTOR BUILDINGS
LOCATION OF SETTLEMENT MARKERS
(NOT TO SCALE)

Amendment 85 (Soils): Slide 21

Amendment 85 (Soils): Slide 22





LEGEND

——— MEASURED SETTLEMENT (MARKER DG-3)

– – – PREDICTED SECONDARY COMPRESSION SETTLEMENT ASSUMING SURCHARGE REMAINS

A – VALVE PIT/DUCT BANK DEWATERING STARTED 2/26/80

B – UNIT 2 DEWATERING STARTED 8/10/80

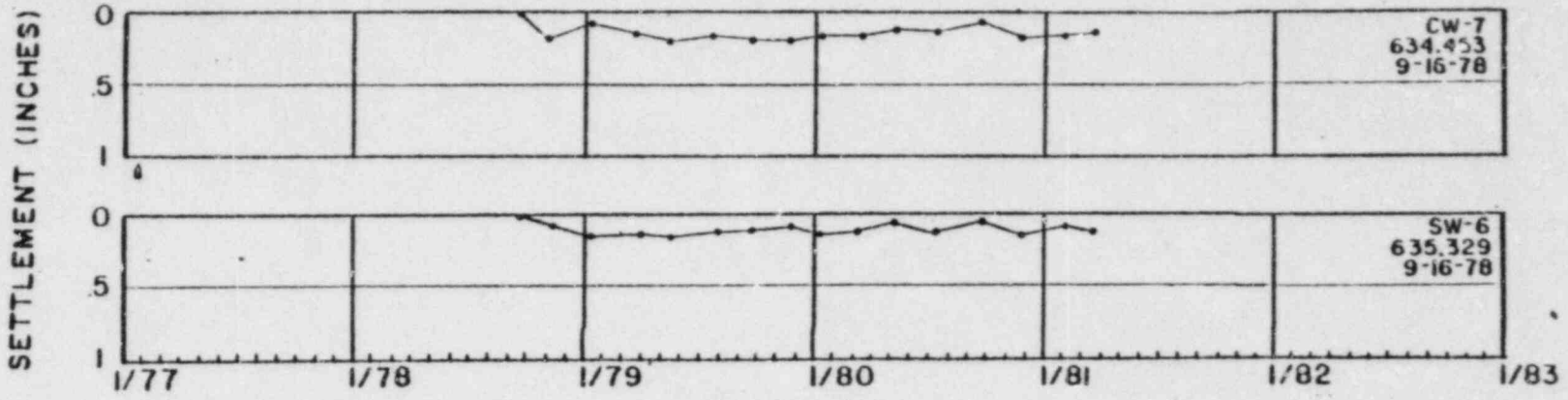
C – UNIT 1 DEWATERING STARTED 11/19/80

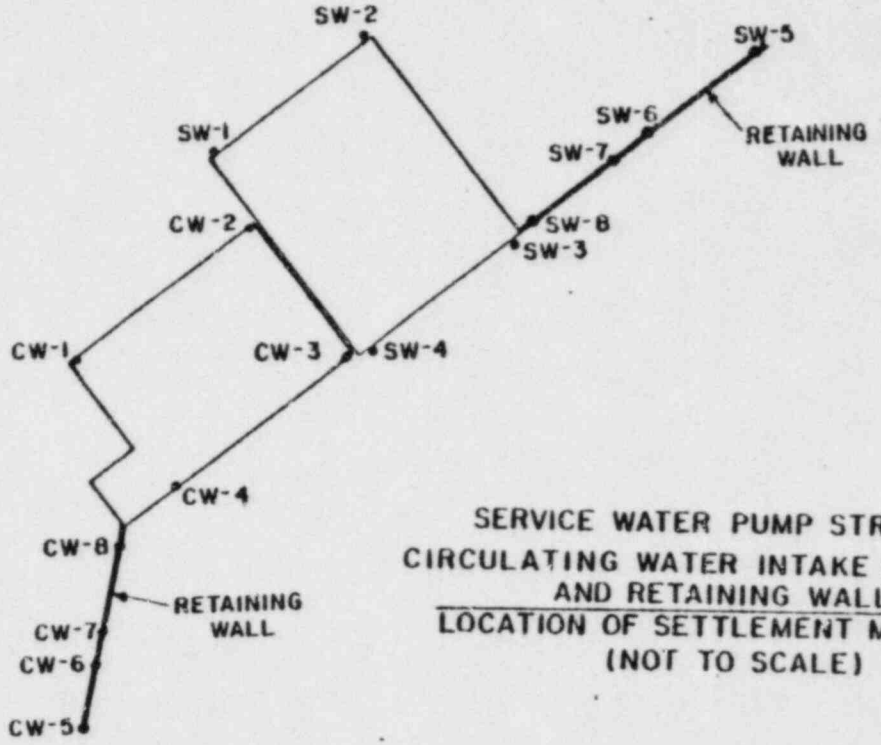
NOTES:

1. The permanent marker could not be monitored from 3-22-79 to 9-14-79 due to surcharge. Temporary markers at elevation 664'-0" ± were used during this period to estimate the settlement of the permanent markers. On 9-14-79 the settlement was again based directly upon the permanent markers.
2. The following seismic Category I service water piping was connected around September 1979:

1 HBC – 81	2HBC – 81
1 HBC – 82	2HBC – 82
1 HBC – 310	2HBC – 310
1 HBC – 311	2HBC – 311

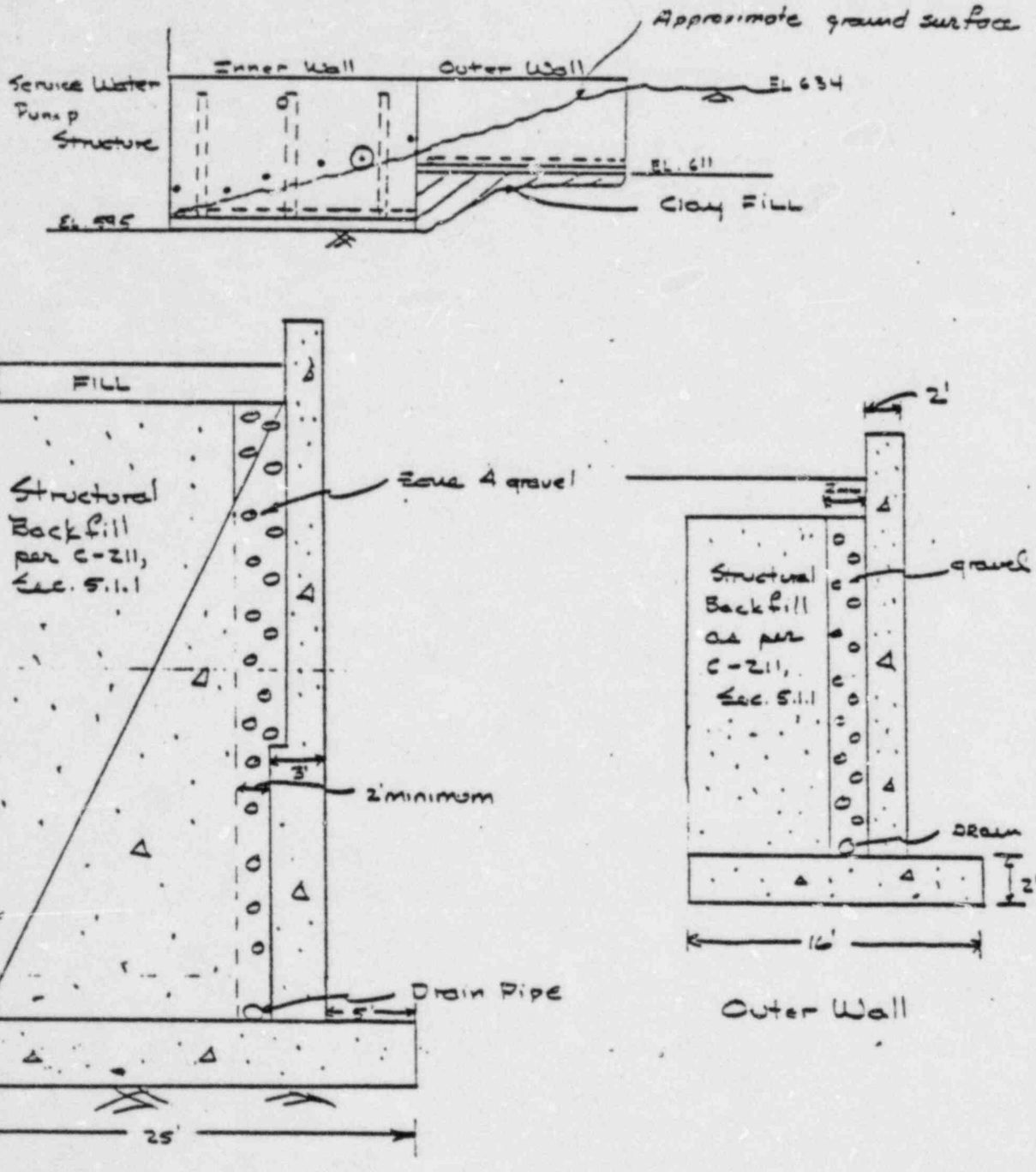
BECHTEL ANN ARBOR			
MIDLAND POWER PLANT			
MEASURED AND PREDICTED SETTLEMENT VS LOG OF TIME (DG-3)			
	JOB NO.	DRAWING NO.	REV.
	7220	FIGURE 27-9	5



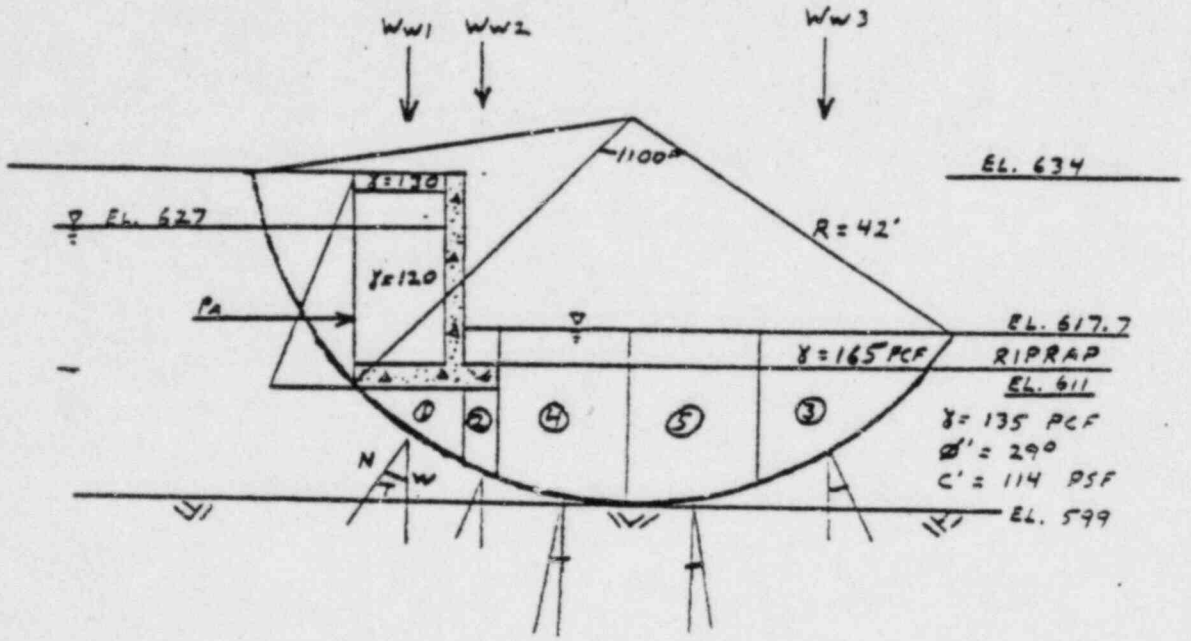


SERVICE WATER PUMP STRUCTURE
CIRCULATING WATER INTAKE STRUCTURE
AND RETAINING WALL
LOCATION OF SETTLEMENT MARKERS
(NOT TO SCALE)

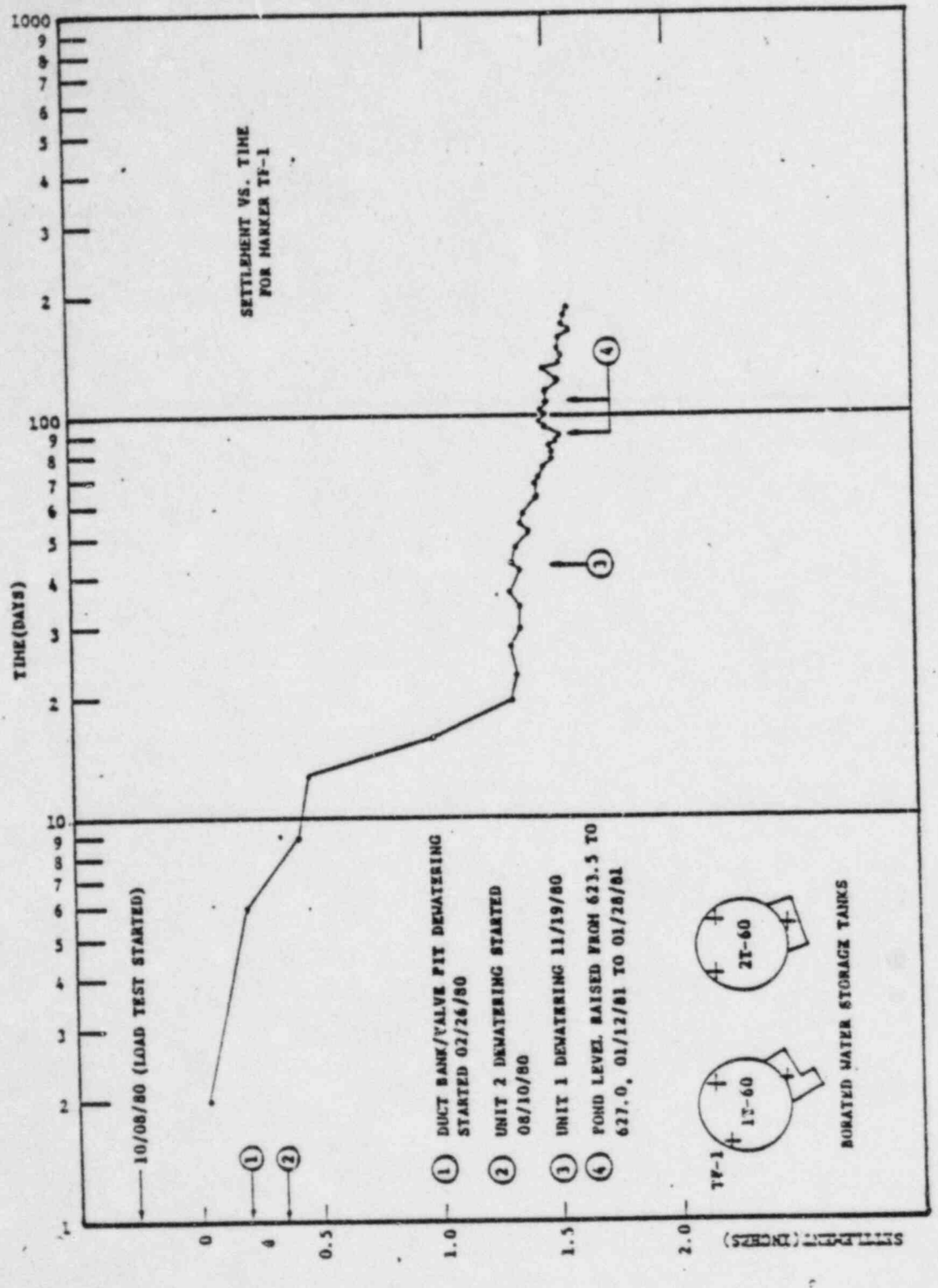
Amendment 85 (Soils): Slide 24

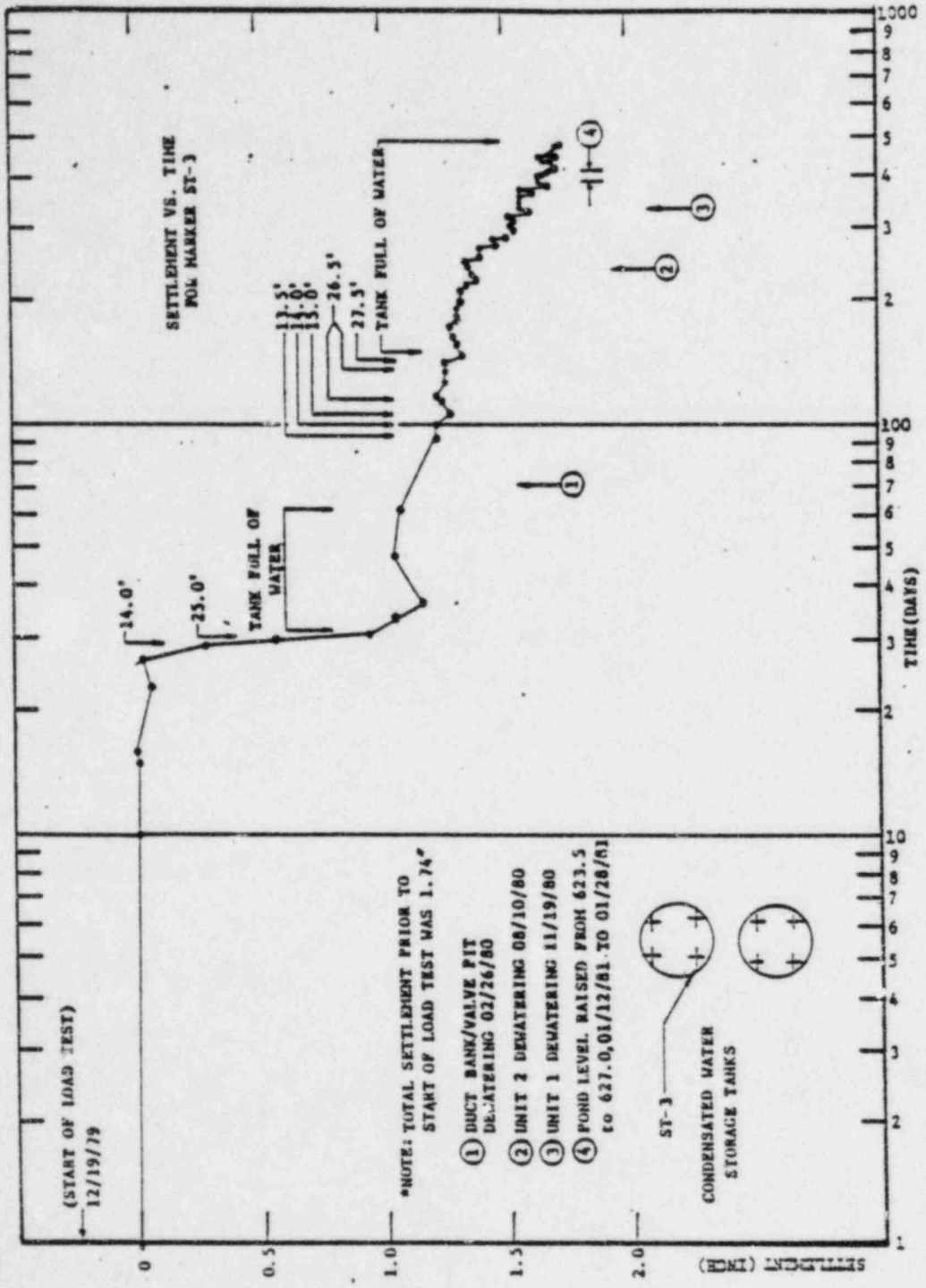


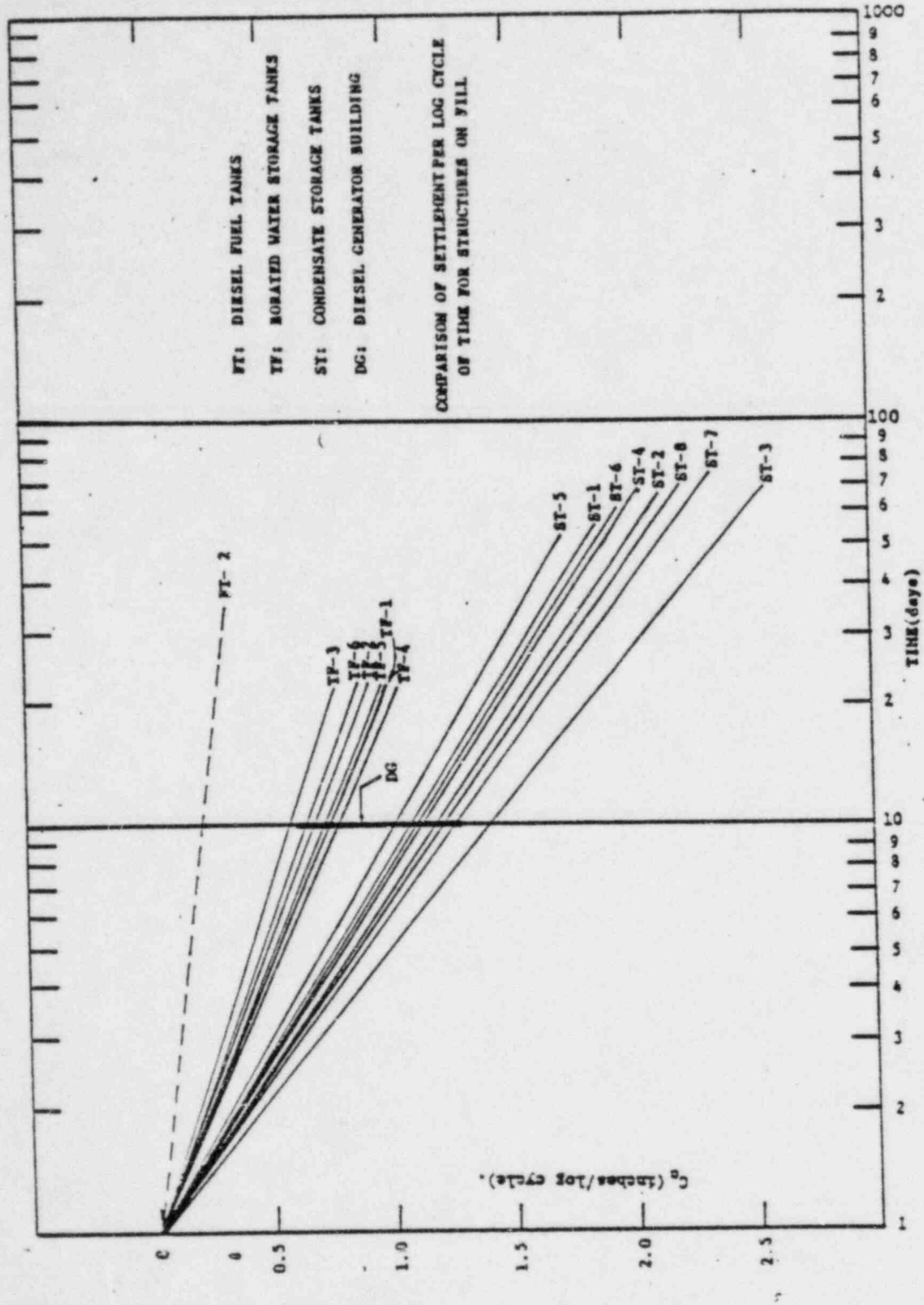
RETAINING WALL CROSS-SECTION

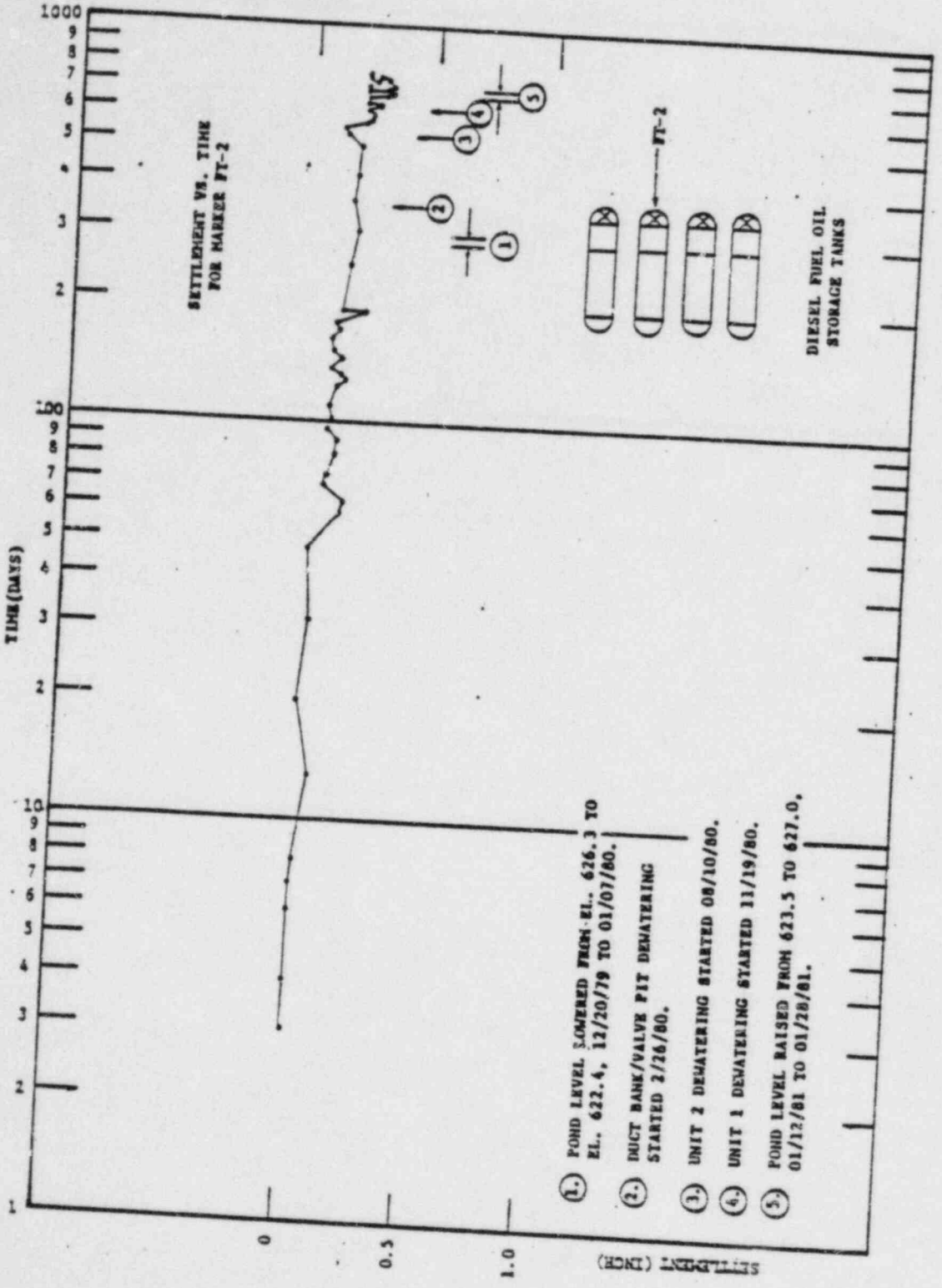


RETAINING WALL SLOPE STABILITY MODEL


SETTLEMENT VS. TIME
FOR MARKER TF-1
TIME(DAYS)
SETTLEMENT (INCHES)
10/08/80 (LOAD TEST STARTED)
① DUCT BANK/VALVE PIT DEWATERING STARTED 02/26/80
② UNIT 2 DEWATERING STARTED 08/10/80
③ UNIT 1 DEWATERING 11/19/80
④ POND LEVEL RAISED FROM 623.5 TO 627.0, 01/12/81 TO 01/28/81
TF-1
1T-60
2T-60
BORATED WATER STORAGE TANKS


SETTLEMENT VS. TIME
FOR MARKER ST-3
(START OF LOAD TEST)
12/19/79
14.0'
25.0'
TANK FULL OF WATER
13.5'
13.8'
15.0'
26.5'
27.5'
TANK FULL OF WATER
*NOTE: TOTAL SETTLEMENT PRIOR TO START OF LOAD TEST WAS 1.74"
① DUCT BANK/VALVE PIT DEWATERING 02/26/80
② UNIT 2 DEWATERING 08/10/80
③ UNIT 1 DEWATERING 11/19/80
④ POND LEVEL RAISED FROM 623.5 to 627.0, 01/12/81 TO 01/28/81
ST-3
CONDENSATED WATER STORAGE TANKS
SETTLEMENT (INCH)
TIME (DAYS)


COMPARISON OF SETTLEMENT PER LOG CYCLE OF TIME FOR STRUCTURES ON FILL
FT: DIESEL FUEL TANKS
TF: BORATED WATER STORAGE TANKS
ST: CONDENSATE STORAGE TANKS
DG: DIESEL GENERATOR BUILDING
FT- 2
TF-3
TF-6
TF-5
TF-1
TF-4
DG
ST-5
ST-1
ST-6
ST-4
ST-2
ST-8
ST-7
ST-3
TIME(days)
C_c (inches/log cycle)
0
0.5
1.0
1.5
2.0
2.5
1000
100
10
1


SETTLEMENT VS. TIME
FOR MARKER FT-2
FT-2
DIESEL FUEL OIL
STORAGE TANKS
TIME (DAYS)
SETTLEMENT (INCH)
1000
100
10
1
0
0.5
1.0
1. POND LEVEL LOWERED FROM EL. 626.3 TO EL. 622.4, 12/20/79 TO 01/07/80.
2. DUCT BANK/VALVE PIT DEWATERING STARTED 2/26/80.
3. UNIT 2 DEWATERING STARTED 08/10/80.
4. UNIT 1 DEWATERING STARTED 11/19/80.
5. POND LEVEL RAISED FROM 623.5 TO 627.0, 01/12/81 TO 01/28/81.

BORATED WATER STORAGE TANK

STRUCTURAL REANALYSIS AFTER 10 CFR 50.54(f) ISSUE

(Foundation)

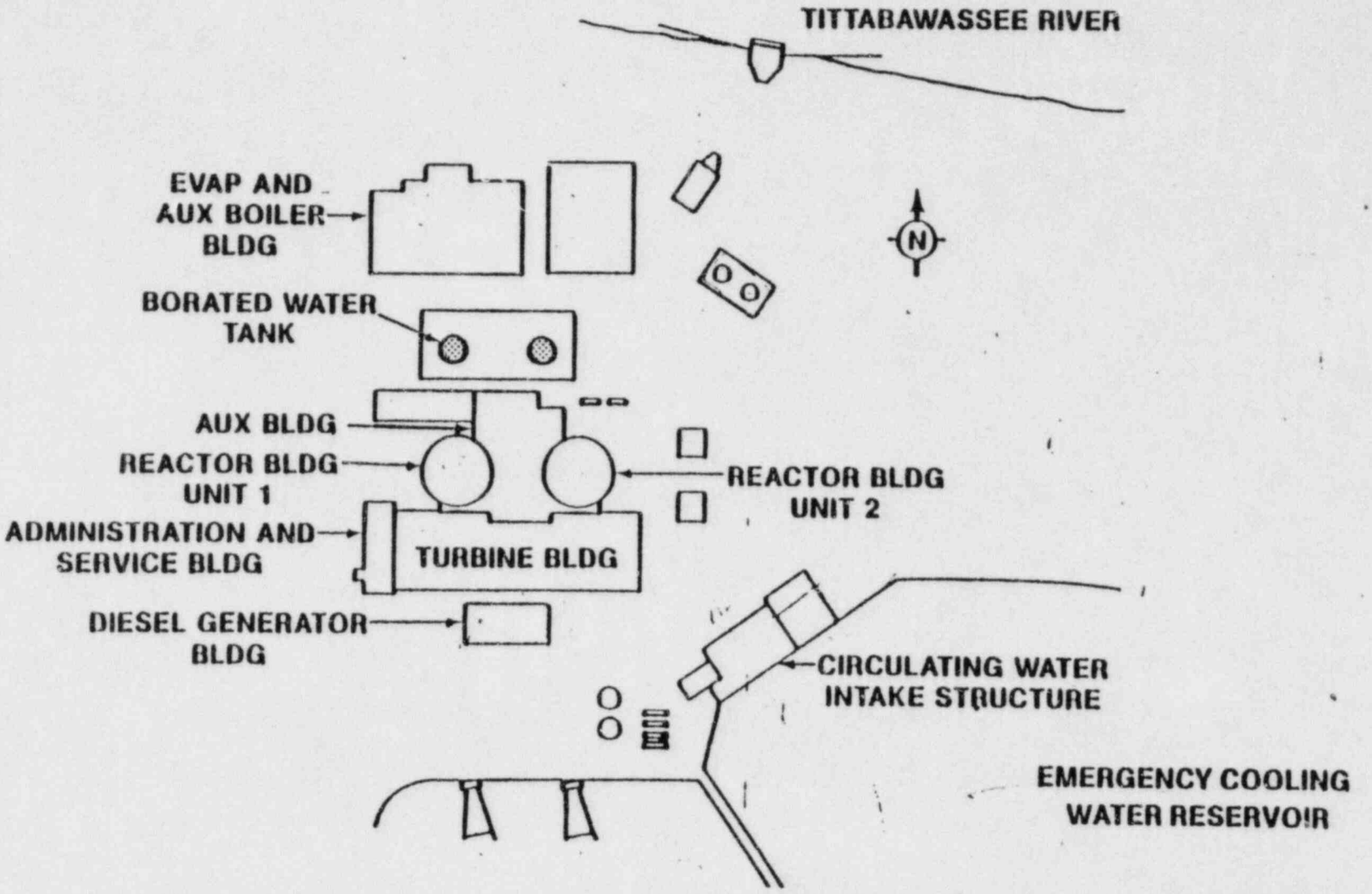
- DESCRIPTION
- CURRENT STATUS
- PROPOSED REMEDIAL WORK
- SCHEDULE

G-1534-27

10/82

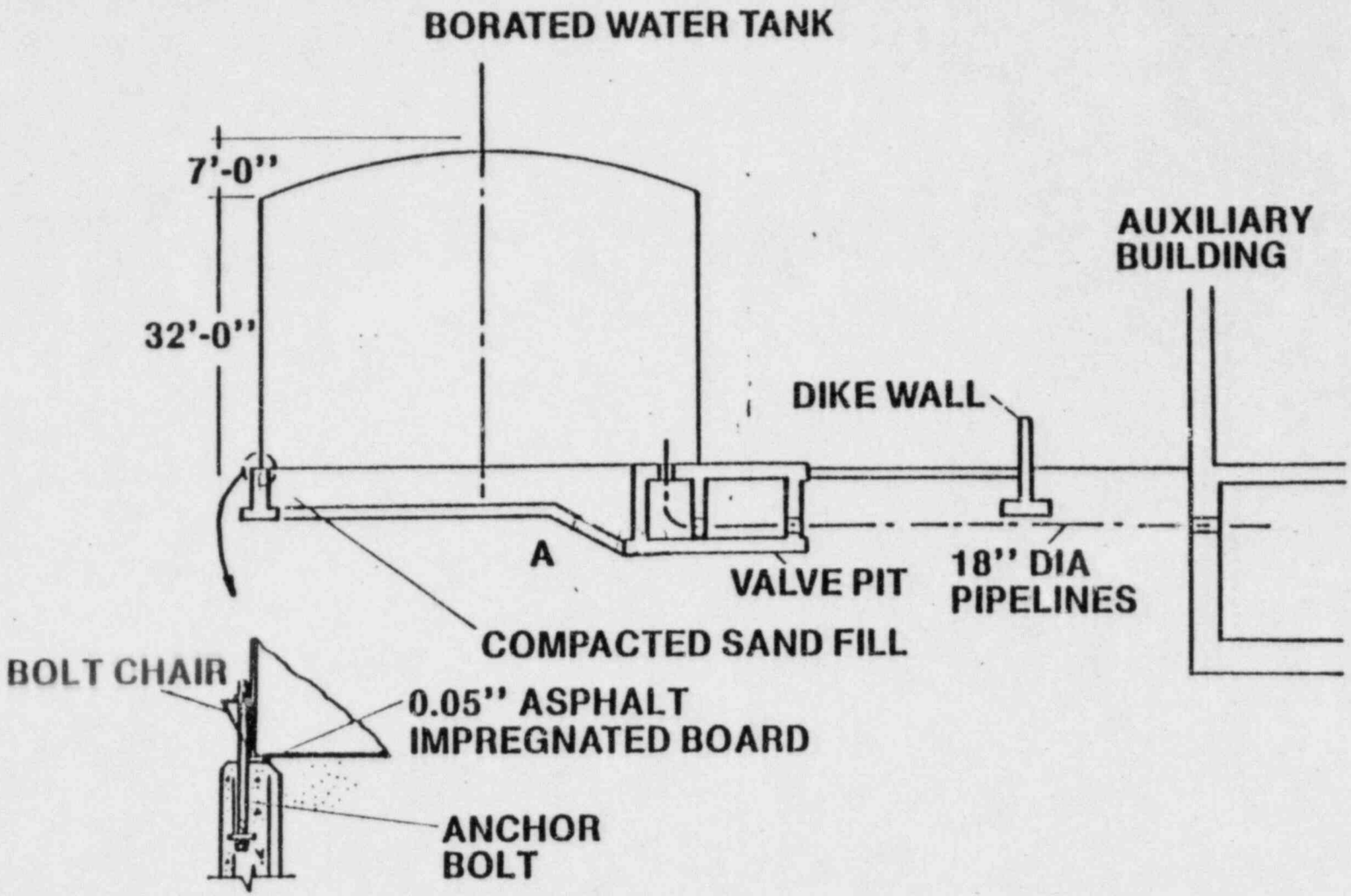
B W S T: Slide 1

MIDLAND SITE PLAN



B W S T: Slide 2

BORATED WATER STORAGE TANK



G-1534-28

BWST: Slide 3

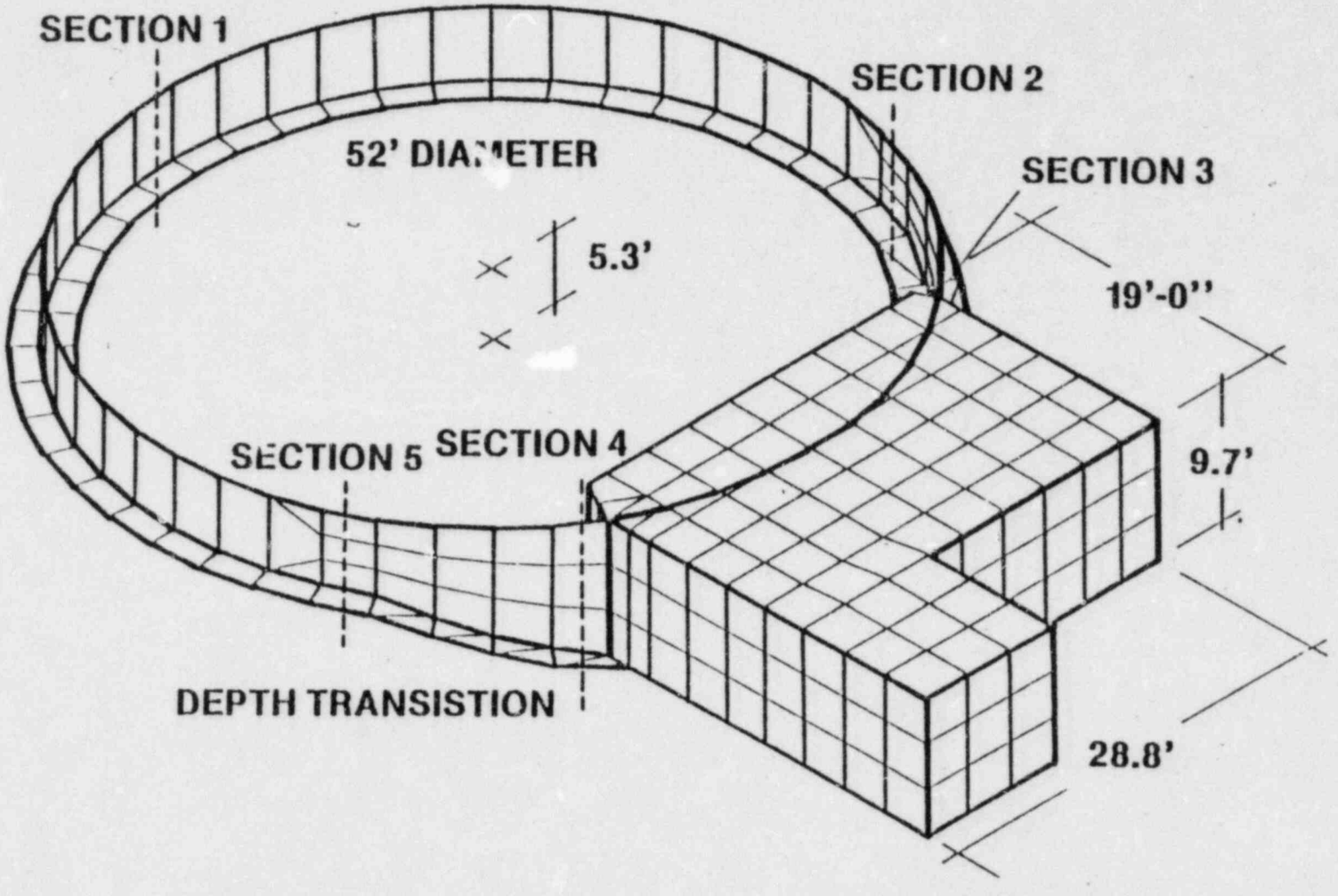
BORATED WATER STORAGE TANK
CURRENT STATUS

- LOAD TEST ONGOING SINCE 10/16/80
- SETTLEMENT MONITORING (noted discrepancy)
- FINITE ELEMENT MODELING
- 50.55(e) REPORT
- CORRECTIVE ACTION IN PLANNING

G-1634-29

B W S T: Slide 4

BORATED WATER STORAGE TANK
FOUNDATION STRUCTURE
FINITE ELEMENT MODEL



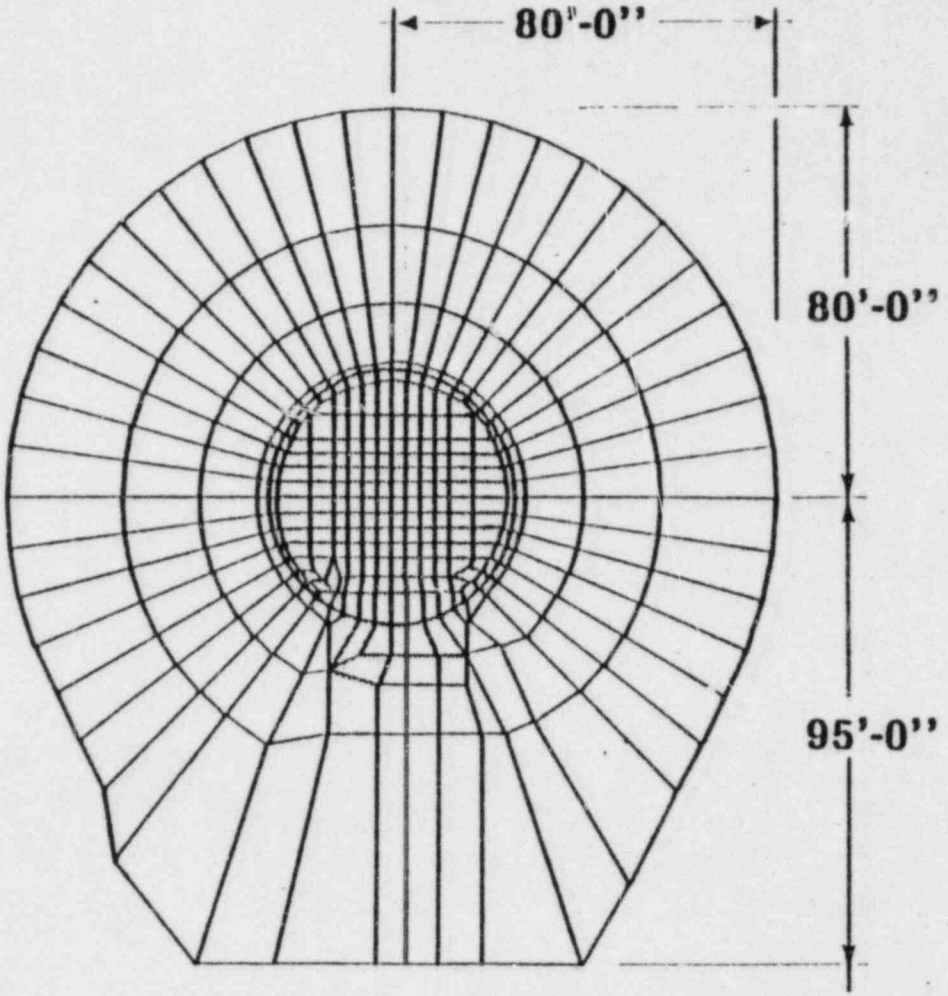
G 1534 23

BWST: Slide 5

BORATED WATER STORAGE TANK

FOUNDATION SUBGRADE SOIL FINITE ELEMENT MODEL

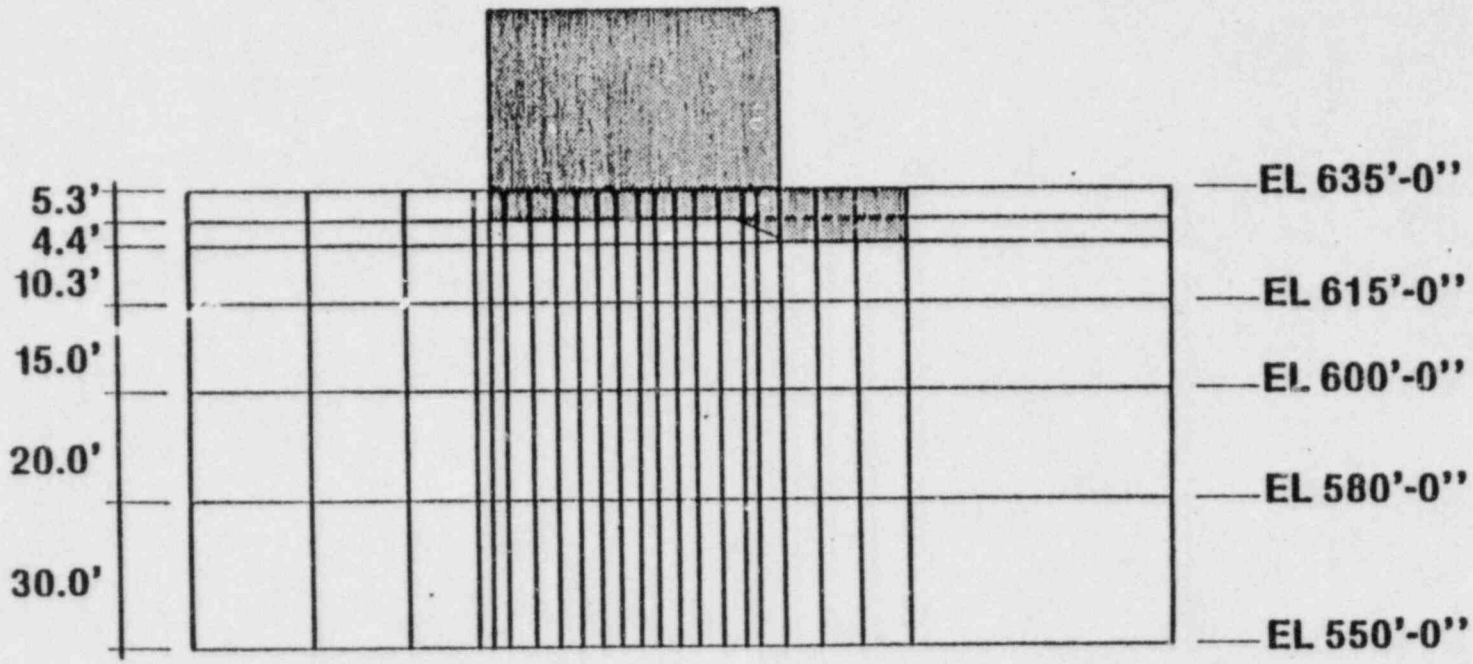
PLAN VIEW



BORATED WATER STORAGE TANK

FOUNDATION SUBGRADE SOIL FINITE ELEMENT MODEL

PROFILE VIEW



G-1634-22

BWST: Slide 7

BORATED WATER STORAGE TANK

BENDING MOMENTS AND BENDING MOMENT CAPACITIES (K-FT)

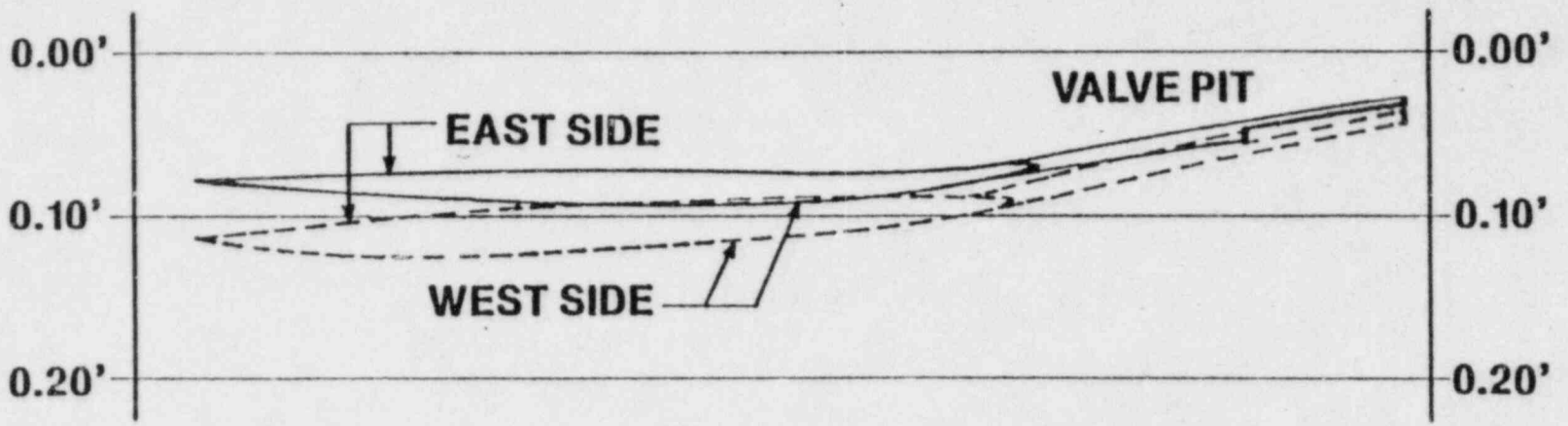
SOIL PROPERTIES OF FILL/TILL MODULUS OF ELASTICITY (ksf)

LOCATION	159/370	340/980*	700/2,000	2,717/7,854	CAPACITY
1	412	446	397	198	860
2	1,850	1,653	1,221	446	860
3	2,803	2,762	2,219	872	2,450
4	3,324	2,676	1,945	794	2,450
5	1,925	1,316	782	236	860

*Value which best represents actual soil conditions

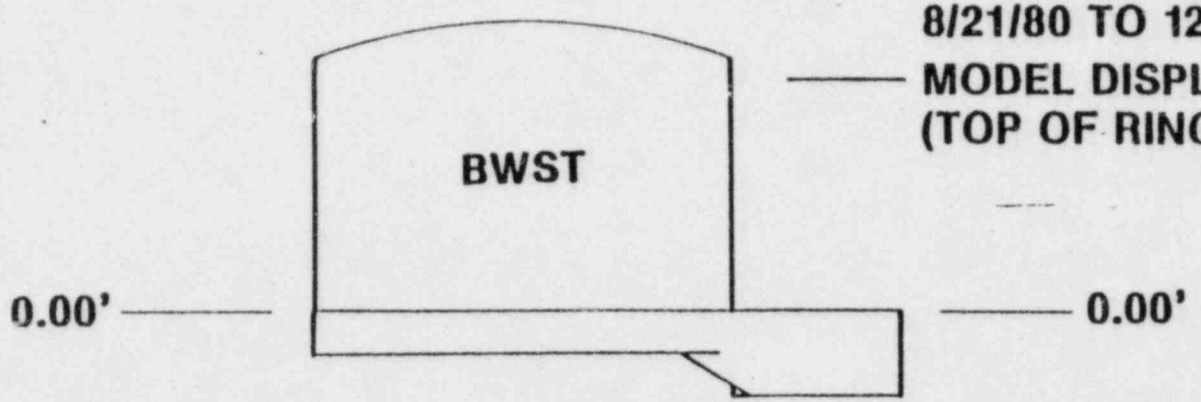
BORATED WATER STORAGE TANK

FINITE ELEMENT MODEL DISPLACEMENTS & MEASURED SETTLEMENTS



---- MEASURED SETTLEMENTS 8/21/80 TO 12/9/80

—— MODEL DISPLACEMENTS (TOP OF RING WALL)

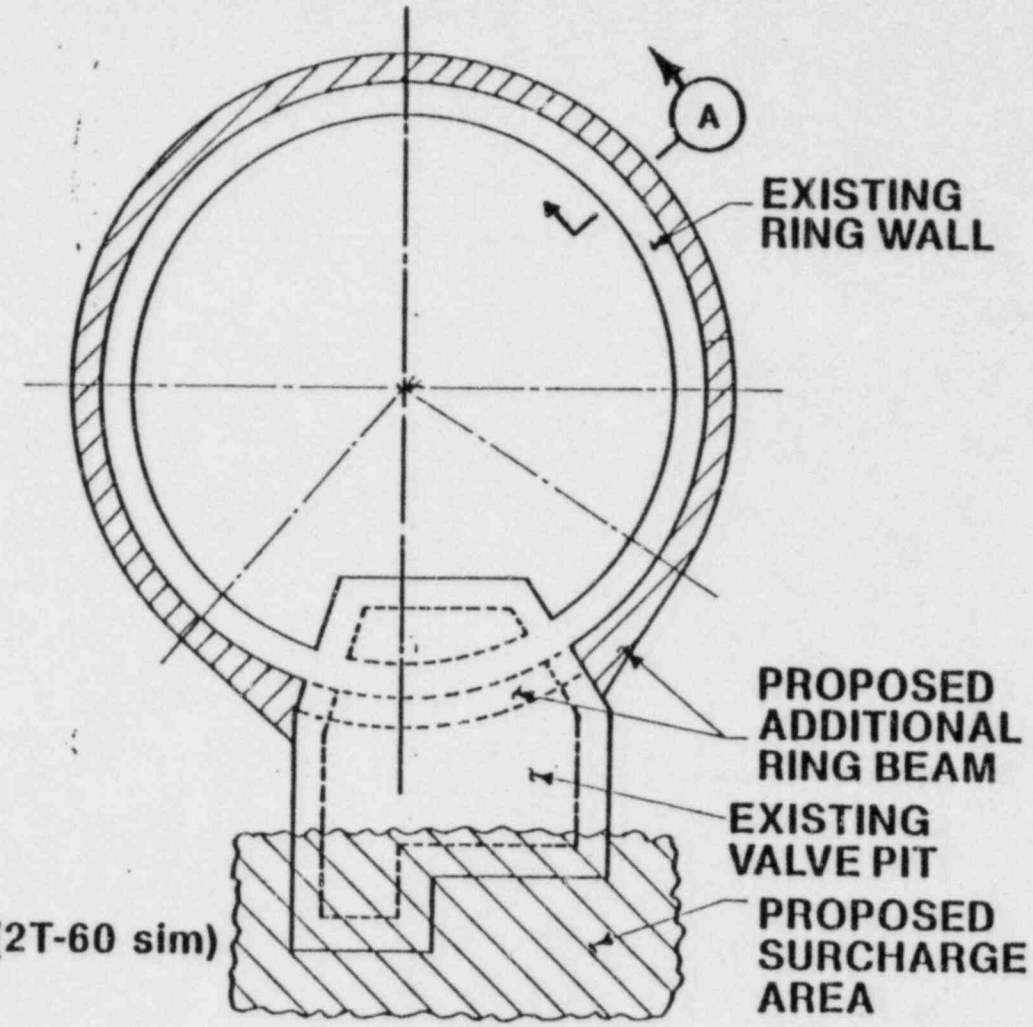


G-1534-32

BWST: Slide 9

BORATED WATER STORAGE TANK

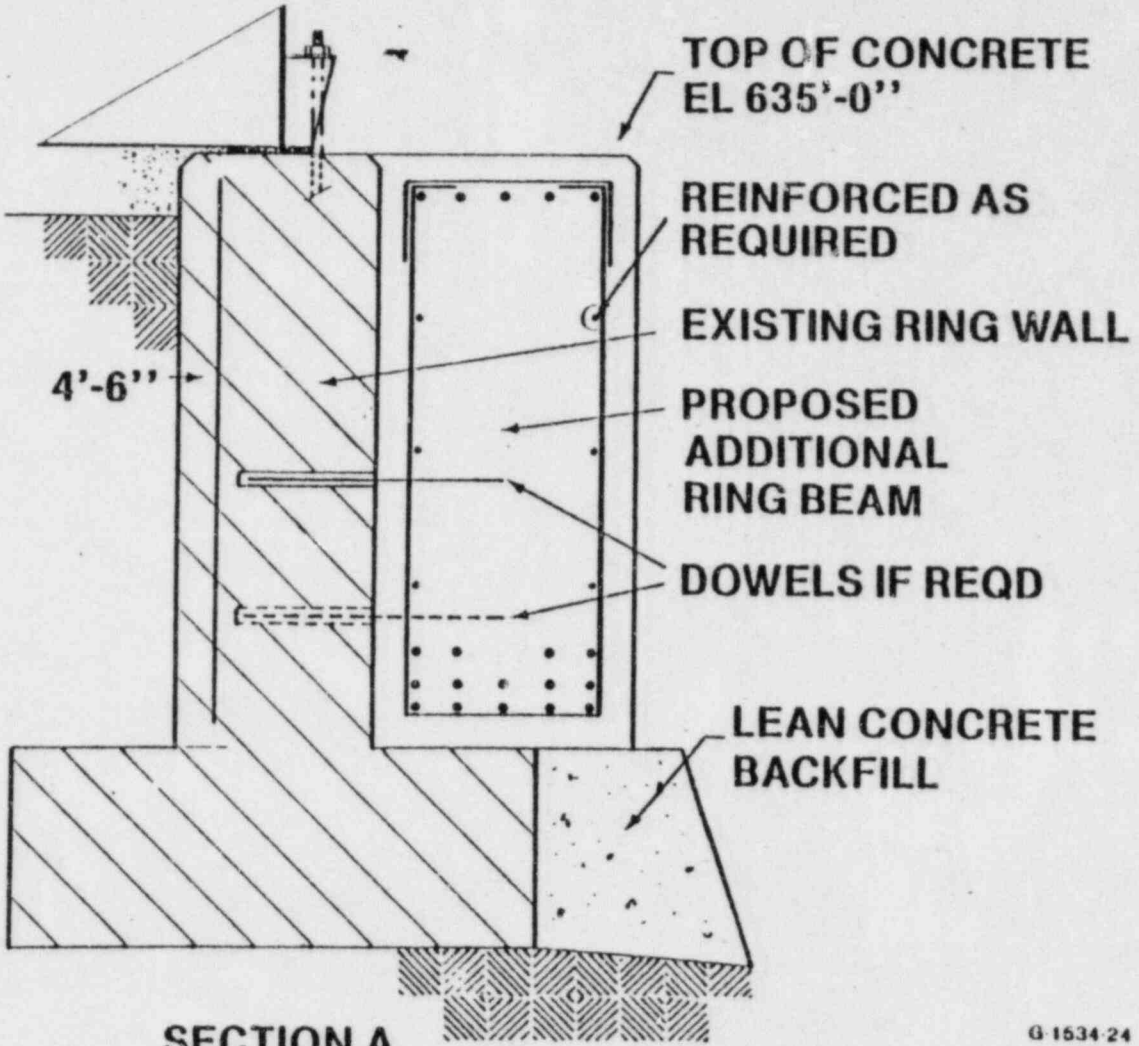
REMEDIAL MEASURES FOR FOUNDATION STRUCTURE



PLAN BWST 1T-60 (2T-60 sim)

BORATED WATER STORAGE TANK

REMEDIAL MEASURES FOR FOUNDATION STRUCTURE



SECTION A

G-1534-24

BWST slide 11

BORATED WATER STORAGE TANK
SCHEDULE

ACTIVITY	COMPLETION DATE
• SURCHARGE VALVE PIT AREA	5/81 to 9/81
• DRAIN TANK	9/81
• CONSTRUCT RING BEAM MODIFICATION	9/81 to 11/81
• RESET (shim) TANK SHELL (if reqd)	9/81 to 12/81
• RE-HYDRO TANK (if reqd)	12/81

BWST slide 12

1

TYPES OF LOADS

1) MECHANICAL - STEADY STATE
(DEAD, LIVE, WIND & TORNADO)

2) CYCLIC - EARTHQUAKE

3) TRANSIENT - PIPE RUPTURE

4) IMPACT - PIPE RUPTURE & TORNADO IMPACT

5) THERMAL, SETTLEMENT, CREEP & SHRINKAGE

2

DEFINITION OF LOADS

D - DEAD

L - LIVE

E - OBE (EARTHQUAKE)

E′ - SSE (EARTHQUAKE)

W - WIND

W′ - TORNADO

T_o - OPERATING THERMAL

T - THERMAL, SETTLEMENT, CREEP & SHRINKAGE

MIDLAND BASIC CRITERIA

$U = 1.4D + 1.7L$

$U = 1.25 (D + L + E) + 1.0T_o$

$U = 1.4 (D + L + E) + 1.0T_o$ (SHEAR WALLS)

$U = 1.25 (D + L + W) + 1.0T_o$

$U = 1.0 (D + L + E') + 1.0T_o$

$U = 1.0 (D + L + W') + 1.0T_o$

MODIFIED CRITERIA FOR SETTLEMENT

$U = 1.05D + 1.3L + 1.05T$

$U = 1.4D + 1.4T$

$U = 1.0D + 1.0L + 1.0E + 1.0T$

$U = 1.0D + 1.0L + 1.0W + 1.0T$

4

ACI-349 CRITERIA

$$U = 1.05D + 1.3L + 1.05T$$

$$U = 1.05D + 1.3L + 1.3E + 1.05T$$

$$U = 1.05D + 1.3L + 1.3W + 1.05T$$

$$U = 1.0D + 1.0L + 1.0E' + 1.0T$$

$$U = 1.0D + 1.0L + 1.0W' + 1.0T$$

BEHAVIOR OF REINFORCED CONCRETE BEAMS

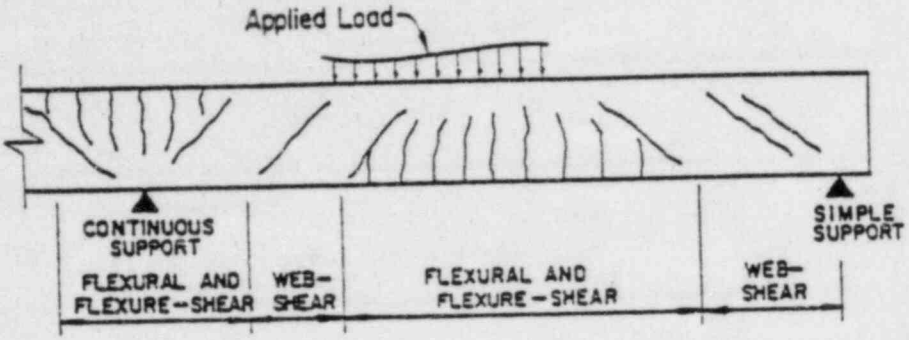
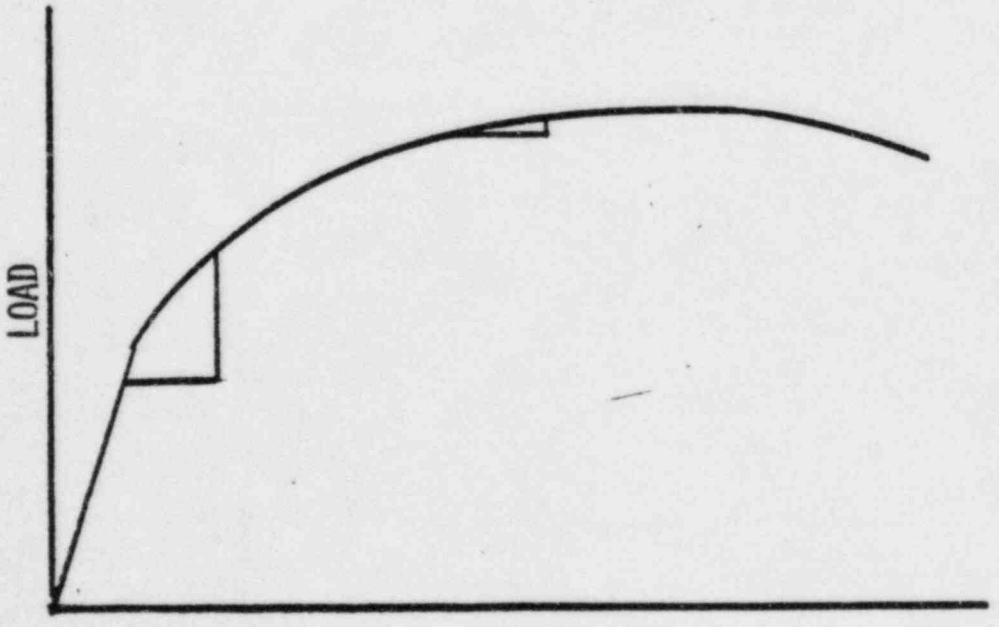
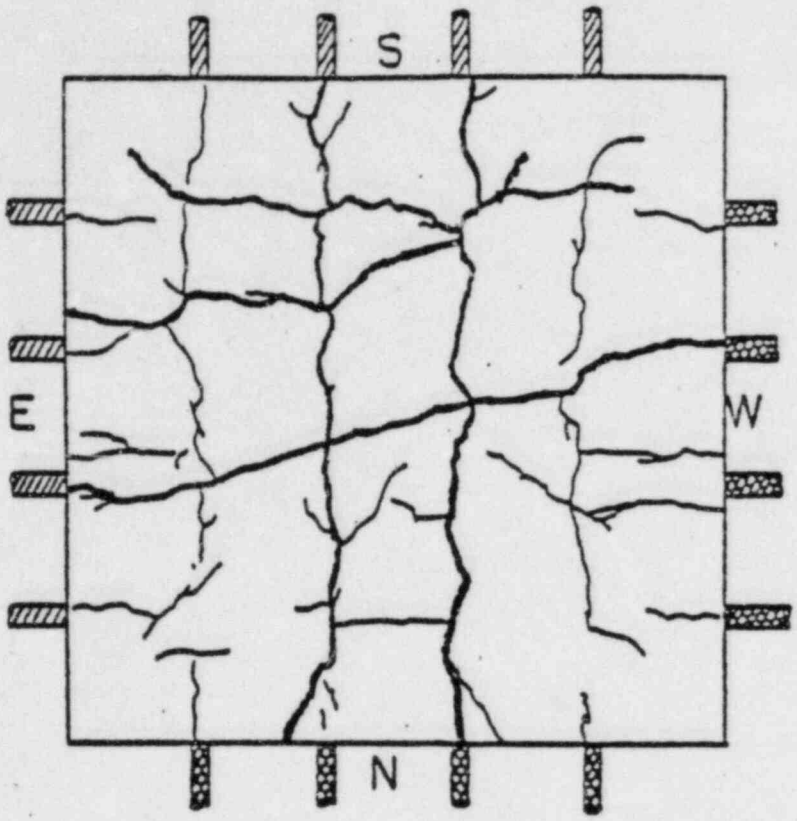


Fig. 11-1 – Types of cracking in concrete beams

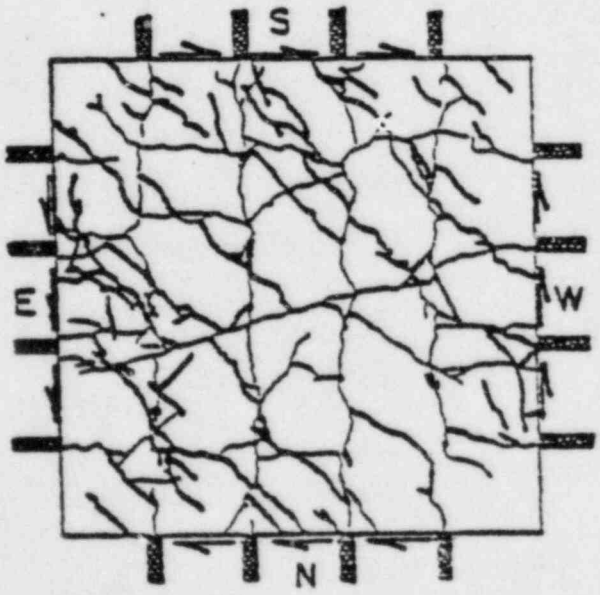
(REF. ACI-318 COMMENTARY)



BEHAVIOR OF REINFORCED CONCRETE WALLS



BIAXIAL TENSION



BIAXIAL TENSION & INPLANE SHEAR

(REF. NUREG/ CR-1374)

SETTLEMENT

ANALYTICAL APPROACH

1) LOWER OR VARIABLE FOUNDATION MODULUS

2) INDUCE OR MATCH PREDICTED SETTLEMENT

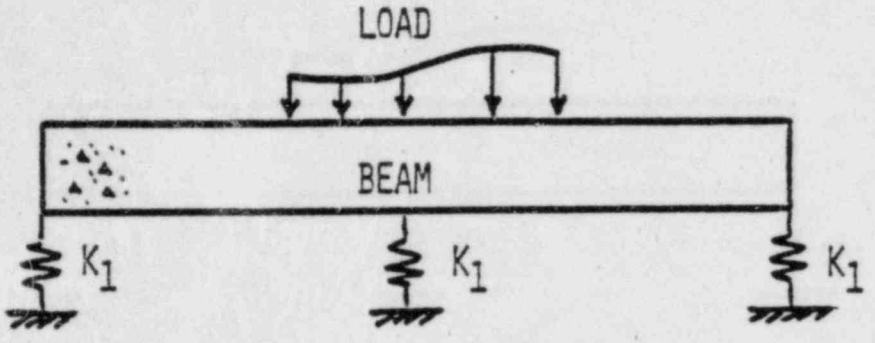
EFFECTS OF SETTLEMENT

1) STRUCTURAL DISPLACEMENT

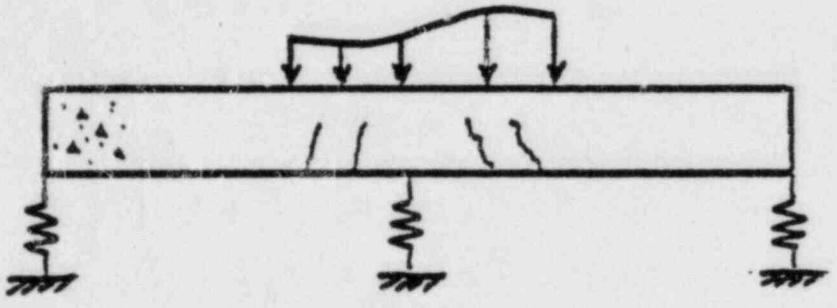
2) STRAIN & STRESS IN CONCRETE AND REINFORCING STEEL

3) CONCRETE CRACKING

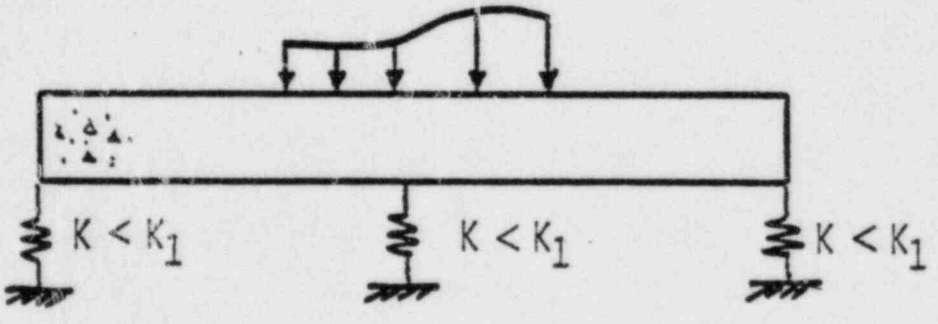
8



DESIGN



OBSERVED



REANALYSIS

9

CRACKING & SETTLEMENT

COMBINED WITH

1) STEADY STATE LOADS

2) CYCLIC

3) TRANSIENT & STRUCTURAL RESPONSE

4) LOCAL MISSILE IMPACT

DIESEL GENERATOR & BORATED WATER STORAGE TANK FOUNDATION

(1) DETERMINE BY ANALYSIS SECTION FORCES - SETTLEMENT CONSIDERED BY REDUCED FOUNDATION MODULUS

(2) CHECK SECTION CAPACITIES OR STRESSES FOR VARIOUS LOAD COMBINATIONS - SETTLEMENT COMBINED WITH OTHER LOADS

(3) HIGHEST STRESSED SECTIONS WITH CRACKS - WILL CONSERVATIVELY CONVERT CRACK WIDTH TO REINFORCING STRESS & COMBINE WITH RESULTS FROM (2) *

(4) TORNADO MISSILE IMPACT STRUCTURAL RESPONSE WILL BE COMBINED WITH RESULTS FROM (2) *

(5) LOCAL TORNADO MISSILE IMPACT EFFECTS (SPALLING) WILL BE CHECKED - NO COMBINATION WITH OTHER EFFECTS OR LOADS *

* NOT REQUIRED FOR BORATED WATER STORAGE TANK FOUNDATIONS

AUXILIARY BUILDING & SERVICE WATER PUMP STRUCTURE

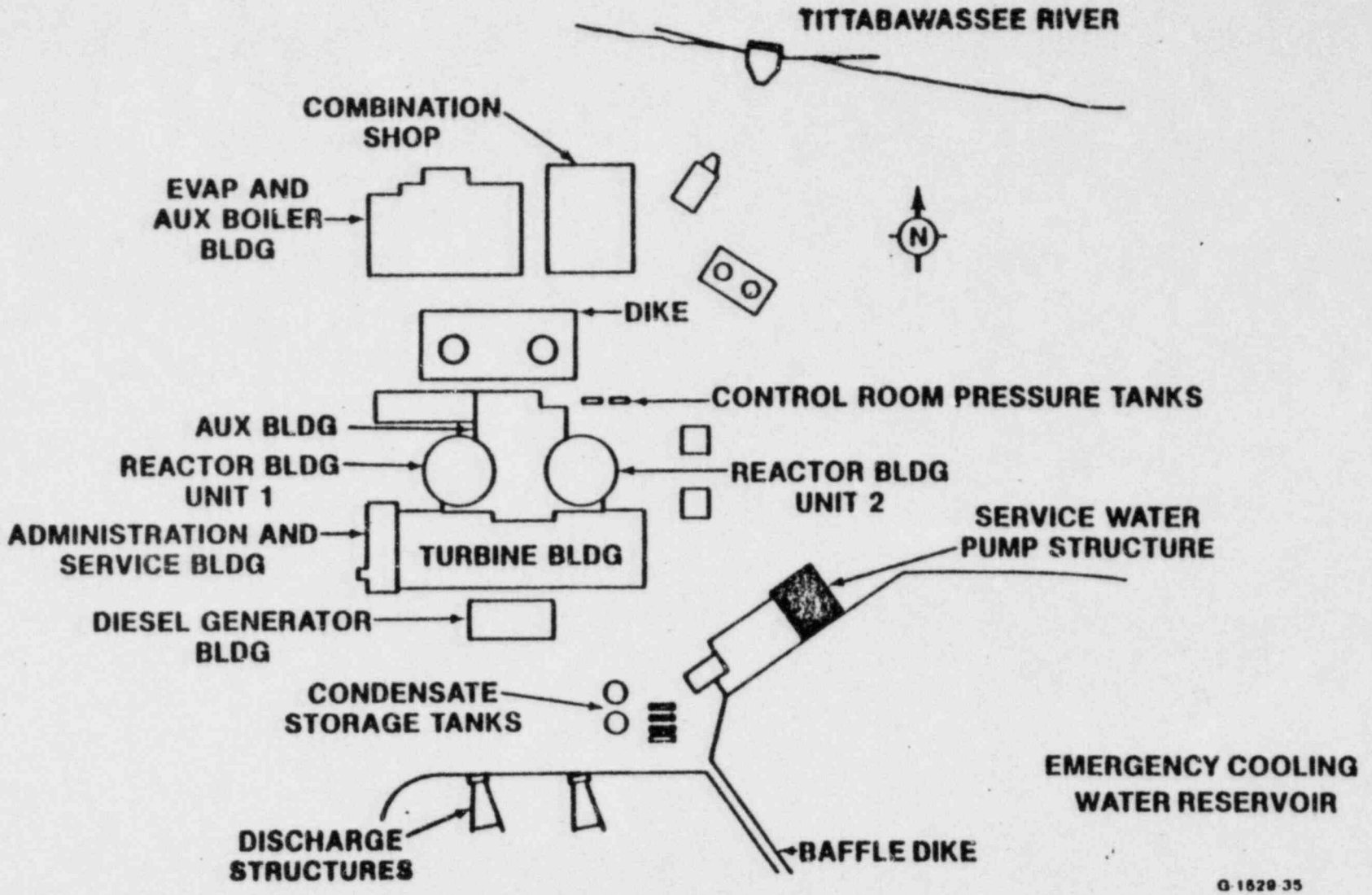
(1) DETERMINE BY ANALYSIS SECTION FORCES - UNDERPINNING & FILL PROPERTIES WILL BE VARIED RELATIVE TO TILL PROPERTIES

(2) CHECK SECTION CAPACITIES OR STRESSES FOR VARIOUS LOAD COMBINATIONS - INCORPORATING UNDERPINNING (FORCES & CAPACITIES)

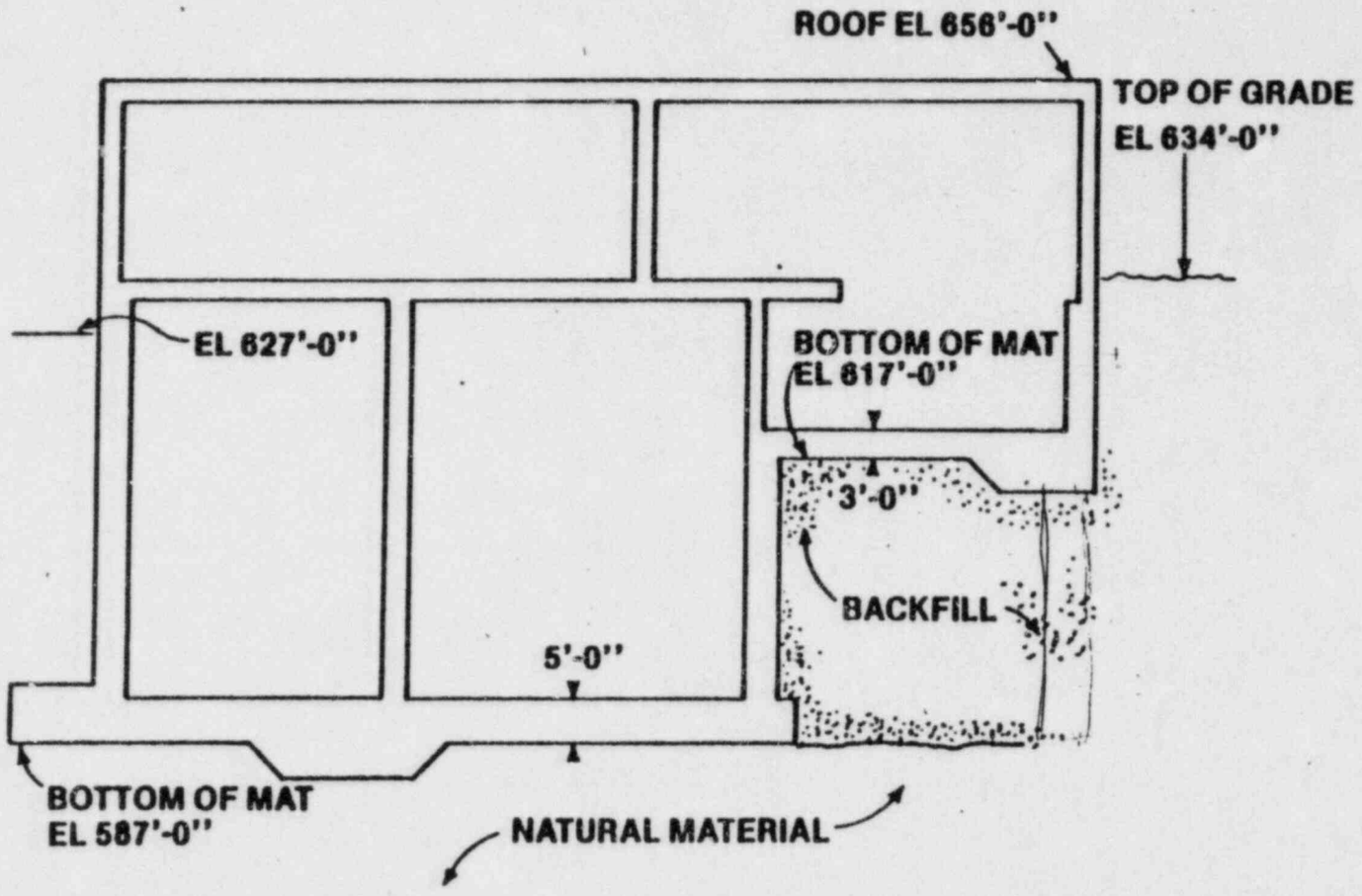
(3) TORNADO MISSILE IMPACT STRUCTURAL RESPONSE AND PIPE RUPTURE WILL BE COMBINED WITH FROM (2)

(4) LOCAL TORNADO MISSILE IMPACT EFFECTS (SPALLING) WILL BE CHECKED - NO COMBINATION WITH OTHER EFFECTS OR LOADS

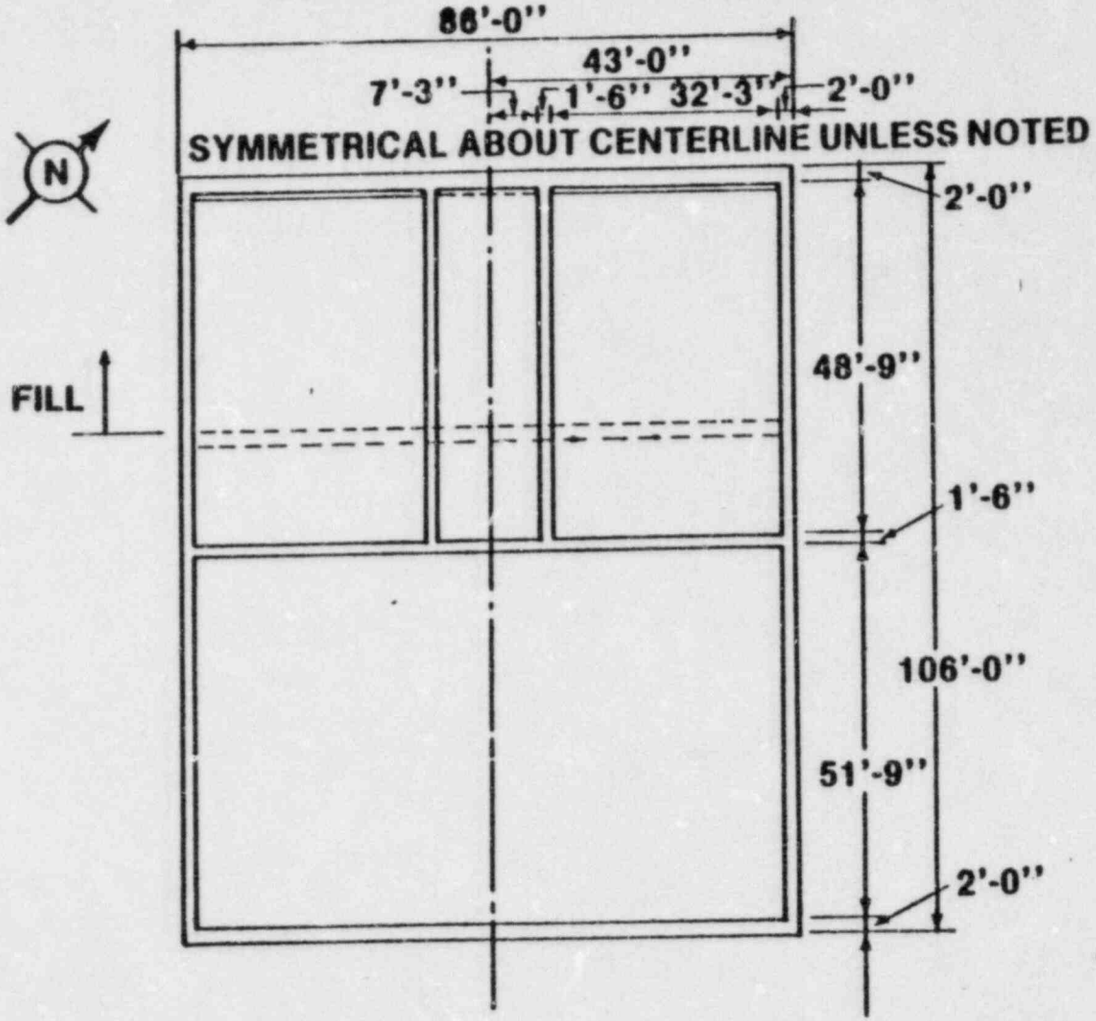
MIDLAND SITE PLAN



SERVICE WATER PUMP STRUCTURE
TYPICAL SECTION
(Looking West)



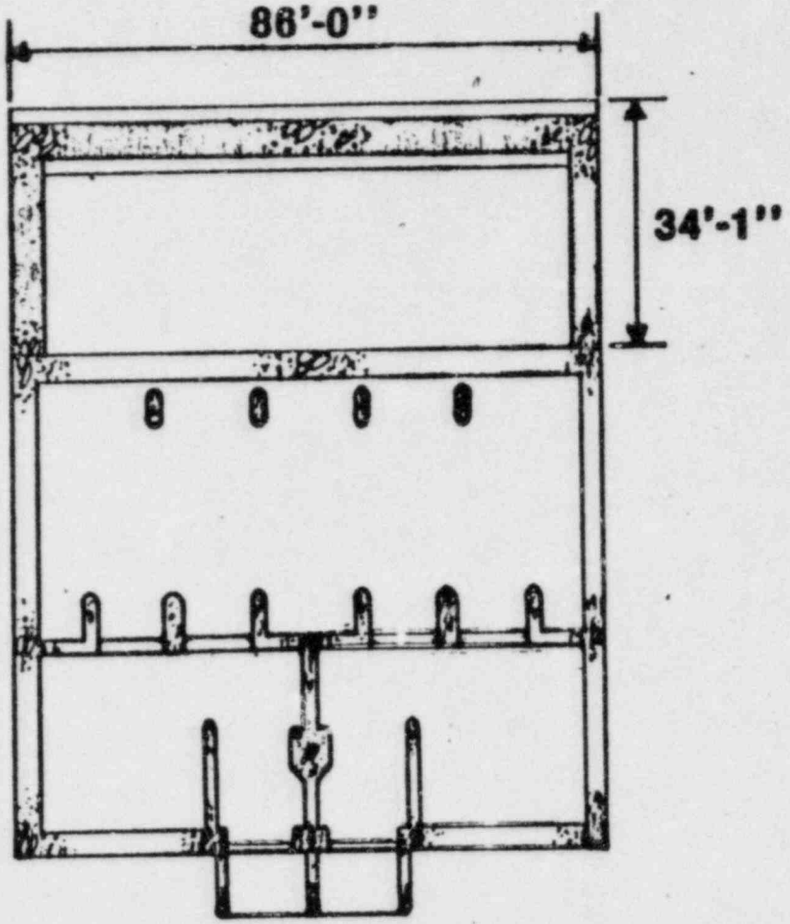
SERVICE WATER PUMP STRUCTURE
PLAN AT EL 634'-6"



G 1514 21

617 07

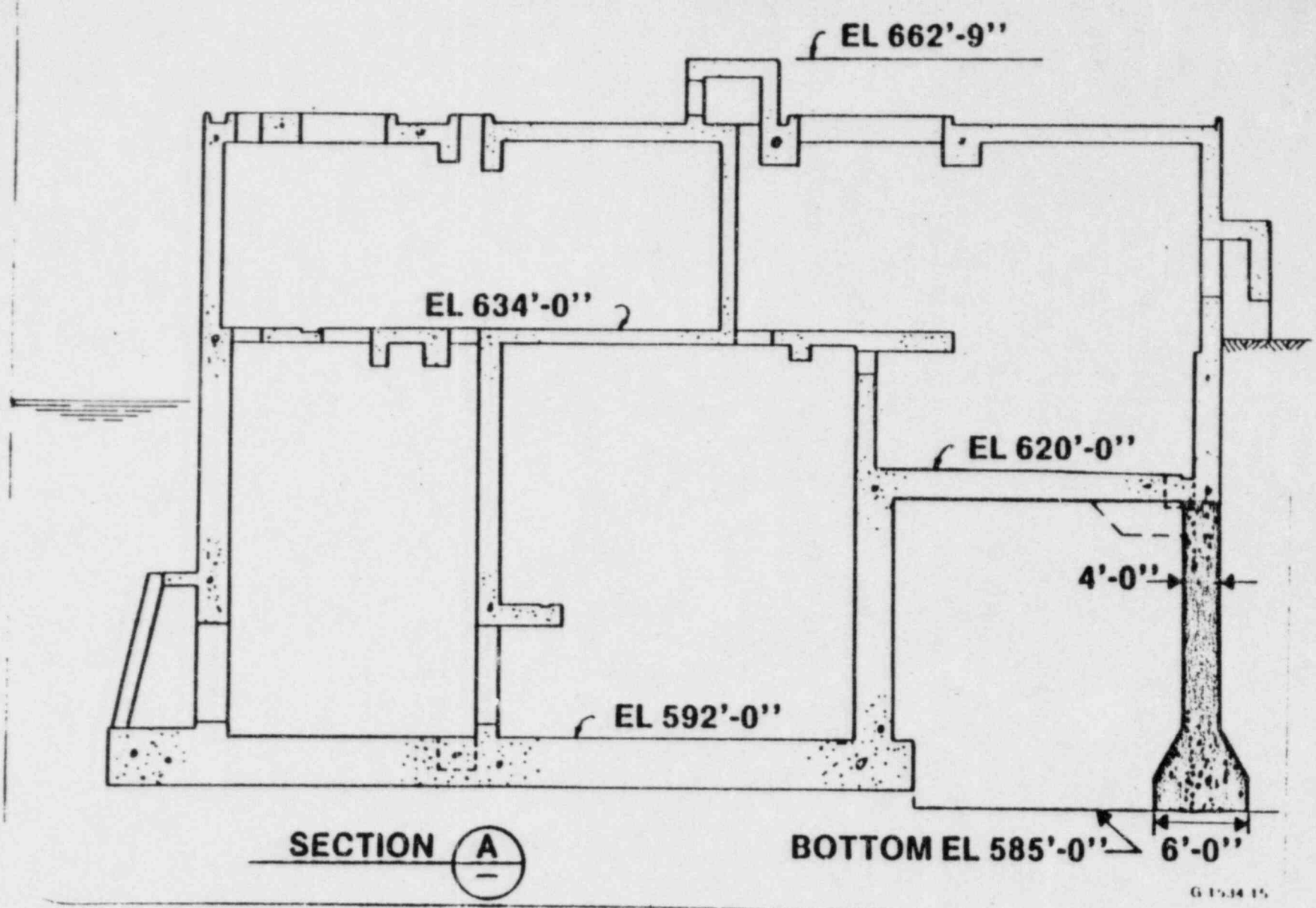
SERVICE WATER PUMP STRUCTURE
PLAN AT EL 592'-0"



G-1634-89

SERVICE WATER PUMP STRUCTURE

SECTION A



UNDERPINNING

DIVISION OF RESPONSIBILITY BETWEEN BECHTEL AND MRJD

- **BECHTEL**
  - **Seismic and Structural Analyses**
  - **Connection Details Between Existing Structure and Underpinning**
  - **Rebar Requirements of Underpinning Wall**
  - **Initial and Final Jacking Load Requirement for Structure**
  - **Dewatering**
  - **Underpinning Subcontract Administration**

UNDERPINNING

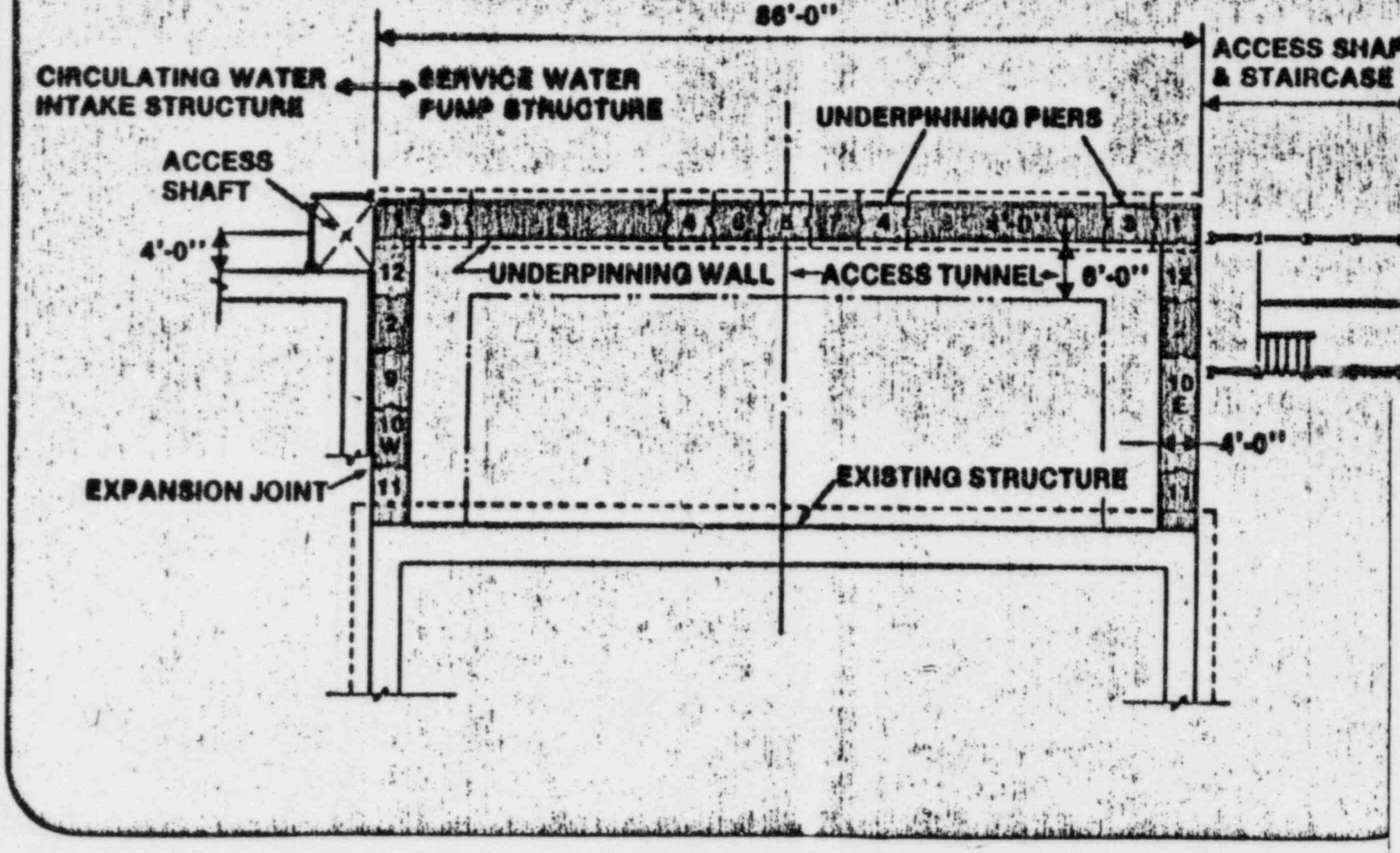
DIVISION OF RESPONSIBILITY BETWEEN BECHTEL AND MRJD (cont'd)

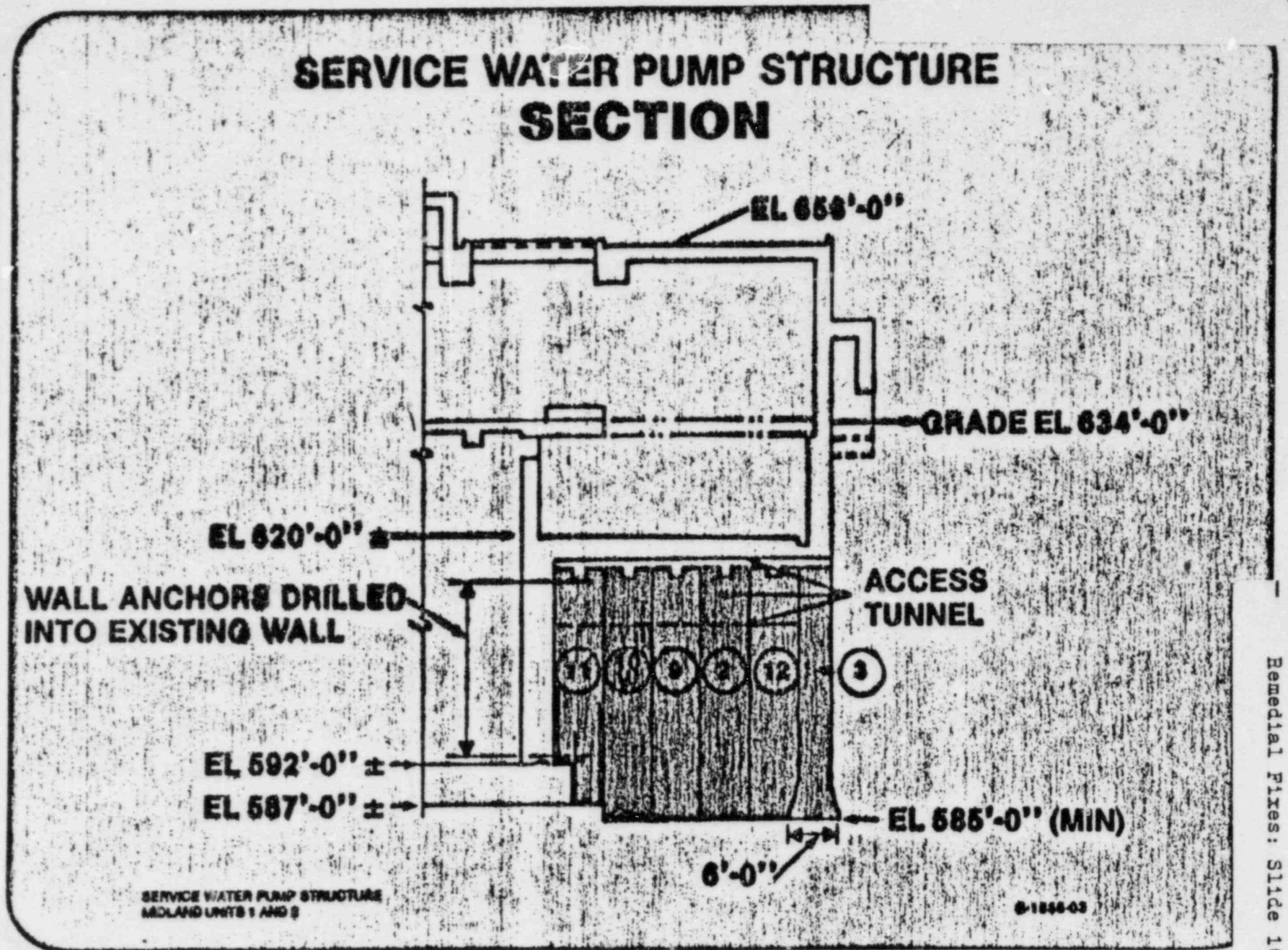
- MRJD
  - Depth and Base Requirement of Underpinning Wall
  - Construction Procedure and Rebar Detail
  - Settlement Calculations and Settlement Monitoring Program
  - Input for Underpinning Specification

SERVICE WATER PUMPHOUSE DESIGN ACTIVITIES
MILESTONE SCHEDULE DATES

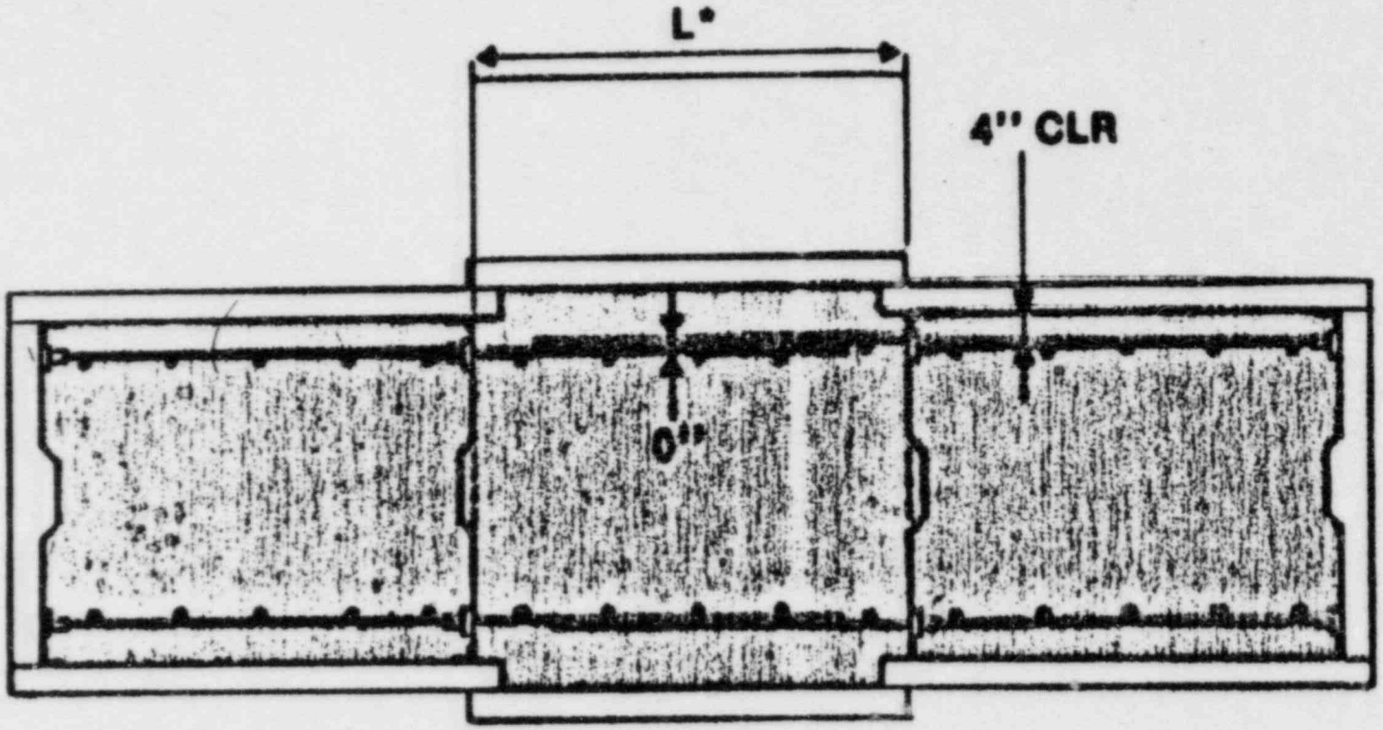
- CONCEPTUAL DESIGN — 5/30/81
- COMMITTED PRELIMINARY DESIGN — 6/30/81
- FINAL DESIGN — 12/31/81

SERVICE WATER PUMP STRUCTURE
PLAN




SERVICE WATER PUMP STRUCTURE
SECTION
EL 659'-0"
GRADE EL 634'-0"
EL 620'-0" ±
WALL ANCHORS DRILLED INTO EXISTING WALL
ACCESS TUNNEL
11
10
9
2
12
3
EL 592'-0" ±
EL 587'-0" ±
EL 585'-0" (MIN)
6'-0"
SERVICE WATER PUMP STRUCTURE
MIDLAND UNITS 1 AND 2
8-1886-03

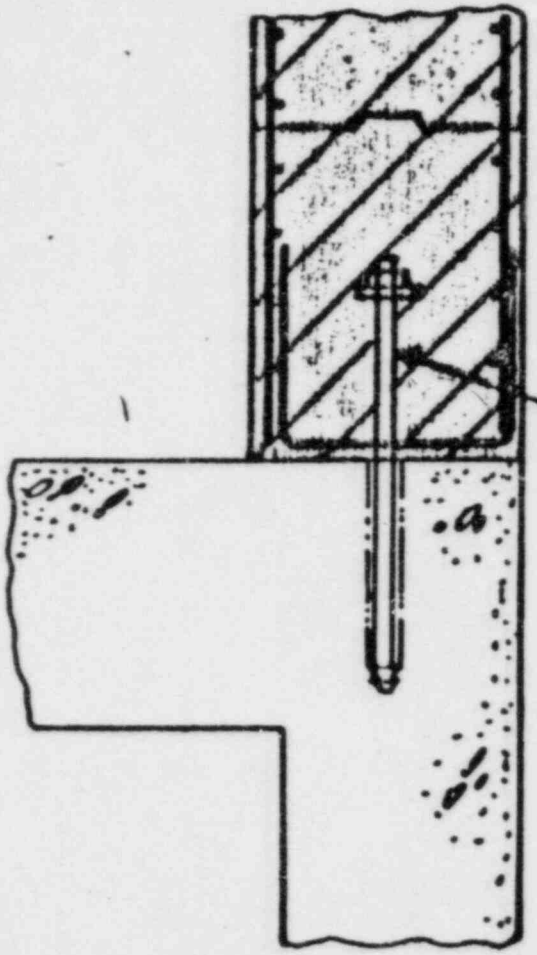
SERVICE WATER PUMP STRUCTURE
DETAILS OF ADJOINING PIERS



MIDLAND UNITS 1 AND 2

0-1656-06

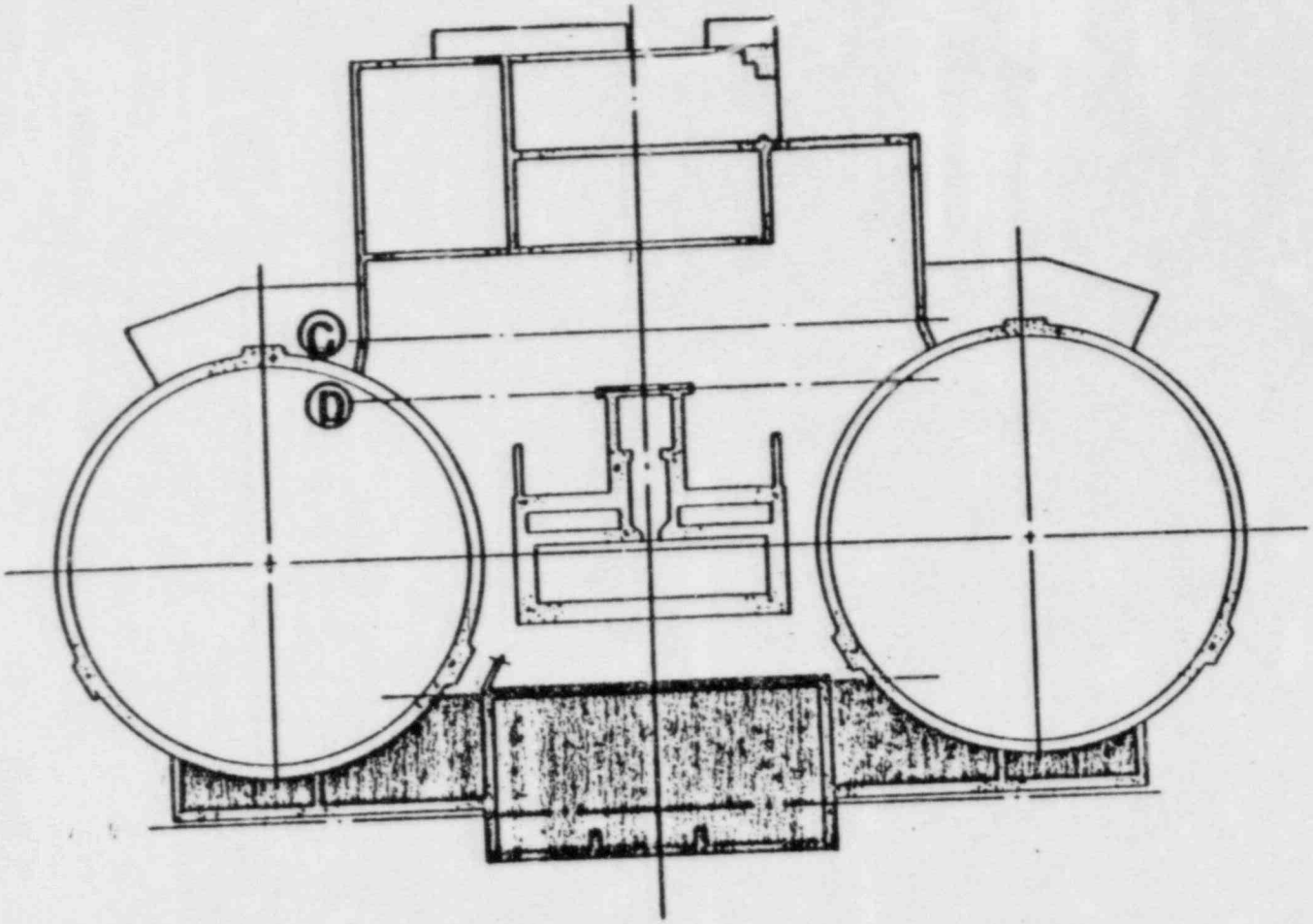
SERVICE WATER PUMP STRUCTURE
PLAN
(Connection to Existing Structure)



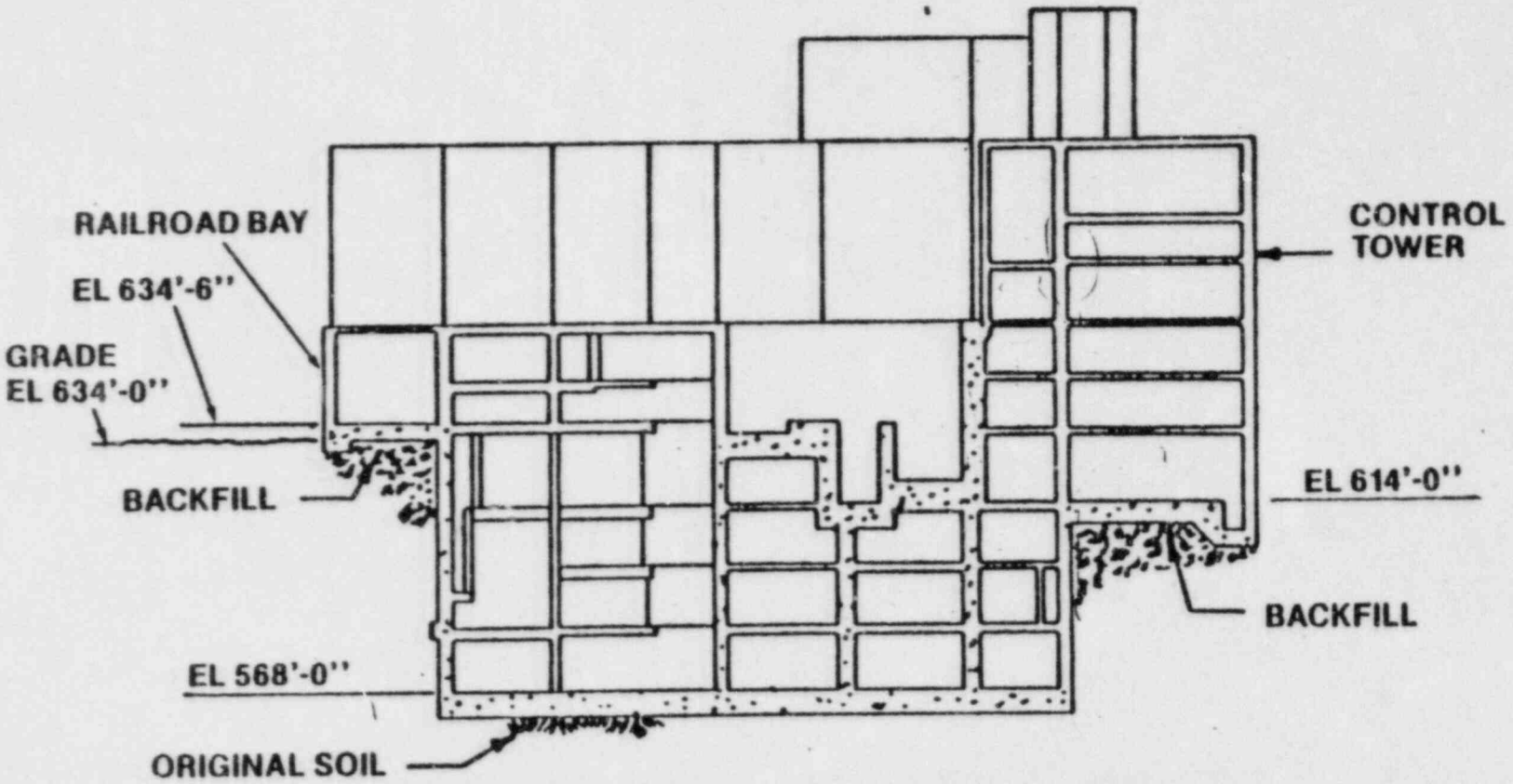
NOTES:
1. DRILL AND GROUT ROCK ANCHORS INTO EXISTING WALL
2. PIERS 11 TO BE POURED ONLY AFTER COMPLETION OF ALL JACKING PROCEDURES

ANCHOR BOLTS SIZE & SPACING TO BE DETERMINED

AUXILIARY BUILDING
PLAN AT EL 634'-6"



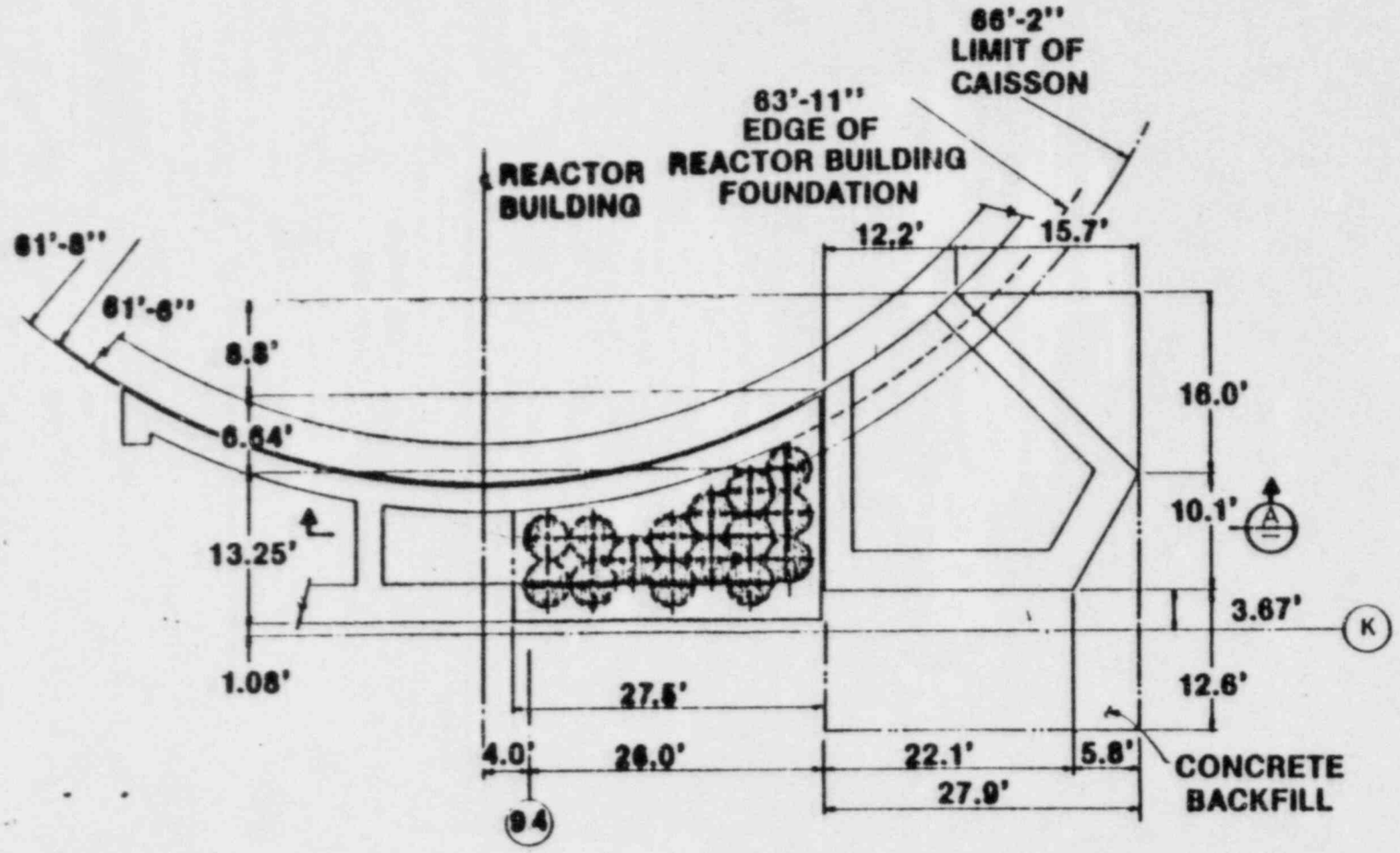
AUXILIARY BUILDING
TYPICAL SECTION
(Looking East)



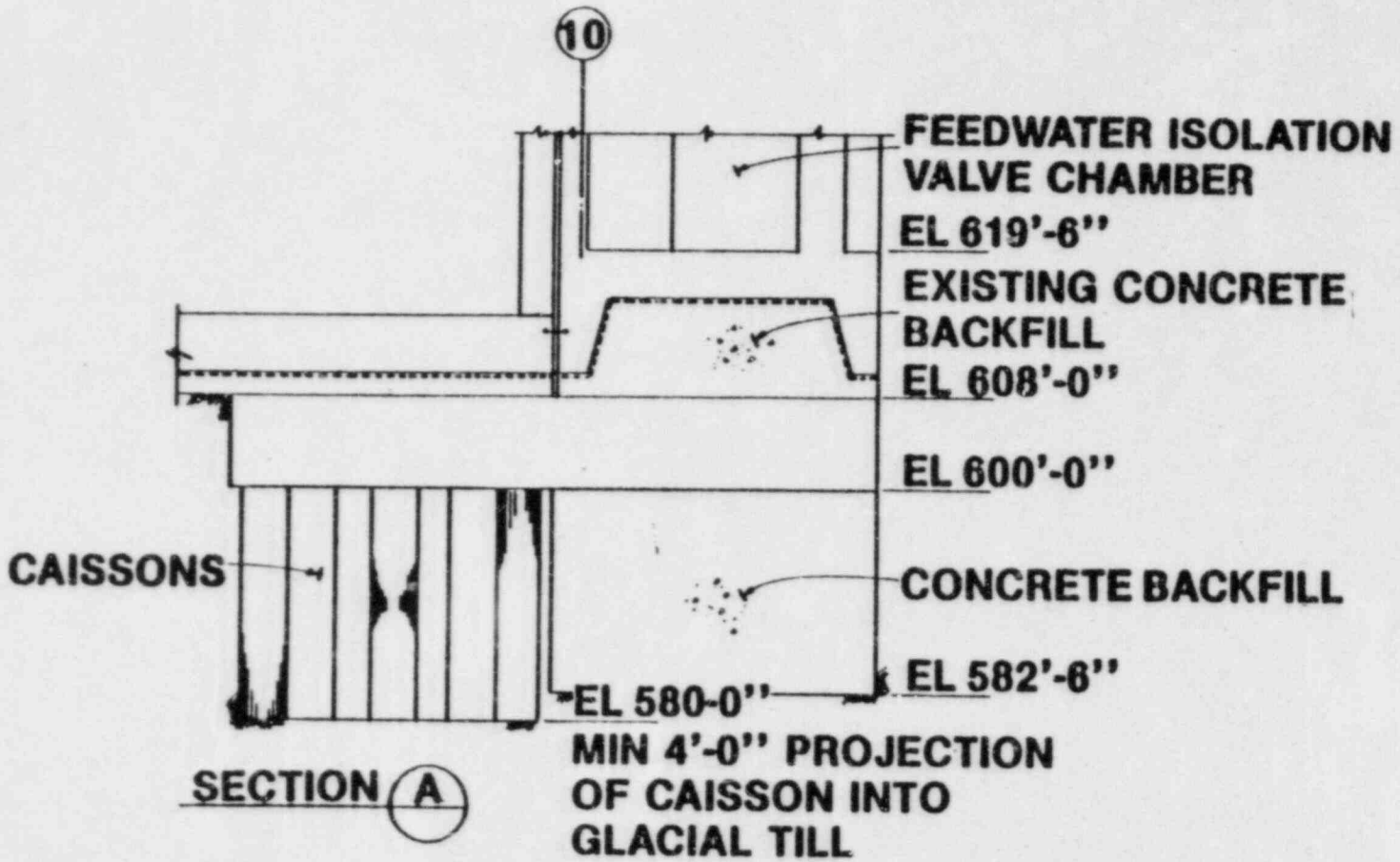
G 1555-07

AUXILIARY BUILDING WING AND FEEDWATER VALVE CHAMBER

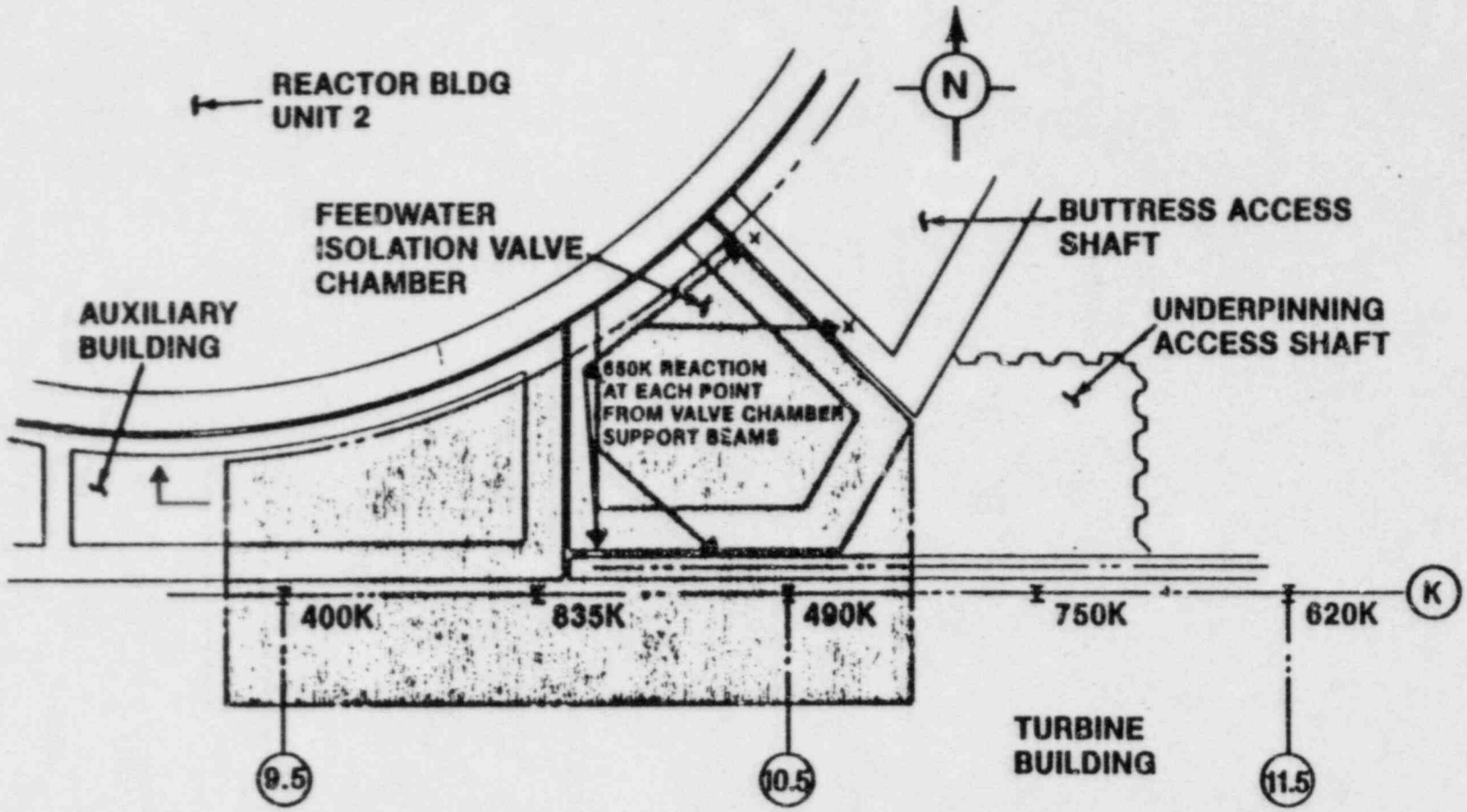
PLAN AT EL 614'-0"



AUXILIARY BUILDING



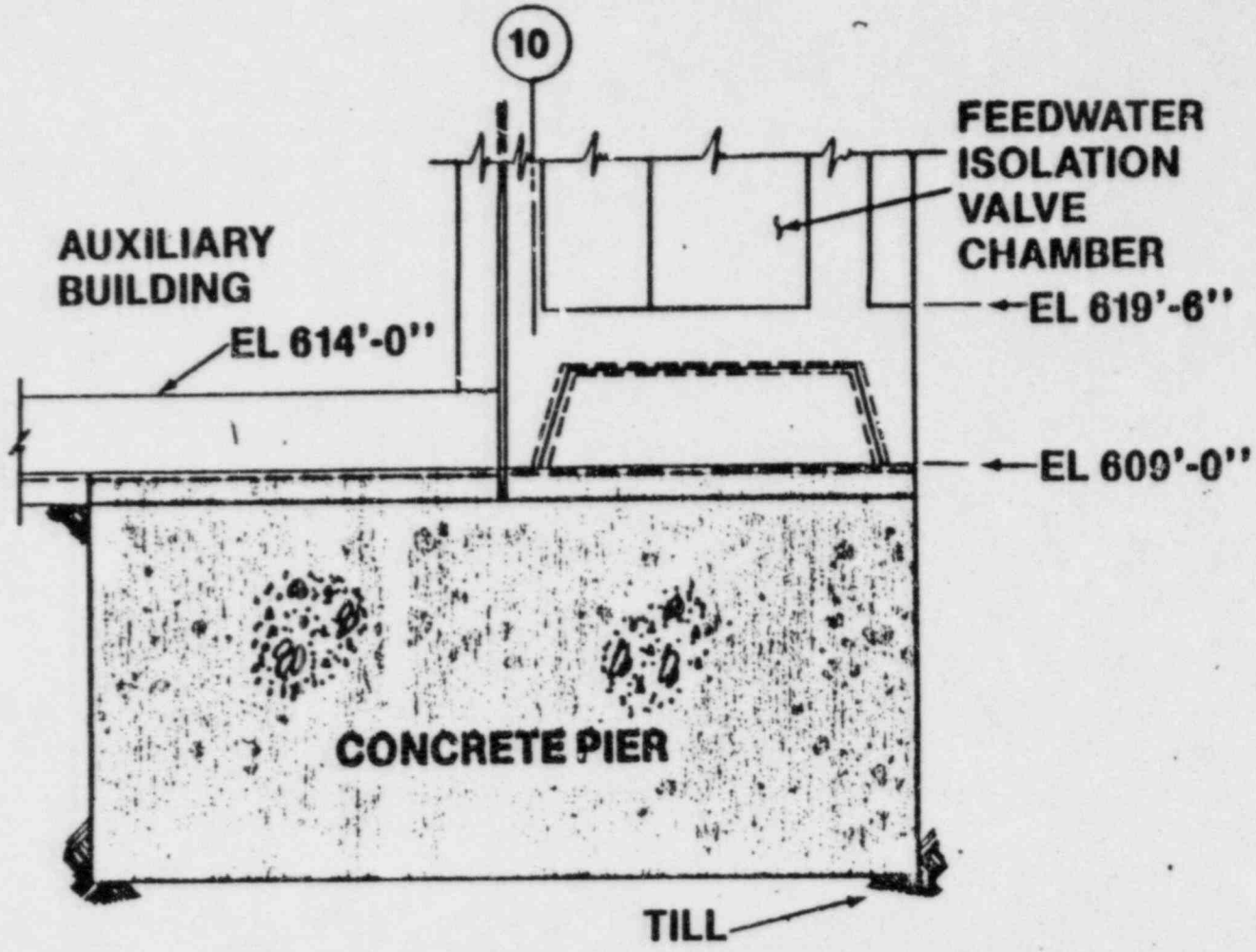
AUXILIARY BUILDING UNDERPINNING
PLAN AT EL 614'-0"



MIDLAND UNITS 1 AND 2

G-1555-04

AUXILIARY BUILDING UNDERPINNING
SECTION



MIDLAND UNITS 1 AND 2

G-1555-05

AUXILIARY BUILDING ELECTRICAL PENETRATION AREA

NRC CONCERNS

- REANALYSIS OF BUILDING WITH MODIFIED SUPPORT CONDITION
- CRACKS IN THE STRUCTURE
- ERROR IN COMPUTER MODEL IN ORIGINAL SEISMIC ANALYSIS
- ADDITIONAL LOADING ON CONTROL TOWER DUE TO CHANGE OF SUPPORT CONDITION FOR ELECTRICAL PENETRATION AREA

AUXILIARY BUILDING ELECTRICAL PENETRATION AREA
NRC CONCERNS

- BENDING EFFECT OF ELECTRICAL PENTRATION AREA AND CONSEQUENT REDISTRIBUTION OF LOAD ON CAISSONS
- LOAD AND CAPACITY CALCULATION OF CAISSON CONSIDERING EFFECT OF FRICTION
- VALUE OF SUBGRADE MODULUS FOR BACKFILL SOIL UNDER CONTROL TOWER
- UNEQUAL PRESSURE DISTRIBUTION UNDER CONTROL TOWER SLAB

AUXILIARY BUILDING DESIGN ACTIVITIES

MILESTONE SCHEDULE DATES

- CONCEPTUAL DESIGN — 6/15/81
- COMMITTED PRELIMINARY DESIGN — 8/15/81
- FINAL DESIGN — 12/31/81

10/82

Permanent Dewatering: Slide 1

A. FIELD ACTIVITIES SINCE SUBMITTAL OF AMENDMENT 85

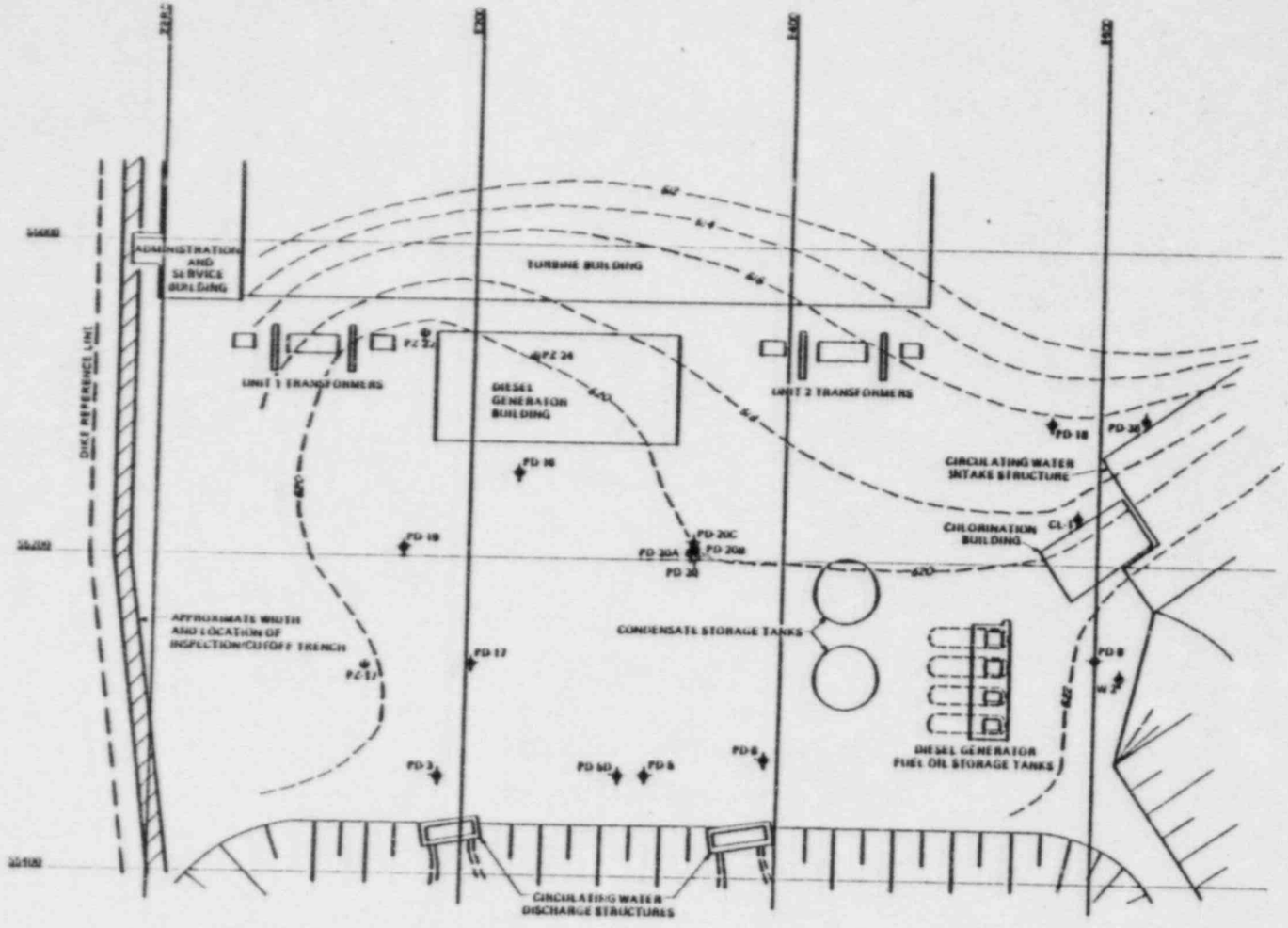
1. PD-20 PUMPING TEST 10/2/80 TO 11/13/80

2. UNIT 1 DEWATERING SYSTEM INITIATED 11/19/80

3. COOLING POND RAISED FROM ELEVATION 623.5 TO 627 1/12/81 TO 1/28/81

4. TURBINE BUILDING DEWATERING AND PD-17, PD-20 PUMPING INITIATED 4/16/81

SLIDE 2



EXPLANATION

PD 20 — LOCATION OF TEST WELL

PD 3 — LOCATION OF MEASURED OBSERVATION WELLS

PZ 17 — LOCATION OF MEASURED PIEZOMETERS

640 — APPROXIMATE ELEVATION OF GROUND WATER LEVEL. CONTOUR INTERVAL IS 2 FEET.

NOTES:

1. The duct bank/valve pit dewatering system was started 2/26/80.
2. The Unit 2 dewatering system was started 8/10/80.
3. Only observation wells and piezometers screened through pervious material were used to prepare this figure.
4. For detailed locations of the duct bank/valve pit and Unit 2 dewatering systems, see Figure 42-8.
5. Test well PD 20 was pumped at 2.4 gpm in and 11/13/80.

N

0 25 50 100 150

SCALE IN FEET

BECHTEL

MIDLAND POWER PL

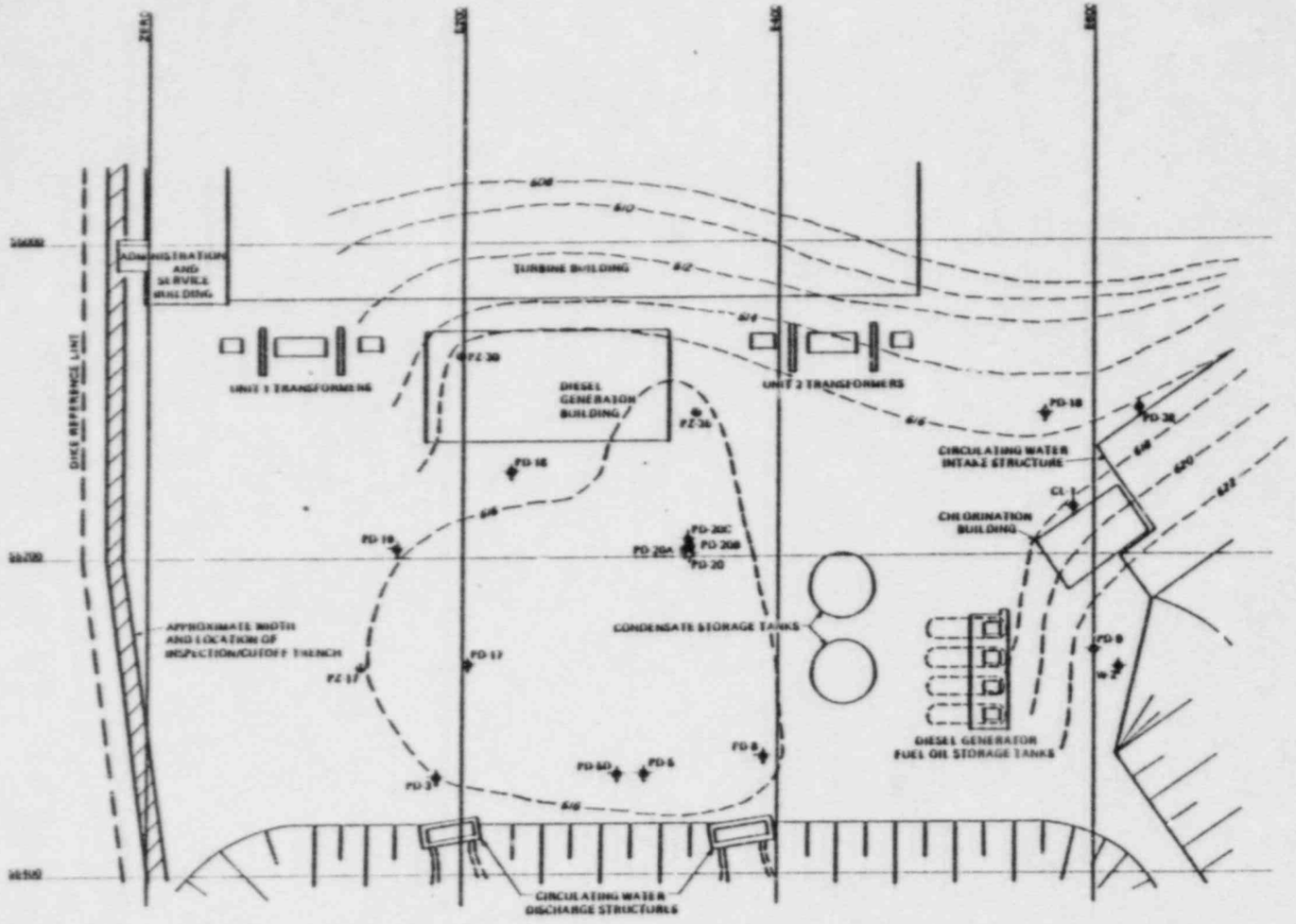
GROUND WATER LEVELS IN THE VICINITY OF THE DIESEL GENERATOR BUILDING PRIOR TO PUMPING TEST WELL PD 20 (10/2/80)

	7220	FIGURE	A

SK-6-516

Permanent Dewatering: Slide 2

SLIDE 3



EXPLANATION

PD-20 ▽ LOCATION OF TEST WELL

PD-3 ◆ LOCATION OF MEASURED OBSERVATION WELLS

PZ-17 ● LOCATION OF MEASURED PIEZOMETERS

620' APPROXIMATE ELEVATION OF GROUND WATER LEVEL. CONTOUR INTERVAL IS 2 FEET.

NOTES:

1. The duct bank/valve pit dewatering system was started 2/21/80.
2. The Unit 2 dewatering system was started 8/10/80.
3. Only observation wells and piezometers screened through pervious material were used to prepare this figure.
4. For detailed locations of the duct bank/valve pit and Unit 2 dewatering systems, see Figure 4.2-6.
5. Test well PD-20 was pumped at 2 4 gpm between and 11/13/80.

N

0 25 50 100 150

SCALE IN FEET

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ANN ARBOR

MIDLAND POWER PLAN

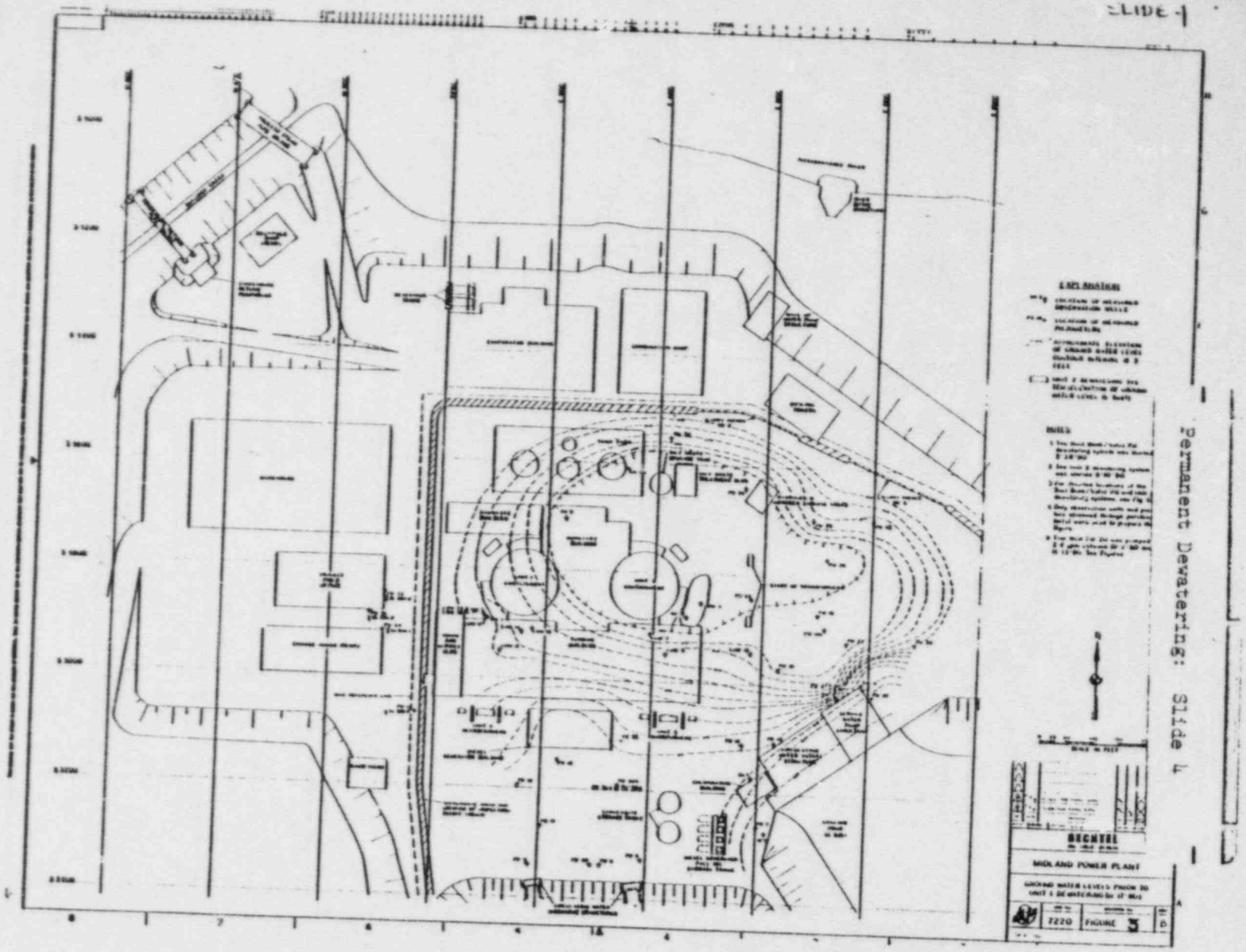
GROUND WATER LEVELS IN THE VICINITY OF THE DIESEL GENERATOR BUILDING NEAR THE COMPLETION OF PUMPING TEST WELL PD 20 (11/12/80)

	7220	FIGURE 2	A

54-6-543

Permanent Dewatering: Slide 3

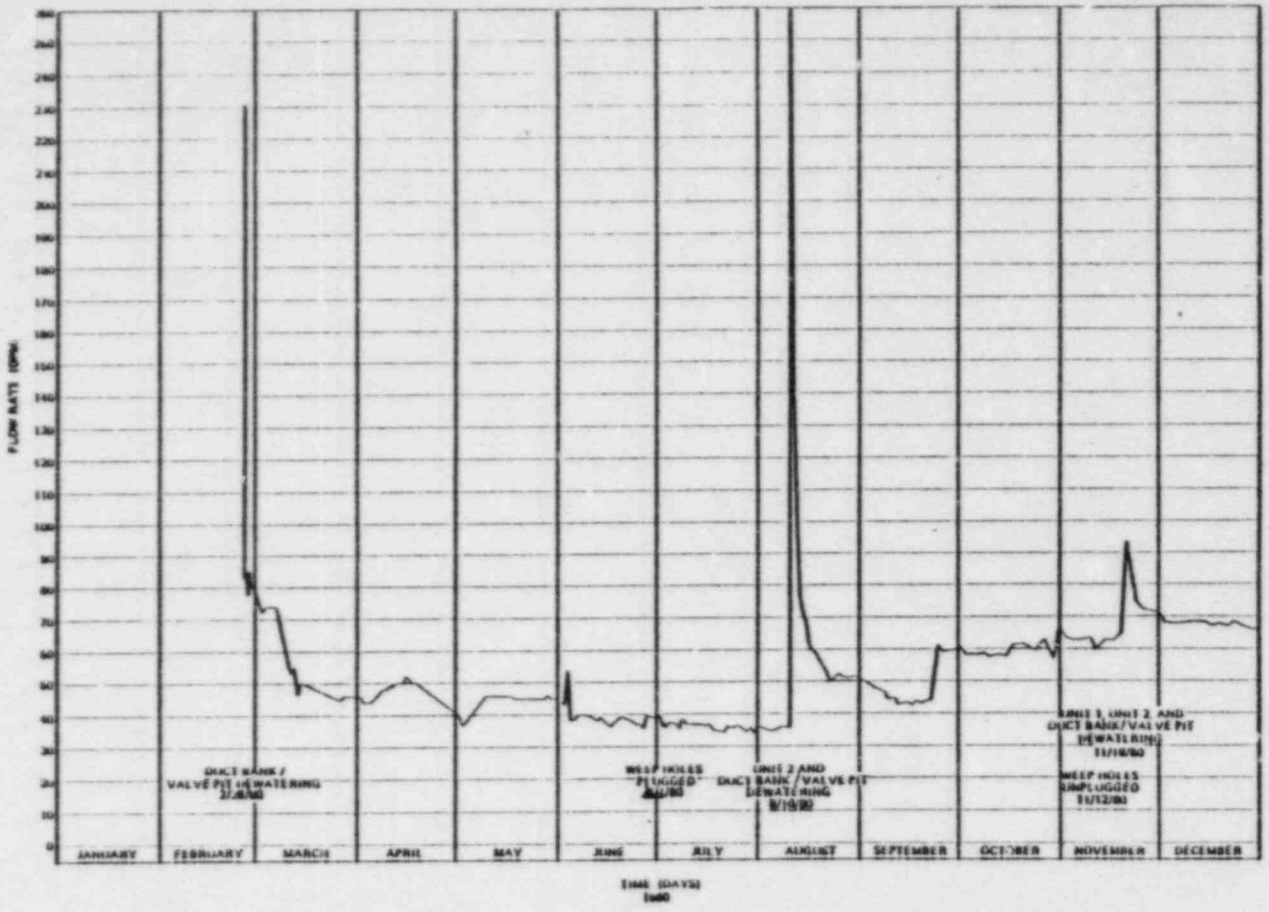
SLIDE 4



Permanent Dewatering: Slide 4

Slide 5

Permanent Dewatering: Slide 5



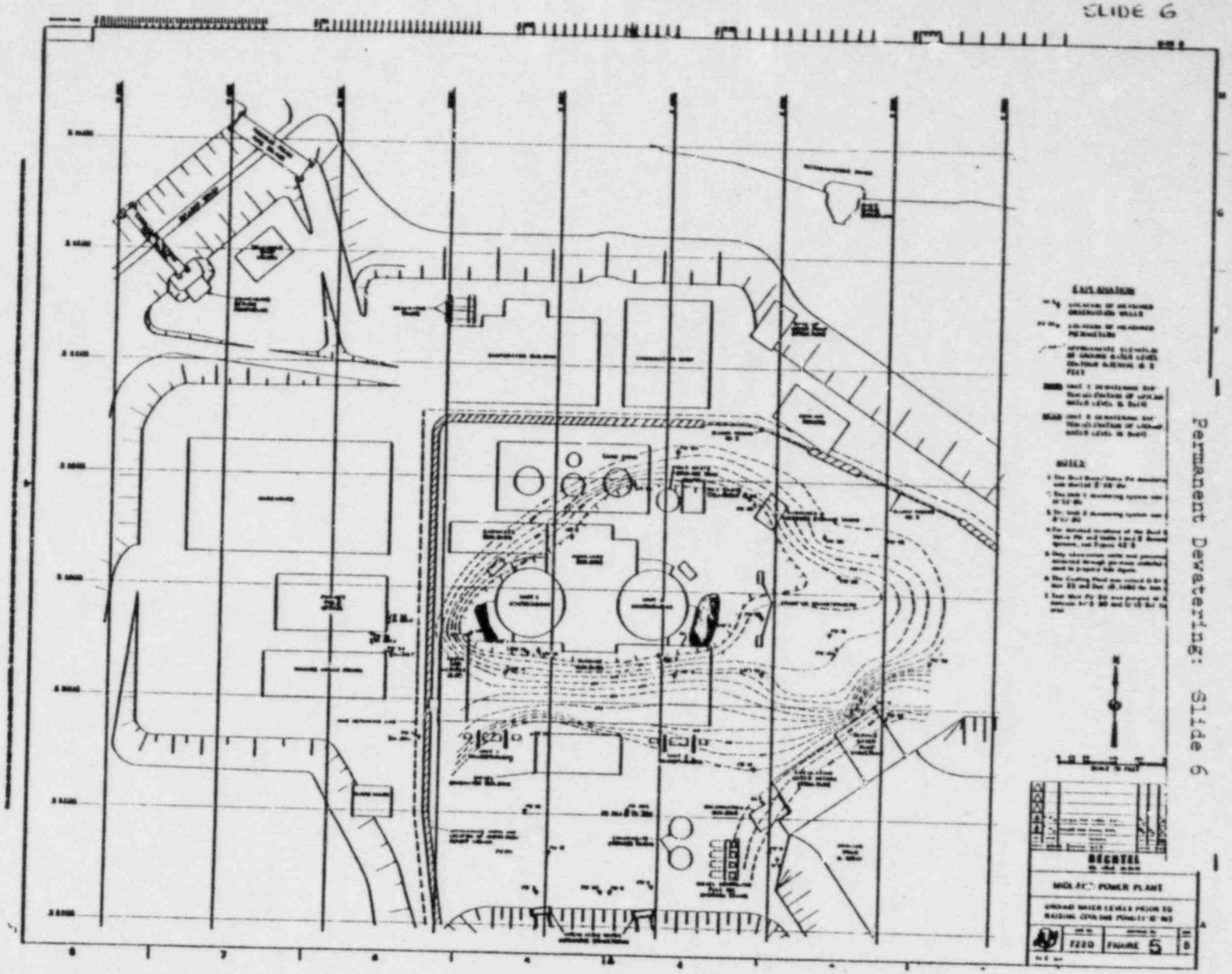
BECHTEL

MIDLAND POWER PLANT

FLOWRATE VS TIME
CONSTRUCTION DEWATERING SYSTEM
1980 (SHEET 1)

7220 | FIGURE 4

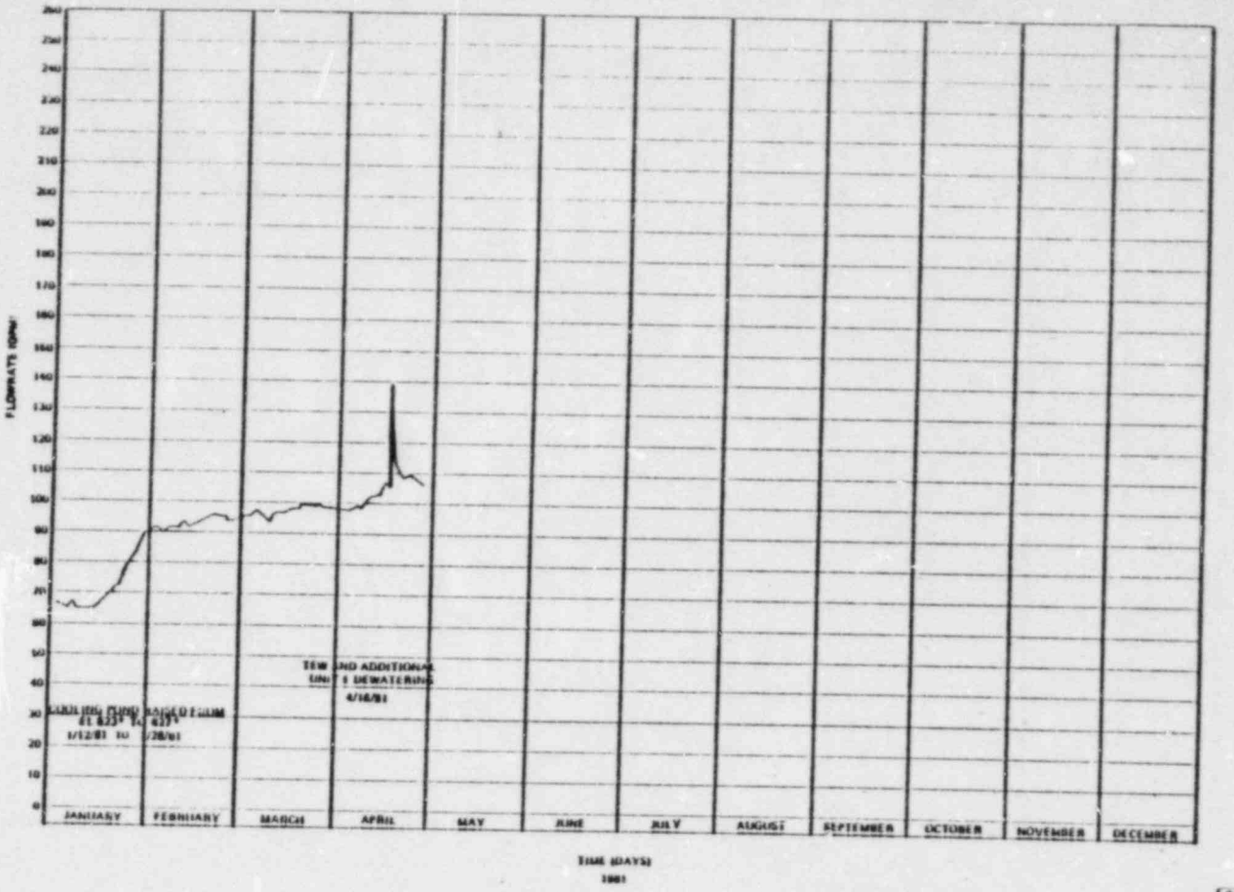
SLIDE 6



Permanent Dewatering: Slide 6

SLIDE 7

Permanent Dewatering: Slide 7



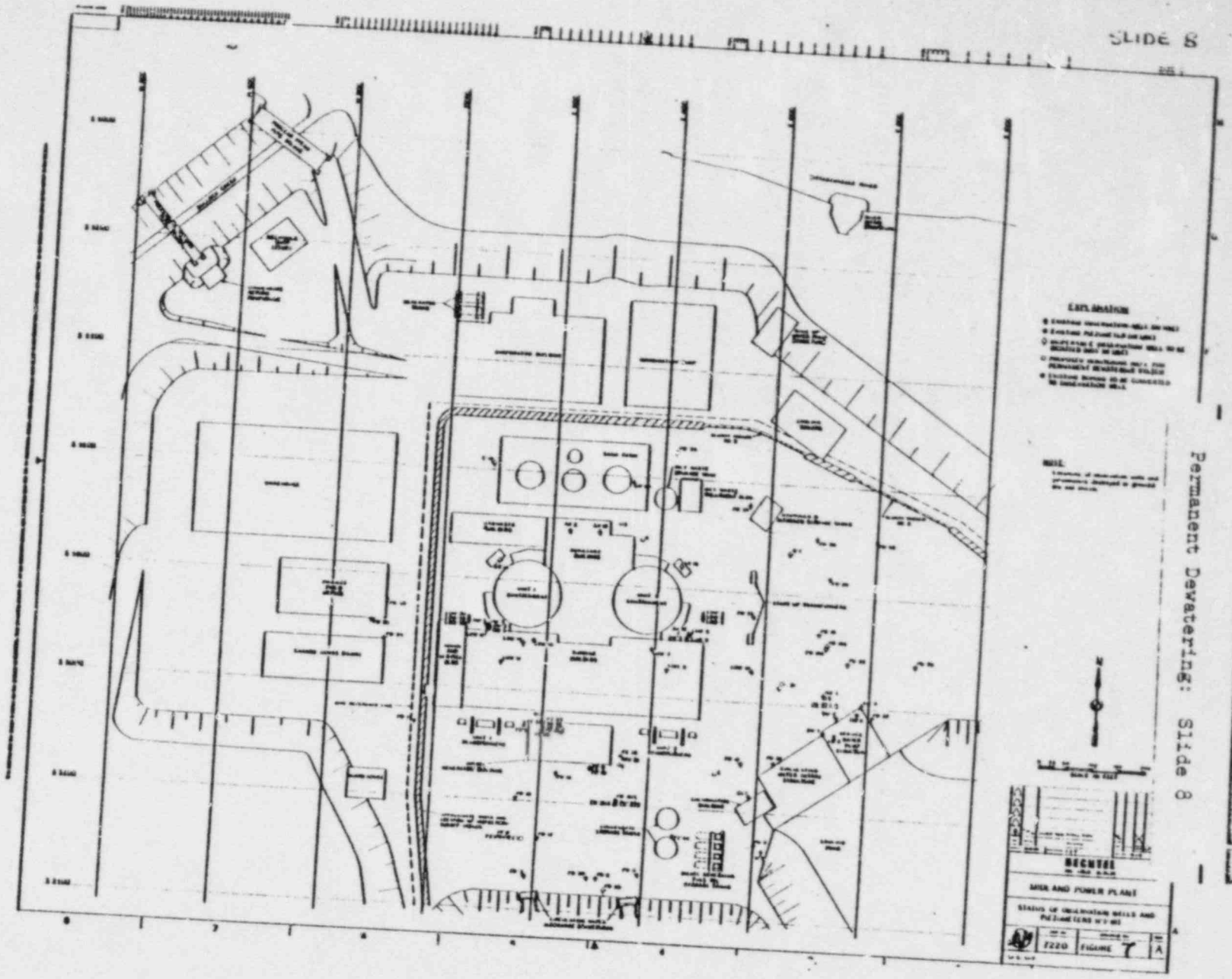
BECHTEL

MIDLAND POWER PLANT

FLOWRATE VS TIME
CONSTRUCTION DEWATERING SYSTEM
1981 (SHEET 2)

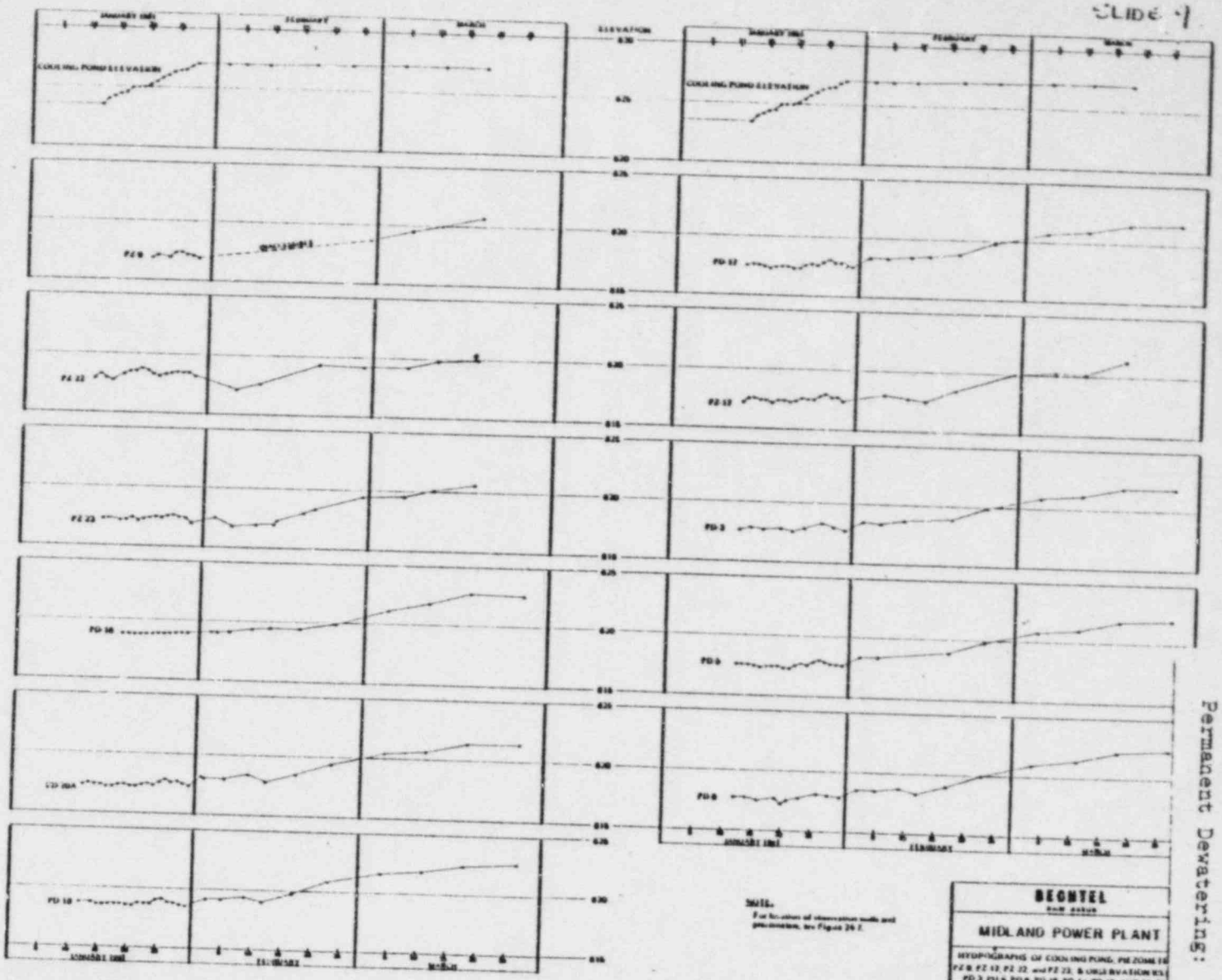
7220 FIGURE 6

SLIDE 8



Permanent Dewatering: Slide 8

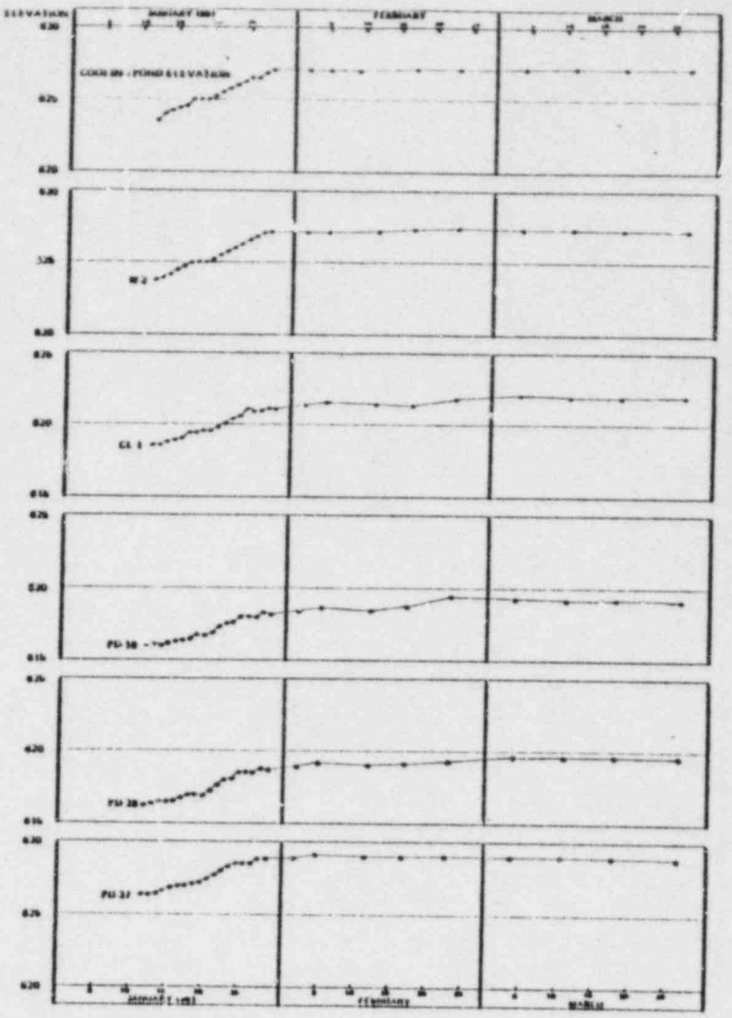
SLIDE 7



Permanent Dewatering: Slide 9

SLIDE 10

Permanent Dewatering: Slide 10



NOTE: For location of observation wells, see Figure

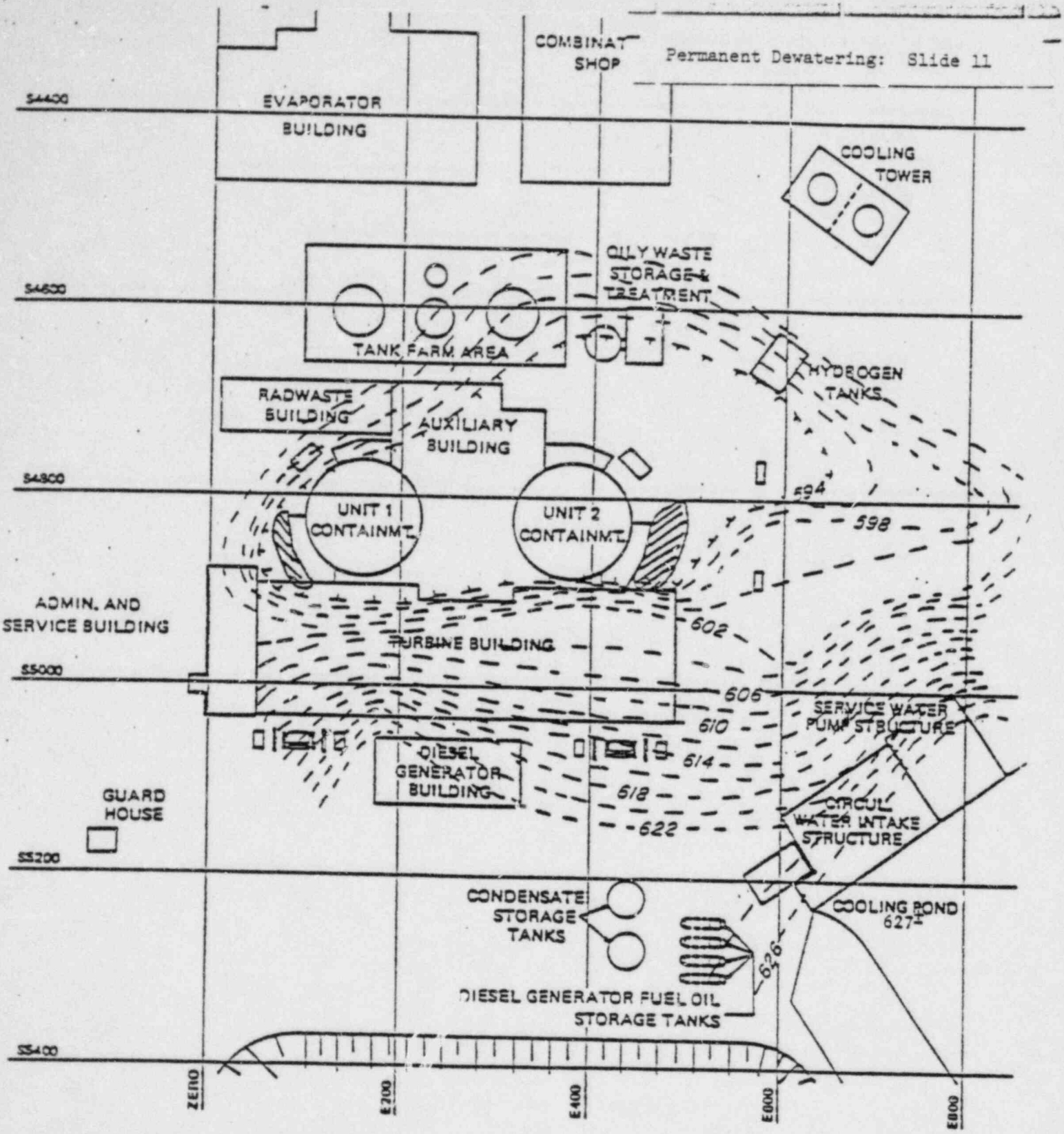
BECHTEL

MIDLAND POWER PLANT

HYDROGRAPHS OF COOLING POND AND OBSERVATION WELLS W-2, CL-1, PD-36, PD-36, AND PD-37

7220 | FIGURE 9 | A

Permanent Dewatering: Slide 11



NOTE: Contour interval is 2 feet.

0 50 100 150 200
SCALE IN FEET

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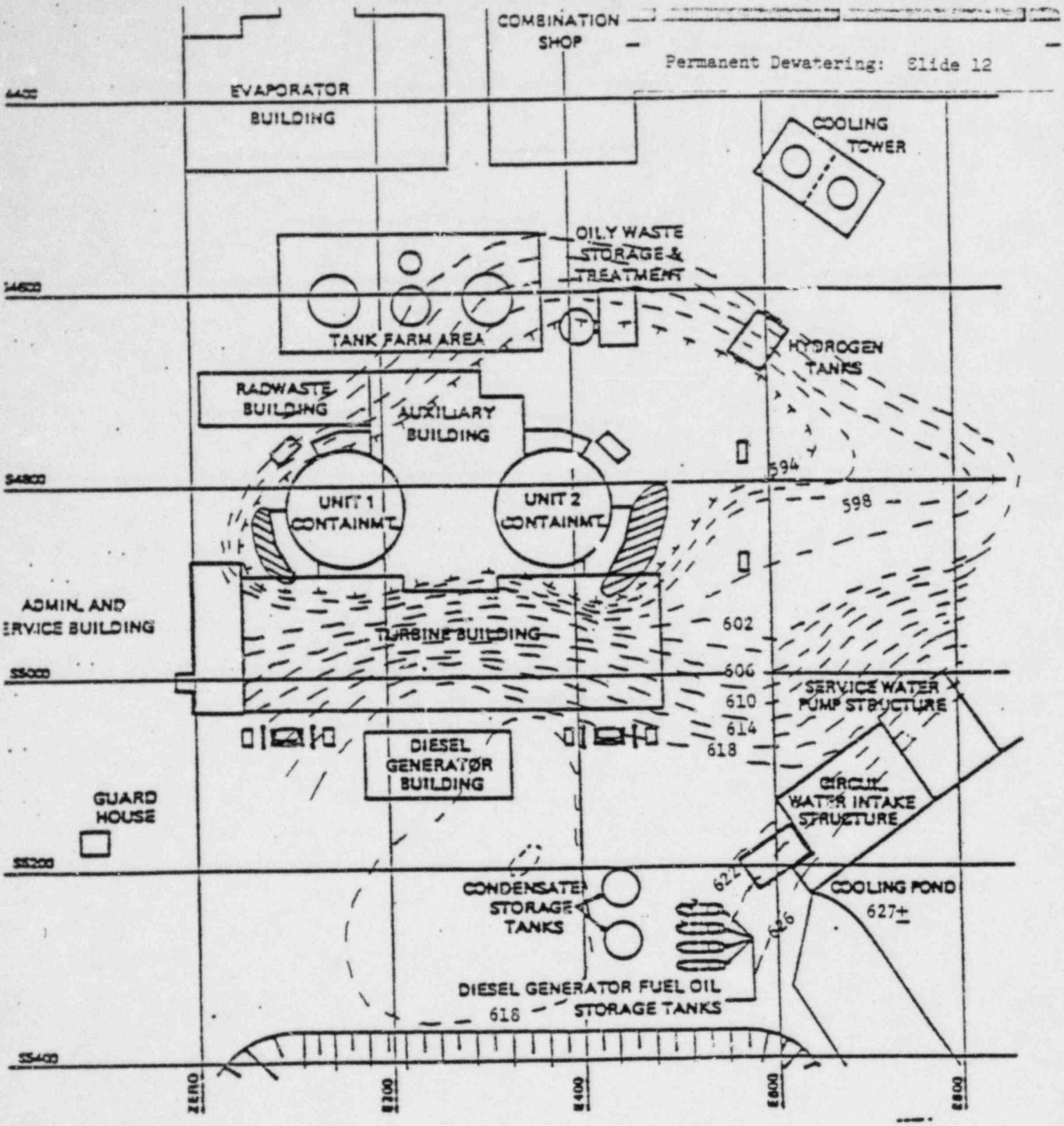
ANN ARBOR

MIDLAND POWER PLANT

GROUNDWATER LEVELS 4/17/81

JOB NO. 7220 DRAWING NO. FIGURE 10



NOTE: Contour interval is 2 feet.

0 50 100 150 200
SCALE IN FEET

BECHTEL
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MIDLAND POWER PLANT

GROUNDWATER LEVELS 4/30/81

Figure 11

B. STAFF'S CONSIDERATION OF DEWATERING RESPONSE ADEQUACY (2/24/81)

REQUEST NO.	STATUS	FOLLOW-UP REQUESTS
24 (a)	INADEQUATE	47, 48, 49, 52
24 (b)	INADEQUATE	42, 47, 48, 49, 50, 51, 52, 53, INTERROGATORY 16
24 (c)	INADEQUATE	47, 49
24 (d)	ADEQUATE	---
24 (e)	ADEQUATE	---
24 (f)	ADEQUATE	---
24 (g)	INADEQUATE	36, 42, 47
24 (h)	ADEQUATE	---
24 (i)	ADEQUATE	---
42 (2a)	UNDER REVIEW	---
47	UNDER REVIEW	---
48	UNDER REVIEW	---
49	UNDER REVIEW	---
50	ADEQUATE	---
51	UNDER REVIEW	---
52	UNDER REVIEW	---
53	UNDER REVIEW	---

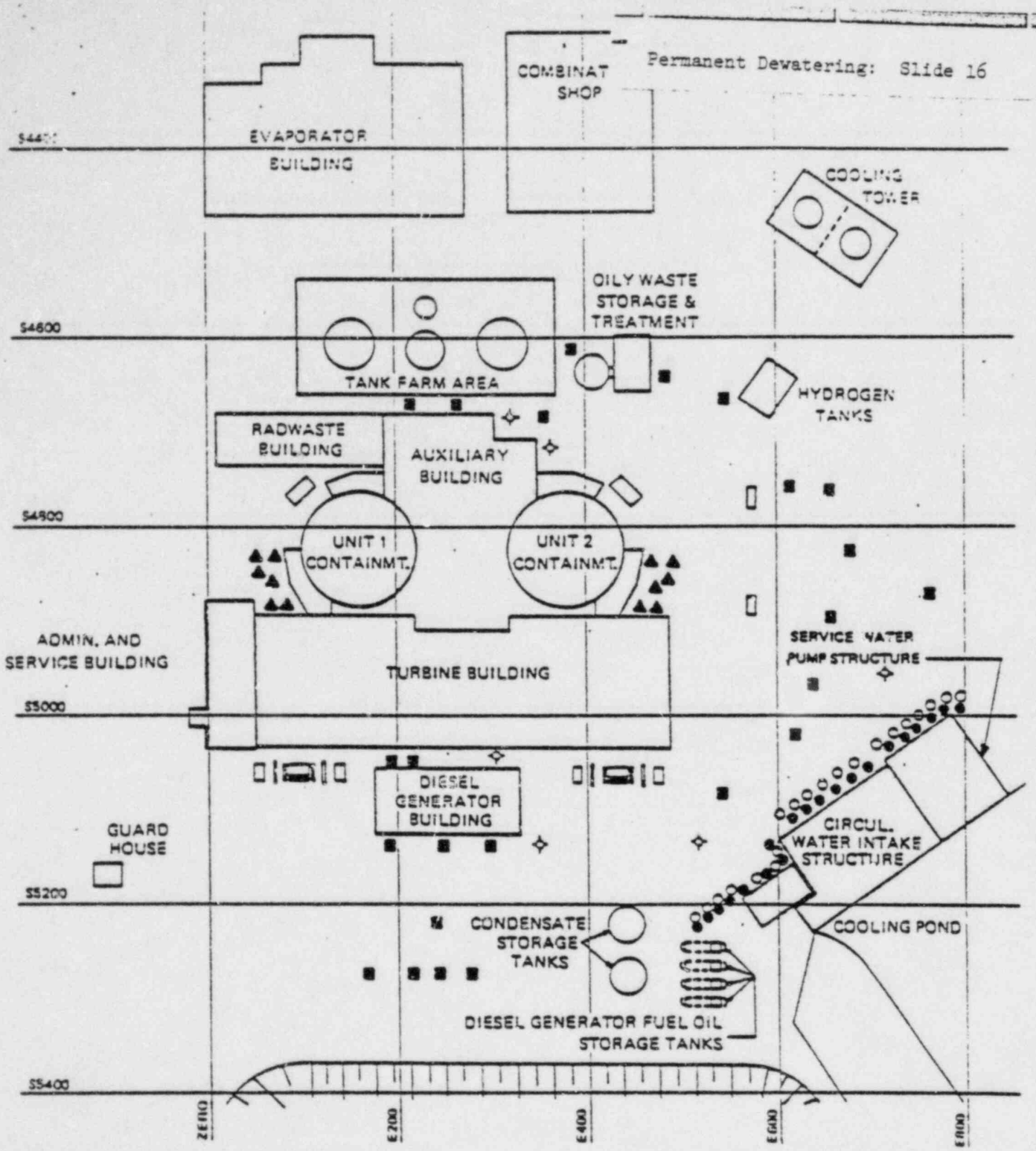
C. COE/STAFF'S CONSIDERATION OF DEWATERING RESPONSE ADEQUACY BASED ON NRC DEPOSITIONS (3/81)

Request No.	Status
36	CONCUR
42 (2a)	CONCUR
47 (1a)	CONCUR
47 (1b)	CONCUR
47 (1c)	CONCUR BASED ON RECHARGE TEST
47 (2)	AGREE THAT MAJORITY OF RECHARGE IS FROM SWP AREA
47 (3)	COMMENTS ON REDUCING PERMEABILITY FROM 31 FT/DAY TO 17 FT/DAY
50	CONCUR

D. COE/STAFF REQUESTS UNDER REVIEW (3/81)

Request No.	Description
47(4)	Construction Plans, Specifications, Monitoring
47(5)	Plugging Weep Holes
47(6)	Well Maintenance
47(7)	Monitoring Water Table in Control Tower
47(8)	Incrustation of Piping
47(9)	Perched Water Table Conditions
49(a)	Correct Equation
49(b)	Value of $\bar{h}$
49(c)	Value of X
49(c1)	Recalculate Recharge Analysis
49(c2)	Consider Failure of Non-Seismic Pipe
49(c3)	Demonstrate Time to Install Backup Wells
51	Number of Wells for Storage Justify 14% Specific Yield
52(1)	Describe Dow Pond
52(2)	Details of West Plant Dike
52(3)	As-Builts of West Plant Dike
52(4)	Tests re: Effect of Dow Pond
52(5)	Effects of Dow Pond
52(6)	Ground Water Levels in Warehouse Area
53	Recompute Inflow without Reduction for CWI and SWP Structures
Interrogatory 15	Values of Specific Yield and Effective Porosity
Interrogatory 16	Justification of Two Reference Planes

Permanent Dewatering: Slide 16



- INTERCEPTOR WELL
- BACKUP INTERCEPTOR WELL
- AREA WELL
- SINKING CONSTRUCTION DEWATERING WELL
- MONITORING WELL

0 50 100 150 200
SCALE IN FEET

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MIDLAND POWER PLANT

GENERAL LOCATION PLAN OF DEWATERING SYSTEM

JOB NO.	DRAWING NO.
7220	FIGURE 12

E. OUTSTANDING ITEMS REGARDING INSTALLATION OF 20 BACKUP WELLS

1. LABORATORY METHOD FOR SAND DETERMINATION

2. Q-LISTED INSTALLATION

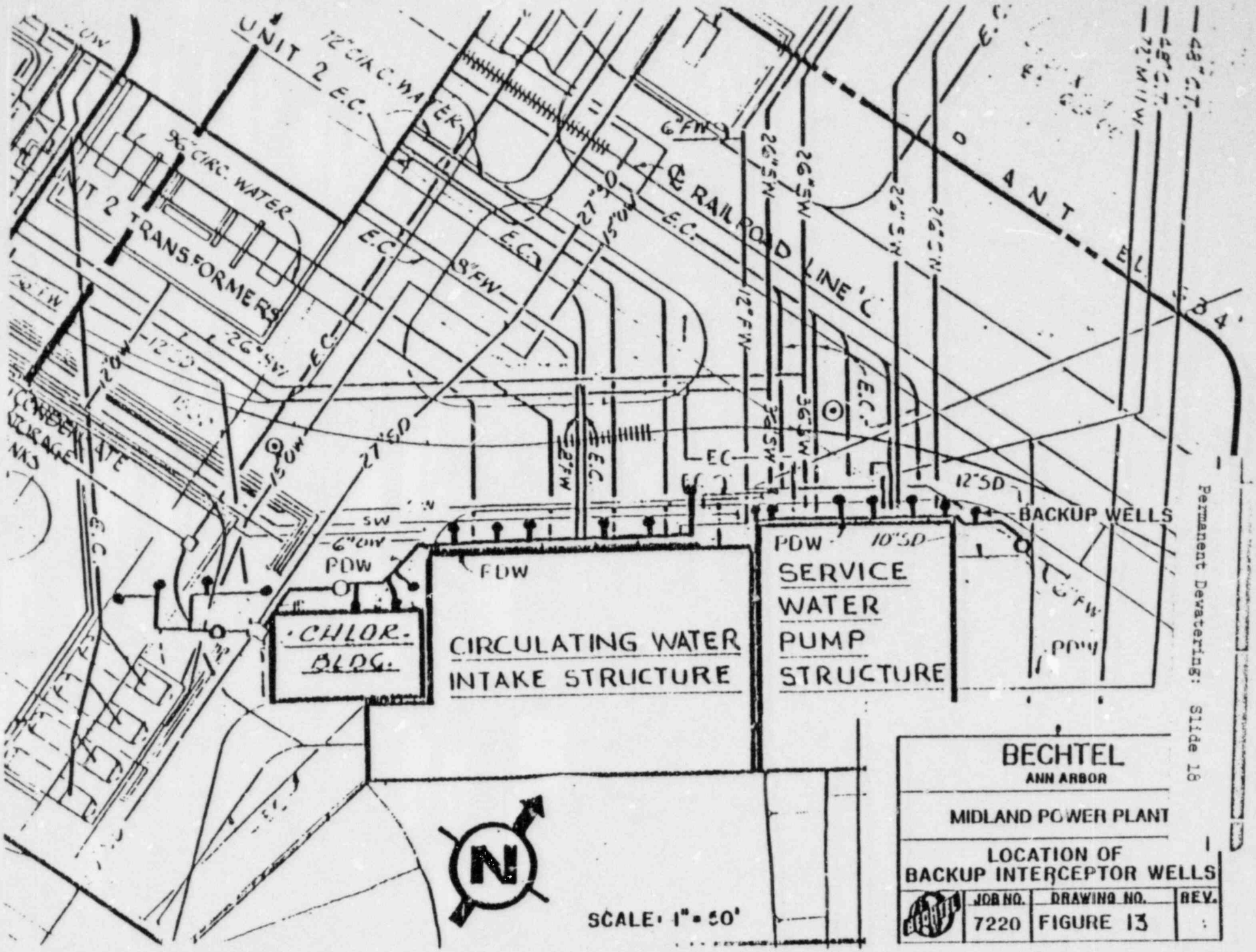
3. WATER CIRCULATION DURING FILTER PACK PLACEMENT

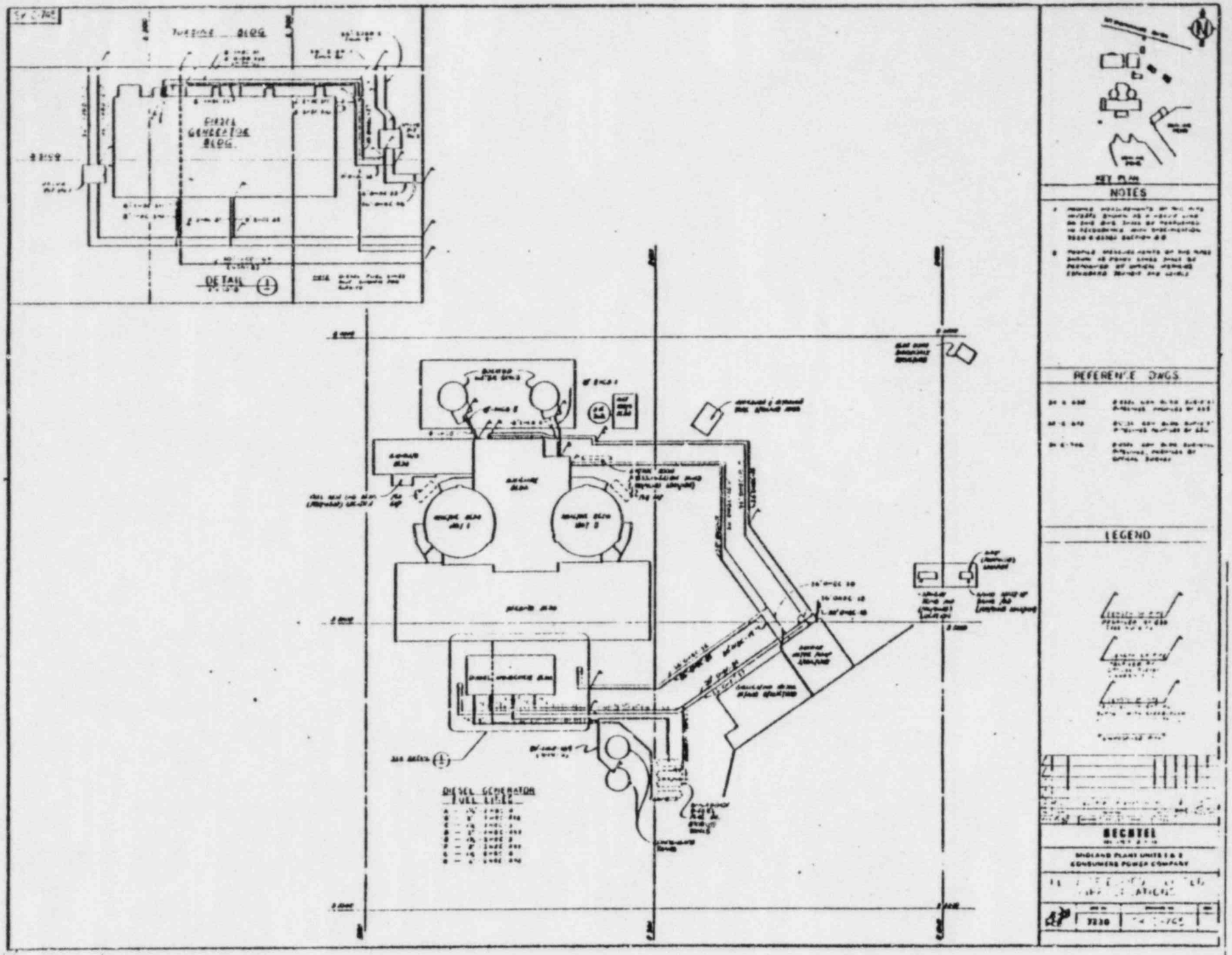
4. METHOD OF WELL DEVELOPMENT

5. ADEQUACY OF INFORMATION FOR FILTER PACK DESIGN

6. ESTIMATE OF AMOUNT OF MATERIAL REMOVED DURING WELL DEVELOPMENT

7. ADEQUACY OF WELL DEPTHS FOR CONSTRUCTION DEWATERING


UNIT 2 E.C.
12" CIRC. WATER
96" CIRC. WATER
UNIT 2 TRANSFORMERS
E.C.
8"FW
6"FW
27"SD
15"SD
RAILROAD LINE 'C'
26"SW
12"FW
36"SW
12"SD
BACKUP WELLS
PDW
10"SD
SERVICE WATER PUMP STRUCTURE
CHLOR. BLDG.
CIRCULATING WATER INTAKE STRUCTURE
SW
6"OW
SCALE: 1" = 50'
N
BECHTEL
ANN ARBOR
MIDLAND POWER PLANT
LOCATION OF BACKUP INTERCEPTOR WELLS
JOB NO. 7220
DRAWING NO. FIGURE 13
REV.
Permanent Dewatering: Slide 18



Underground Piping: Slide 1

10/82

UNDERGROUND PIPING

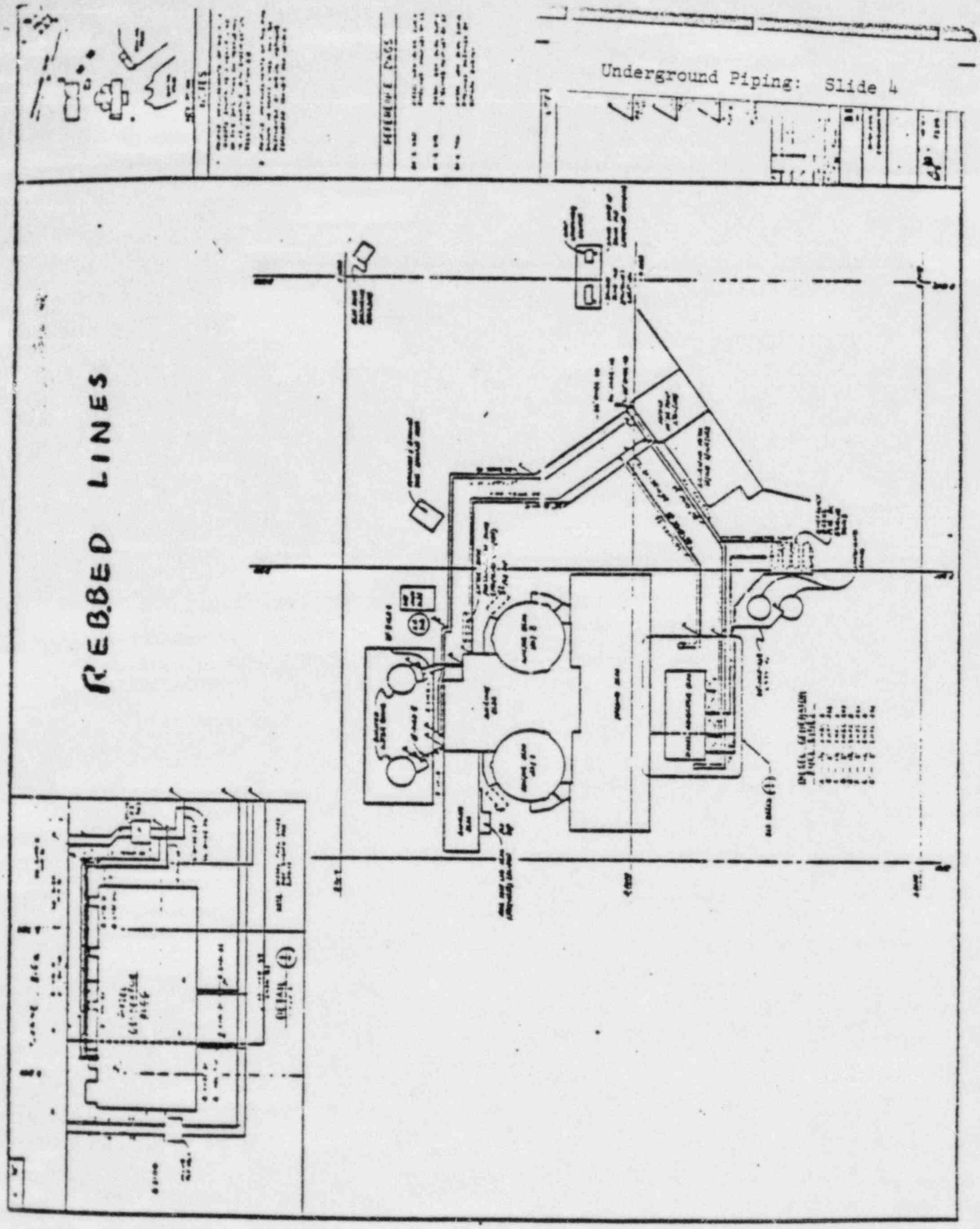
Line	Pipe Profile	Safety Related	Remarks
Service Water Lines			
26"/36"-OHBC-15	No	Yes	
26"/36"-OHBC-16	Yes	Yes	Parallel to 26"/36"-OHBC-16
26"/36"-OHBC-19	Yes	Yes	
26"/36"-OHBC-20	No	Yes	
26"-OHBC-53	No	Yes	Parallel to 26"/36"-OHBC-19
26"-OHBC-54	Yes	Yes	Parallel to 26"/OHBC-55
26"-OHBC-55	Yes	Yes	
26"-OHBC-56	No	Yes	
10"-OHBC-27	Yes	Yes	Parallel to 26"-OHBC-53
10"-OHBC-28	No	Yes	
8"-1HBC-81	Yes	Yes	Parallel to 10"-OHBC-27
8"-1HBC-82	No	Yes	
8"-2HBC-81	No	Yes	Parallel to 8"-1HBC-81
8"-2HBC-82	Yes	Yes	Parallel to 8"-2HBC-81
8"-1HBC-310	No	Yes	
8"-1HBC-311	Yes	Yes	Parallel to 8"1HBC-311
8"-2HBC-310	No	Yes	
8"-2HBC-311	No	Yes	Parallel to 8"-1HBC-81
26"-1JBD-1	No	No	Parallel to 8"-1HBC-81
26"-1JBD-2	Yes	No	Parallel to 26-1JBD-2
26"-2JBD-1	Yes	No	
26"-2JBD-2	No	No	
4-OJBD-739	Yes	No	Parallel to 26-2JBD-1
Borated Water Lines			
18"-1HBC-1	No	Yes	
18"-1HBC-2	Yes	Yes	Parallel to 18"-1HBC-2
18"-2HBC-1	Yes	Yes	
18"-2HBC-2	No	Yes	Parallel to 18"-2HBC-1
Emergency Diesel Fuel Lines			
1-1/2"-1HBC-3	No	Yes	
1-1/2"-1HBC-4	No	Yes	
1-1/2"-2HBC-3	No	Yes	
1-1/2"-2HBC-4	No	Yes	
2"-1HBC-497	No	Yes	
2"-1HBC-498	No	Yes	
2"-2HBC-497	No	Yes	
2"-2HBC-498	No	Yes	
Condensate Water Lines			
20"-1HCD-169	Yes	No	
20"-2HCD-169	No	No	Parallel to 20"-1HCD-169
6"-1HCD-513	No	No	
6"-2HCD-513	No	No	

Underground Piping: Slide 3

Line	Pipe Profile	Safety Related	Remarks
Carbon Dioxide Line			
4"-2GBF-341	No	No	
Oily Waste Lines			
3"-1JBD-537	No	No	
3"-1JBD-538	No	No	
3"-2JBD-537	No	No	
3"-2JBD-538	No	No	
8"-1JBD-437	No	No	
Circulating Water Lines			
12"-1YBJ-13	No	No	
96"-2YBJ-1.2,3,4	No	No	Bedded on Original Till
72"-1YBJ-3.4	No	No	Bedded on Original Till
12"-2YBJ-8	No	No	
Control Room Air Pressurization Line			
4"-CDBC-1	No	Yes	

WJCloutier
4/22/81

Underground Piping: Slide 4



SLIDE 5

SETTLEMENT STRESSES PROJECTED FROM CURRENT INFORMATION

Location Of Max Stress (Station)	Line	Seismic Category I	Location Shown In Figure	Profile Shown In Figure	Highest Stress(1) (ksi)	Code Allowable(2) (ksi)	Stresses Projected From Settlement Data Dated
	Service Water Lines						
0 + 90	26"/36"-OHBC-16	Yes	17-1	17-2	19.8	52.5	July 79
3 + 15	26"/36"-OHBC-19	Yes	17-1	17-2	74.8	52.5	July 79
0 + 51	26"-OHBC-54	Yes	17-1	17-2	57.9	52.5	July 79
4 + 28	26"-OHBC-55	Yes	17-1	17-2	103.9	52.5	July 79
0 + 05	10"-OHBC-27	Yes	19-1	19-1	296.6	45.0	September 79
-	8"-1HBC-81	Yes	19-1	19-1	*	45.0	*
0 + 15	8"-2HBC-82	Yes	19-1	19-1	14.3	45.0	September 79
0 + 25	8"-1HBC-311	Yes	19-1	19-1	23.8	45.0	September 79
0 + 30	26"-1JBD-2	No	19-1	19-1	13.1	47.1	September 79
0 + 08	26"-2JBD-1	No	19-1	19-1	95.8	47.1	September 79
0 + 43	26"-OHBC-54(Fr Vlv Pit)	Yes	19-1	19-1	23.1	52.5	September 79
0 + 12	26"-OHBC-55(Fr Vlv Pit)	Yes	19-1	19-1	18.5	52.5	September 79
	Condensate Water Line						
1 + 60	20"-1HCD-169	No	17-1	17-2	186.9	47.7	September 79

*8"-1HBC-81 Was Dug Up & Rebedded.

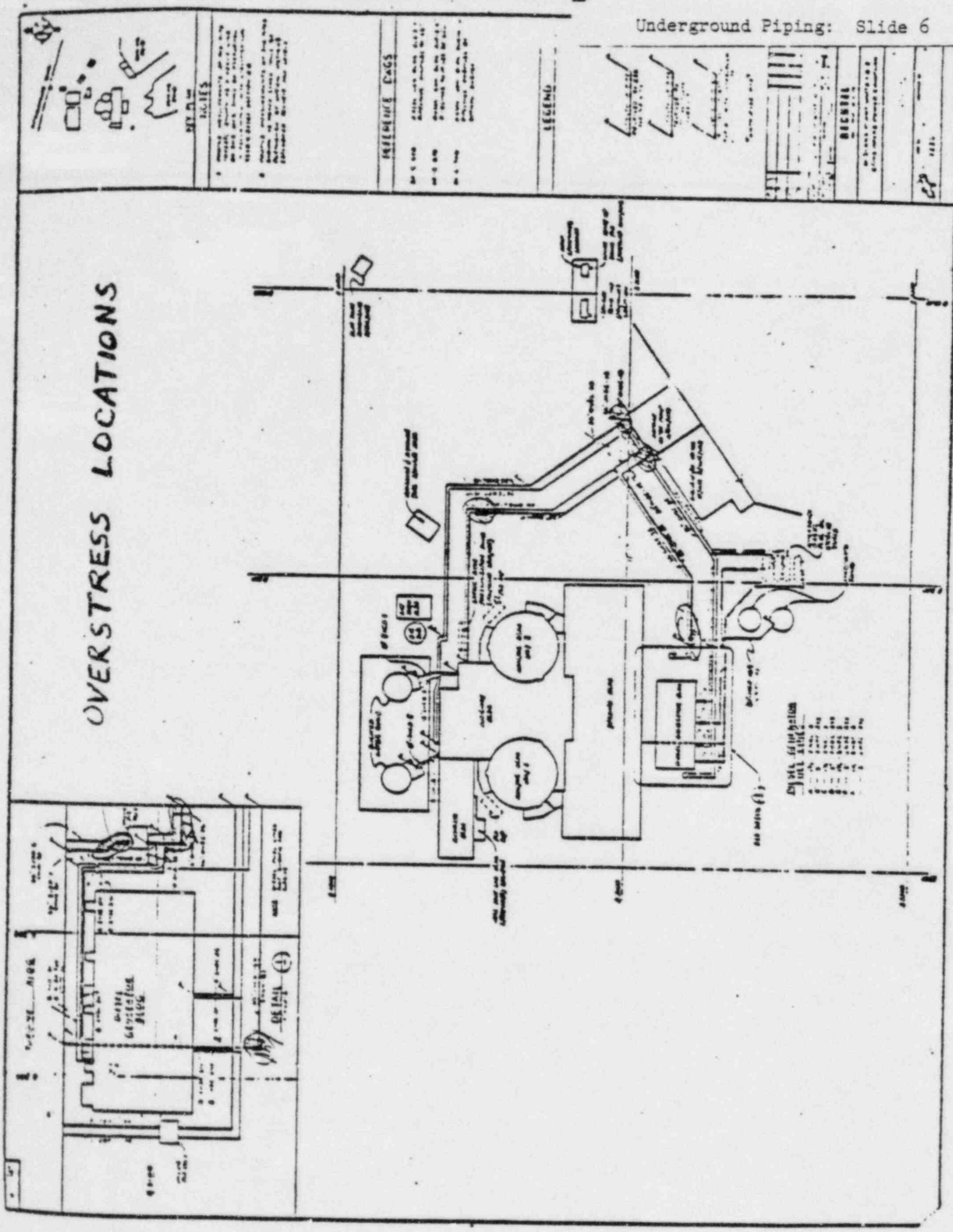
(1) Analytical values generated from settlement gage data. Rounding in excess of the accuracy of the gage was necessary in several zones.

(2) Equation 10a, ASME Section III, Division 1, Subsection NC.

WJCloutier
4/27/81

Underground Piping: Slide 5

Underground Piping: Slide 6



FAILURE MODES

1. EXCESSIVE PLASTIC DEFORMATION
2. FATIGUE
3. BRITTLE FRACTURE
4. CREEP
5. STRESS CORROSION CRACKING
6. ELASTIC INSTABILITY
7. PLASTIC INSTABILITY

DETERMINATION OF PLASTIC BENDING MOMENT FOR LONG CYLINDER

Simplified Formula

$$\sigma_b = \left(\frac{2}{3}\right)^{5/2} \bar{E} \frac{t}{r} - \left(\frac{4}{\pi} - 1\right) \left(1 - \frac{E_2}{E_1}\right) \sigma_1$$

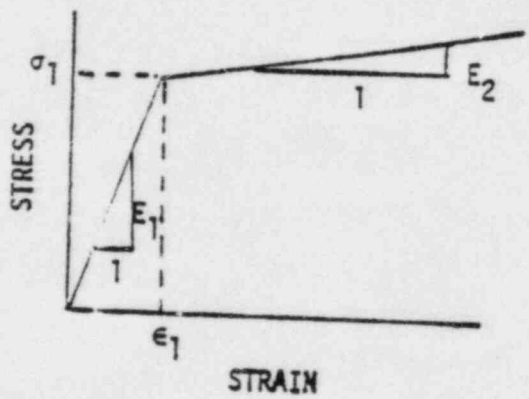
$$= 0.363 \bar{E} \left(\frac{t}{r}\right) - 0.273 \left(1 - \frac{E_2}{E_1}\right) \sigma_1$$

where

$$\bar{E} = E_s \left(\frac{1}{4} + \frac{3}{4} \frac{E_2}{E_s}\right)$$

$$M_b = \left(\frac{2}{3}\right)^{5/2} \pi \bar{E} rt^2$$

$$= 1.14 \bar{E} rt^2$$



BOSOR5

APPLICATION AND THEORY

BOSOR5 Program is applicable to any segmented or branched, ring stiffened shell of revolution. It is based on energy minimization with finite difference discretization in the meridional direction and trigonometric variation in the circumferential direction. In the prebuckling analysis, large deflection effects and elastic-plastic material behavior are simultaneously accounted for by means of a double iteration loop. In the inner loop the nonlinear equations, including terms due to moderately large deflections are solved by the Newton method. Material properties are held constant in this loop. In the outer loop the material properties are updated by means of a subincremental process. Plasticity calculations are based on the Von Mises yield criterion and associated flow rule with isotropic strain hardening. Incremental flow theory is always used for the prebuckling analysis.

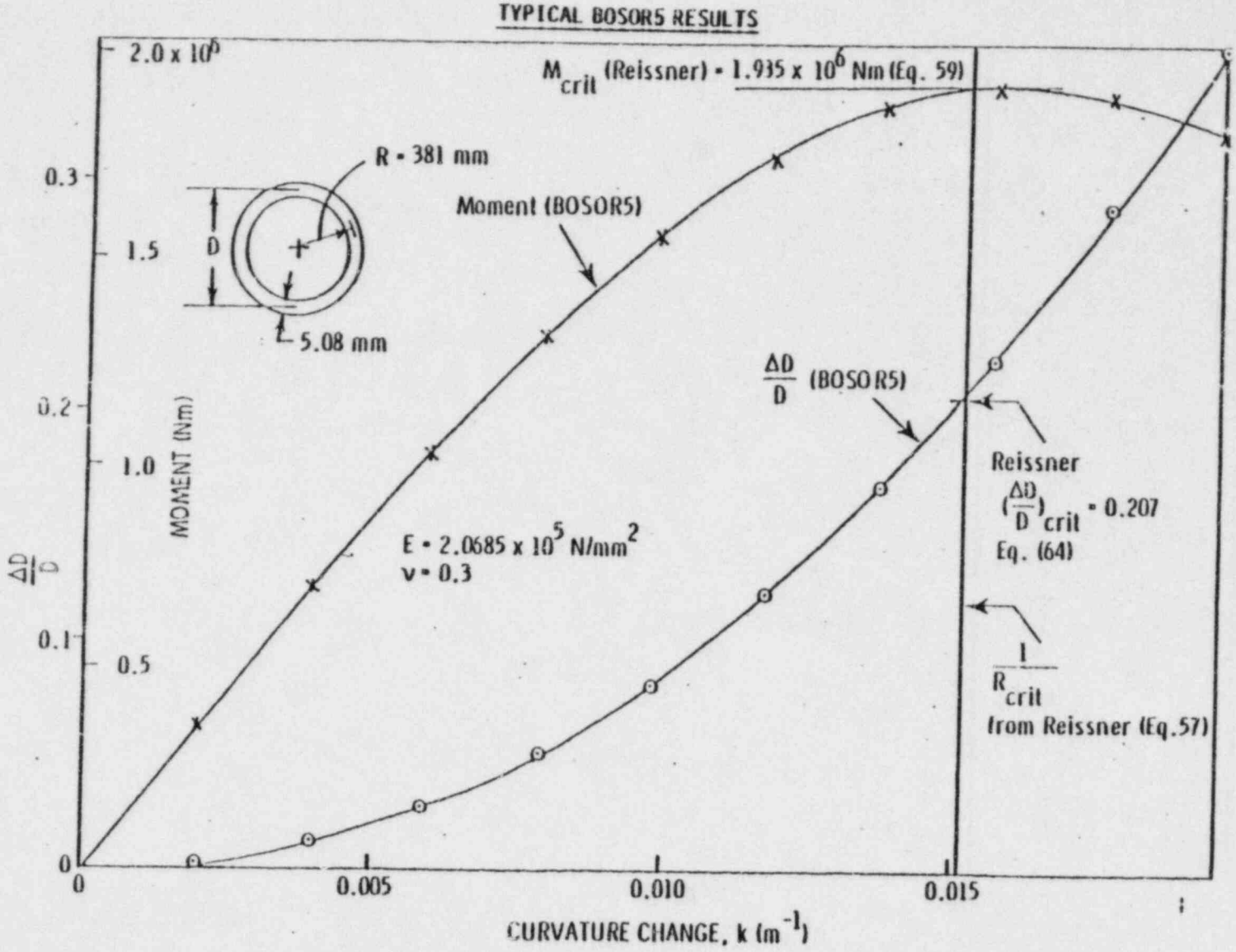
BOSOR5

PROGRAM FOR BUCKLING OF ELASTIC - PLASTIC COMPLEX SHELLS OF REVOLUTION INCLUDING LARGE DEFLECTIONS AND CREEP

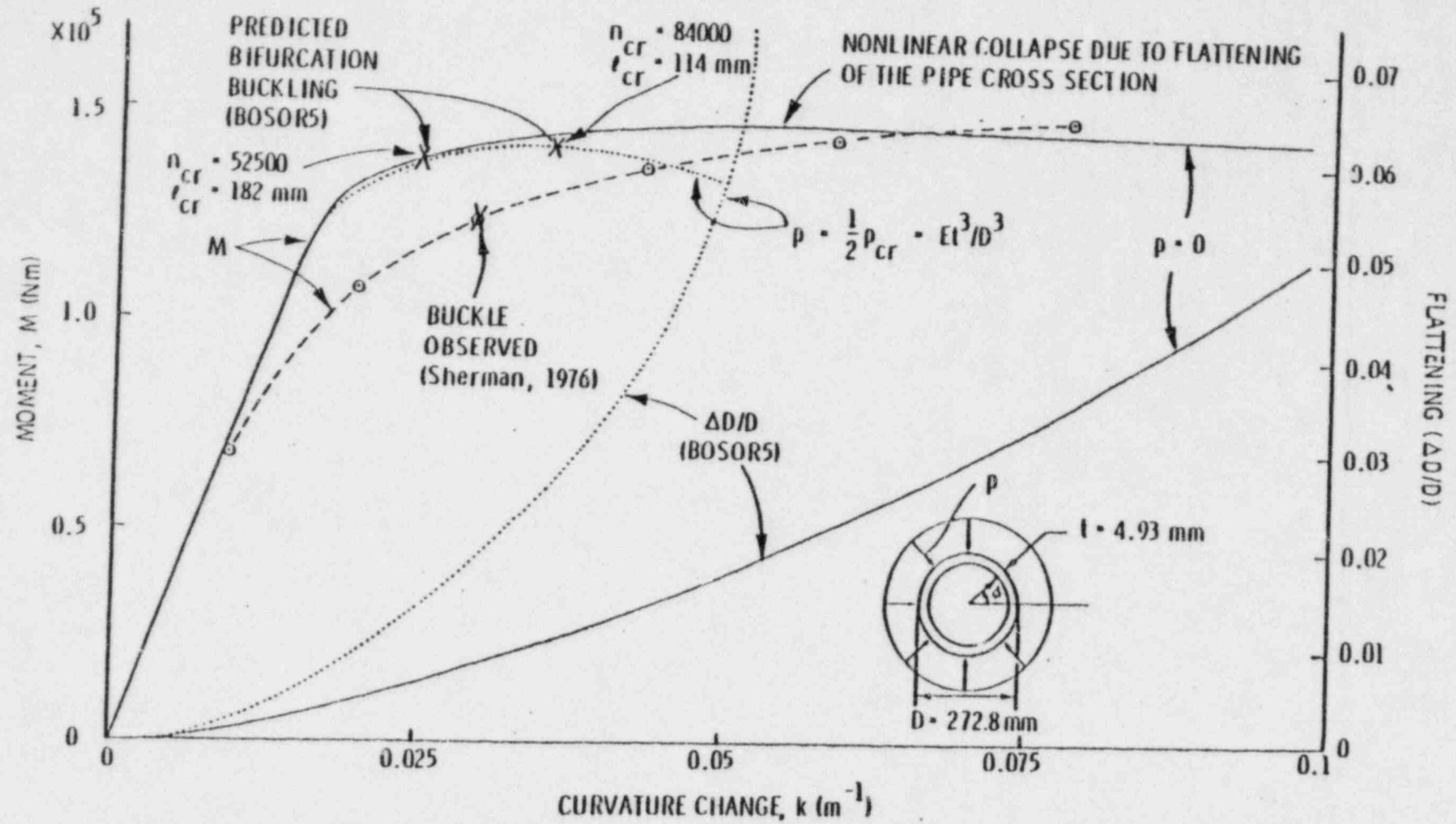
BOSOR5 can handle segmented and branched shells with discrete ring stiffeners, meridional discontinuities, and multi-material construction. The shell wall can be made up of as many as six layers, each of which is a different nonlinear material. In the prebuckling analysis large-deflection axisymmetric behavior is presumed. Bifurcation buckling loads are computed corresponding to axisymmetric or nonaxisymmetric buckling modes. The strategy for solving the nonlinear prebuckling problem is such that the user obtains reasonably accurate answers even if he uses very large load or time steps.

The prebuckling and plastic bifurcation (eigenvalue) analyses are based on a finite difference energy method. The strategy for solving problems simultaneously involving large deflections, elastic-plastic material behavior, and primary and secondary creep permits the use of rather large time and load steps without undue sacrifice in accuracy. This strategy is based on a subincremental iteration method in which the size of the subincrement is automatically determined such that the change in stress is less than a certain prescribed percentage of the effective stress. Evaluation of discrete ring stiffners, the material of which is elastic-plastic and can creep according to a primary or secondary creep law, is also feasible. Discrete rings of arbitrary cross-section are considered to be assemblages of thin rectangular elements. The BOSOR5 runs on the CDC 6600 and on the UNIVAC 1108 and 1110.

The BOSOR5 program has been verified adequately by means of closed form solutions and numerous experimental results. This program is extensively used in nuclear and aerospace industries.


TYPICAL BOSOR5 RESULTS
2.0 x 10^6
M_crit (Reissner) = 1.935 x 10^6 Nm (Eq. 59)
R = 381 mm
Moment (BOSOR5)
1.5
D
5.08 mm
ΔD/D (BOSOR5)
0.2
1.0
MOMENT (Nm)
Reissner
(ΔD/D)_crit = 0.207
Eq. (64)
E = 2.0685 x 10^5 N/mm^2
ν = 0.3
0.1
0.5
1/R_crit
from Reissner (Eq.57)
0
0
0.005
0.010
0.015
CURVATURE CHANGE, k (m^-1)

TYPICAL BOSOR5 RESULTS



BOSOR5 - INPUT DATA

1. SHELL SEGMENT AND MESH POINT DATA
2. REFERENCE SURFACE GEOMETRY
3. DISCRETE RING PROPERTIES
4. TEMPERATURE DISTRIBUTION
5. PRESSURE AND SURFACE TRACTION
6. DISCRETE RING LINE LOADS
7. MATERIAL PROPERTIES
8. CONSTRAINT CONDITIONS
9. BOUNDARY CONDITIONS
10. ANALYSIS OPTIONS
11. POST-PROCESSOR DATA

BOSOR5 - OUTPUT DATA

1. PREBUCKLING DISPLACEMENTS
2. PREBUCKLING STRESS RESULTANTS
3. EFFECTIVE STRESS AND STRAIN
4. MERIDIONAL STRESS
5. CIRCUMFERENTIAL STRESS
6. PLASTIC STRAIN
7. TANGENT MODULUS
8. EFFECTIVE UNIAXIAL STRAIN
9. STIFFNESS COEFFICIENTS
10. STABILITY DETERMINANT
11. PIPE BENDING MOMENT
12. BUCKLING MODES

BOSOR5 OUTPUT

***** RESULTS FOR TIME STEP NUMBER 1 *****

TIME = 5.00000000E-05

SEGMENT	PRESSURE MULTIPLIER	TEMPERATURE MULTIPLIER (MULTIPLY THESE AMPLITUDES BY DISTRIBUTIONS GIVEN FOR EACH SEGMENT)
1	1.00000000E+00	5.00000000E+00

PREBUCKLING DISPLACEMENTS AND STRESS RESULTANTS FOR SEGMENT NO. 1, TIME STEP NO. 1

POINT	STATION	WO	UO	BETA	UV	N1O	N2O	M1O	M2O
1	0.	-4.577E-04	0.	0.	0.	5.631E-02	1.535E+03	1.009E+00	3.028E-01
2	1.269E-01	-4.593E-04	1.027E-06	6.381E-06	-9.994E-06	5.690E-02	1.532E+03	1.011E+00	3.034E-01
3	4.661E-01	-4.541E-04	3.662E-06	2.337E-05	-3.642E-05	5.251E-02	1.523E+03	1.000E+00	3.001E-01
4	9.207E-01	-4.378E-04	6.532E-06	4.563E-05	-6.959E-05	3.977E-02	1.512E+03	9.649E-01	2.895E-01
5	1.381E+00	-4.110E-04	8.115E-06	6.711E-05	-9.855E-05	1.855E-02	1.477E+03	9.067E-01	2.720E-01
6	1.841E+00	-3.746E-04	7.759E-06	8.701E-05	-1.208E-04	-9.568E-03	1.442E+03	8.277E-01	2.483E-01
7	2.302E+00	-3.296E-04	4.926E-06	1.049E-04	-1.348E-04	-4.467E-02	1.386E+03	7.299E-01	2.190E-01
8	2.762E+00	-2.772E-04	-8.195E-07	1.203E-04	-1.393E-04	-8.542E-02	1.329E+03	6.161E-01	1.848E-01
9	3.222E+00	-2.189E-04	-9.616E-06	1.333E-04	-1.336E-04	-1.306E-01	1.253E+03	4.896E-01	1.469E-01
10	3.683E+00	-1.564E-04	-2.227E-05	1.427E-04	-1.176E-04	-1.790E-01	1.176E+03	3.537E-01	1.061E-01
11	4.143E+00	-9.145E-05	-3.825E-05	1.492E-04	-9.171E-05	-2.291E-01	1.081E+03	2.123E-01	6.367E-02
12	4.603E+00	-2.576E-05	-5.769E-05	1.524E-04	-5.682E-05	-2.796E-01	9.866E+02	6.937E-02	2.078E-02
13	5.064E+00	3.881E-05	-8.040E-05	1.524E-04	-1.432E-05	-3.289E-01	8.770E+02	-7.134E-02	-2.144E-02
14	5.524E+00	1.005E-04	-1.063E-04	1.492E-04	3.404E-05	-3.756E-01	7.675E+02	-2.059E-01	-6.182E-02
15	5.984E+00	1.577E-04	-1.341E-04	1.431E-04	8.624E-05	-4.185E-01	6.462E+02	-3.309E-01	-9.931E-02
16	6.445E+00	2.088E-04	-1.643E-04	1.342E-04	1.401E-04	-4.562E-01	5.250E+02	-4.429E-01	-1.329E-01
17	6.905E+00	2.526E-04	-1.951E-04	1.229E-04	1.935E-04	-4.879E-01	3.957E+02	-5.371E-01	-1.614E-01
18	7.365E+00	2.879E-04	-2.266E-04	1.096E-04	2.442E-04	-5.126E-01	2.665E+02	-6.171E-01	-1.852E-01
19	7.826E+00	3.140E-04	-2.577E-04	9.482E-05	2.903E-04	-5.297E-01	1.332E+02	-6.753E-01	-2.026E-01
20	8.286E+00	3.303E-04	-2.874E-04	7.890E-05	3.303E-04	-5.387E-01	-5.011E-02	-7.123E-01	-2.137E-01
21	8.746E+00	3.365E-04	-3.149E-04	6.237E-05	3.626E-04	-5.396E-01	-1.333E+02	-7.276E-01	-2.183E-01
22	9.207E+00	3.327E-04	-3.394E-04	4.575E-05	3.866E-04	-5.324E-01	-2.666E+02	-7.214E-01	-2.164E-01
23	9.667E+00	3.193E-04	-3.601E-04	2.950E-05	4.017E-04	-5.174E-01	-3.998E+02	-6.946E-01	-2.084E-01
24	1.013E+01	2.973E-04	-3.761E-04	1.409E-05	4.077E-04	-4.951E-01	-5.331E+02	-6.483E-01	-1.945E-01
25	1.059E+01	2.667E-04	-3.868E-04	-5.805E-08	4.052E-04	-4.665E-01	-6.663E+02	-5.847E-01	-1.754E-01
26	1.105E+01	2.295E-04	-3.917E-04	-1.258E-05	3.946E-04	-4.325E-01	-7.676E+02	-5.062E-01	-1.519E-01
27	1.151E+01	1.867E-04	-3.934E-04	-2.316E-05	3.769E-04	-3.941E-01	-8.771E+02	-4.158E-01	-1.247E-01
28	1.197E+01	1.400E-04	-3.826E-04	-3.156E-05	3.532E-04	-3.527E-01	-9.867E+02	-3.166E-01	-9.498E-02
29	1.243E+01	9.090E-05	-3.661E-04	-3.763E-05	3.246E-04	-3.096E-01	-1.081E+03	-2.122E-01	-6.367E-02
30	1.289E+01	4.110E-05	-3.472E-04	-4.126E-05	2.924E-04	-2.661E-01	-1.176E+03	-1.062E-01	-3.186E-02
31	1.335E+01	-7.702E-06	-3.198E-04	-4.253E-05	2.576E-04	-2.236E-01	-1.253E+03	-2.260E-03	-6.707E-04
32	1.381E+01	-5.387E-05	-2.865E-04	-4.145E-05	2.212E-04	-1.839E-01	-1.329E+03	9.621E-02	2.867E-02
33	1.427E+01	-9.587E-05	-2.478E-04	-3.821E-05	1.841E-04	-1.477E-01	-1.386E+03	1.858E-01	5.575E-02
34	1.473E+01	-1.323E-04	-2.043E-04	-3.306E-05	1.467E-04	-1.164E-01	-1.442E+03	2.636E-01	7.908E-02
35	1.519E+01	-1.620E-04	-1.568E-04	-2.628E-05	1.096E-04	-9.101E-02	-1.477E+03	3.269E-01	9.807E-02
36	1.565E+01	-1.839E-04	-1.063E-04	-1.824E-05	7.273E-05	-7.224E-02	-1.512E+03	3.737E-01	1.121E-01
37	1.611E+01	-1.972E-04	-5.432E-05	-9.454E-06	3.671E-05	-6.079E-02	-1.523E+03	4.023E-01	1.207E-01
38	1.645E+01	-2.015E-04	-1.483E-05	-2.594E-06	9.992E-06	-5.680E-02	-1.532E+03	4.112E-01	1.234E-01
39	1.657E+01	-2.018E-04	0.	1.963E-17	0.	-5.681E-02	-1.535E+03	4.097E-01	1.229E-01

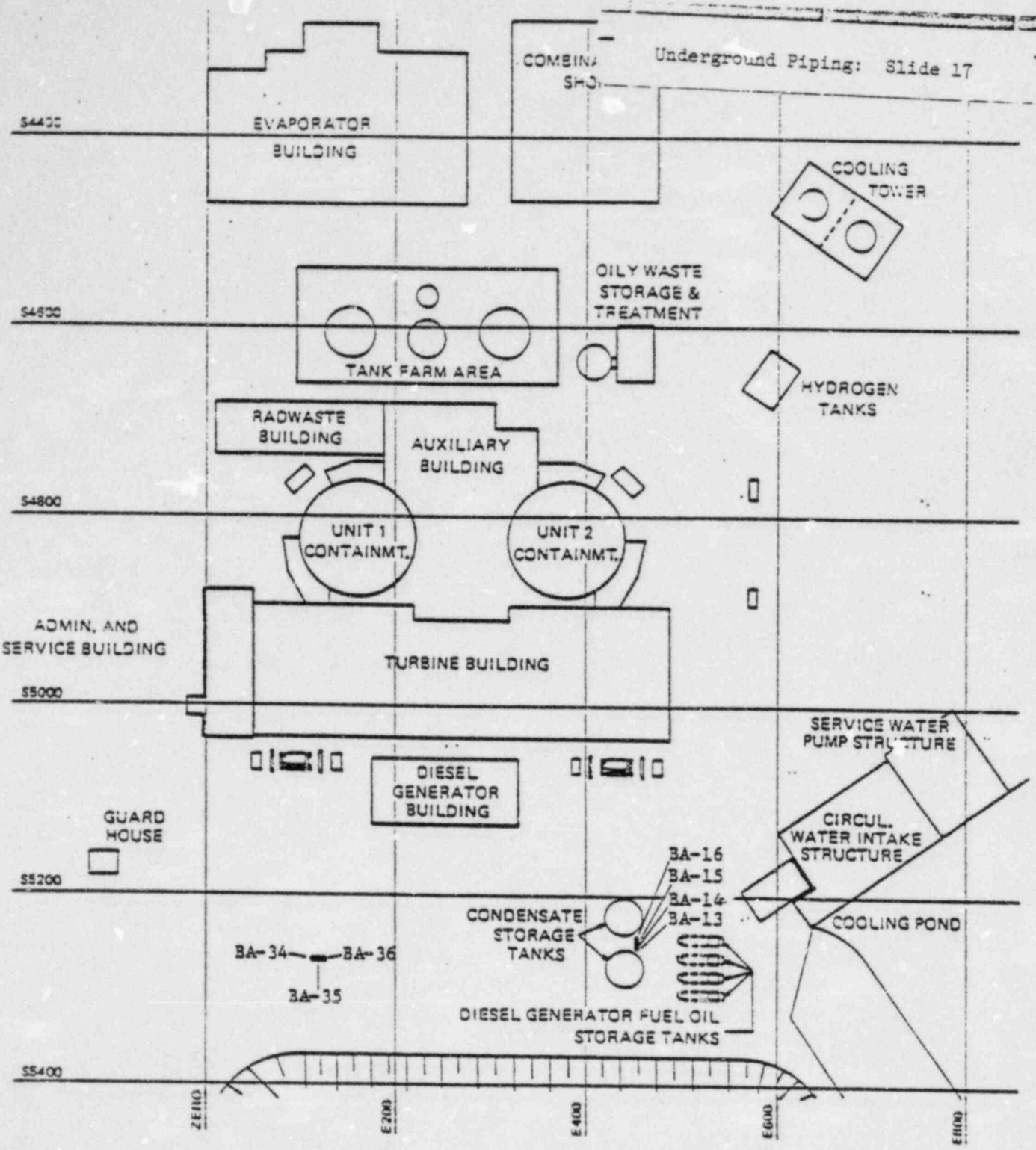
***** PIPE BENDING TOTAL MOMENT, AXIAL LOAD....
MOMENT = 1.3390E+05

Underground Piping: Slide 15

BOSOR5 OUTPUT

SEG.	PT.	LAYER	Z (FROM INNER)	EFFECT. STRESS (KSI)	MERID. STRESS (KSI)	CIRC. STRESS (KSI)	PLASTIC STRAIN MERID. (P E R C E N T)	PLASTIC STRAIN CIRC. (P E R C E N T)	CREEP STRAIN MERID. (P E R C E N T)	CREEP STRAIN CIRC. (P E R C E N T)	EFFECT. PLASTIC STRAIN	TEMP. (DEG)	YIELD STRESS (KSI)	TANGENT MODULUS X10-6	TOTAL-THERMAL STRAIN COMPONENTS MERID.	TOTAL-THERMAL STRAIN COMPONENTS CIRC.	EFFECT. UNIAXIAL STRAIN
1	1	1	-.097	7.88	.16	7.96	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.007	.026	.026
1	1	1	-.048	7.90	.08	7.94	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	1	1	.000	7.91	.00	7.91	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	1	1	.049	7.93	-.08	7.89	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	1	1	.097	7.94	-.16	7.86	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	2	1	-.097	7.86	.16	7.94	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.007	.026	.026
1	2	1	-.048	7.88	.08	7.92	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	2	1	.000	7.89	.00	7.90	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	2	1	.049	7.91	-.08	7.87	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	2	1	.097	7.93	-.16	7.85	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	3	1	-.097	7.82	.16	7.90	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.007	.026	.026
1	3	1	-.048	7.84	.08	7.87	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	3	1	.000	7.85	.00	7.85	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	3	1	.049	7.87	-.08	7.83	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	3	1	.097	7.89	-.16	7.80	0.000	0.000	0.000	0.000	0.000	-5.0	61.10	30.0000	-.008	.026	.026
1	4	1	-.097	7.76	.15	7.84	0.000	0.000	0.000	0.000	0.000	-4.9	61.10	30.0000	-.007	.026	.026
1	4	1	-.048	7.78	.08	7.81	0.000	0.000	0.000	0.000	0.000	-4.9	61.10	30.0000	-.008	.026	.026
1	4	1	.000	7.79	.00	7.79	0.000	0.000	0.000	0.000	0.000	-4.9	61.10	30.0000	-.008	.026	.026
1	4	1	.049	7.81	-.08	7.77	0.000	0.000	0.000	0.000	0.000	-4.9	61.10	30.0000	-.008	.026	.026
1	4	1	.097	7.82	-.15	7.75	0.000	0.000	0.000	0.000	0.000	-4.9	61.10	30.0000	-.008	.026	.026
1	5	1	-.097	7.59	.14	7.68	0.000	0.000	0.000	0.000	0.000	-4.8	61.10	30.0000	-.007	.025	.025
1	5	1	-.048	7.60	.07	7.68	0.000	0.000	0.000	0.000	0.000	-4.8	61.10	30.0000	-.007	.025	.025
1	5	1	.000	7.61	.00	7.61	0.000	0.000	0.000	0.000	0.000	-4.8	61.10	30.0000	-.008	.025	.025
1	5	1	.049	7.63	-.07	7.59	0.000	0.000	0.000	0.000	0.000	-4.8	61.10	30.0000	-.008	.025	.025
1	5	1	.097	7.64	-.14	7.57	0.000	0.000	0.000	0.000	0.000	-4.8	61.10	30.0000	-.008	.025	.025
1	6	1	-.097	7.41	.13	7.47	0.000	0.000	0.000	0.000	0.000	-4.7	61.10	30.0000	-.007	.025	.025
1	6	1	-.048	7.42	.07	7.49	0.000	0.000	0.000	0.000	0.000	-4.7	61.10	30.0000	-.007	.025	.025
1	6	1	.000	7.43	-.00	7.43	0.000	0.000	0.000	0.000	0.000	-4.7	61.10	30.0000	-.007	.025	.025
1	6	1	.049	7.45	-.07	7.41	0.000	0.000	0.000	0.000	0.000	-4.7	61.10	30.0000	-.008	.025	.025
1	6	1	.097	7.46	-.13	7.40	0.000	0.000	0.000	0.000	0.000	-4.7	61.10	30.0000	-.008	.025	.025
1	7	1	-.097	7.12	.12	7.18	0.000	0.000	0.000	0.000	0.000	-4.5	61.10	30.0000	-.007	.024	.024
1	7	1	-.048	7.13	.06	7.18	0.000	0.000	0.000	0.000	0.000	-4.5	61.10	30.0000	-.007	.024	.024
1	7	1	.000	7.14	-.00	7.14	0.000	0.000	0.000	0.000	0.000	-4.5	61.10	30.0000	-.007	.024	.024
1	7	1	.049	7.16	-.06	7.13	0.000	0.000	0.000	0.000	0.000	-4.5	61.10	30.0000	-.007	.024	.024
1	7	1	.097	7.17	-.12	7.11	0.000	0.000	0.000	0.000	0.000	-4.5	61.10	30.0000	-.007	.024	.024

Underground Piping: Slide 17



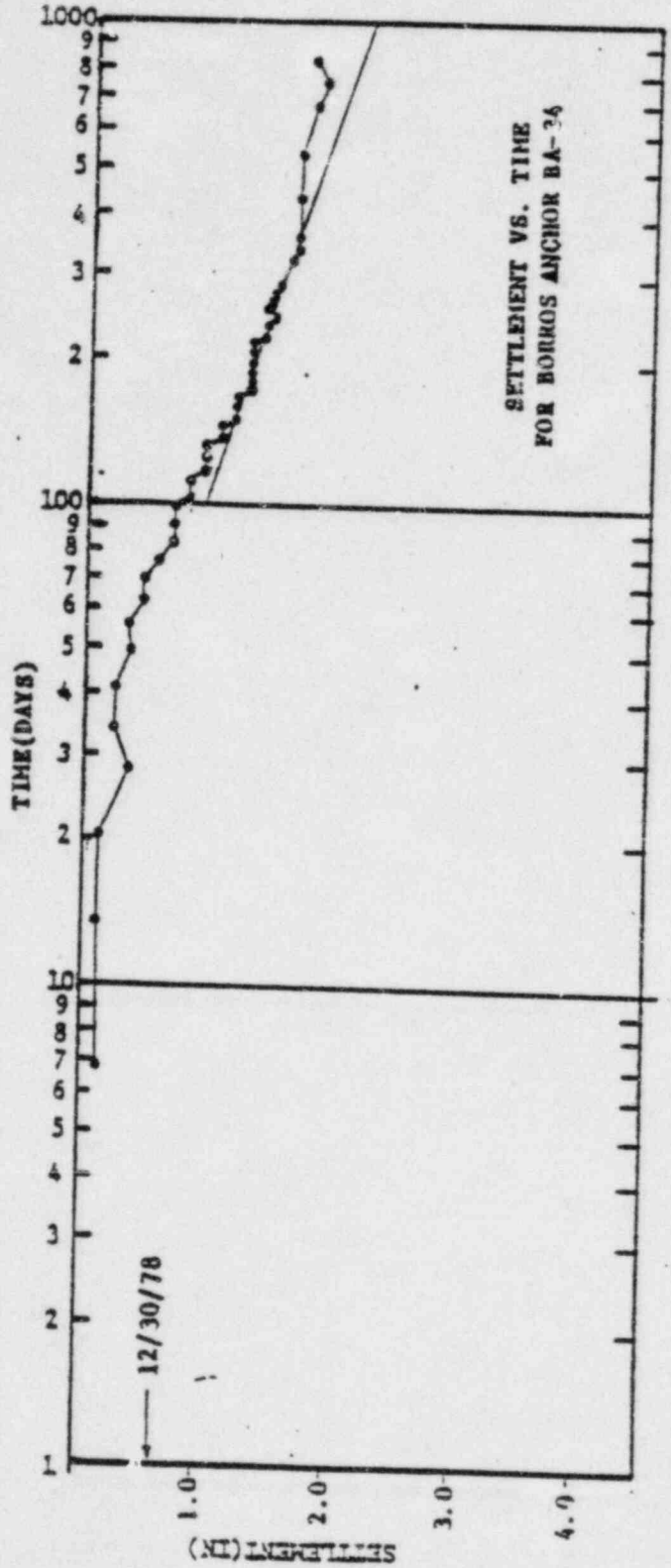
0 50 100 150 200
SCALE IN FEET

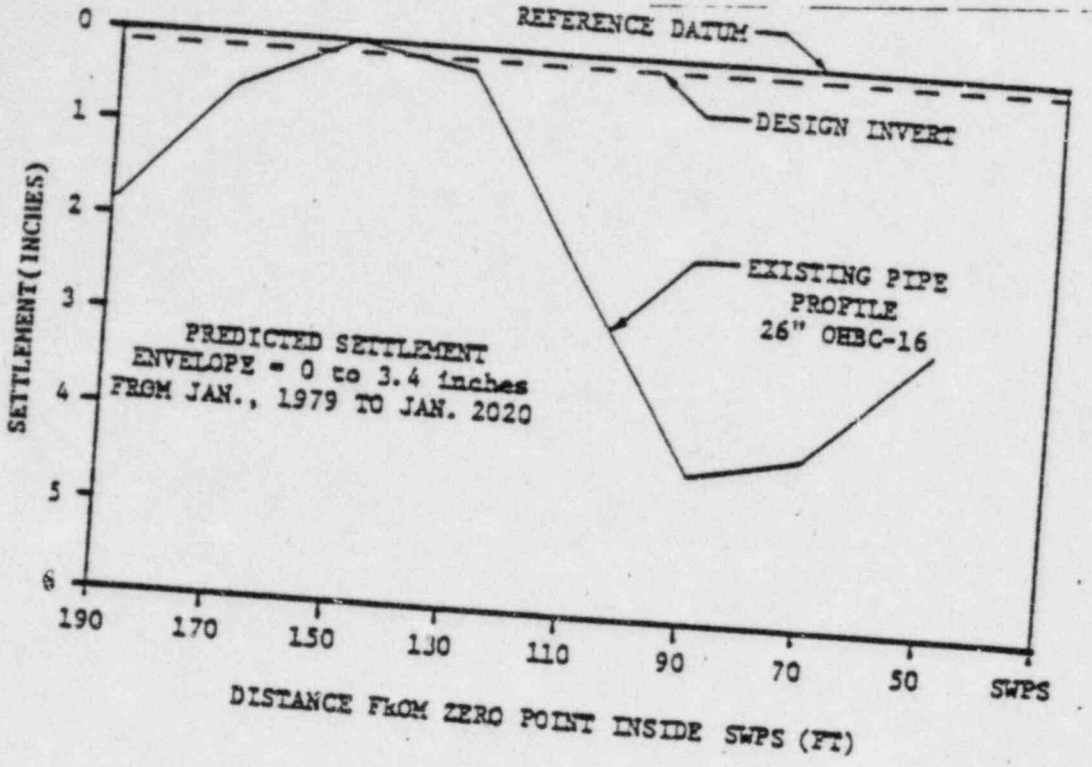
BECHTEL
ANN ARBOR

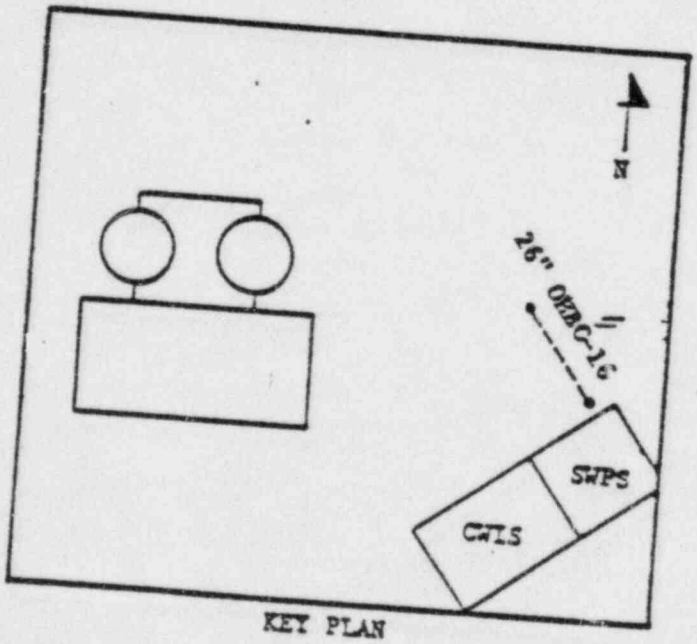
MIDLAND POWER PLANT

LOCATION OF BORROS ANCHORS USED FOR PIPELINE SETTLEMENT EVALUATION

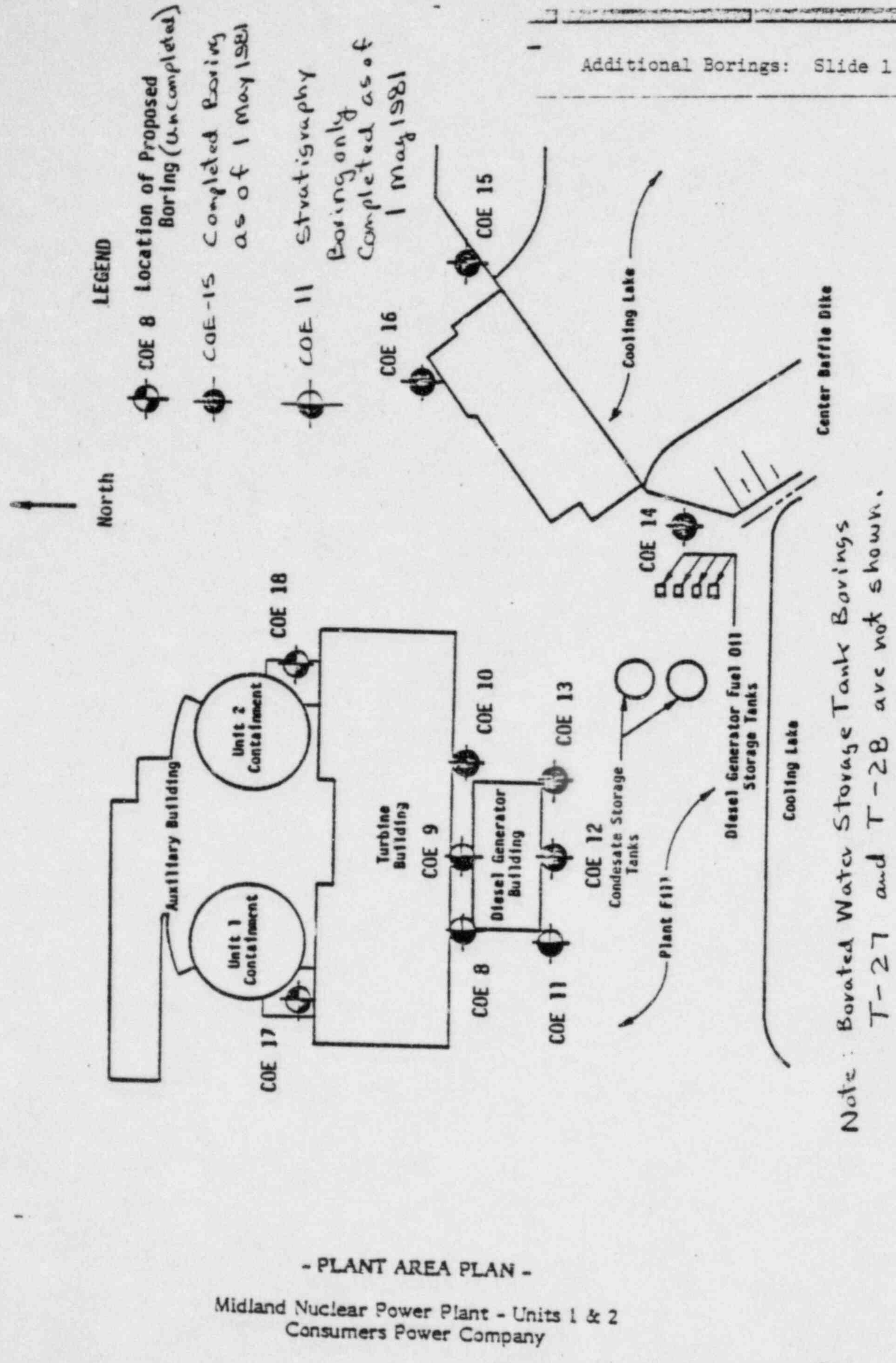
JOB NO.	DRAWING NO.
7220	FIGURE


SETTLEMENT VS. TIME
FOR BORROS ANCHOR BA-34
TIME(DAYS)
1000
100
10
1
12/30/78
1.0
2.0
3.0
4.0
SETTLEMENT (IN)





PIPING SETTLEMENT



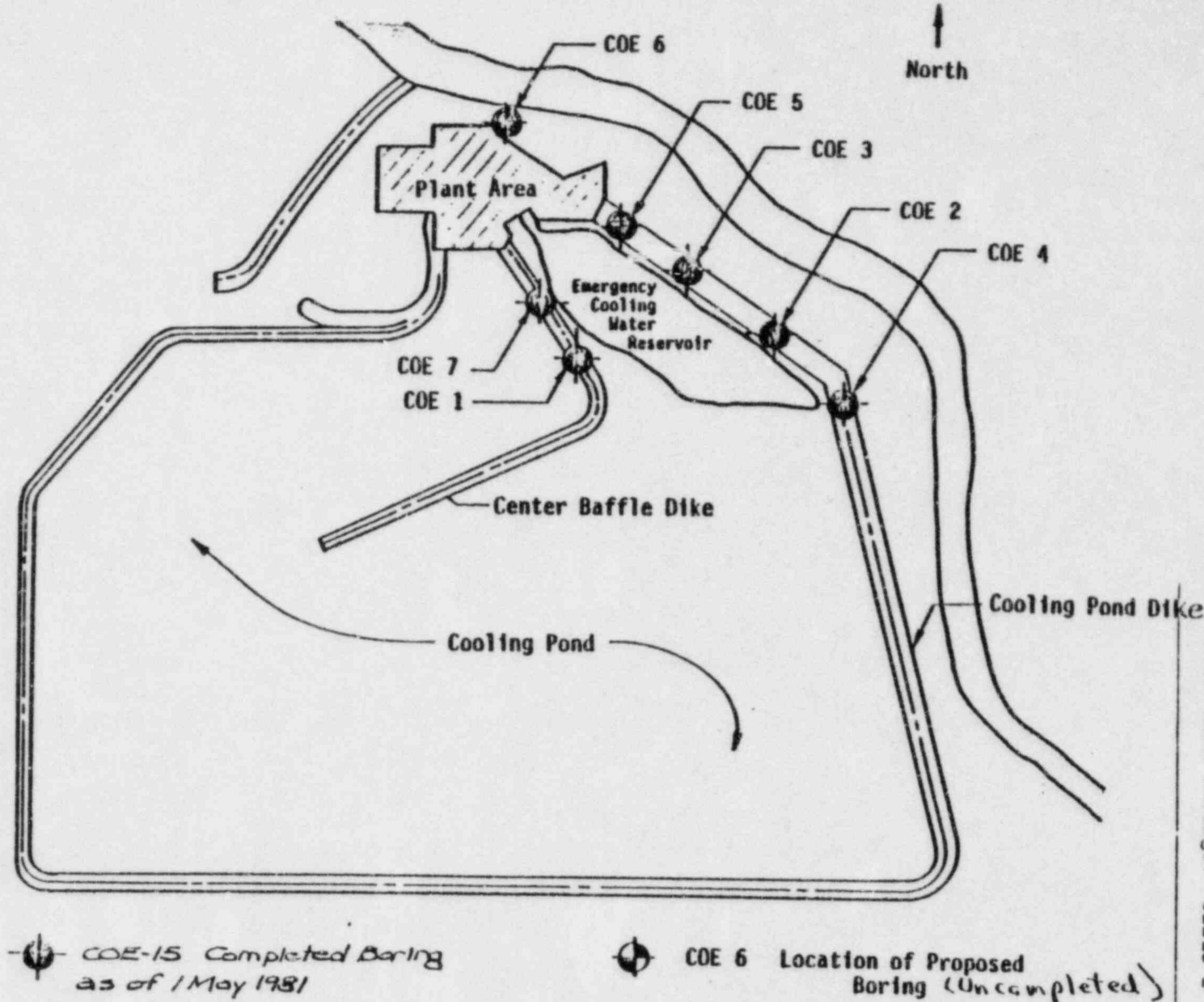
- PLANT AREA PLAN -

Midland Nuclear Power Plant - Units 1 & 2
Consumers Power Company

Woodward-Clyde Consultants

Figure 2

Additional Borings: Slide 2



\- GENERAL SITE PLAN -

Midland Nuclear Power Plant - Units 1 & 2
Consumers Power Company

Woodward-Clyde Consultants

Figure 1

SOIL BORINGS AND TESTING PROGRAM

DIKE AREA

ITEM	DETAILS
Number of Borings	7 (COE 1, 2, 3, 4, 5, 6, and 7)
Type of Sampling	Continuous undisturbed sampling
Depth of Boring	Minimum 5 ft into foundation till (el ≃ 578') Depth from top of dike: ≃ 50 ft
Type of Laboratory Testing - Fill and Till	•Liquid limit •Plastic limit •Moisture content •Density •Gradation •CIU triaxial test with pore pressure measurements •UU triaxial test
Interpretation of Test Results - Fill and Till	•Undrained shear strength (Su) •Effective stress parameters (C', Ø') •If soil paremeters are equal to or better than the design values used in FSAR, no reanalysis is required for static and seismic conditions.

SOIL BORINGS AND TESTING PROGRAM

DIESEL GENERATOR BUILDING AREA

ITEM	DETAILS
Number of Borings	12 (COE 8, 8A, 9, 9A, 10, 10A, 11, 11A, 12, 12A, 13, and 13A)
Type of Sampling	•Continuous undisturbed sampling in 6 borings (COE 8, 9, 10, 11, 12, and 13) •Undisturbed sampling in 6 borings (COE 8A, 9A, 10A, 11A, 12A, and 13A) for consolidation tests •Standard Pentrometer Test (SPT) for 5 ft into the natural soil
Depth of Boring	5 ft into the natural soil (el ≃600') Depth from ground surface: ≃40 ft
Type of Laboratory Testing - Fill	•Liquid limit •Plastic limit •Density •Moisture content •Gradation •CIU and CAU triaxial test with pore pressure measurements •Consolidation test with unload and reload cycles
Interpretation of Test Results - Fill	•Preconsolidation pressure, Pc' •Undrained shear strength (Su) •Effective stress parameters (C', Ø') •Preconsolidation pressure, Pc', will be compared with the pressures calculated from the surcharge program.

SOIL BORING AND TESTING PROGRAM

SERVICE WATER STRUCTURE AREA

ITEM	DETAILS
Number of Borings	1 (COE 16)
Type of Sampling	Continuous undisturbed sampling
Depth of Boring	•20 ft below the bottom of the wall footing (el≅560') •Depth from ground surface: ≅75 ft
Type of Laboratory Testing - Fill	•Liquid limit •Plastic limit •Density •Moisture content •Gradation •CIU and UU triaxial tests
Type of Laboratory Testing - Till	Same as above, plus consolidation test and triaxial test
Interpretation of Test Results - Fill	•Undrained shear stength (Su) •Effective stress parameters (C', Ø')
Interpretation of Test Results - Till	•Undrained shear strength (Su) •Effective stress parameters (C', Ø') •Settlement and bearing capacity analysis

SOIL BORINGS AND TESTING PROGRAM

AUXILIARY BUILDING

ITEM	DETAILS
Number of Borings	2 (COE 17 and 18)
Type of Sampling	Continuous undisturbed sampling
Depth of Boring	Should extend to el ≃ 460' Depth Depth from ground surface: ≃ 170 ft
Type of Laboratory Testing - Fill	•Liquid limit •Plastic limit •Density •Moisture content •Gradation •CIU and UU triaxial tests
Type of Laboratory Testing - Till	Same as above, plus consolidation test and triaxial test
Interpretation of Test Results - Fill	•Undrained shear strength (Su) •Effective stress paramenters (C', Ø')
Interpretation of Test Results - Till	•Undrained shear strength (Su) •Effective stress parameters (C', Ø') •Settlement and bearing capacity analysis

SOIL BORINGS AND TESTING PROGRAM

RETAINING WALLS

ITEM	DETAILS
Number of Borings	2 (COE 14 and 15)
Type of Sampling	Continuous undisturbed sampling
Depth of Boring	5 ft into the natural soil (el ≃595') Depth from ground surface: ≃ 40 ft
Type of Laboratory Testing - Fill and Till	•Liquid limit •Plastic limit •Moisture content •Density •Gradation •CIU and UU triaxial test
Interpretation of Test Results	•Undrained shear strength (Su) •Effective stress parameters (C', Ø')

SOIL BORINGS AND TESTING PROGRAM

BORATED WATER STORAGE TANK

ITEM	DETAILS
Number of Borings	2 (T-27 and T-28)
Type of Sampling	Continuous undisturbed sampling
Depth of Boring	5 ft into the natural soil (el ≃595') Depth from ground surface ≃40 ft
Type of Laboratory Testing - Fill	•Liquid limit •Plastic limit •Moisture content •Density •Gradation •CIU and UU triaxial •Consolidation test
Interpretation of Test Results	•Undrained shear strength (Su) •Effective stress parameters (C', Ø')

ENCLOSURE 2

10/82

LIST OF ATTENDEES

MEETING MAY 8, 1981

NRC

J. P. Knight
E. Brown
A. Schwencer (for R. Tedesco)
E. Adensam
D. Hood

Consumers Power Company

J. Cook
D. Budzik
T. Thiruvengadam

Bechtel

T. Johnson
A. Boos